International Journal of Medicine

journal homepage: www.ijmjournal.org

Original Research Article

Vitamin D Levels in Cord Blood and Their Relationship With Body Measurements in Full Term, Appropriate for Gestational Age Infants: A Cross-Sectional Study

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HIGHLIGHTS

1. Cord blood vitamin D levels in full-term infants.
2. Study explores links with body measurements.
3. Examines impact on gestational age.
4. Crucial for growth and development.
5. Highlights importance of

ARTICLE INFO

Handling Editor: Dr. S.K. Singh

Key words:
Vitamin D Levels
Cord Blood
Anthropometric Measurements

ABSTRACT

INTRODUCTION: Vitamin D deficiency is a global issue, affecting populations worldwide, including in India. Insufficient vitamin D levels during pregnancy can result in similar deficiencies in the fetus, adversely affecting fetal development due to its critical role in calcium regulation and skeletal formation. **OBJECTIVE:** The study aims to assess vitamin D levels in neonatal cord blood and explore their association with the anthropometric measurements of term newborns who are appropriate for their gestational age. **MATERIALS AND METHODS:** This cross-sectional research was conducted at a major health facility. The study included **200 TERM** newborns, appropriately sized for their gestational age. Measurements of vitamin D (25(OH)D) levels and various growth metrics were recorded at birth. Statistical analysis was performed, with significance assessed using Analysis of Variance (ANOVA). **RESULTS:** Cord blood analysis revealed vitamin D levels were deficient (less than 12 ng/dL) in 42.5% of samples, insufficient (less than 20 ng/dL) in 43.28%, and sufficient (above 20 ng/dL) in 14.22% of samples. No significant correlations were observed between the vitamin D levels in the cord blood and the neonates weight, length, and head circumference at birth ($p>0.05$). **CONCLUSION:** The study documented a significant prevalence of vitamin D deficiency and insufficiency in neonatal cord blood. However, these vitamin D levels did not show a correlation with the anthropometric outcomes of the infants.

INTRODUCTION

Vitamin D, classified as a steroid hormone, plays a pivotal role in numerous bodily functions and impacts nearly every tissue. Predominantly synthesized through the exposure of skin to solar ultraviolet-B (UV-B) radiation, this process transforms 7-dehydrocholesterol into vitamin D, fulfilling around 90% of the human body's requirements for this nutrient. Despite India's tropical climate, a significant proportion of the population, ranging from 40% to 90%, suffers from vitamin D deficiency. This deficiency not only affects adults but also extends to neonates, leading to potential adverse effects on their growth metrics[1-3].

In addition to its well-known benefits for bone health, vitamin D is also involved in metabolic processes such as the secretion of Insulin-like Growth Factor 1 (IGF-1) and its binding protein, IGFBP-3, as well as the modulation of IGF-1 receptors across various tissues. Maintaining adequate levels of vitamin D is therefore crucial for optimal health and growth[4-6].

The American Academy of Pediatrics advocates for a minimum serum vitamin D concentration of 32 ng/mL in pregnant women to support the optimal development of the fetus. Contrastingly, the Indian Academy of Pediatrics defined different thresholds in their 2017 guidelines, which were updated in 2021: levels below 12ng/mL

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Received 28 April 2023; Received in revised form 19 May 2024; Accepted 24 May 2024

are considered deficient, between 12-20 ng/mL as insufficient, and above 20 ng/mL as sufficient. The US Endocrine Society also categorizes vitamin D status into deficiency (less than 20 ng/mL), insufficiency (21-30 ng/mL), and sufficiency (more than 30 ng/mL)[7-10].

The relationship between high vitamin D levels in cord blood and fetal growth remains uncertain, with studies reporting varied findings that suggest positive, negative, or no correlations with neonatal physical dimensions at birth. The objective of this study is to assess the status of vitamin D in cord blood and explore its association with the anthropometric outcomes of newborns who are full-term and of appropriate gestational age. This research focuses exclusively on healthy, breastfed infants, creating a consistent and specific group for analysis[11-14].

