

<https://doi.org/10.48047/AFJBS.6.11.2024.1971-1976>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Maternal Vitamin A and D Deficiency in Pregnancy and Its Relationship with Maternal and Neonatal Hemoglobin Concentration

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Article History

Volume 6, Issue 11, 2024

Received: 10 Sep 2024

Accepted: 14 Nov 2024

Published: 30 Nov 2024

[doi:10.48047/AFJBS.6.11.2024.1971-1976](https://doi.org/10.48047/AFJBS.6.11.2024.1971-1976)

ABSTRACT

Background: Deficiencies in vitamin A and D are prevalent among pregnant women, which may further exacerbate anemia during pregnancy and diminish the health of the newborn. These lipophilic vitamins are essential for the formation of red blood cells and the transfer of fetal nutrients. The impact of vitamin A and D deficiencies on maternal and neonatal hemoglobin levels is of concern; however, it lacks comprehensive examination among various local populations. To evaluate the association between maternal vitamin A and D deficiency and hemoglobin concentration in mothers and their newborns.

Methods: This cross-sectional study, conducted at Khyber Medical College and its affiliated hospital, lasted from January 2023 to January 2024. Ninety-seven pregnant women who delivered at term were enrolled. Blood samples from mothers and umbilical cords were taken to evaluate Vitamin A and D levels, serum levels, and hemoglobin concentrations. Sociodemographic, clinical, and other relevant data were also captured. Deficient and non-deficient group comparisons were made using independent sample t-tests to ascertain the differences between the two groups' hemoglobin levels.

Results: Vitamin A deficiency was identified in 36.1% of participants, while 43.3% were deficient in vitamin D. Maternal anemia was present in 42.3% of cases, and 37.1% of neonates had low hemoglobin levels. Women with vitamin A or D deficiency had significantly lower mean hemoglobin levels than normal ($p < 0.05$). A similar trend was observed in neonatal hemoglobin concentrations.

Conclusion: Vitamin A and D deficiency during pregnancy are significantly associated with reduced hemoglobin levels in both mothers and their newborns. Early identification and correction of these deficiencies could help prevent maternal anemia and improve neonatal outcomes. Strengthening antenatal nutrition programs may be a practical approach to addressing this public health issue.

Keywords: Vitamin A, Vitamin D, Maternal anemia, Neonatal hemoglobin, Pregnancy, Micronutrient deficiency, Maternal nutrition, Cord blood.

INTRODUCTION:

Lack of sufficient vitamins and minerals, termed 'nutritional deficiency' in pregnant women, continues to be a prevalent concern, especially in developing and underdeveloped countries. Out of all nutritional deficiencies, lack of vitamin A and D is particularly worrisome considering how widespread these deficiencies are and their potential effects on pregnant women and their fetuses' health [1]. Pregnancy is a crucial time for the intake of essential body nutrients to ensure proper fetal development. Not consuming these during the requisite time can have notable ill effects, ranging from anemia to infant developmental delays [2, 3].

Vitamin A is crucial for maintaining immune functions, vision, and cellular development. Furthermore, it supports hematopoiesis by aiding iron metabolism, which is important for sustaining adequate levels of haemoglobin [4]. A lack of this vitamin has been shown to increase the risk of anemia in expectant mothers and may complicate childbirth. In the same manner, vitamin D, which is primarily linked to bone metabolism, is now known to contribute to the production of red blood cells. New studies indicate that low vitamin D levels may contribute to inflammation and decreased erythropoiesis, thus leading to anemia [5, 6].

Anemia is a prevalent condition in pregnancy that affects around 40% of the world's pregnant women. It is linked with tiredness, higher susceptibility to infections, and adverse outcomes in the perinatal period [7]. Infants delivered to anemic women face numerous risks such as anemia, impaired growth, and developmental delays. Maternal nutrition deeply affects neonatal well-being and the intrauterine environment. Moreover, certain deficiencies, such as fat-soluble vitamins A and D, may hinder proper nutrient transfer to the fetus [8, 9].

