

The Relationship Between the Neonatal and Maternal Vitamin D Level at Birth in a Tertiary Hospital in Southwest, Nigeria

Kehinde Funke Fasina

University College Hospital

Olumide Olatokunbo Jarrett

University College Hospital

Olukemi Oluwatoyin Tongo

University College Hospital

Modupe Akinrele Kuti

University of Ibadan

Oyebola Olugbemiga Sonuga

University of Ibadan

Akinlolu Adedayo Adepoju

University College Hospital

Bose Etaniamhe Orimadegun

University of Ibadan

Adebola Emmanuel Orimadegun

University College Hospital

Olusegun Olusina Akinyinka

University College Hospital

Abiodun John Kareem

biodunkareem13@gmail.com

Federal Medical Centre

Research Article

Keywords: Mothers, Newborn, Nigeria, Prevalence, Vitamin D

Posted Date: August 20th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10524822/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Endocrine Disorders on October 15th, 2026. See the published version at <https://doi.org/10.1186/s12902-026-02675-3>.

**THE RELATIONSHIP BETWEEN THE NEONATAL AND MATERNAL VITAMIN D
LEVEL AT BIRTH IN A TERTIARY HOSPITAL IN SOUTHWEST, NIGERIA**

TITLE PAGE

Kehinde Funke Fasina,^{1,2} Olumide Olatokunbo Jarrett,^{1,2} Olukemi Oluwatoyin Tongo,^{1,2}
Modupe Akinrele Kuti,^{2,3} Oyebola Olugbemiga Sonuga,^{2,3} Akinlolu Adedayo Adepoju,^{1,2}
Bose Etaniamhe Orimadegun,^{2,3} Adebola Emmanuel Orimadegun,^{1,4} Olusegun Olusina
Akinyinka,^{1,2} Abiodun John Kareem^{5*}

¹Department of Paediatrics, University College Hospital, Ibadan, Oyo State, Nigeria.

²College of Medicine, University of Ibadan, Oyo State, Nigeria.

³Department of Chemical Pathology, University College Hospital, Ibadan, Oyo State,
Nigeria.

⁴Institute of Child Health, College of Medicine, University of Ibadan, Oyo State, Nigeria.

⁵Department of Paediatrics, Federal Medical Centre, Owo, Ondo State, Nigeria

***Corresponding Author**

Name: Abiodun John Kareem

Address: Department of Paediatrics, Federal Medical Centre, Owo, Ondo state Nigeria

ORCID number: 0000-0002-2565-08881

Email: biodunkareem13@gmail.com

Phone number: +2348034319940

ABSTRACTS

Background: Vitamin D deficiency during pregnancy is on the increase in many parts of the world, including tropical countries. The mother is the main source of circulating vitamin D in the newborn; therefore, the maternal vitamin D status is an important determinant of the infant's vitamin D status. This study determined the relationship between the vitamin D status of the parturient mothers and their term newborns.

Methods: This was a cross-sectional study among one hundred and twenty-eight women during labour or at delivery in the labour ward and their term newborns. The serum vitamin D levels of the mother and term newborn were determined at delivery using the Enzyme-Linked Immunosorbent Assay (ELISA) method. A p-value of less than 0.05 was considered statistically significant.

Results: The mean (SD) maternal and newborn serum vitamin D levels were 18.3 (6.9) ng/ml and 20.5 (8.6) ng/ml respectively, with a statistically significant association ($t=3.83$; $p<0.001$). Seventy-six (59.4%) mothers and 64 (50.0%) newborns were vitamin D deficient, while only 17 (13.3%) mothers and 30 (23.4%) newborns had sufficient vitamin D level and this was not statistically significant ($\chi^2=6.964$; $p=0.073$). The overall prevalence of hypovitaminosis D in the mothers and newborns was 86.7% and 76.6%, respectively. The odds of vitamin D deficiency in newborns were 6.12 times higher when mothers were deficient than in the non-deficient and this was statistically significant (OR=6.12; 95% CI=2.78-13.48, $p=0.043$).

Conclusion: The high prevalence of vitamin D deficiency among the parturient mothers and newborns calls for pre-conceptional and antenatal vitamin D supplementation.

Keywords: Mothers, Newborn, Nigeria, Prevalence, Vitamin D.

INTRODUCTION

Vitamin D or calciferol is an essential micronutrient crucial for optimal health throughout life, and it is endogenously produced in the skin from cholesterol after exposure to sunlight or obtained from foods such as cod liver oil, fatty fish including salmon, and tuna as well as ultraviolet irradiated mushrooms [1]. Solar ultraviolet B (UV-B) (wavelength 290–320nm) irradiation is the primary source of vitamin D other than dietary supplements [2], while trans-placental passage of maternal vitamin D is the only source in the developing foetus and the newborn [3].

Vitamin D is important for growth and development, regulating cellular proliferation and differentiation, apoptosis, immune system development, and brain development right from foetal life [4]. Classical functions of vitamin D in pregnancy involve calcium uptake and bone metabolism and the non-classical roles in the developing foetus include modulation of the innate and adaptive immune system and regulation of cell proliferation [5]. The placenta produces and responds to Vitamin D where it functions as a modulator of implantation, cytokine production, and immune response to infection [5].

Vitamin D deficiency in pregnancy is on the increase with attendant health consequences such as pre-eclampsia, preterm delivery, neonatal infections, impaired neurocognitive development, rickets, muscular weakness, heart failure, respiratory infections in children [6,7]. It is now a public health problem that requires prompt attention and intervention for the prevention of these health consequences. The prevalence of vitamin D deficiency in pregnant women globally is between 5% to 84% [8,9]. The prevalence ranges from 27% to 91% in the United States [10], 19% to 96% in Europe [11], 31.9% to 58% in Qatar [12], and 86% in Iran [8]. There is however paucity of data on prevalence of vitamin D deficiency among pregnant women in Nigeria.