MATERIALS AND METHODS

This study was a cross-sectional analysis carried out at the MRA Medical College,Ambedkarnagar, U.P India. The research spanned from July 2023 to April 24. Ethical approval was secured from the institutional ethical committee. Parental consent was also duly obtained for each participant involved in the study.

Inclusion Criteria

The study included a total of 200 neonates who were born at term (37 completed weeks or more) and were appropriate for gestational age with a birth weight of at least 2.5 kg. These participants were all from the specified study center, covering the duration from July 2023 to April 24.

Exclusion Criteria

Neonates were excluded from the study if they required resuscitation at birth or were delivered using instrumental methods. Additional exclusion criteria included neonates presenting with cephalohematoma, those diagnosed with major congenital anomalies, or any neonates who were admitted to the Neonatal Intensive Care Unit (NICU) for any reason during the study period. This selection process ensured a homogeneous sample by excluding those with conditions that could potentially confound the results related to vitamin D impact on neonatal growth metrics.

PROCEDURE

The process for collecting and measuring data in this study was meticulously designed to ensure accuracy and reliability of the findings related to neonatal growth and vitamin D status.

Anthropometric Measurements

Within the first 24 hours of life, key anthropometric measurements of the newborns were taken. The baby's weight was accurately measured using an electronic weighing scale, with a precision of ±10 grams. Length was assessed using an infantometer, ensuring a measurement accuracy of 0.5 centimeters. The head circumference was determined with a flexible, non-stretchable tape, also with an accuracy of 0.5 centimeters.

Collection and Analysis of Umbilical Cord Blood

Umbilical cord blood samples, amounting to 3cc, were collected immediately after birth by proficient nursing staff. These samples, amounting to 3cc, were collected immediately after birth by proficient nursing staff. These samples were promptly processed to separate the serum, which was then stored at -20°C until further analysis. The vitamin D levels were measured using an automated chemiluminescent immunoassay method to determine the concentration of 25-hydroxyvitamin D (25(OH)D).

Definition of Vitamin D Status

The study adhered to the Indian Academy of Pediatrics (IAP) guidelines to classify the vitamin D status of the samples. According to these guidelines:

Concentrations of vitamin D less than 12 ng/mL in the cord blood were classified as deficient.

Levels between 12 and 20 ng/mL were considered insufficient.

A concentration exceeding 20 ng/mL was deemed sufficient.

This classification was essential for evaluating the correlation between vitamin D levels and the physical development of neonates at birth.

STATISTICALANALYSIS

The statistical evaluation of the data collected in this study was conducted using SPSS (Statistical Package for the Social Sciences) version 28. This advanced software facilitated comprehensive analysis to ensure robust and reliable results. A p-value of less than 0.05 was established as the threshold for statistical significance. This standard is widely accepted in the scientific community for determining the likelihood that the observed differences or relationships are not due to random chance. The main statistical method employed was the Analysis of Variance (ANOVA). This technique was chosen to compare the mean differences across multiple groups, particularly useful in assessing the varying levels of vitamin D status and their impact on neonatal anthropometric measurements. The ANOVA test helps in identifying whether any statistically significant differences exist between the groups of neonates categorized by their cord blood vitamin D concentrations.

RESULTS

The study successfully enrolled 120 newborns, providing a balanced demographic spread of 55 male neonates (45.84%) and 65 female neonates (54.16%). The collected data revealed key insights into the physical attributes of the babies at birth and their vitamin D levels. The mean weight for deficient, insufficient and sufficient was recorded as 2880.00 ± 220.00, 2920.00 ± 260.00 and 2885.00 ± 225.00 grams, respectively. The mean length (cm) for deficient, insufficient and sufficient was recorded as 51.80 ± 2.00, 51.75 ± 1.60 and 51.60 ± 1.50 cm, respectively. The mean Head Circumference (cm) for deficient, insufficient and sufficient was recorded as 35.85 ± 1.10, 36.05 ± 1.15 and 36.00 ± 1.10 cm, respectively.The mean vitamin D concentration in the cord blood was 15.18 ng/mL, with a standard deviation of ±5.97 ng/mL.