While information exists regarding the link between maternal anemia and micronutrient status, particularly local studies on integrated effects of vitamin A and D deficiencies on maternal and neonatal hemoglobin levels remain scarce [10]. Grasping this connection is critical for enhancing maternal nutrition frameworks and averting neonatal issues. This research intends to determine the level of vitamin A and D deficiency prevalent among expectant mothers, and how these deficiencies correlate to the hemoglobin concentrations of mothers and their infants.

METHODOLOGY

This cross-sectional observational study was conducted over a period of one year, from January 2023 to January 2024. The setting of this study was Khyber Medical College and the affiliated teaching hospital, which offers tertiary healthcare services to a comprehensive array of patients from within the city and the countryside.

The women included in the study were those who were pregnant and delivered at the hospital, which was selected for data collection. The selection criteria included women above the age of eighteen and had a single pregnancy, along with alive babies born at term or near term (more than or equal to 37 weeks of gestation). The participants in the study were required to provide... Along with sign consent forms, they had to be willing to participate in the blood tests that were conducted. Participants were not eligible if they had any chronic medical conditions including but not limited to thalassemia, chronic kidney disease, or any endocrine disorders due to the potential confounding effects such conditions could have on hemoglobin or vitamin levels, which needed to be studied.

Using a non-probability consecutive sampling technique, 97 participants were enrolled into the study. Sample size was determined based on prior research which indicated a moderate correlation between maternal micronutrient status and hemoglobin levels in mothers and their neonates. The ethics committee of Khyber Medical College reviewed and approved the study protocol. Participants were fully briefed about the study and its objectives. Consent was collected in writing prior to their participation in the study. Precautions were taken to ensure anonymity and confidentiality of the study respondents throughout the study.

Upon delivery, maternal venous blood samples were collected within 24 hours postpartum, while umbilical cord blood samples were taken immediately after birth. Both samples were sent to the hospital laboratory for assessment of hemoglobin concentration, serum vitamin A (retinol), and vitamin D (25-hydroxyvitamin D) levels. All laboratory tests were performed using standardized techniques approved by the hospital's diagnostic unit.

In addition to biochemical testing, demographic and clinical data were recorded using a structured proforma. This included maternal age, gravidity, education level, body mass index (BMI), socioeconomic status, and delivery type (vaginal or cesarean). Information on antenatal supplement use and any relevant obstetric history was also documented.

Vitamin A deficiency was defined as serum retinol levels below 20 µg/dL. Vitamin D status was categorized as follows: deficient (<20 ng/mL), insufficient (20–29 ng/mL), and sufficient (≥30 ng/mL). Anemia in pregnancy was defined as hemoglobin concentration below 11 g/dL. Neonatal anemia was considered present if cord blood hemoglobin was under 14 g/dL.

Data were entered and analyzed using SPSS version 26. Descriptive statistics were used to summarize categorical variables as frequencies and percentages, while continuous variables were expressed as means and standard deviations. Independent sample t-tests were applied to compare mean hemoglobin levels between vitamin-deficient and non-deficient groups. A p-value of less than 0.05 was considered statistically significant.

RESULT

Most of the pregnant women in this study were between the ages of 20 and 29 years, representing the most common childbearing age group. Educational attainment was mixed, with a notable portion having received only primary or secondary education. A significant number came from low to middle socioeconomic backgrounds, which could influence their nutritional and health status. In terms of nutritional status, nearly half had a normal BMI, while a notable segment was overweight or obese. More than half were multigravida, and vaginal deliveries were more frequent than cesarean sections, consistent with general delivery trends in similar healthcare settings.

Table 1: Maternal Demographic and Clinical Characteristics (n = 97)

Variable	Category	Frequency (%)
Age (years)	<20	8 (8.2%)
	20–29	45 (46.4%)
	30–39	33 (34.0%)
	≥40	11 (11.3%)
Education level	No education	21 (21.6%)
	Primary	28 (28.9%)
	Secondary	31 (32.0%)
	Graduate	17 (17.5%)
Socioeconomic status	Low	39 (40.2%)
	Middle	43 (44.3%)
	High	15 (15.5%)
BMI (kg/m ²)	<18.5 (Underweight)	14 (14.4%)
	18.5–24.9 (Normal)	48 (49.5%)
	25–29.9 (Overweight)	26 (26.8%)
	≥30 (Obese)	9 (9.3%)
Gravida	Primigravida	38 (39.2%)
	Multigravida	59 (60.8%)
Mode of Delivery	Vaginal	65 (67.0%)
	Cesarean	32 (33.0%)