In southwest Nigeria, Okonofua *et al* [13], reported a mean Vitamin D level of 20ng/ml in purdah practicing women while the non-purdah practicing had a mean value of 37ng/ml. Sanchez *et al* [14] in Northeast Nigeria reported a mean Vitamin D level of 17.8ng/ml in the teenage mothers at delivery and 16.1ng/ml in non-pregnant controls and the mean value in the newborns was 13.2ng/l (33nmol/l). The overall prevalence of vitamin D deficiency was not stated.

The prevalence of several micronutrient deficiencies has been reported in Nigeria [15,16], especially under the prevailing economic situation, but there is a paucity of information on the vitamin D status of pregnant women and their babies. A lot of spotlights have been placed on other micronutrient deficiencies like vitamin A and iron particularly among mothers and children in Nigeria with appropriate interventions on a large scale [17,18]. Vitamin D deficiency has not yet received similar attention in Nigeria probably because there is limited data to show its magnitude. These limited studies emphasize the state of hypovitaminosis D in women in Nigeria [13,14]. This present study sought to determine the vitamin D status of parturient mothers and their babies with a view of providing current data on the prevalence of vitamin D deficiency among this population and to determine the sociocultural risk factors involved in hypovitaminosis D. It is hoped that results from this study will help in determining whether or not vitamin D supplementation should be recommended for pregnant Nigerian women. Also, identifying the sociocultural risk factors for a deficiency will provide useful information for the formulation of appropriate preventive strategies such as health education on lifestyle modification and policies to address vitamin D deficiency thereby mitigating against the associated bad pregnancy or neonatal outcomes.

METHODS

Study design: This is a hospital-based cross-sectional study which involved recruitment of mothers and their newborns immediately after child birth.

Study location: The study was carried out in the Labour Ward of the University College Hospital (UCH), Ibadan, Oyo State, Nigeria. The UCH is a tertiary hospital which serves other health facilities in Ibadan and its environs. The Labour Ward of the UCH receives about 2,500 pregnant mothers annually both booked and referred. After delivery, stable mothers are transferred to the Lying-in Wards within 6 hours. On the average, primiparous mothers are discharged with their healthy infants within 48 to 72 hours of delivery, while multiparous mothers are discharged within 24 to 48 hours. Mothers who have caesarean section are usually discharged with their well infants on the 4th or 5th post-operative day. Babies requiring admission are transferred to the Special Care Baby Unit (SCBU). The SCBU is located on the fourth floor of the East wing of the hospital with two sections; the inborn and the out born. The inborn section has 10 beds, while the out-born has nine beds.

Study population: Participants were mothers who delivered at term in the Labour Ward of UCH and their newborns during the study period and who gave written informed consent. Women with chronic diseases like rheumatoid arthritis, thyroid diseases, parathyroid or adrenal disease, hepatic, renal failure, metabolic bone disease, diabetes mellitus, mal-absorption diseases and women on medications (corticosteroids, cholestyramine, antiretroviral drugs, antineoplastic drugs, antituberculous drugs, diuretics, benzodiazepams, antihypertensives, antidepressants, anticonvulsants or other medications influencing bone, vitamin D or calcium metabolism) were excluded from the study.

Sample size determination: The estimated sample size was calculated using the formula:

$$n = \frac{(Z\alpha + Z\beta)^2 (p1 (1 - p1) + p2 (1 - p2))}{(p1 - p2)^2}$$

p1 = prevalence of Vitamin D deficiency in neonates. Fifty per cent was used as an estimate since there are no studies with considerable sample size in our environment

p2 = prevalence of Vitamin D deficiency in mothers of neonates = 50% - 20% = 30%

(p1 – p2) = difference in prevalence of Vitamin D deficiency between mothers and neonates = 20%

$$n = \frac{(1.96 + 1.28) (0.5 \times (1 - 0.5)) + (0.3 \times (1 - 0.3))}{(0.5 - 0.3)}$$

$$= 105$$

This gave a minimum of 105 in each group. However, to allow for a non-response rate of 22%, the sample size was increased to 128 in each group.

Sampling method and data collection procedures: One hundred and twenty-eight consecutive pregnant women at term presenting in the labour ward were recruited for this study. A semi-structured questionnaire was used to obtain information on their socio-demographic characteristics such as maternal age, marital status, educational status, occupation, past and present medical history; the obstetrics history like parity, mode of delivery, and dietary vitamin D intake. Socioeconomic status was determined according to Oyediji's classification [19]. Socioeconomic index scores were awarded to each participant based on the occupation and educational attainment of the women and their husbands. The mean of four scores (two for the husband and two for the woman) to the nearest whole number, was the social class assigned to the subject [19]. The newborn gestational age, Apgar score, birthweight, birth length, head circumference, and chest circumference were recorded.

At delivery, the anthropometric measurements of the newborn were done:

Birth weight was measured soon after delivery with the naked neonate in supine position placed on pan scale of the weighing scale (WAYMASTER). The birth weight was measured to the nearest 10g.

Birth length was measured from the crown to the heel on a purpose built infantometer by (SECA model:210 1821009), with newborn in the supine position, newborn's head was put against the head board of the infantometer with the legs gently flattened and fully extended by an assistant. The length was the furthest point that the feet reached on the foot board. Measurement was taken to the nearest 0.1 centimetre.

Head circumference was measured by placing the non-stretchable measuring tape along the largest occipitofrontal diameter over the occiput and the eyebrow, both at birth and after 48hours (where moulding and caput succedaneum have misshaped the head). Head circumference was measured to the nearest 0.1 cm.

The chest circumference was measured by placing the non-stretchable measuring tape along the point of nipples. Chest circumference was measured to the nearest 0.1 cm.