Table 1: Association of Vitamin D with anthropometry.

Vitamin D Levels	Weight (kg)	Length (cm)	Head Circumference (cm)	p-value
Deficient	2880.00 ± 220.00	51.80 ± 2.00	35.85 ± 1.10	0.250
Insufficient	2920.00 ± 260.00	51.75 ± 1.60	36.05 ± 1.15	0.255
Sufficient	2885.00 ± 225.00	51.60 ± 1.50	36.00 ± 1.10	0.290

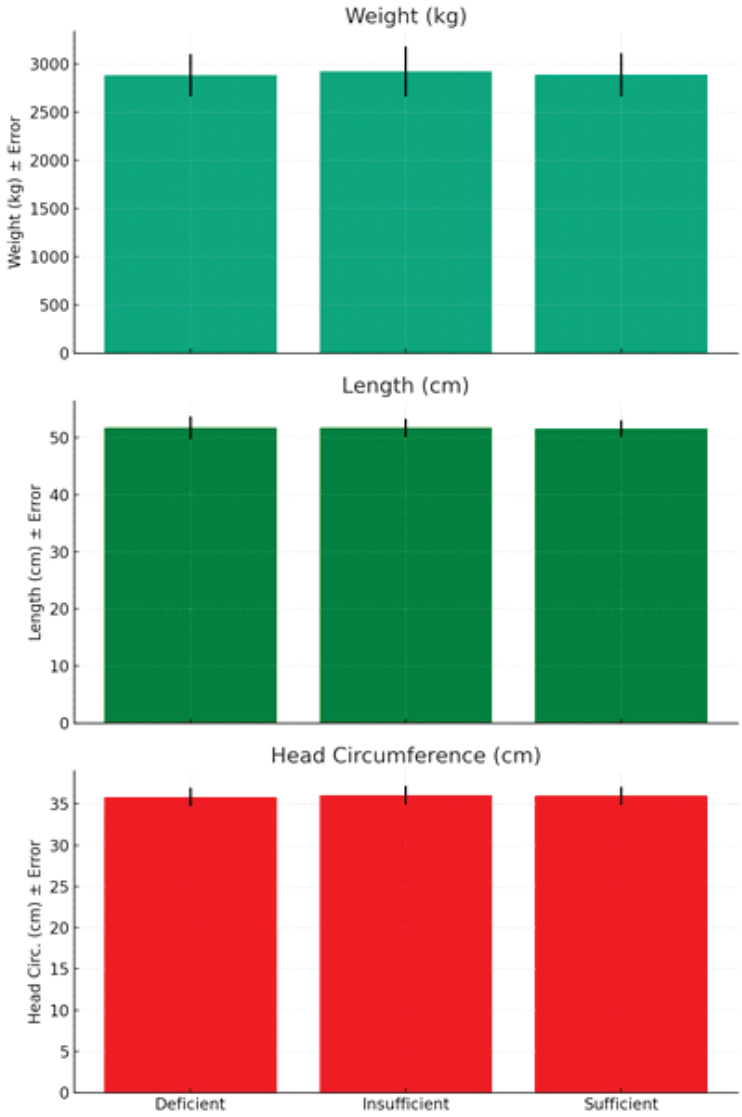

Figure 1: Graphical representation of association of vitamin D with anthropometry.

These results underscore the variations in birth metrics and vitamin D levels among the newborns, providing a foundation for further analysis to explore correlations between vitamin D status and neonatal growth parameters.

In the study, vitamin D levels in the cord blood of newborns varied significantly, with 42.5% showing deficiency at levels below 12 ng/dL, 43.28 % being insufficient with levels below 20 ng/dL, and 14.22% classified as sufficient with levels exceeding 20 ng/dL. The neonates with vitamin D deficiency had an average birth weight of 2880 grams, a centimeters, and a head circumference of 35.85 centimeters. For those in the insufficient and sufficient vitamin D groups, the mean birth weights were 2920 grams and 2885 grams, respectively. Statistical analysis revealed no significant correlation between neonatal anthropometric measurements and vitamin D levels in cord blood, as indicated by p-values greater than 0.05 for each measured parameter. This suggests that other factors might play a more critical role in influencing these neonatal outcomes.

