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Association Between Maternal Blood Vitamin D Levels And Neonatal Anthropometry In A Tertiary Care Hospital In Chennai

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ABSTRACT:-

INTRODUCTION:-

Vitamin D deficiency is surprisingly common in tropical nations like India, despite abundant sunlight. While vitamin D can be obtained from fish oil, fortified foods, and supplements, sunlight remains the primary source, and insufficient UVB exposure contributes to widespread deficiency. Pregnant women are particularly vulnerable, as they need adequate levels for both their own health and fetal development. Studies from countries like Turkey, Greece, Iran, Australia, and Pakistan have shown high rates of vitamin D deficiency in pregnant women and newborns, with similar trends observed among Indian women. Maintaining adequate vitamin D levels during pregnancy is critical for maternal and child health.

AIM & OBJECTIVES: This study aims to evaluate vitamin D deficiency in pregnant women and its correlation with neonatal anthropometric measurements. The objective is to assess maternal vitamin D levels and their impact on newborn growth.

MATERIALS & METHODS: A cross-sectional study was conducted at Sree Balaji Medical College in Tamil Nadu, including 88 healthy mothers of singleton births. Maternal and cord blood were analyzed for 25(OH)D3 using chemiluminescence immunoassay. Neonatal anthropometric data were recorded, and statistical analysis was done using SPSS.

RESULTS: Of the mothers, 51% were moderately vitamin D deficient, and 13% had sufficient levels. Among newborns, 84.1% had normal birth weights, and significant correlations were found between maternal vitamin D levels and neonatal measurements.

CONCLUSION: This study suggests that maternal vitamin D levels influence newborn anthropometry, emphasizing the need for adequate vitamin D levels during pregnancy. Larger studies are needed to confirm these findings before implementing supplementation programs.

INTRODUCTION:-

Vitamin D deficiency is unexpected in a tropical nation like India, where there is plentiful sunlight throughout the year. Although vitamin D can be found in fish oil, fortified foods, and dietary supplements, relying solely on diet does not fulfil the body's requirements. A lack of ultraviolet B (UVB) radiation, which limits the skin's ability to produce vitamin D, significantly contributes to this deficiency(1,2).

During pregnancy, women need to satisfy their own vitamin D requirements while also supporting the development of their foetus. Consequently, it is particularly important for pregnant women to maintain adequate vitamin D levels compared to other groups(3). Increasing evidence suggests that vitamin D status during pregnancy is essential for maternal health, foetal growth, and favorable outcomes for newborns, as well as for the future health of children(4-7).

Studies have shown a high incidence of vitamin D deficiency among pregnant women and their infants in Turkey, Greece, and Iran(8-10), with assessments made through cord blood analysis. An Australian investigation revealed that insufficient prenatal and postnatal vitamin D levels elevate the risk of deficiency and hinder proper bone development in breastfed infants. Likewise, research from Pakistan documented widespread vitamin D deficiency among pregnant women, demonstrating a link between maternal and cord blood vitamin D levels(11-13). Notably, pregnant women of Indian origin are particularly susceptible to vitamin D deficiency(14-16).

The present study was conducted among women at a tertiary care facility in Chennai, with the objective of evaluating vitamin D deficiency in pregnant women and their newborns. It aimed to investigate the correlation between maternal and neonatal vitamin D levels and to assess its effects on newborn anthropometry.

AIMS AND OBJECTIVES:-

Aim:

The present study has been done to evaluate the association between the levels of vitamin D in the maternal blood and corresponding neonatal anthropometric measurements.

Objectives:

The objective of the study has been to measure the Vitamin D levels in the maternal blood and to evaluate its impact on the neonatal anthropometric measurements which is a direct reflection of the growth and well-being of the neonate.

MATERIALS AND METHODS:-

Study design:

This cross-sectional, hospital-based study was conducted at the obstetrics and gynaecology department of Sree Balaji Medical College and Hospital, India (Tertiary care centre predominantly catering to the needs of the poorer population of Tamil Nadu). A total of 88 consecutive singleton healthy mothers with no co-morbidities, immediately after delivery were included. Twin or multiple pregnancies, congenital anomalies in the newborn and liver and kidney disorder subjects were excluded from the study. Informed consent was obtained from each study subject after the nature of the study was fully explained. The Institutional ethical clearance was obtained to conduct the study.

The sample size was calculated using the following formula:-:

Dobson's formula

n=Z2(1-α/2)PQ/ d2 n=88

$Z^2_{(1-\alpha/2)}$ – Level of confidence 95% which is 1.96

P- Approximate proportion of outcome. The prevalence of vitamin deficient mothers is 64.06%

ELIGIBILITY CRITERIA:-

Inclusion criteria:

Full term healthy mothers without any co morbidities immediately after delivery and her newborn will be included.

