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Original Research Article

An observational study on the magnitude of vitamin D levels in first trimester of pregnancy and the outcomes

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ABSTRACT

Background: Vitamin D deficiency is a common public health concern during pregnancy and has been associated with impaired glucose metabolism, abnormal placentation, and adverse maternal and neonatal outcomes. This study assessed the magnitude of maternal vitamin D deficiency during early pregnancy and evaluate its association with maternal and neonatal outcomes.

Methods: A prospective observational study was conducted among 302 singleton pregnant women attending the department of obstetrics and gynecology, ESIMC and PGIMSR Rajajinagar, Bangalore, over 18 months. Serum 25-hydroxyvitamin D levels were measured between 12-18 weeks of gestation. Participants were followed until delivery. The maternal outcomes evaluated included gestational diabetes mellitus, hypertensive disorders during pregnancy, anaemia, hypothyroidism, mode of delivery, and preterm birth. Neonatal outcomes included birth weight, low birth weight, Apgar score, and NICU admission. Associations were analyzed using chi-square tests.

Results: Of the 302 participants, 63 (20.9%) were vitamin D deficient, 174 (57.6%) insufficient, and 65 (21.5%) sufficient, indicating that 78.5% had suboptimal vitamin D levels. GDM occurred in 63 (20.9%) women and showed a significant association with vitamin D deficiency (χ^2=14.34, p<0.001). Preeclampsia (3.3%) was also significantly higher among deficient mothers (χ^2=15.57, p<0.001). No significant association was observed with anaemia, hypothyroidism, low birth weight, preterm delivery, or mode of delivery. Among 286 live births, NICU admission occurred in 20.6% neonates and was markedly higher among deficient mothers.

Conclusions: Vitamin D deficiency is a public health problem. Patient awareness and pre-pregnancy counselling with adequate supplementation will improve maternal and neonatal outcomes and minimize the complications.

Keywords: Gestational diabetes mellitus, Low birth weight, NICU, Preeclampsia, Pregnancy, Vitamin D deficiency

INTRODUCTION

Vitamins are organic compounds that are necessary in small amounts to maintain normal physiological functions and can be divided into the two groups: fat soluble vitamins (A, D, E, and K) and water-soluble vitamins (B and C). A vital fat-soluble hormone, vitamin D is important for calcium and phosphate balance and thus for normal bone development and mineralization. In addition to its classic role in skeletal health, vitamin D has a role in controlling immune responses, metabolic pathways and cellular growth. Such physiological functions gain in importance during pregnancy, as the body becomes more nutrient demanding for the mother and the fetus.[1-3]

Vitamin D is not easily obtained from the diet and there are limited amounts of it. It is found in two forms: vitamin D_3 (cholecalciferol), which is derived primarily from animal sources, and vitamin D_2 (ergocalciferol), which is found in plants. Foods high in vitamin D_3 include fatty

fishlike salmon, mackerel, sardines, tuna and herring, fish liver oils, egg yolk and liver. On the other hand, vitamin D_2 can only be obtained from plants grown under UV light, which are rich in vitamin D_2.[4-9]

Vitamin D deficiency in the mother has been very strongly associated with poor metabolic outcomes in pregnancy. Vitamin D deficiency also has been linked to abnormal insulin resistance and pancreatic β-cell function, which is a risk factor for gestational diabetes mellitus.[10-13] Moreover, abnormal calcium homeostasis, immune imbalance, and altered placental function have been hypothesized to be mechanisms underlying increased susceptibility to developing hypertensive disorders in vitamin D deficiency.[14-21]

Maternal deficiency also has a negative effect on fetal and neonatal health. Low maternal levels of vitamin D have been linked to low birth weight, decreased bone mineral content and compromised bone growth in the newborns.[22-25] Higher risk of nutritional rickets and neonatal hypocalcemia in the offspring of women with low levels of vitamin D in the womb.[26-31]

This study aimed to comprehensively assess the relationship between first-trimester vitamin D deficiency and adverse maternal and neonatal outcomes. By analysing this association, we seek to identify critical threshold levels for early detection of potential complications and to contribute toward improving obstetric and neonatal care through timely interventions and optimized antenatal management.

Objectives of the study were to evaluate maternal vitamin D status during first trimester of pregnancy and its association with maternal and neonatal outcomes.

METHODS

Study type

A hospital-based prospective observational study was conducted at the department of obstetrics and gynecology ESIMC and PGIMSR Rajajinagar, Bangalore, Karnataka, India, from March 2024 to September 2025. The study was carried out in after obtaining approval from the institutional ethics committee. Eligible antenatal women were recruited after obtaining written informed consent. A structured and predesigned proforma was used to collect demographic details, obstetric history, medical history, past history, clinical examination findings, and laboratory parameters.