Vitamin D assay: Five millilitres of maternal venous blood samples were obtained before delivery and two millilitres of the babies' venous cord blood after clamping were collected immediately after delivery: these were dispensed into respective serum separator tubes. The samples were allowed 30 minutes for clot retraction and the serum was separated within an hour of sample collection by centrifugation at a speed of $3000 \times g$ ($g = 1118 \times 10^{-8}$) for 10 minutes at room temperature. Quantification of serum vitamin D was performed on Enzyme linked Immunosorbent Assay reader StatFax 4200 using competitive–Enzyme linked Immunosorbent Assay (ELISA) Kit manufactured by Calbiotech Diagnostics Inc, California, USA with manufacturer stated analytical sensitivity of 2.5ng/ml and standard detection range of 2.5ng/ml to 150 ng/ml. The Diagnostic Automation, Inc. Vitamin D

(total) ELISA is an enzyme immunoassay for the quantitative in vitro diagnostic measurement of total vitamin D in human serum and plasma.

The vitamin D levels were measured in ng/ml and classified using the International Endocrine Society definition of vitamin D status. Vitamin D deficiency was defined as serum Vitamin D level of 20ng/ml or less; insufficiency as 21ng/ml to 29ng/ml; sufficiency as greater than 30ng/ml, and toxicity as greater than 150ng/ml [20].

Data analysis: The data was analysed using Statistical Package for Social Sciences (SPSS) for Window version 20.0 (SPSS Inc., Chicago, IL, USA). The dependent variables were maternal and foetal serum vitamin D levels. The independent variables included socio-demographic characteristics, obstetric variables, pregnancy outcome variable, and newborn anthropometric measurements. Continuous variables were summarized as mean with standard deviation and qualitative variables using proportions. Chi-Square and student t tests were used to explore association between qualitative variables and differences between continuous variables respectively. The Pearson correlation coefficient (r) was used to explore relationship between quantitative variables, like the maternal and foetal vitamin D levels and correlation between anthropometry and vitamin D level. The Chi square was used to compares the maternal vitamin D deficiency and new born vitamin D deficiency. Statistical significance level was set at less than 5%.

RESULTS

One hundred and twenty-eight each of mother and term newborn were recruited for this study. The ages of the mothers ranged from 22 to 52 years with a mean (SD) of 32.5 (4.7) years. Table 1 shows the socio-demographic characteristics of the mothers. The age group shows that six (4.7%) were less than 25 years, and more than half (62.5%) were aged 25-34 years. The participants from the Yoruba ethnic group constituted 83.6%. Ninety-three (72.7%) women were educated to the tertiary level and almost all were into monogamous relationships. Sixty-six (51.6%) of the women were in the socioeconomic class 1.

Table 1: Socio-demographic characteristics of the mother

Variables	Frequency	%
Mothers' age group (years)		
<25	6	4.7
25-34	80	62.5
35-44	41	32.0
>44	1	0.8
Ethnicity		
Yoruba	107	83.6
Non-Yoruba	21	16.4
Religion		
Christianity	104	81.3
Islam	24	18.8
Mother's highest level of Education		
Tertiary	93	72.7
Post-Secondary	10	7.8
Secondary	25	19.5
Family structure		
Polygamous	3	2.3
Monogamous	125	97.7
Socioeconomic status		
Class 1	66	51.6
Class 2	49	38.3
Class 3	13	10.1
Housing Type		
Bungalow	52	40.6
Storey building	76	59.4

Table 2 shows the obstetrics history of the mother. Thirty-two (25.0%) participants were nulliparous and 96 (75%) were multiparous. The Gestational age (GA) at delivery in 75

(58.6%) of the women was between 37 and 38 weeks, while 16 delivered at GA > 40 weeks and more than half (57.0%) delivered through caesarean section.

Table 2: Obstetrics characteristics of the mother

Obstetrics characteristics	Frequency	%
Parity		
0	32	25.0
1	57	44.5
2	32	25.0
>2	7	5.5
Gestational Age at delivery (weeks)		
37-38	75	58.6
39-40	37	28.9
>40	16	12.5
Mode of delivery		
Spontaneous vaginal delivery	55	43.0
Caesarean section	73	57.0

The mean (SD) serum vitamin D level in mothers was 18.3 (6.9) ng/ml and in newborns 20.5 (8.6) ng/ml with a statistically significant association ($t=3.83$; $p = <0.001$). Figure 1 shows vitamin D status of the mother and newborn. Seventy-six (59.4%) mothers were vitamin D deficient, while only 17 (13.3%) were vitamin D sufficient. Sixty-four (50.0%) newborn were vitamin D deficient and 30 (23.4%) had sufficient vitamin D level. Of the 76 mothers who were vitamin D deficient, fifty-one (67.1%) babies were vitamin D deficient. 10 (28.6%) babies of the 35 mothers with insufficient vitamin D were vitamin D deficient; and 3 (17.6%) babies of the 17 mothers with sufficient vitamin D level were deficient. There was no statistically significant association between the distribution of the mothers and newborns by the category of vitamin D status ($\chi^2= 6.964$; $p = 0.073$). The overall prevalence of hypovitaminosis D in the mothers and newborns was 86.7% and 76.6%, respectively.

