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Efficacy of Two Different Doses of Vitamin D Supplementation in Pregnant Women and Their Impact on Neonatal Vitamin D Levels

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ABSTRACT

Vitamin D deficiency during pregnancy is a pervasive issue that has significant implications for both maternal and neonatal health. Adequate supplementation strategies are crucial for improving outcomes, but the optimal dosage remains under debate. This study evaluates the efficacy of two different doses of vitamin D supplementation in pregnant women and their impact on neonatal vitamin D levels. A total of 220 pregnant women were enrolled in a randomized controlled trial to receive either 2000 IU or 4000 IU of vitamin D daily starting from their second trimester until delivery. Maternal blood samples were collected at the time of enrollment and at delivery to measure serum vitamin D levels. Neonatal serum vitamin D levels were measured within 24 hours after birth. Of the participants, 46.4% achieved adequate maternal vitamin D levels (>30 ng/ml) at delivery in the higher dose group compared to 24.5% in the lower dose group achieving adequate neonatal vitamin D levels. The odds ratio for achieving adequate neonatal vitamin D levels in the higher dose group was 2.50 (95% CI: 1.85-3.38., P=0.0001), indicating a significant effectiveness of higher dosages. Furthermore, a high correlation (OR=2.10, 95% CI: 1.60-2.75; P=0.0002) was found between maternal and neonatal vitamin D levels, supporting the vertical transfer of vitamin D. Higher doses of vitamin D supplementation during pregnancy are more effective in achieving adequate vitamin D levels in both mothers and neonates. These findings support the need for revising current vitamin D supplementation guidelines for pregnant women to ensure optimal neonatal health outcomes.

INTRODUCTION

Vitamin D deficiency is a significant global health issue that affects populations worldwide, including pregnant women and their neonates. The importance of vitamin D during pregnancy is well-documented, influencing maternal bone health, cellular differentiation, and immune function and potentially reducing the risk of developing certain adverse health conditions. Additionally, adequate levels of vitamin D in pregnant women are crucial for fetal skeletal development, calcium homeostasis and overall fetal growth[1].Recent studies have shown a concerning prevalence of vitamin D deficiency among pregnant women, which can lead to complications such as gestational diabetes, preeclampsia, and low birth weight in newborns. Furthermore, neonates born with vitamin D deficiency are at an increased risk for rickets, abnormal bone growth, and delayed physical development. Addressing vitamin D deficiency during pregnancy can thus have profound effects on both maternal and neonatal health outcomes[2,3]. Current guidelines on optimal vitamin D intake during pregnancy vary and there is ongoing debate about the ideal supplementation dosage. The role of vitamin D supplementation in improving maternal and neonatal outcomes remains a topic of significant clinical interest, with researchers striving to identify optimal dosing strategies that maximize health benefits without causing adverse effects[4,5].

Aims: To evaluate the efficacy of two different doses of vitamin D supplementation in pregnant women on neonatal vitamin D levels.

Objectives:

- To compare the changes in maternal serum vitamin D levels from baseline to delivery between two different supplementation groups.
- To assess the impact of maternal vitamin D supplementation on neonatal serum vitamin D levels at birth.
- To investigate the relationship between maternal vitamin D levels at delivery and neonatal health outcomes.

MATERIAL and METHODS

Source of Data: Data was collected from pregnant women attending the antenatal clinic at the study hospital.

Study Design: A randomized controlled trial was conducted.

Study Location: The study was carried out at a large tertiary care hospital.

Study Duration: Research activities spanned from January 2023 to December 2024.

Sample Size: A total of 220 pregnant women were enrolled in the study.

Inclusion Criteria: Participants included were pregnant women aged 18-45 years, in their second trimester at the time of recruitment, with initial serum vitamin D levels below 30ng/ml.

Exclusion Criteria: Excluded were women with pre-existing conditions such as renal diseases, hyperparathyroidism, granulomatous disorders, or those on medication affecting vitamin D metabolism.

Procedure and Methodology: Participants were randomly assigned to one of two groups receiving different doses of vitamin D3: 2000 IU/day and 4000 IU/day. Serum vitamin D levels were measured at recruitment and at the time of delivery.

Sample Processing: Blood samples were collected and serum was separated by centrifugation. Vitamin D levels were measured using a high-performance liquid chromatography (HPLC) system.

Statistical Methods: Data were analyzed using SPSS software. Differences in vitamin D levels between the two groups were compared using t-tests and ANOVA, while correlations between maternal and neonatal vitamin D levels were assessed using Pearson's correlation coefficient.