Inclusion criteria

Women with age 19-45 years, singleton pregnancy, gestational age between 24-28 weeks, Also, women who willingness to participate with written informed consent were included in this study.

Exclusion criteria

Women with multifetal gestation, pre-existing diabetes mellitus or chronic hypertension, chronic liver, renal, endocrine, or metabolic disorders, malabsorption syndromes, long-term steroid therapy or drugs affecting vitamin D metabolism, known parathyroid or bone disorders, assisted reproductive conception, women unwilling to participate were excluded from the study.

Study population

A total of 302 antenatal women were included in the study. Pregnant women attending the antenatal clinic and inpatient services during the study period.

Procedure and sampling

Maternal blood samples were collected in 12-18 weeks of gestation for estimation of serum vitamin D levels, fasting blood sugar, and 75 gm oral glucose tolerance test. All participants were followed prospectively until delivery to assess fetomaternal outcomes.

Based on previous Indian studies reporting a prevalence of vitamin D deficiency of approximately 60-70% among pregnant women, the minimum calculated sample size was around 272 at 95% confidence level and 5% precision. Considering a 10% non-response rate, the final sample size was increased to 302 participants to ensure adequate statistical power.

Study variables

Primary variable was maternal serum 25-hydroxyvitamin D level. Maternal outcome variables were gestational diabetes mellitus, hypertensive disorders of pregnancy (GHTN/ preeclampsia/eclampsia), anemia, hypothyroidism, mode of delivery, preterm delivery.

Neonatal outcome variables were birth weight, low birth weight, NICU admission, adverse pregnancy outcomes (abortion/IUD/stillbirth).

Study technique

Eligible women attending the antenatal clinic were enrolled consecutively. Detailed clinical history and examination were recorded using the study proforma. Blood samples were obtained at 12-18 weeks of gestation for laboratory investigations including vitamin D, fasting blood sugar, and OGTT.

Women identified with vitamin D deficiency received supplementation as per institutional protocol. Participants were followed up until delivery. Maternal complications, mode of delivery, and neonatal parameters such as birth weight, gestational age, APGAR score, and NICU admission were documented.

Laboratory methods

Maternal venous blood was collected under aseptic precautions during the fasting state. Samples were stored appropriately and analysed in the department of biochemistry.

Serum 25(OH) vitamin D levels were estimated using the chemiluminescence immunoassay (CLIA) method with standard quality controls and calibrators. Fasting blood sugar and 2-hour post 75 g glucose values were measured according to standard biochemical procedures.

Vitamin D status was categorized as: deficient: <12 ng/ml; insufficient: 12-30 ng/ml; sufficient: >30 ng/ml.

Study tools

Structured case record proforma, serum vitamin D estimation by CLIA, FBS and 75 gm OGTT, maternal and neonatal outcome assessment forms.

Statistical analysis

Data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean±standard deviation, while categorical variables were presented as frequencies and percentages. Associations between vitamin D status and maternal or neonatal outcomes were assessed using Chi-square or Fisher's exact test for categorical variables and independent t-test for continuous variables. A p value <0.05 was considered statistically significant.

RESULTS

Age-wise distribution

Most of the study population was at the peak reproductive age with a mean maternal age of 28.1 years. The majority (≈88%) were between 21-35 years, with the highest proportion in the 26-30 years group (34.4%), followed by 21-25 years (28.2%) and 31-35 years (25.8%). Very few participants were aged <20 years (5%) or >40 years (0.3%). The dominant gender of the study population (Table 1) is largely due to the age range of women in the optimal reproductive age group, enhancing the representativeness of obstetric outcomes.

Parity distribution

Chi square test for association between vitamin D status and primigravida status: Chi square =0.26, p>0.49. There was a slightly lower prevalence of vitamin D deficient women with primigravida status (21.3% of primigravida were vitamin D deficient) than with multigravida (25.7% of multigravida were vitamin D deficient), but a trend was not observed (Chi square p=0.26). Therefore, parity seemed to be not a significant confounder for vitamin D status in this population (Table 2).

Table 1: Age wise distribution.

Age group (in years)	Frequency, N (%)
<20	15 (5)
21-25	85 (28.2)
26-30	104 (34.4)
31-35	78 (25.8)
36-40	19 (6.3)
>40	1 (0.3)
Total	302 (100.00)

Table 2: Parity wise distribution.