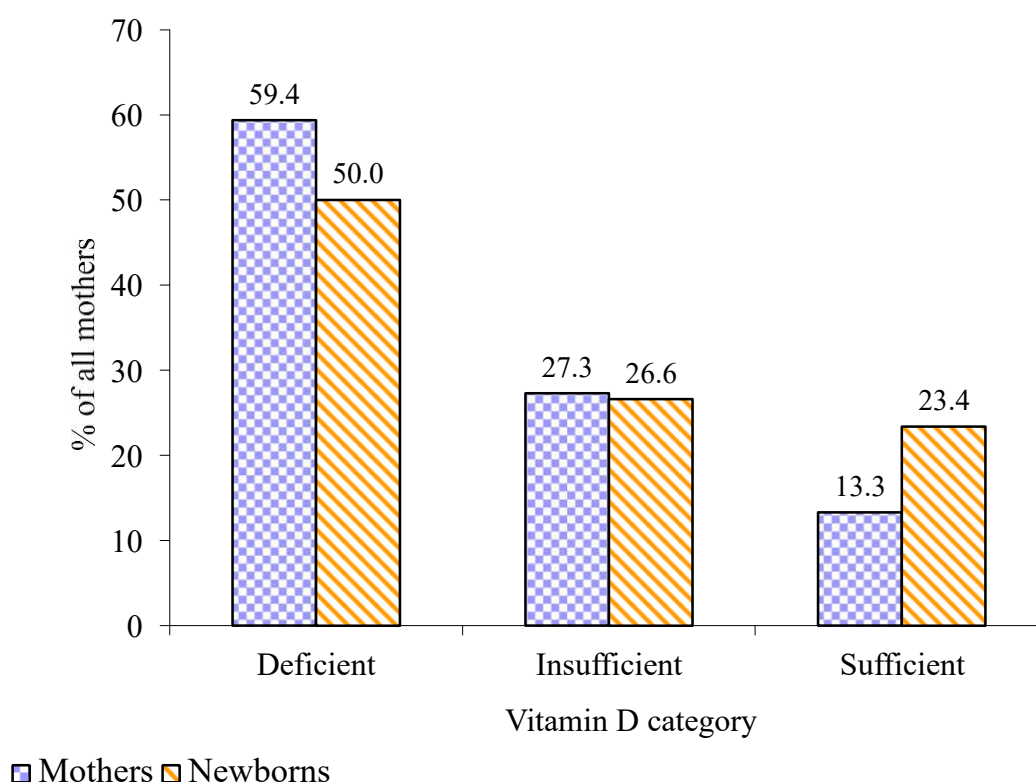


Figure 1: Distribution of Mothers and Newborns Vitamin D status

Table 3 shows the factors associated with vitamin D deficiency in the mother. More than half (57.9%) of the mother 35 years and below had vitamin D deficiency, similarly, almost two-third (63.6%) of the mother greater than 35 years had vitamin D deficiency. The difference was not statistically significant ($\chi^2 = 0.025$, $p=0.682$). The mother's level of education has no statistically significant association with the vitamin D level ($\chi^2 = 1.260$, $p=0.261$). Although, about two-third (62.4%) of the mother with tertiary level of education were vitamin D deficient. Similarly, the social class ($\chi^2 = 2.860$, $p=0.091$) and mother's parity ($\chi^2 = 0.009$, $p=0.925$) had no statistically significant association with the vitamin D level. However, type of house had statistically significant association with maternal vitamin D level ($\chi^2 = 18.940$, $p=0.012$). The majority (53.8%) of those living in a storey building had no vitamin D deficiency, while 68.4% of those living in the bungalow were vitamin D deficient. The odds of vitamin D deficiency were lower among

mothers who lived in storey-buildings than those living in bungalows (OR = 0.40; 95% CI = 0.91, 0.82).

Table 3: Factors associated with Vitamin D deficiency in the mothers

Variables	Deficient N	%	Not Deficient N	%	p value	OR (95% CI)
Age (years)						
≤35	55	57.9	40	42.1	0.682	0.79 (0.35, 1.78)
>35	21	63.6	12	36.4		
Mother's education						
Tertiary or more	58	62.4	35	37.6	0.261	1.57 (0.71, 3.43)
Less than tertiary	18	51.4	17	48.6		
Social Class						
I	42	63.6	24	36.4	-	1
II	29	59.2	20	40.8	0.627	1.21 (0.57, 2.58)
III	5	38.5	8	61.5	0.091	2.80 (0.82, 9.53)
Housing type						
Storey building	24	46.2	28	53.8	0.012	0.40 (0.91, 0.82)
Bungalow	52	68.4	24	31.6		
Mother's parity						
Nulliparous	17	58.6	12	41.1	0.925	0.96 (0.41, 2.23)
Multiparous	59	59.6	40	40.4		

OR = Odd ratio; CI = Confidence interval.

All (100.0%) the newborns were singleton and delivered at term, 77 (52.3%) were females and 61 (47.7%) were males. Seven (6.4%) of the babies had APGAR scores <7 at 1 minute of life and all (100.0%) babies had Apgar scores ≥7 at 5 minutes of life. Table XVI shows the summary statistics for gestational age, Apgar scores, birth weight, length, head circumference and chest circumference. The mean (SD) birth weight, birth length, head circumference, and chest circumference were 3.1 (0.5) kg, 49.9 (3.0) cm, 34.8 (1.3) cm,

and 32.5 (2.0) cm, respectively. Nine (7.0%) had birthweight <2.5 kg. Table 4 shows the newborn characteristics.

Table 4: The range and mean of the newborn characteristics

Variables	Minimum	Maximum	Mean	Standard deviation
Gestational age (weeks)	37	42	38.5	1.3
Apgar score	5	9	8.1	0.9
Birth weight (kg)	2.00	4.85	3.1	0.5
Length at birth (cm)	41.0	57.3	49.9	3.0
Head circumference (cm)	31.0	38.0	34.8	1.3
Chest circumference (cm)	28.0	41.0	32.5	2.0

Table 5 shows the association between the newborn anthropometry and the maternal vitamin D status. There were no statistically significant associations between the mothers' vitamin D status and the birth weight ($\chi^2=0.120$, $p=0.809$), birth length ($\chi^2=0.370$, $p=0.737$), head circumference ($p=0.347$), and chest circumference ($p=0.266$).

Table 5: Association between newborn anthropometry and maternal vitamin D status.