Exclusion criteria:

- Women with preterm delivery, multiple pregnancy, pregnancy-induced hypertension, chronic illness, diabetes mellitus chronic heart disease, hepatic or renal impairment, tuberculosis and fat malabsorption diseases will be excluded from the study.
- Women using medications known to affect bone metabolism, for example, anticonvulsants, corticosteroids, rifampicin, cholestyramine, isoniazid and theophylline, will be excluded from the study
- Children with congenital anomalies and babies in NICU

STUDY METHODOLOGY:

Maternal information, including age, height, weight, parity, education, occupation, family income, and obstetric history (gestational age, term of delivery), was documented. Cord blood was collected at birth to measure vitamin D levels. Newborn measurements such as birth weight, height, and head and neck circumference were recorded. Socioeconomic status was determined based on education, occupation, and per capita family income. Maternal blood samples were analyzed for 25(OH)D3 levels using a chemiluminescence immunoassay (CLIA). Vitamin D deficiency was classified according to Institute of Medicine (IOM) criteria: severe deficiency (<10 ng/mL), deficiency (<20 ng/mL), insufficiency (20-30 ng/mL), and sufficiency (>30 ng/mL).

Statistical analysis: Data were processed using SPSS software. Chi-square and ANOVA tests were used to compare vitamin D levels between mothers and newborns and to identify predictors of deficiency. A p-value of <0.05 was considered statistically significant.

RESULTS:-

Table 1: Socio-Demographic Characteristics

S.NO	SOCIO-DEMOGRAPHIC VARIABLE	FREQUENCY (N=88)	PERCENTAGE (%)
1.	AGE (years)		
	22-26	37	42
	27-31	38	43.2
	>32	13	14.8
2.	EDUCATION		

	Illiterate	10	11.4
	Primary school	5	5.7
	Middle school	3	3.4
	High School	5	5.7
	Diploma	15	17.0
	Graduate	29	33.0
	Postgraduate	21	23.9
3.	OCCUPATION		
	Clerical, shop owner	8	9.1
	Professional	6	6.8
	Semi professional	19	21.6
	Semi skilled	17	19.3
	Skilled	14	15.9
	Un skilled	10	11.4
	Unemployed	14	15.9
4.	SOCIO-ECONOMIC STATUS		
	Upper class	25	28.4
	Upper middle class	39	44.3
	Middle class	22	25.0
	Lower middle class	2	2.3
5.	TYPE OF FAMILY		
	Joint	12	13.6
	Nuclear	76	86.4

Table 1 outlines the sociodemographic characteristics of the study population. Participants aged 27-31 years made up 43.2%. In terms of education, 17% had a diploma, 33% were graduates, 5.7% completed high school, 11.4% were illiterate, 3.4% completed middle school, 23.9% had a postgraduate degree, and 5.7% finished primary school. Regarding occupation, 9.1% were clerical workers, 6.8% were professionals, 21.6% semi-professionals, 19.3% semi-skilled, 15.9% skilled, 11.4% unskilled, and 15.9% unemployed. In terms of socioeconomic status44.3% belonged to upper middle class. Additionally, 13.6% belonged to joint families, while 86.4% were from nuclear families.

Table 2: Maternal Characteristics

S. NO	MATERNAL CHARACTERISTICS	FREQUENCY (N=88)	PERCENTAGE (%)
1.	Parity		
	Multiparous	54	61.4
	Primiparous	34	38.6
2.	Gestational weeks		
	37-38	44	50.0
	39-40	44	50.0
3.	Type of delivery		
	NVD	42	47.7
	LSCS	46	52.3

The mean height, weight and BMI was 155.54 $\pm$ 5.53 cm, 72.70$\pm$ 4.09 kgs, 27.07$\pm$1.55 Kg/m^{2}.

Table 3: Neonatal Characteristics

S.NO	NEONATAL CHRACTERISTICS	FREQUENCY (N=88)	PERCENTAGE (%)
1.	Weight at birth		
	LBW (<2.5kgs)	14	15.9
	Normal (>2.5kgs)	74	84.1
2.	Circumference of the head(cm)		
	29	18	20.5
	30	48	54.5
	31	22	25.0
3.	Chest circumference(cm)		
	28	18	20.5
	29	48	54.5
	30	22	25.0
4.	Length (cm)		
	45-47	34	38.7
	48-50	34	38.7
	>50	20	22.7

Table 3 represents the neonatal characteristics, the first one being the birth weight,74 were above 2.5kg which is 84.1% , the next parameter was head circumference. The head circumference was 30cm in 48 participants (54.5%). The chest circumference was 29 cm in 48 participants(54.5) and 25 % , finally the length of the study participants. The length of the study participants were 45cm - 47cm and 48-50cm were 38.7%