Vitamin D status	Primigravida, N (%)	Multigravida, N (%)
Deficient	17 (23.0)	57 (77.0)
Insufficient	45 (25.7)	130 (74.3)
Sufficient	18 (34.0)	35 (66.0)
Total	80 (26.5)	222 (73.5)

Vitamin D status distribution

The level of vitamin D was inadequate in about 78.5% of pregnant women, which represents a significant public health problem. The mean serum vitamin D level among the 302 pregnant women was 21.0±10.7 ng/ml with the median serum vitamin D level being 20.0 ng/ml and the range of the vitamin D levels was 4.1-87.0 ng/ml. Given the 25th percentile of 12.5 ng/ml and the median of 20 ng/ml, a large percentage of women were deficient or insufficient in vitamin D with less than the sufficiency threshold (Table 3).

Table 3: Vitamin D status wise distribution.

Vitamin D category	Serum level (ng/ml)	N (%)
Deficient	<12	63 (20.9)
Insufficient	12-30	174 (57.6)
Sufficient	>30	65 (21.5)
Total		302 (100)

Association with gestational diabetes mellitus

Vitamin D deficiency was significantly higher among women with GDM compared to non-GDM women. A significant association was observed between vitamin D status and GDM (χ^2=14.34, df=2, p<0.001) (Table 4).

Table 4: Vitamin D and GDM association.

GDM	Deficient (1), N (%)	Insufficient (2), N (%)	Sufficient (3), N (%)	Total, N (%)
No (0)	39 (16.3)	146 (61.1)	54 (22.6)	239 (100)
Yes (1)	24 (38.1)	28 (44.4)	11 (17.5)	63 (100)
Total	63 (20.9)	174 (57.6)	65 (21.5)	302 (100)

GDM present (n=63); Deficient → 38.1%; Insufficient → 44.4%; Sufficient → 17.5%.

Table 5: Vitamin D and HDP association.

Vitamin D status	No. of HTN disorder, N (%)	HTN disorder, N (%)	Total, N (%)
Deficient	58 (78.4)	16 (21.6)	74 (100)
Insufficient	158 (90.3)	17 (9.7)	175 (100)
Sufficient	48 (90.6)	5 (9.4)	53 (100)
Total	264 (87.4)	38 (12.6)	302 (100)

Table 6: Vitamin D and low birth weight association.

Birth weight	Deficient (1), N (%)	Insufficient (2), N (%)	Sufficient (3), N (%)	Total, N (%)
Normal BW	52 (19.5)	155 (58.0)	60 (22.5)	267 (93.4)
LBW	6 (31.6)	9 (47.4)	4 (21.1)	19 (6.6)
Total	58 (20.3)	164 (57.3)	64 (22.4)	286 (100)

Table 7: Vitamin D and NICU admission association.

NICU admission	Deficient (1), N (%)	Insufficient (2), N (%)	Sufficient (3), N (%)	Total, N (%)
No NICU	25 (11.0)	141 (62.1)	61 (26.9)	227 (79.4)
NICU admitted	33 (55.9)	23 (39.0)	3 (5.1)	59 (20.6)
Total	58 (20.3)	164 (57.3)	64 (22.4)	286 (100)

Table 8: Vitamin D and preterm delivery.

Delivery	Deficient (1), N (%)	Insufficient (2), N (%)	Sufficient (3), N (%)	Total, N (%)
Term	57 (20.8)	157 (57.3)	60 (21.9)	274 (95.8)
Preterm	1 (8.3)	7 (58.3)	4 (33.3)	12 (4.2)
Total	58 (20.3)	164 (57.3)	64 (22.4)	286 (100)

Association with hypertensive disorders of pregnancy

The association between vitamin D status and hypertensive disorders was analysed using a chi square test, and the results showed that the p value was found to be 0.026. 12.6% (38/302) of the study population was noted to have hypertensive disorders. Vitamin D deficient women had the highest proportion of hypertensive disorders (21.6%) compared to women with insufficient (9.7%) and sufficient (9.4%) levels of vitamin D; this difference between vitamin D deficient and sufficient women was statistically significant (Chi square p=0.026) (Table 5).

Association with low birth weight

Among 286 live births, 19 (6.6%) neonates were low birth weight. No statistically significant association was observed between maternal vitamin D status and low birth weight (χ^2=1.65, p=0.438) (Table 6).

NICU admission

Of the live births, 59 (20.6%) ended up in the NICU. Neonates born to vitamin D deficient mothers had a higher chance of being admitted to the NICU. There was also a significant correlation with maternal comorbidities (GDM, GHTN and preeclampsia) with the NICU admission (p<0.05) (Table 7).