Variables	Mothers' Vitamin D status				P value	OR (95% CI)
	Deficient		Not Deficient			
	N	%	N	%		
Birth weight (kg)						
<2.5	5	55.6	4	44.4	0.809	0.85 (0.21, 3.31)
≥2.5	71	59.7	48	40.3		
Birth length (cm)						
≤50	30	61.2	19	38.8	0.737	1.13 (0.55, 2.35)
>50	46	58.2	33	41.8		
Head circumference (cm)						
<33 - >37	28	65.1	15	34.9	0.347	1.44 (0.67, 3.07)
33 – 37	48	56.5	37	43.5		
Chest circumference (cm)						
<31 - >35	26	66.7	13	33.3	0.266	1.56 (0.71, 3.43)
31-35	50	56.2	39	43.8		

Table 6 shows the association between the newborn anthropometry and the newborn vitamin D status. There were no statistically significant associations between the newborn vitamin D status and the birth weight ($p=0.730$), birth length ($\chi^2=0.400$, $p=0.856$), head circumference ($\chi^2=2.800$; $p=0.092$), and chest circumference ($\chi^2=0.300$; $p=0.565$).

Table 6: Association between newborn anthropometry and newborn vitamin D status.

Variables	Vitamin D Level in Newborns				P value	OR (95% CI)
	Deficient		Not deficient			
	n	%	n	%		
Birth weight (kg)						
<2.5	4	44.4	5	55.6	0.730	0.79 (0.20, 3.07)
≥2.5	60	50.4	59	49.6		
Baby's length (cm)						
≤50	24	49.0	25	51.0	0.856	0.94 (0.46, 1.91)
>50	40	50.6	39	49.4		
Head circumference (cm)						
<33>37	26	60.5	17	39.5	0.092	1.89 (0.89, 3.99)
33-37	38	44.7	47	55.3		
Chest circumference (cm)						
<31 - >35	21	53.8	18	46.2	0.565	1.25 (0.59, 2.65)
31-35	43	48.3	46	51.7		

There was a statistically significant positive correlation between the newborn vitamin D levels and the mothers (correlation coefficient $r = 0.613$; $p < 0.001$). Figure 2 shows the scatter plot of the relationship between maternal and newborn vitamin D levels.

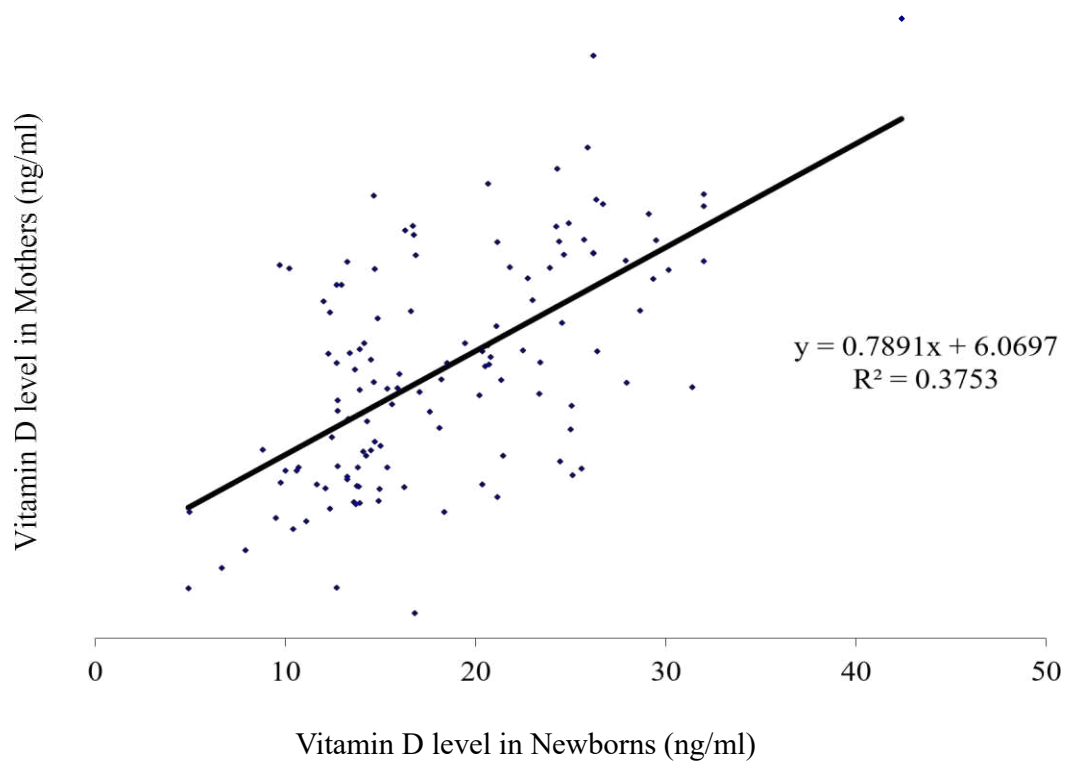


Figure 2: Scatter plots of the relationship between the maternal and newborn vitamin D levels

The association between the mothers and newborn vitamin D status is as shown in Table 7. The odds of vitamin D deficiency in newborns were 6.12 times higher when mothers were deficient than in the non-deficient and the association was statistically significant (OR = 6.12; 95% CI = 2.78, 13.48, $p = 0.043$).