DISCUSSION

This study focused exclusively on term, healthy, and appropriately gestational-aged infants. Notably, despite prevalent low vitamin D levels among mothers, as indicated by the maternal cord blood levels, the neonates' average anthropometric parameters remained consistent with other reported values across the Indian subcontinent [15-17].

A significant finding was that 85.78% of the mothers exhibited low vitamin D levels (less than 20 ng/mL), according to the Indian Academy of Pediatrics (IAP) guidelines, with the average cord blood vitamin D level at 14.98 ng/mL. This prevalence of vitamin D deficiency aligns with other Indian studies; for example, Mohapatra JN et al. reported a deficiency in 86.69% of cord blood samples at an average of 18.39 ng/mL. Similarly, Sachan A et al. found an extremely low average of 8.4 ng/mL in cord blood, with 95.7% of mothers below the 20 ng/mL threshold. Contrary to various studies that suggest a positive correlation between neonatal anthropometric measurements and cord blood vitamin D levels, our findings did not establish any significant associations. Several similar observations have been noted in other research[18-20].

Wierzejska R et al. observed no relationship between vitamin D levels in maternal and neonatal cord blood and various neonatal measures such as weight, length, head, and chest circumference [21]. Loudyi FM et al. found no link between maternal vitamin D status and neonatal weight among mothers, 90% of whom were deficient in vitamin D. Rodriguez A et al. reported in their study on the Spanish population that higher cord blood vitamin D levels correlated with smaller head circumferences in neonates, though no significant associations were found for length and weight [22]. Eggemoen AR et al., in a multi-ethnic study involving 719 pregnant women, also reported no significant connections between neonatal anthropometric outcomes and maternal vitamin D levels [23]. Similarly, Farrant HJW et al. found no correlation between neonatal body measurements and maternal vitamin D status in their study on Indian mothers. Tiwari et al., 2024 study shows that vitamin D levels were deficient (<12 ng/dL) in 80 (40%) samples, insufficient (<20 ng/dL) in 93 (46.5%) samples, and sufficient in 27 (13.5%) samples of cord blood. No significant relationship was found between cord blood vitamin D concentrations and neonatal weight, length, and head circumference at birth ($p>0.05$)[24,25].

These findings suggest that while vitamin D deficiency is widespread among pregnant mothers in India, its direct influence on neonatal physical development at birth appears limited. This discrepancy points to the possibility of other determining factors that influence neonatal anthropometry more significantly than maternal vitamin D levels alone. Further research could explore these factors to better understand the complex dynamics affecting neonatal growth and development.

LIMITATIONS

One notable limitation of this study is the exclusion of maternal nutritional data and maternal serum vitamin D levels pregnancy from the analysis. These factors are crucial as they can significantly influence fetal development and the physical anthropometry of newborns. By not accounting for these variables, the study may not fully capture the broader spectrum of influences on neonatal growth metrics. This omission could affect the interpretation of the relationship—or lack thereof—between neonatal anthropometric outcomes and cord blood vitamin D levels. Future studies should consider including these elements to provide a more comprehensive understanding of the factors that impact newborn development.

CONCLUSIONS

The findings of this study highlight a substantial prevalence of vitamin D deficiency in cord blood among newborns in India, a country known for its ample sunlight exposure. Despite these deficiencies, no statistically significant correlations were found between the levels of vitamin D in cord blood and the neonatal anthropometric measurements (weight, length, and head circumference) at birth. Given the inconsistency in results across various studies regarding the impact of vitamin D on neonatal growth outcomes, our study underscores the need for further research. A comprehensive and well-structured prospective study or a meta-analysis would be beneficial to clarify and conclusively determine the effects of cord blood vitamin D levels on the physical development of neonates. Such studies could help resolve the conflicting findings and guide future interventions aimed at improving maternal and neonatal health outcomes related to vitamin D status.

CONFLICTS OF INTEREST

Authors declared that there is no conflict of interest.

FUNDING

None

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

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