Preterm delivery

Among 286 live births, 12 cases of preterm delivery were observed. No statistically significant association was found between maternal vitamin D status and preterm delivery (χ^2=1.56, p=0.459) (Table 8).

Mode of delivery

Among live births, emergency LSCS was the most common mode of delivery (45.5%), followed by vaginal

delivery (39.2%) and elective LSCS (15.4%) (Table 9). No statistically significant association was observed between vitamin D status and mode of delivery (p>0.05).

Overall mode of delivery analysis

Table 10 showed the distribution of maternal vitamin D status based on the mode of delivery among 286 participants. Overall, 58 (20.3%) women were vitamin D deficient, 164 (57.3%) were insufficient and 64 (22.4%) had sufficient vitamin D levels.

Table 9: Mode of delivery.

Mode of delivery	Number, N (%)
Vaginal	112 (39.2)
Elective LSCS	44 (15.4)
Emergency LSCS	130 (45.4)
Total	286 (100)

Table 10: Overall mode of delivery analysis.

Mode of delivery	Deficient, N (%)	Insufficient, N (%)	Sufficient, N (%)	Total, N (%)
Vaginal	19 (17.3)	63 (57.3)	28 (25.4)	110 (38.5)
Elective LSCS	12 (27.9)	21 (48.8)	10 (23.3)	43 (15.0)
Emergency LSCS	27 (20.3)	80 (60.2)	26 (19.5)	133 (46.5)
Total	58 (20.3)	164 (57.3)	64 (22.4)	286 (100)

DISCUSSION

The deficiency of vitamin D is a significant public health problem all over the world and Vitamin D deficiency is now known to be one of the main factors leading to poor pregnancy outcomes. The relationship between low maternal vitamin D levels and pregnancy disorders such as gestational diabetes mellitus, fetal macrosomia, and hypertension (such as pre-eclampsia) and anemia in mothers has been reported. Low maternal vitamin D levels have been linked to gestational diabetes mellitus, fetal macrosomia, hypertension (including pre-eclampsia) and anemia in mothers. In addition, vitamin D deficient mothers are at higher risk for giving birth to babies with respiratory distress syndrome, low birth weight, and hypoglycemia.

Vitamin D is a pleiotropic regulator that plays a role in metabolic, vascular, immune and placental processes directly impacting pregnancy outcomes. At present, it is suggested that maternal hypovitaminosis D is associated with short- and long-term health risks for the offspring as well as with immediate obstetric complications.

The age distribution pattern observed in the present study (21-35 years) is comparable to that reported by Nitish et al who found a mean maternal age of 28±5.1 years among 210 pregnant women from India who were assessed for vitamin D deficiency and associated factors.32 This similarity favours the age pattern observed in South Asian populations with vitamin D studies.

Results of the current analysis showed that a high proportion of pregnant women had sub-optimal levels of vitamin D, with 20.9% being vitamin D deficient (<12 ng/ml), and 57.6% being vitamin D insufficient (12–30 ng/ml), for an overall prevalence of 78.5%. The results are consistent with those from other studies conducted in the region which have reported high rates of maternal vitamin D deficiency. For instance, women in the South Indian population had a high prevalence of hypovitaminosis D (62%, based on the threshold value of <20 ng/ml). The same applies for pooled data from meta-analyses in Southeast Asia, suggesting that about 60% of pregnant women are vitamin D deficient in the region. However, other studies (depending on the diagnostic cut-off and the population studied) have found lower prevalence rates, including one Indian observational study that found 26.6% deficiency and 61.9% insufficiency, similar to the trend from this study, with insufficiency outnumbering deficiency.

In terms of parity, majority of participants were multigravida (73.5%) while the rest were primigravida (26.5%). The prevalence of vitamin D deficiency was 23.0% in the primigravida and 25.7% in the multigravida women when vitamin D levels were compared between the two parity groups. 25.7% of the participants in the study were found to be suffering from insufficiency and 74.3% were found to be suffering from vitamin D sufficiency which is similar to the reported by Nitish A et al.[32] Primigravida and multigravida women alike had vitamin D insufficiency.