Table 7: The association between the maternal and newborn vitamin D status

Mothers' vitamin D level	Newborns vitamin D level					
	Deficient		Not Deficient		Total	
	N	%	N	%	n	%
Deficient	51	79.7	13	20.3	64	100.0
Not Deficient	25	39.1	39	60.9	64	100.0
Total	76	59.4	52	40.6	128	100.0

Odds Ratio = 6.12, 95% Confidence Interval = 2.78, 13.48, $p = 0.043$

DISCUSSION

This present study revealed varying degrees of vitamin D deficiency among parturient mothers and their newborns. The maternal serum vitamin D and the cord vitamin D levels of their respective newborn had a clear relationship, suggesting that low serum levels in the mother indicate similarly low levels in the newborn. The high prevalence of vitamin D deficiency and insufficiency observed among parturient women in our study is comparable with reports from India [9], Qatar [12], and China [21]. However, the present study demonstrated a higher prevalence than what was reported in studies from Lagos and Anambra, Nigeria [22,23]. Cultural behaviour, nutritional, and religious differences between these Nigerian women living with different tribes and states of origin, may explain these variations in vitamin D status of studied population of mothers in these recent studies in Oyo, Lagos and Anambra states [22,23]. It was also higher than what was reported in Greece [24].

Previous studies have attributed variations in the burden of vitamin D deficiency across countries to similarities and differences in sunlight exposure. It is therefore conceivable that the comparably low prevalence in Australia and Greece is compatible with the abundance of sunlight at these locations. On the other hand, the high prevalence of vitamin D deficiencies observed in India [9], Qatar [12], China [21], and Iran [8] was likely due to reduced sunlight exposure. Whilst women in those countries [8,9,12,21] wear dresses that limit their exposure to sunlight and practice Islam which promotes the religious practice of wearing veil (hijab or niqab) and culture of keeping women indoors, the women in Nigeria are relatively outgoing and experience a relatively higher degree of sunlight exposure. It is therefore unexpected that the prevalence reported among parturient women in our study would be similar to those countries [8,9,12,21].

The geographical position of Nigeria, the current research area, is latitude 9° 4' 55.2" North, which is at a solar zenith angle much like the Indian latitude 8° 4'N to 37° 6'N and explains in part the similarity in the prevalence of maternal vitamin D deficiency in our study and the Indian study [9]. However, the production of vitamin D is expected to be maximum at this angle, since people living in the far northern and southern hemispheres of the equator hardly make any vitamin D₃ for up to 6 months in the year [2]. Consequently, the prevalence of vitamin D deficiency in these two countries is expected to be much lower than what is documented due to their proximity to the equator. Nonetheless, other factors that reduce the skin's ability to produce vitamin D₃ could explain the high level of deficiency. These factors include poor intake of food enriched with vitamin D, air pollution with toxic chemicals that deplete the protective ozone layer in the atmosphere, skin tone (dark pigmented skin), use of sunscreen for fashion purposes, especially body creams containing sun protection factors. Some of the creams can absorb approximately 95-98% of solar UVB radiation. [25]. It has also been shown that dark-skinned people populating regions like Nigeria and India have reduced skin's ability to produce vitamin D₃ by the same amount [25].

The mean serum maternal vitamin D level in this current study was 18.28 (6.69) ng/ml, while the newborn value was 20.5 (8.6) ng / ml; both of which were within the deficiency range. Like other research, a strong positive correlation between maternal and cord blood vitamin D was found [8-10,24].

The level of newborn cord serum vitamin D is higher than that of the maternal level although both are within the range of deficiencies. The same phenomenon was observed in other studies where the mean vitamin D values of newborns were found to be higher than maternal values, although, they were all within the deficiency range [24,26,27]. This phenomenon could be explained by the "free metabolite index", describing the maternal-

foetal gradient for vitamin D. The free vitamin D concentration in foetal circulation exceeds maternal levels due to the differences in the vitamin D binding protein concentration of the two bloodstreams [28]. This gradient is the resultant effect of increments and gradual increase in maternal serum vitamin D binding protein concentration from the first trimester of pregnancy through the third trimester, resulting in free vitamin D concentration in foetal circulation exceeding maternal levels of vitamin D, as noted in this current study [29].

The study reported the lowest deficiency prevalence rate ever despite the low sunlight level in that environment [30]. The prevalence rate of deficiency reported in the current study was expected to be much lower than other studies because women who participated in this study were more exposed to sunlight because of the environmental condition. Hence, this difference indicates that it is not only the amount of sunlight available that determines the status of vitamin D in any population. Other factors should be considered, such as diet, type of dressing (degree of body exposure to sunlight), and sociocultural attitude. Findings from our research add to the evidence that cord blood vitamin D was positively and substantially associated with maternal values. This is understandable because newborn plasma levels of vitamin D are equivalent to about 60-70 percent of maternal levels [3,6,7]. This explains the trend of vitamin D levels observed in the newborns, which signifies the importance and the need for vitamin D supplementation for pregnant mothers as it reflects in that of the newborns.

In our study, low vitamin D status was observed in all age groups of women regardless of their age, as no significant association between age and vitamin D level was found in these mothers. Furthermore, low vitamin D status was found to be independent of the educational level, social class, type of delivery, weight, and parity. While more women in social class 1 (high socioeconomic class) had low levels of vitamin D relative to mothers

in social classes 2 and 3 (lower socioeconomic class), similar to the Okonofua et al [13] study showing higher levels of plasma vitamin D in non-purdah clad pregnant women belonging to lower socio-economic groups. This is contrary to the reports of Nicolaidou et al [24], Al-Wassia et al [27], and Ozdemir et al [31], which stated that, mothers with low socioeconomic status were more likely to be vitamin D deficient compared to subjects with higher socioeconomic status. From different study locations, Sachan et al [9] and Hosseinzadeh et al [32] established that the socioeconomic status of pregnant women who took part in their studies had no significant effect on vitamin D status.