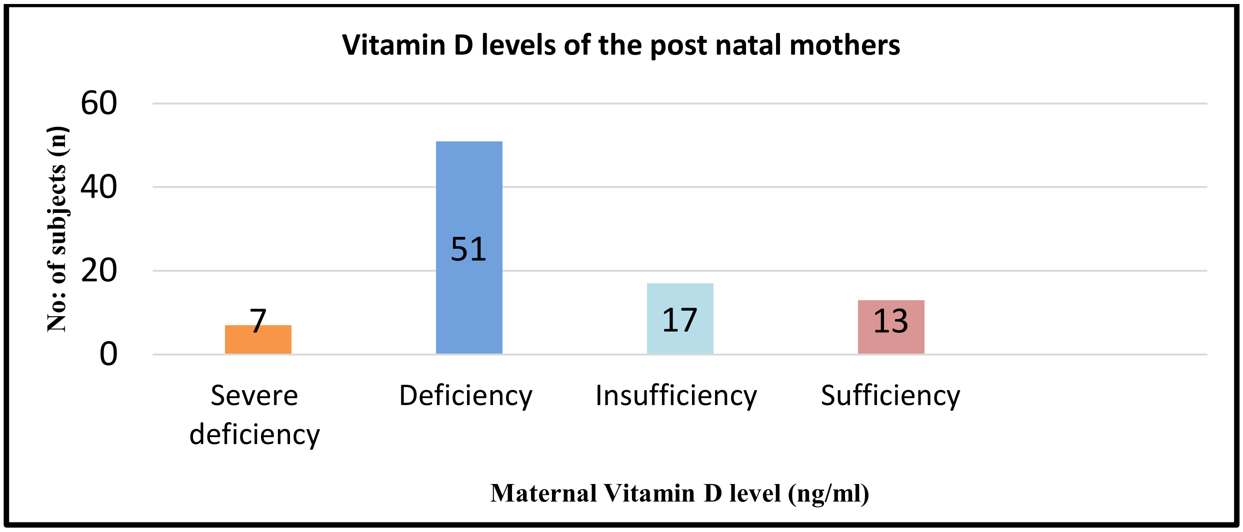

Fig 1 : Vitamin-D Levels of the Post Natal Mother

Table 4: Maternal Vitamin-D Level Association with Demographic, Economic And Obstetrical Characteristics

S.No	Characteristics	Vitamin-D				P value
		Severe deficiency (N=7)	Deficiency (N=51)	Insufficiency (N=17)	Sufficiency (N=13)	
1.	Age (Years)					
	≤ 27	4	27	7	6	.849
	>27	3	24	10	7	
2.	Education					
	Illiterate	2	6	2	0	.268
	Literate	5	45	15	13	
3.	Occupation					
	Unemployed	2	8	3	1	.711
	Employed	5	43	14	12	
4.	Socioeconomic status					
	Upper class	1	3	3	6	**.004***
	Upper middle class	1	7	4	3	
	Middle class	1	16	8	3	
	Lower middle class	4	25	2	1	
5.	Type of family					
	Nuclear	7	45	14	10	.470
	Joint	0	6	3	3	

S.No	Characteristics	Vitamin-D				P value
		Severe deficiency (N=7)	Deficiency (N=51)	Insufficiency (N=17)	Sufficiency (N=13)	
6.	Parity					
	Primiparous	3	20	5	6	.804
	Multiparous	4	31	12	7	
7.	Type of delivery					
	NVD	1	23	13	5	0.427
	LSCS	6	28	4	8	
8.	BMI (Kg/m^2)					
	25-29	7	46	15	12	.895
	30-35	0	5	2	1	

*Statistically significant at $p<0.05$ level by chi-square analysis

Table 4 represents theMaternal vitamin D level in association with demographic, economic and obstetrical characteristics. The p value in relation to age group is 0.849, for that in relation with education is 0.268, with relation to occupation the p value is 0.711.

The p value in relation with socio economic status is .004, type of family is 0.470 , parity is 0.804, type of delivery is 0,427 and that in relation with BMI is 0.895

DISCUSSION:-

UVB sunlight is the primary source of vitamin D, accounting for over 90% of the body's requirements. Factors such as age, BMI, sunscreen use, clothing, and geographic location can affect vitamin D production. In higher latitudes, UVB exposure decreases during winter, increasing the need for dietary sources, though foods naturally rich in vitamin D are not commonly consumed.

This reliance on sunlight and limited dietary options results in high vitamin D deficiency rates, especially among pregnant women in countries like Ireland, the UK, and the US(17). Although maintaining 25-hydroxyvitamin D (25(OH)D) levels above 100 nmol/L during pregnancy is advised, the long-term effects on infant health are still unclear. Research reveals complex associations between 25(OH)D levels and health outcomes, with both low and high levels potentially posing risks(18).