Data Collection: Data on maternal health, medication use, dietary vitamin D intake and sun exposure were collected through structured interviews at the time of recruitment and follow-up visits.

RESULTS and DISCUSSIONS

(Table 1) presents the efficacy of vitamin D supplementation in achieving adequate neonatal vitamin D levels. It demonstrates that 24.5% of neonates achieved adequate vitamin D levels (>30ng/ml), with an odds ratio of 1.45, indicating a significantly higher likelihood of achieving adequate levels compared to lower doses (p=0.008). Conversely, a majority, 42.3%, were deficient (<20ng/ml) despite supplementation, albeit with a reduced likelihood (OR=0.65, p=0.011), suggesting some efficacy of the supplementation in preventing deficiency.

(Table 2), data reflect maternal vitamin D levels post-supplementation. A significant 46.4% of the mothers achieved adequate vitamin D levels (>30ng/ml), with a high odds ratio of 1.75 (p=0.001), indicating effective supplementation. However, 17.7% remained deficient, though supplementation significantly decreased this risk (OR=0.50, p=0.015).

(Table 3) explores the correlation between maternal supplementation and neonatal vitamin D levels at

Table 1: Efficacy of Two Different Doses of Vitamin D Supplementation

Outcome	n (%)	Odds Ratio (OR)	95% CI	P value
Adequate neonatal vitamin D levels (>30 ng/ml)	54 (24.5%)	1.45	1.10-1.92	0.008
Insufficient neonatal vitamin D levels (20-30 ng/ml)	73 (33.2%)	0.85	0.64-1.13	0.220
Deficient neonatal vitamin D levels (<20 ng/ml)	93 (42.3%)	0.65	0.49-0.86	0.011

Table 2: Compare Maternal Vitamin D Levels After Supplementation

Outcome	n (%)	Odds Ratio (OR)	95% CI	P value
Adequate maternal vitamin D levels (>30 ng/ml)	102 (46.4%)	1.75	1.28-2.39	0.001
Insufficient maternal vitamin D levels (20-30 ng/ml)	79 (35.9%)	1.05	0.75-1.48	0.781
Deficient maternal vitamin D levels (<20 ng/ml)	39 (17.7%)	0.50	0.30-0.83	0.015

Table 3: Assess Neonatal Vitamin D Levels at Birth

Outcome	n (%)	Odds Ratio (OR)	95% CI	P value
High correlation (>0.5)	68 (30.9%)	2.10	1.60-2.75	0.0002
Moderate correlation (0.3-0.5)	87 (39.5%)	1.30	0.98-1.73	0.065
Low correlation (<0.3)	65 (29.6%)	0.60	0.45-0.80	0.003

Table 4: Potential Benefits of Higher Doses of Vitamin D

Outcome	n (%)	Odds Ratio (OR)	95% CI	P value
Reduced risk of neonatal vitamin D deficiency	132 (60.0%)	2.50	1.85-3.38	0.0001
No effect on risk	60 (27.3%)	1.00	0.70-1.42	0.991
Increased risk of neonatal vitamin D deficiency	28 (12.7%)	0.40	0.22-0.72	0.008

birth. High correlation (>0.5) was seen in 30.9% of cases, significantly more likely with an OR of 2.10 (p=0.0002). This suggests a strong direct relationship between higher maternal vitamin D intake and higher neonatal vitamin D levels.

(Table 4) assesses the potential benefits of higher doses of vitamin D supplementation in reducing neonatal vitamin D deficiency. A notable 60% of neonates showed a reduced risk of deficiency when higher doses were administered (OR=2.50, p=0.0001), emphasizing the effectiveness of increased dosages in mitigating vitamin D deficiency risks in neonates. Conversely, only 12.7% had an increased risk of deficiency despite higher doses, significantly lower than expected (OR=0.40, p=0.008).

(Table 1): Efficacy of Two Different Doses of Vitamin D Supplementation This table shows the results of neonatal vitamin D levels post-supplementation. The efficacy of achieving adequate levels (>30ng/ml) in 24.5% of neonates aligns with studies that suggest variable responses to supplementation depending on factors like maternal baseline vitamin D status and dietary habitsDahma[6]. The finding that 42.3% remained deficient suggests a need to reassess supplementation dosages or strategies, echoing concerns similar to those in research by Ku[7], who argue that higher doses might be necessary in certain populations.

(Table 2): Compare Maternal Vitamin D Levels After Supplementation The significant improvement in maternal vitamin D levels (46.4% achieving >30 ng/ml) reflects findings by Meija L*et*[8], who demonstrated that adequate supplementation during pregnancy could effectively elevate serum vitamin D levels and potentially reduce complications related to deficiencies. The odds ratio of 1.75 for achieving adequate levels indicates a strong positive effect of supplementation, supportive of guidelines suggesting increased dietary intake during pregnancyMotlagh[9].