Interestingly, housing type has a statistically significant association with maternal vitamin D status in this present study. This result is consistent with the study conducted among African migrant women living in high-rise public housing in Melbourne, Australia who were at higher risk of vitamin D deficiency due to extreme difficulty in getting enough outdoor time, making it difficult for them to gain sufficient exposure to the Sun [33]. This is also related to sun exposure, because mothers living in bungalows have little or no difficulty coming out to observe their daily routine home activities, thereby having regular sun exposure unlike the subjects living in storey buildings who most of the times, have difficulty climbing or descending staircases to perform their routine work, subsequently having inadequate sun exposure.

In this present study, there was no association between the newborn vitamin D level and their anthropometric indices. Other studies also reported similar outcomes [26,34]. The study done by Sathish et al [35], however, reported a statistically significant relationship between maternal/cord vitamin D levels and newborn anthropometry. Other study reported a significant correlation between maternal vitamin D level and newborn birth length [36].

The limitation of this study was the single site used hence, the findings might not be used to represent the general population in Oyo state since it was a hospital-based. However, the findings could be a vital stepping stone for future studies.

In conclusion, vitamin D deficiency is high among parturient mothers and their newborns and there was a strong positive correlation between the maternal serum vitamin D and the cord vitamin D level of their respective newborn. Hence, there is a need for pregnant women to receive pre-conceptional and antenatal vitamin D supplementation. Although, the anthropometry of the newborns is not related to the maternal and newborn vitamin D status there is need for further study on newborn vitamin D and its effect on the newborn.

DECLARATIONS

Ethical approval and consent to participate: The study was approved by the University of Ibadan/University College Hospital Ethics Committee of the College of Medicine, University of Ibadan, Ibadan, Nigeria with the number UI/EC/13/0335. The written informed consent was obtained from the mothers following the provision of a detailed explanation of the study as well as assurance of the freedom to participate without any threat of sanction or unfavourable treatment. The data collection instrument had no personal identification information. All participants were identified using only serial numbers. Data was secured by password-protecting the research-related data. The study adhered to the Declaration of Helsinki.

Consent for publication: The consent for publication has been obtained.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest – The authors declare that they have no competing interests.

Funding – There was no financial support of any kind, either in terms of grants or equipment or otherwise.

Authors' contribution:

KFF, OOJ, OOT, MAK: Concept and design of the study, acquisition of data, analysis of data, interpretation of data, drafting the article, and final approval of the version to be published.

OOS, AAA, BEO, AEO, OOA, AJK: Concept and design of the study, interpretation of data, drafting the article, revising it critically for important intellectual content, and final approval of the version to be published.

Acknowledgements: We acknowledged the resident doctors in the Department of Paediatrics University of Ibadan, Oyo State, Nigeria who helped in the recruitment of the participants.

REFERENCES

1. Bendik I, Freidel A, Roos F, Weber P, Eggersdorfer M. Vitamin D: a critical and essential micronutrient for human health. *Frontiers in Physiology*. 2014; 5:1-14.
2. Nikooyeh B, Abdollahi Z, Shariatzadeh N, Kalay Ai, Zahedirad M, Neyestani T. Effect of latitude on seasonal variations of vitamin D and some cardiometabolic risk factors: national food and nutrition surveillance. *East Mediterr Health J*. 2021;27(3):269-278.
3. Thandrayen K, Pettifor J. Implications for the development of infantile nutritional rickets. *Rheum Dis Clin North Am*. 2012; 38:61-79.
4. Bikle DD. Vitamin D: Production, Metabolism, and Mechanism of Action. [Updated 2025 Jun 15]. In: Feingold KR, Adler RA, Ahmed SF, et al., editors. *Endotext* [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK278935/>. (Accessed 15 July,2026).
5. Octavia L, Nabila P, Panjarwanto DA, Geany PL, Kosen YD, Rahman AA, et al. The role of vitamin D deficiency in fetal growth restriction: a systematic review. *Front. Med*. 2026; 12:1725177. doi: 10.3389/fmed.2025.1725177
6. Hamilton S, McNeil R, Hollis B, Davis D, Winkler J, Cook C, et al. Profound vitamin D deficiency in a diverse group of women during pregnancy living in a sun rich environment at latitude 32 degrees North. *Int J Endocrinol*. 2010; 917428:1-10.
7. Chien MC, Huang CY, Wang JH, Chia-Lung S, Pensee W. Effects of vitamin D in pregnancy on maternal and offspring health-related outcomes: An umbrella review of systematic review and meta-analyses. *Nutr. Diabetes*. 2024;14: 35. <https://doi.org/10.1038/s41387-024-00296-0>
8. Tabrizi R, Moosazadeh M, Akbari M, Dabbaghmanesh MH, Mohamadkhani M, Asemi Z, et al. High Prevalence of Vitamin D Deficiency among Iranian Population: A

Systematic Review and Meta-Analysis. Iran J Med Sci. 2018 Mar;43(2):125-139. PMID: 29749981; PMCID: PMC5936844.

9. Chacham S, Rajput S, Gurnurkar S, Mirza A, Saxena V, Dakshinamurthy S, et al. Prevalence of Vitamin D Deficiency Among Infants in Northern India: A Hospital Based Prospective Study. *Cureus*. 2020; 12(11): e11353. DOI 10.7759/cureus.11353

10. Kanike N, Hospattankar KG, Sharma A, Worley S, Groh-Wargo S. Prevalence of Vitamin D Deficiency in a Large Newborn Cohort from Northern United States and Effect of Intrauterine Drug Exposure. *Nutrients*. 2020; 12(7):2085.

11. Vandevijvere S, Amsalkhir S, Van Oyen H, Moreno-Reyes R. High Prevalence of Vitamin D deficiency in pregnant women: A National Cross Sectional Survey. *PLoS One*. 2012; 7:1-9.

12. AL Emadi S, Hammoudeh M. Vitamin D study in Pregnant women and their babies. *Qatar Med J*. 2013; 1:32-7.

13. Okonofua F, Houlder S, Bell J, Dandona P. Vitamin D nutrition in pregnant Nigerian women at term and their newborn infants. *J Clin Pathol*. 1986; 39:650-3.