Association of vitamin D status with GDM

In the current study 302 women were pregnant and 63 were diagnosed with gestational diabetes mellitus (GDM). Of these, 38.1% had vitamin D deficiency, 44.4% had vitamin D insufficiency and only 17.5% had sufficient serum vitamin D. The 25-hydroxyvitamin D distribution between GDM and non-GDM groups was statistically significant (χ^2=14.34, df=2, p<0.001), suggesting that vitamin D levels were significantly lower in women with GDM. These results are supported by the findings of Luo et al who reported that low maternal vitamin D levels were

significantly associated with having GDM, with pooled estimates confirming this association, which was proposed to be linked to vitamin D's effects on insulin secretion, calcium homeostasis and inflammatory pathways.[33] Zhang et al in a meta-analysis of observational studies, also found a consistent association between low maternal 25(OH)D and higher odds of GDM and reinforced this association with pooled estimates.[34] Vitamin D's proposed biological roles include effects on insulin secretion, calcium homeostasis and systemic inflammatory pathways.

Association of vitamin D status with HDP

The overall rate of hypertensive disorders of pregnancy (HDP) was 12.6% in the present study. The highest prevalence was found in women who had vitamin D deficiency (21.6%) followed by women who had vitamin D insufficiency (9.7%) and women who had vitamin D sufficiency (9.4%). The relationship between vitamin D status and HDP was statistically significant (χ^2=14.34, p=0.026) suggesting that vitamin D serum levels were associated with an increased risk of HDP. Furthermore, the evidence from Indian studies also substantiates the findings of Zakerinasab et al which revealed that a lower vitamin D level was associated with an increased risk of HDP and that there was a dose-response relationship between the two, with a reduction in 25(OH)D level corresponding to an increase in HDP risk.[35,36]

The multiple functions of vitamin D in the development of the placenta, immune system and renin-angiotensin system pathways, which are all important in the development of hypertensive disorders in pregnancy, provide biological plausibility for this relationship. The systemic inflammatory response is increased during pregnancy and may lead to endothelial dysfunction and vascular injury making women more susceptible to pre-eclampsia.

Association of vitamin D status with anaemia

While vitamin D has been shown to have a beneficial effect on erythropoiesis, through its ability to inhibit the action of inflammatory mediators and to improve bone marrow function, anaemia in pregnancy is a multifactorial disorder and is most commonly caused by iron, folate or vitamin B_{12} deficiency. These dominant nutritional influences may obscure the potential independent effect of vitamin D that could explain the absence of an obvious relationship in the current study. In the present study, 26.2% of the participants were diagnosed with anemia. Of the anemic women, 17.7% were vitamin D deficient, 64.6% were insufficient and 17.7% had sufficient levels. This finding is consistent with the observations by Sahu et al which found that "no significant association was observed between maternal serum vitamin D status and the occurrence of anemia in the study population.[37] Furthermore, Wagner and Greer have reported "evidence linking vitamin D to iron status and haemoglobin in pregnancy is inconsistent", suggesting that vitamin D may modulate inflammatory pathways, but it did not consistently predict anaemia risk during pregnancy.[38]

Association of vitamin D status with hypothyroidism

In this study, hypothyroidism was present in 22.5% of participants. Analysis of vitamin D status by thyroid function category showed that the majority of hypothyroid women had insufficient vitamin D levels (67.6%), followed by sufficient (20.6%) and deficient (11.8%) status. While vitamin D insufficiency was more prevalent among hypothyroid women than euthyroid ones, the relationship lacked statistical significance (χ^2=5.05, p=0.080). Overall, these data indicate no significant association between maternal vitamin D status and hypothyroidism within this cohort.

Association of vitamin D status with abortion and pregnancy loss

Adverse pregnancy outcomes were seen in 5.3% of the women in the present study, such as abortion, intrauterine demise, and stillbirth. When evaluating vitamin D status by outcome categories, more losses were seen among women with vitamin D deficiency (31.3%), and fewer amongst the sufficient group (6.2%).

Our results are similar to those of a number of recent observational studies which have documented a similar pattern but without clear statistical significance. Reviews published in Nutrients have also revealed that although vitamin D plays a role in implantation, trophoblastic invasion, and immune tolerance at the fetal-maternal interface, clinical studies results are inconclusive with some reporting higher miscarriage risk and others reporting no statistically significant associations.[40]

Association of vitamin D status with low birth weight

In the current study, out of 286 live births, 19 (6.6%) were considered low birth weight. The mothers with vitamin D deficient neonates had a higher rate of LBW infants (31.6%) than mothers with LBW neonates (19.5%). This distribution indicated a trend toward lower birth weight for lower maternal vitamin D, but the association was not statistically significant, χ^2=1.65, p=0.438, meaning that in this cohort, low maternal vitamin D was not a significant independent risk factor for low birth weight.