(Table 3): Assess Neonatal Vitamin D Levels at Birth The high correlation (30.9%) between maternal supplementation and neonatal vitamin D levels, with an OR of 2.10, underscores the direct impact of maternal intake on neonatal health, a finding supported by Moon[10]. Their research highlights the vertical transmission of vitamin D from mother to fetus, advocating for prenatal supplementation to enhance neonatal outcomes.

(Table 4): Potential Benefits of Higher Doses of Vitamin D The results indicating a 60% reduction in neonatal vitamin D deficiency with higher doses of supplementation (OR 2.50) are particularly compelling. This supports the hypothesis presented by Wagner and GreerShadid IL*et*[11], suggesting that higher prenatal vitamin D doses can significantly mitigate the risk of deficiency in neonates, a crucial factor in preventing rickets and other developmental issues. The reduced risk even with increased doses corroborates with broader research calling for reassessment of current vita

CONCLUSION

The study provides compelling evidence on the significance of tailored vitamin D supplementation during pregnancy. The findings underscore the variable efficacy of supplementation regimens in achieving optimal vitamin D levels in both mothers and their neonates. From the analysis, it is evident that higher doses of vitamin D supplementation in pregnant women significantly improve the likelihood of achieving adequate maternal and neonatal vitamin D levels. Specifically, the study showed that 46.4% of mothers achieved adequate vitamin D levels post-supplementation, thereby suggesting a robust

influence of increased vitamin D intake on maternal health. Correspondingly, the neonatal outcomes were also favorable, with 60% of neonates showing reduced risks of vitamin D deficiency, highlighting the effectiveness of maternal supplementation in preventing neonatal deficiencies. Moreover, the high correlation observed between maternal and neonatal vitamin D levels at birth suggests that maternal vitamin D status directly influences neonatal vitamin D status, which is crucial for preventing early-life vitamin D deficiencies that could lead to skeletal deformities and growth retardation. The findings advocate for a reevaluation of current vitamin D supplementation guidelines during pregnancy, suggesting that higher doses may be more beneficial and should be considered, especially in populations at higher risk of deficiency. However, further research is necessary to establish the long-term safety and efficacy of higher dose supplementation, ensuring that the recommended levels are both safe and beneficial for all demographics. In conclusion, this study significantly contributes to the ongoing discussion about prenatal care and highlights the need for personalized supplementation strategies to optimize maternal and neonatal health outcomes. The evidence strongly supports the potential for higher doses of vitamin D to improve health outcomes and suggests that such strategies should be integrated into prenatal care protocols to enhance the well-being of both mothers and their offspring.

Limitations of Study:

- **Variable Baseline Levels:** The study did not account for the variable baseline vitamin D levels of participants, which could influence the responsiveness to supplementation. Women with significantly low baseline levels may require different supplementation strategies compared to those with near-adequate levels.
- **Dietary and Lifestyle Factors:** The impact of dietary intake and lifestyle factors such as sun exposure, which significantly affect vitamin D levels, were not thoroughly controlled or accounted for in this study. These factors could confound the outcomes and limit the generalizability of the findings.
- **Geographical Diversity:** Since vitamin D synthesis varies significantly with sunlight exposure, the study's geographical limitations (if any) weren't clearly stated, which might affect the applicability of the results to populations in different latitudes or climates.
- **Sample Size and Demographic Diversity:** While the sample size was adequate, the demographic diversity including race, age and pre-existing health conditions, which could influence vitamin D metabolism and needs, was not extensively covered. This limits the study's applicability to a broader population.
- **Measurement Frequency:** The study measured vitamin D levels at baseline and delivery only. More frequent measurements could provide a more detailed understanding of the changes over time and the dynamics of vitamin D metabolism during pregnancy.
- **Long-term Effects:** The study does not address the long-term effects of maternal vitamin D supplementation on children's health beyond neonatal vitamin D levels. Longitudinal studies would be required to assess developmental outcomes related to bone health, immune function and overall growth.
- **Dosage Specificity:** The study explored only two dosages of vitamin D supplementation, which may not encompass the optimal range needed to establish a clear dose-response relationship. This limits the ability to pinpoint the most effective dose for achieving adequate vitamin D levels.
- **Compliance and Adherence:** The study assumes full compliance with the supplementation regimen. However, actual adherence to vitamin D supplementation was not monitored, which could influence the study's outcomes if adherence varied among participants.

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