A considerable proportion of the participants showed deficiencies in essential vitamins. Over a third were deficient in vitamin A, while nearly half had insufficient or deficient levels of vitamin D. Anemia affected 42.3% of the women, suggesting a strong nutritional gap during pregnancy. Furthermore, more than one-third of the newborns had low hemoglobin levels, raising concerns about maternal-fetal nutrient transfer. These findings highlight the potential public health impact of micronutrient insufficiency in pregnancy.

Table 2: Prevalence of Vitamin A and D Deficiency and Anemia

Parameter	Status	Frequency (%)
Maternal Vitamin A level	Deficient (<20 µg/dL)	35 (36.1%)
	Normal (≥20 µg/dL)	62 (63.9%)

Maternal Vitamin D level	Deficient (<20 ng/mL)	42 (43.3%)
	Insufficient (20–29)	28 (28.9%)
	Normal (≥30 ng/mL)	27 (27.8%)
Maternal Hemoglobin (g/dL)	<11 (Anemia)	41 (42.3%)
	≥11 (Normal)	56 (57.7%)
Neonatal Hemoglobin (g/dL)	<14 (Low)	36 (37.1%)
	≥14 (Normal)	61 (62.9%)

The comparison of maternal hemoglobin levels between vitamin-deficient and non-deficient groups revealed a statistically significant difference. Women with vitamin A deficiency had lower hemoglobin concentrations than those with normal levels. Similarly, vitamin D deficiency was associated with a drop in hemoglobin values. These results underline the influence of micronutrient status on maternal anemia and suggest that correcting these deficiencies may improve hemoglobin outcomes during pregnancy.

Table 3: Relationship between Vitamin A & D Deficiency and Maternal Hemoglobin

Micronutrient Status	Mean Maternal Hb (g/dL)	SD	p-value
Vitamin A Deficient	10.2	0.9	0.021*
Vitamin A Normal	11.3	1.1	
Vitamin D Deficient	10.1	1.0	0.008*
Vitamin D Normal	11.5	1.2	

*Independent sample t-test applied

Similar to the maternal findings, neonates born to vitamin-deficient mothers had significantly lower hemoglobin concentrations. This trend was evident for both vitamin A and D. The data imply that maternal micronutrient status plays a direct role in fetal hematological development, and deficiencies may predispose newborns to anemia at birth, potentially impacting their early growth and immunity.

Table 4: Association between Maternal Vitamin Deficiency and Neonatal Hemoglobin

Micronutrient Status	Mean Neonatal Hb (g/dL)	SD	p-value
Vitamin A Deficient	13.5	1.0	0.034*
Vitamin A Normal	14.3	1.1	
Vitamin D Deficient	13.4	0.9	0.011*
Vitamin D Normal	14.4	1.0	