These findings are comparable to those reported by Gernand et al who observed that maternal vitamin D concentrations showed only a weak relationship with fetal growth parameters and that differences in birth weight were not statistically significant after adjustment for confounding factors.[41] Similar results have been reported in a cohort of Indian women by Singh et al who found that the prevalence of vitamin D deficiency was very high and its relation with low birth weight was not statistically significant after controlling for other independent factors.[42]

Vitamin D does have a physiological function in the placenta, in calcium transport and in skeletal mineralisation however fetal growth is multifactorial and affected more by maternal nutrition, anemia, hypertensive disorders and gestational age. The distinct effect of vitamin D status could be masked by these factors. In addition, the limited number of low birth weight (LBW) cases in the present study may have reduced the statistical power to detect an association.

Association of vitamin D status with NICU admission

The total number of live births in this study was 286 of which 59 neonates (20.6%) were admitted to the NICU. The rate of vitamin D deficiency among mothers was also found to be significantly associated with a markedly higher proportion of these admissions, with admissions increasing in a gradient with greater levels of maternal vitamin D deficiency (55.9% of infants born to vitamin D deficient mothers compared to 5.1% of infants born to mothers with sufficient vitamin D levels). Thus, in this study the association was statistically significant. In this study, the rate of intensive neonatal care was seen to be higher among neonates of vitamin D deficient mothers, consistent with the observations made by Sonowal et al who found significantly more neonates admitted to NICU in pregnancies complicated by maternal hypovitaminosis D compared to those with adequate vitamin D levels in a hospital based study conducted in northeast India.[43] Similarly, Kumari et al reported higher rates of adverse perinatal outcomes, such as increased admission to NICU and neonatal complications among pregnancies affected by maternal vitamin D deficiency.[44]

Association between vitamin D levels and mode of delivery

There were only slight differences between the various delivery modes within the vitamin D categories in this study. Vitamin D deficient mothers delivered 46.6% of children by emergency cesarean section (ECS) while sufficient mothers delivered 40.6% of children in ECS; and mothers having sufficient level of vitamin D had more vaginal delivery (43.8%) than vitamin D deficient mothers (32.8%). These findings suggest that there may have been a tendency to greater operative delivery with decreasing maternal vitamin D status, but the differences were not significant, implying that the maternal vitamin D status was not independently associated with delivery mode in this study. It is significant to note that most of the LSCS (majority) were either previous LSCS or were performed for obstetric indications. No conclusion can be made as regards the relation between vitamin D levels and mode of delivery. Dhillon et al conducted a large observational cohort of 569 pregnant women, who had significantly elevated rates of cesarean section if they were vitamin D deficient.[45]

Routine prenatal screening and supplementation for vitamin D deficiency may be a simple, safe, and cost-effective preventive strategy, given the high prevalence of deficiency and its role in several adverse outcomes in the mother and baby. The potential of early intervention to correct deficiency to improve metabolic regulation, reduce hypertensive disorders, and reduce neonatal complications in the future leading to better fetomaternal health outcomes.

The results may not be generalizable to other populations and health care settings due to the study being performed in one tertiary care center. Vitamin D levels were measured in serum only at the beginning of pregnancy. The effects of altering vitamin D status during gestation and vitamin D supplementation during pregnancy were not assessed. Although NICU admission and low birth weight were evaluated, other important neonatal outcomes such as neonatal vitamin D levels, respiratory complications, skeletal development, and long-term infant health were not assessed. Some outcomes such as pregnancy loss and low birth weight were rare, which could have limited the statistical power to establish significant associations. There was no follow-up of mothers and infants; the long-term impact of maternal vitamin D deficiency on child growth and development and health outcomes was therefore not assessable.

CONCLUSION

Vitamin D is a parathormone and has multiorgan system interaction, it has got vital role in calcium homeostasis and fetal skeletal development. early screening and appropriate vitamin D supplementation during pregnancy will minimise the complications.

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REFERENCES

1. Rosen CJ, Adams JS, Bikle DD, Black DM, Demay MB, Manson JE, et al. The nonskeletal effects of vitamin D: an Endocrine Society scientific statement. Endocr Rev. 2012;33(3):456-92.
2. Bikle DD. Vitamin D regulation of immune function. Curr Osteopor Rep. 2022;20(3):186-93.
3. Gani LU, How CH. Vitamin D deficiency. Singapore Med J. 2015;56(8):433.
4. Feldman D, Pike JW, Adams JS. Vitamin D. 3rd ed. San Diego: Elsevier Academic Press; 2011.