14. Sanchez P, Idrisa A, Bobzom D, Airede A, Hollis B, Liston D, et al. Calcium and Vitamin D Status of Pregnant Teenagers in Maiduguri, Nigeria. *J Natl Med Assoc*. 1997; 89:805-11.

15. Nema J, Wadhwani N, Randhir K, Dangat K, Pisal H, Kadam V, et al. Association of maternal vitamin D status with the risk of preeclampsia. *Food Funct*. 2023;14(10):4859-4865. doi: 10.1039/d3fo00007a. PMID: 37129568.

16. Ma R, Gu Y, Zhao S, Sun J, Groome L, Wang J. Expressions of vitamin D metabolic components VDBP, CYP2R1, CYP27B1, CYP24A1, and VDR in placentas from normal and preeclamptic pregnancies. *Am J Physiol Endocrinol Metab*. 2012; 303:928-35.

17. Tynadall J, Okoye V, Elumelu F, Dahiru A, Pariya A. Vitamin A and Iron deficiency in pregnant women, lactating mothers and their infants in Adamawa State, Nigeria: a prospective cohort study. *Am J Food Nutr.* 2012; 2:14-20.
18. Uchendu F. Micronutrient Malnutrition: A tragedy to childhood growth and education. *Glob J Med RES.* 2011; 11:27-34.
19. Oyedeji G. Socioeconomic and cultural background of hospitalized children in Ilesa. *Paediatr* 1985; 12:111-7.
20. Holick M, Binkley N, Bischoff-Ferrari H, Gordon C, Hanley D, Heaney R, et al. Evaluation, Treatment, and Prevention of Vitamin D Deficiency: An Endocrine Society Clinical Guideline. *J Clin Endocrinol Metab.* 2011; 96:1911-30.
21. Wang J, Yang F, Mao M, Liu D, Yang H, Yang S. High Prevalence of Vitamin D and Calcium Deficiency among Pregnant women and their newborns in Chengdu, China. *World J Pediatr.* 2010; 6:265-7.
22. Black L, Seamans K, Cashman K, Kiely M. An Updated Systematic Review and Meta-Analysis of the Efficacy of Vitamin D Food Fortification. *The Journal of Nutrition.* 2012; 142: 1102-1108.
23. Kühn J, Schutkowski A, Kluge H, Hirche F, Stangl G. Free-range farming: a natural alternative to produce vitamin D-enriched eggs. *J Nutr.* 2013; 30:481-4.
24. Nicolaidou P, Hatzistamatiou Z, Papadopoulou A, Kaleiyas J, Floropoulou E, Lagona E, et al. Low vitamin D Status in Mother-Newborn Pairs in Greece. *Calcif Tissue Int.* 2006; 78:337-42.
25. Holick M. Vitamin D deficiency. *N Eng J Med.* 2007; 357:309-14.
26. Rajoria N, Gupta N, Rajoria R, NB R. Study of Association Between Maternal 25-Hydroxy Vitamin D3 Level and Neonatal Outcome. *SJAMS.* 2016; 4:2588-92.

27. Al-Wassia H, Abo-Ouf N. Prevalence of Vitamin D Deficiency in mother-infant pairs in a Tertiary Hospital in the West Coast of Saudi Arabia. *J Clin Neonatol*. 2016; 5:243-6.
28. Wierzejska R, Jarosz M, Kleminska-Nowak M, Tomaszewska M, Sawicki W, Bachanek M, et al. Maternal and Cord Blood Vitamin D Status and Anthropometric Measurements in Term Newborns at Birth. *Front Endocrinol*. 2018; 9:1-6.
29. Royal College of Obstetricians and Gynaecologists. Vitamin D in Pregnancy. Scientific Impact paper. 2014; 43:1-11.
30. Goswami A, Yadav S, Khan SS, Nigam A, Alam S. Vitamin D Status and Calcium Homeostasis in Mother and Newborn Dyad: A Hospital Based Study from South Delhi. *Indian J Endocrinol Metab*. 2026;30(1):51-57. doi: 10.4103/ijem.ijem_799_25. Epub 2026 Feb 27. PMID: 41918596; PMCID: PMC13035297.
31. Ozdemir A, Gundemir T, Kucuk M, Sarici D, Elgormus Y, Cag Y, et al. Vitamin Deficiency in Pregnant Women and Their Infants. *J Clin Pediatr Endocrinol*. 2018; 10:44-50.
32. Hosseinzadeh Z, Kazemian M, Mashak B, Torkmandi H, Badfar G. Vitamin D Status in Pregnant Women and Their Newborns in Karaj: A Cross-Sectional Study in Iran. *Int J Pediatr*. 2018; 6:7117-27.
33. Horton-French K, Dunlop E, Lucas R, Pereira G, Black L. Prevalence and Predictors of Vitamin D Deficiency among African Immigrants Living in Australia. *Int Environ Res Public Health*. 2019;2855(16):1-9.
34. Kalra P, Das V, Agarwal A, Kumar M, Ramesh V, Bhatia E, et al. Effect of vitamin D supplementation during pregnancy on neonatal mineral homeostasis and anthropometry of the newborn and infant. *British Journal of Nutrition*. 2012; 108:1052-58.

35. Sathish P, Raveendran S, Padma R, Balakrishnan D, Muthusami M. Correlation between maternal and neonatal blood vitamin D levels and its effect on the newborn anthropometry. *Int J Reprod Contracept Obstet Gynecol*. 2016; 5:2983- 88.
36. Song S, Si S, Liu J, Chen X, Zhou L, Jia G, et al. Vitamin D status in Chinese pregnant women and their newborns in Beijing and their relationships to birth size. *Public Health Nutrition*. 2012; 16:687-92.