*Independent sample t-test applied

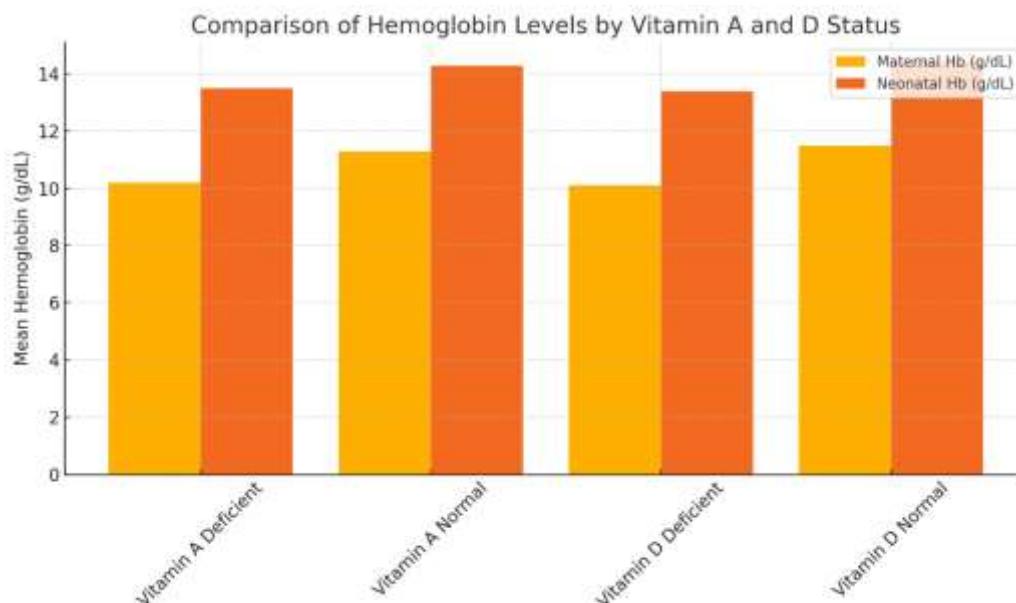


Figure 1: the graph comparing maternal and neonatal hemoglobin levels based on vitamin A and D status. It clearly shows that both maternal and neonatal hemoglobin concentrations are lower in women with vitamin A or D deficiencies compared to those with normal levels.

DISCUSSION

This study revealed a significant relationship between maternal deficiencies of vitamin A and D and lower hemoglobin levels in both mothers and their newborns. The findings reinforce the critical role of micronutrient status in maternal and neonatal health outcomes.

A substantial proportion of women in the study were found to be anemic and deficient in either vitamin A or D. These results were consistent with global and regional estimates reported by the World Health Organization, where maternal micronutrient insufficiencies remain highly prevalent, particularly in low- and middle-income countries ^[11, 12]. In Pakistan, several national nutrition surveys have similarly highlighted widespread vitamin A and D deficiencies among pregnant women, which closely align with the present findings ^[13].

Vitamin A plays a key role in erythropoiesis by supporting iron metabolism and cellular differentiation in bone marrow. The observed link between vitamin A deficiency and low hemoglobin levels supports prior research. Studies noted that vitamin A supplementation improved hemoglobin concentrations in pregnant women with marginal vitamin A status ^[14-16]. Similarly, study found that inadequate vitamin A intake during pregnancy increased the risk of anemia and reduced fetal growth parameters ^[17].

Vitamin D has traditionally been associated with bone health, but recent evidence highlights its broader immunomodulatory and hematopoietic functions. In this study, women with vitamin D deficiency showed significantly lower hemoglobin levels, a finding echoed in research which demonstrated that vitamin D deficiency can impair erythropoiesis and contribute to anemia through inflammatory pathways ^[18]. Moreover, maternal vitamin D status has been linked to fetal hemoglobin regulation. The present study supports this association, with neonates born to vitamin D-deficient mothers exhibiting lower hemoglobin concentrations compared to those born to mothers with adequate levels.

The study also highlighted that maternal nutritional deficiencies are not only a personal health concern but have intergenerational consequences. Neonatal hemoglobin levels were significantly lower in newborns of micronutrient-deficient mothers, underscoring the need for effective antenatal nutrition programs. These findings were consistent with studies that reported that maternal micronutrient deficiencies contribute to fetal anemia, potentially affecting early growth and immune development ^[19, 20].

While the results were meaningful, the study has a few limitations. The cross-sectional design restricts the ability to infer causality. Furthermore, the assessment of vitamin levels was limited to the immediate peripartum period, and dietary intake or sun exposure data were not captured. Despite these limitations, the study adds to the growing body of evidence emphasizing the importance of micronutrient monitoring during pregnancy.

CONCLUSION

The study concludes that maternal deficiencies in vitamin A and D are significantly associated with lower hemoglobin concentrations in both mothers and their newborns. These findings stress the importance of early identification and correction of micronutrient insufficiencies during pregnancy to prevent maternal anemia and improve neonatal hematological outcomes. Strengthening routine antenatal care to include targeted nutritional screening and supplementation could be crucial in enhancing maternal and child health in similar settings.

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