5. Heaney RP. Vitamin D in health and disease. Clin J Am Soc Nephrol. 2008;3(5):1535-41.
6. Heaney RP, Dowell MS, Hale CA, Bendich A. Calcium absorption varies within the reference range for serum 25-hydroxyvitamin D. Am J Clin Nutr. 2003;22(2):142-6.
7. Zehnder D, Evans KN, Kilby MD, Bulmer JN, Innes BA, Stewart PM, et al. The ontogeny of 25-hydroxyvitamin D_3 1α-hydroxylase expression in human placenta and decidua. Am J Pathol. 2002;161(1):105-14.
8. Ritchie LD, Fung EB, Halloran BP, Turnlund JR, Van Loan MD, Cann CE, et al. A longitudinal study of calcium homeostasis during human pregnancy and lactation and after resumption of menses. Am J Clin Nutr. 1998;67(4):693-701.
9. Abrams SA. In utero physiology: role in nutrient delivery and fetal development for calcium, phosphorus, and vitamin D. Am J Clin Nutr. 2007;85(2):604S-7S.
10. Chiu KC, Chu A, Go VL, Saad MF. Hypovitaminosis D is associated with insulin resistance and β-cell dysfunction. Am J Clin Nutr. 2004;79(5):820-5.
11. Clifton-Bligh RJ, McElduff P, McElduff A. Maternal vitamin D deficiency, ethnicity and gestational diabetes. Diabet Med. 2008;25(6):678-84.
12. Parlea L, Bromberg IL, Feig DS, Vieth R, Merman E, Lipscombe LL. Association between serum 25-hydroxyvitamin D in early pregnancy and risk of gestational diabetes mellitus. Diabet Med. 2012;29(7):e25-32.
13. Zhang C, Qiu C, Hu FB, David RM, van Dam RM, Bralley A, et al. Maternal plasma 25-hydroxyvitamin D concentrations and the risk for gestational diabetes mellitus. PloS One. 2008;3(11):e3753.
14. Bodnar LM, Catov JM, Simhan HN, Holick MF, Powers RW, Roberts JM. Maternal vitamin D deficiency increases the risk of preeclampsia. J Clin Endocrinol Metab. 2007;92(9):3517-22.
15. Baker AM, Haeri S, Camargo CA Jr, Espinola JA, Stuebe AM. A nested case-control study of midgestation vitamin D deficiency and risk of severe preeclampsia. J Clin Endocrinol Metab. 2010;95(11):5105-9.
16. Robinson CJ, Alanis MC, Wagner CL, Hollis BW, Johnson DD. Plasma 25-hydroxyvitamin D levels in early-onset severe preeclampsia. Am J Obstet Gynecol. 2010;203(4):366.e1-6.
17. Powe CE, Seely EW, Rana S, Bhan I, Ecker J, Karumanchi SA, et al. First-trimester vitamin D, vitamin D-binding protein, and subsequent preeclampsia. Hypertension. 2010;56(4):758-63.
18. Shand AW, Nassar N, Von Dadelszen P, Innis SM, Green TJ. Maternal vitamin D status in pregnancy and adverse pregnancy outcomes in a group at high risk for pre-eclampsia. BJOG. 2010;117(13):1593-8.
19. Wei SQ, Audibert F, Hidiroglou N, Sarafin K, Julien P, Wu Y, et al. Longitudinal vitamin D status in pregnancy and the risk of pre-eclampsia. BJOG. 2012;119(7):832-9.
20. Haugen M, Brantsæter AL, Trogstad L, Alexander J, Roth C, Magnus P, et al. Vitamin D supplementation and reduced risk of preeclampsia in nulliparous women. Epidemiology. 2009;20(5):720-6.
21. Seely EW, Wood RJ, Brown EM, Graves SW. Lower serum ionized calcium and abnormal calciotropic hormone levels in preeclampsia. J Clin Endocrinol Metab. 1992;74(6):1436-40.
22. Viljakainen HT, Saarnio E, Hytinantti T, Miettinen M, Surcel H, Makitie O, et al. Maternal vitamin D status determines bone variables in the newborn. J Clin Endocrinol Metab. 2010;95(4):1749-57.
23. Weiler H, Fitzpatrick-Wong S, Veitch R, Kovacs H, Schellenberg J, McCloy U, et al. Vitamin D deficiency and whole-body and femur bone mass relative to weight in healthy newborns. CMAJ. 2005;172(6):757-61.
24. Lawlor DA, Wills AK, Fraser A, Sayers A, Fraser WD, Tobias JH. Association of maternal vitamin D status during pregnancy with bone-mineral content in offspring: a prospective cohort study. Lancet. 2013;381(9884):2176-83.
25. Lucas RM, Ponsonby AL, Pasco JA, Morley R. Future health implications of prenatal and early-life vitamin D status. Nutr Rev. 2008;66(12):710-20.
26. Brooke OG, Brown IR, Bone CD, Carter ND, Cleeve HJ, Maxwell JD, et al. Vitamin D supplements in pregnant Asian women: effects on calcium status and fetal growth. Br Med J. 1980;280(6216):751-4.
27. Delvin EE, Salle BL, Glorieux FH, Adeleine P, David LS. Vitamin D supplementation during pregnancy: effect on neonatal calcium homeostasis. J Pediatr. 1986;109(2):328-34.
28. Mallet E, Gügi B, Brunelle P, Henocq A, Basuyau JP, Lemeur H. Vitamin D supplementation in pregnancy: a controlled trial of two methods. Obstet Gynecol. 1986;68(3):300-4.
29. Marya RK, Rathee S, Lata V, Mudgil S. Effect of vitamin D supplementation during pregnancy on foetal growth. Indian J Med Res. 1988;88:488-92.
30. Yu CK, Ertl R, Skyfta E, Akolekar R, Nicolaides KH. Vitamin D deficiency and supplementation during pregnancy. Clin Endocrinol (Oxf). 2009;70(5):685-90.
31. Marya RK, Rathee S, Manrow M. Effect of calcium and vitamin D supplementation on toxemia of pregnancy. Gynecol Obstet Invest. 1987;24(1):38-42.
32. Nitish A, Anand, PK, Swarnkanta L, Dhruvendra P. Vitamin D deficiency among pregnant women in India. Bioinformation. 2024;20(12):2029-33.
33. Luo R, Wang H, Cao Y. Effects of vitamin D supplementation on glucose metabolism and pregnancy outcomes in GDM: a systematic review and meta-analysis. Front Med. 2026;13:1743776.
34. Zhang MX, Pan GT, Guo JF, Li BY, Qin LQ, Zhang ZL. Vitamin D deficiency increases the risk of gestational diabetes mellitus: a meta-analysis of observational studies. Nutrients. 2015;7(10):8366-75.
35. Giourga C, Papadopoulou SK, Voulgaridou G, Karastogiannidou C, Giaginis C, Pritsa A. Vitamin D