Most research focuses on regions with seasonal UVB fluctuations, making it difficult to isolate the direct impact of vitamin D on pregnancy and birth outcomes. Factors like seasonal illnesses and food shortages further complicate this relationship. Studies from regions with consistent year-round UVB exposure are scarce, indicating a need for more research on optimal vitamin D levels across various locations(19).

Newborns depend on maternal vitamin D stores, as shown by the strong correlation between maternal and cord blood 25(OH)D levels. In India, 63% of pregnant women and 81% of newborns are vitamin D deficient, partly due to insufficient intake of vitamin D3-rich and fortified foods, as well as sun avoidance among affluent women.

Maternal vitamin D deficiency is associated with poor pregnancy outcomes, as vitamin D supports muscle function. A deficiency can lead to muscle weakness, increasing the likelihood of cesarean sections(20). The current study also found a significant link between delivery type and vitamin D levels. Since vitamin D is transferred to the baby through the placenta, it is crucial for pregnant women to maintain adequate levels to support their baby's needs for the first 4-6 months. Low vitamin D during pregnancy and infancy is particularly concerning.

The present study revealed a statistically significant link between cord vitamin D levels and various newborn characteristics such as birth weight, birth length, head circumference, and chest circumference. A study conducted among the Chinese population illustrated that newborns born to mothers with severe vitamin D deficiency exhibited reduced birth length and weight, along with smaller head circumference and birth weight compared to other infants[21].

The socio demographic characteristics in the present study revealed that 27-31 years mothers were the major constituent of the total number of mothers involved in the study. They constituted a percentage of 43.2%. 33% of the study subjects were graduates with 21.9% of them being semiprofessionals. 44.3% of them belonged to the upper middle class with 86.4% constituting nuclear families. The mean has been expressed as 27.39 and standard deviation is 3.368.

Of the total population 61.4% were multiparous and 28.4% of the mothers delivered at the gestational weeks of 38 and 40 weeks. Full term delivery was 100% with caesarean section constituting 52.3%. The mothers were found to be moderately deficient in vitamin D (51%) and those sufficient in vitamin D levels were 13%. Only 7% of the mothers were severely deficient in vitamin D. The normal birth weight babies constituted 84.1% with majority of them (54.1%) having a head circumference of 30 cm and 54.5% of them having a chest circumference of 29cm.

The p values were statistically significant using chi square and ANOVA tests for the demographic characteristics and there was a significant association between the maternal levels of vitamin D with neonatal anthropometric characteristics. The present study had majority of women with normal vitamin levels which correlated with the normal anthropometric measurements in the corresponding neonates. Marya et al[22]. conducted a study in India that not only confirmed but also expanded upon previous findings. They observed significantly higher birth weight, length, head circumference, mid-arm circumference, and skin folds in the offspring of 100 pregnant women who were given two doses of 15,000 mg vitamin D in the third trimester, compared to 100 women who received a placebo.

Furthermore, recent findings from a meta-analysis of 25 randomized controlled trials indicate that vitamin D supplementation may offer protection against acute respiratory tract infections..

When considering achievable vitamin D levels during pregnancy, studies by O'Riordan et al. and Holmes et al. found high rates of vitamin D insufficiency (25–50 nmol/L) and deficiency (<25 nmol/L) in Caucasian pregnant women in Ireland and the UK, both located at latitudes between 51–55°N.

This study is the first to evaluate maternal vitamin D levels and their correlation with neonatal anthropometric measures in a population from Tamil Nadu, an equatorial region with consistent UVB sunlight exposure. We used chemiluminescence immune assay, recognized as the gold standard for vitamin D assessment, and accounted for several covariates affecting birth outcomes. However, the small sample size and limited variability in vitamin D levels within the insufficient range hindered the identification of a definitive cut-off for optimal fetal development. Larger studies with broader vitamin D status are needed. Additionally, we lacked data on sun exposure and dietary intake, though UVB exposure is generally uniform in this region. Finally, our cross-sectional analysis could benefit from longitudinal assessments of 25(OH)D during pregnancy for deeper insights into its relationship with birth outcomes.

CONCLUSION:

This study is the first to assess maternal vitamin D levels and their association with neonatal measurements in a Tamil Nadu population, characterized by consistent UVB exposure. We employed the chemiluminescence immune assay and considered various factors influencing birth outcomes.

However, the small sample size and limited variation in vitamin D levels restricted our ability to determine a specific cut-off for optimal fetal growth. Future research with larger samples and a wider range of vitamin D levels is needed. While data on sun exposure and dietary intake were unavailable, UVB exposure remains largely consistent in this region. A longitudinal study tracking 25(OH)D during pregnancy would provide more comprehensive insights.

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