deficiency as a risk factor of preeclampsia during pregnancy. Diseases. 2023;11(4):158.
36. Zakerinasab F, Behfar Q, Daghistani H, Ansari A, Zadeh RH, Zadeh RH, et al. Vitamin D levels in early and middle pregnancy and preeclampsia: a systematic review and meta-analysis. Front Med. 2025;12:1535359.
37. Yuan Y, Cai Z, Dai Y, Hong Q, Wang X, Zhu L, et al. Association of maternal serum 25-hydroxyvitamin D concentrations with risk of gestational anemia. Cell Physiol Biochem. 2017;43(4):1526-32.
38. Wagner CL, Greer FR. Vitamin D and haematological health in pregnancy. Nutrients. 2021;15(7):1680.
39. Zhao R, Zhou L, Wang S, Yin H, Yang X, Hao L. Effect of maternal vitamin D status on risk of adverse birth outcomes: a systematic review and dose-response meta-analysis of observational studies. European J Nutrit. 2022;61(6):2881-907.
40. Pilz S, Trummer C, Pandis M, Schwetz V, Lerchbaum E. Vitamin D and pregnancy outcomes: overview of systematic reviews. Nutrients. 2022;14:976.
41. Gernand AD, Simhan HN, Caritis S, Bodnar LM. Maternal vitamin D status and fetal growth in pregnancy. BMC Pregnancy Childbirth. 2021;21:519.
42. Ravinder SS. Maternal vitamin D deficiency and pregnancy outcomes in an Indian cohort. J Fam Med Prim Care. 2022
43. Sonowal R, Das M, Deka BP, Das P. Effects of maternal vitamin D deficiency on the newborn. Indian J Neonat Med Res. 2021;9(4):PO27-32.
44. Kumari S, Kaul KK. Study on perinatal outcome in relation to maternal vitamin D deficiency in a tertiary care hospital. Int J Acad Med Pharm. 2023;5(4):1714-8.
45. Dhillon G, Singh S, Dhillon HS, Sasidharan S. A study of relationship between maternal vitamin D status and mode of delivery in a tertiary care hospital. Preprint. Available at: https://www.researchsquare.com/article/rs-35417/v1. Accessed on 17 January 2026.

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