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Original Research Article

Correlation of Serum Vitamin B12 and Ferritin Levels in Anaemic Infants and Their Mothers at a Tertiary Care Centre: A Descriptive Cross-Sectional Study

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Abstract

Aims and Objectives: To estimate serum vitamin B12 and ferritin levels in infants with iron deficiency anaemia and vitamin B12 deficiency anaemia, and to assess their correlation with maternal serum vitamin B12 and ferritin levels.

Methods: This descriptive cross-sectional study included 280 infants aged 29 days to 1 year admitted to the Department of Pediatrics, J.K. Lon Hospital, Kota, between March 2023 and March 2024. Infants with anaemia admitted for common medical conditions were enrolled. Complete blood count, serum ferritin, and serum vitamin B12 levels were measured in infants and their mothers. Data were analysed using SPSS software.

Results: Iron deficiency anaemia was the most common cause of anaemia (69.3%). Dimorphic anaemia predominated (41.8%), followed by vitamin B12 deficiency anaemia (32.9%) and isolated iron deficiency anaemia (12.9%). Isolated vitamin B12 deficiency accounted for 32.9% of severe anaemia cases. The mean serum vitamin B12 level in infants was 107.12 pg/mL. A strong correlation was observed between maternal and infant serum vitamin B12 and ferritin levels, with infants of deficient mothers more likely to have similar deficiencies.

Conclusion: Vitamin B12 deficiency is a significant and under-recognized cause of anaemia in infants and is strongly associated with maternal nutritional status. Maternal iron and vitamin B12 deficiencies increase the risk of corresponding deficiencies in infants. Routine evaluation of serum vitamin B12, along with iron studies and peripheral smear examination, should be included in the workup of anaemic infants. Maternal vitamin B12 supplementation during pregnancy and lactation is essential to prevent infant anaemia.

Keyword: Anemia, Vit. B12 Deficiency Anemia, Folic Acid Deficiency.

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Introduction

Anaemia remains a major public health problem worldwide, particularly among women of reproductive age and young children. According to the National Family Health Survey-5 (2019–21), anaemia affects 67.1% of children aged 6–59 months, 57.0% of women aged 15–49 years, and 52.2% of pregnant women in India. [1]

Globally, anaemia is disproportionately concentrated in low-socioeconomic populations, and a strong association exists between maternal anaemia and childhood anaemia. [2] Anaemia is defined as a reduction in haemoglobin concentration and/or red blood cell count below normal for age and physiological status, resulting in inadequate oxygen delivery to tissues. [3] Haemoglobin levels vary with age, showing the most dramatic changes during infancy. Normal haemoglobin concentrations are highest at birth, decline during the first 2–3 months of life, and then gradually increase throughout childhood. [4] The World Health Organization (WHO) age- and sex-specific haemoglobin cut-offs are widely used for diagnosing anaemia in children. [3]

Iron deficiency anaemia (IDA) is the most common cause of anaemia in infancy and early childhood. Iron requirements during infancy are exceptionally high due to rapid growth, being nearly ten times higher per kilogram body weight than in adults. [5] Inadequate dietary intake of bioavailable iron, delayed or inappropriate complementary feeding, and prolonged exclusive breastfeeding without iron supplementation contribute significantly to iron deficiency. [6] Infants born to anaemic mothers are more likely to have reduced iron stores at birth, increasing their risk of developing anaemia within the first year of life. [7]

Iron deficiency during infancy is associated with impaired psychomotor development, cognitive deficits, and long-term adverse effects on central nervous system development, even in the absence of overt anaemia. [8] Vitamin B12 deficiency is another important but often under-recognized cause of anaemia in infants. Vitamin B12 is essential for DNA synthesis, erythropoiesis, and normal neurological development and cannot be synthesized by the human body. [9] Adequate vitamin B12 status during infancy is crucial for optimal growth and neurodevelopment. [8] Infants depend entirely on maternal vitamin B12 stores during pregnancy and on breast milk during early infancy. [10] Since exclusive breastfeeding is recommended for the first six months of life, infants rely solely on prenatal stores and breast milk to meet their vitamin B12 requirements. [11]

Maternal vitamin B12 deficiency results in low breast milk vitamin B12 concentrations, placing exclusively breastfed infants at high risk of deficiency. [10] Vitamin B12 deficiency in infancy typically presents between 4 and 10 months of age and may lead to failure to thrive, developmental regression, irritability, megaloblastic anaemia, and severe neurological impairment. [8,9] Women in resource-limited settings often consume inadequate animal-source foods, contributing to widespread maternal and infant vitamin B12 deficiency. [12]

Iron deficiency anaemia and vitamin B12 deficiency frequently coexist in infancy, resulting in dimorphic anaemia. When both deficiencies are present, routine haematological parameters may be misleading, and diagnosis may be delayed unless iron indices and vitamin B12 levels are evaluated. [5] Despite the high prevalence of both conditions, limited studies have examined the correlation between infant anaemia and maternal iron and vitamin B12 status. [13] Therefore, the present study was undertaken to estimate serum vitamin B12 and ferritin levels in anaemic infants and to assess their correlation with maternal vitamin B12 and ferritin levels, highlighting the impact of maternal nutritional status on infant anaemia.

Materials and Methods

This hospital-based descriptive cross-sectional study was conducted in the Department of Pediatrics, J.K. Lon Hospital, Government Medical College, Kota, from March 2023 to March 2024. A total of 280 infants aged 29 days to 1 year, along with their mothers, were enrolled.

Infants attending the OPD or admitted to the IPD with clinical features of anaemia and confirmed anaemia on complete blood count were included. Infants with anaemia of chronic disease, haemolytic anaemia, critical illness, prior iron or vitamin B12 supplementation, recent blood transfusion, or age <29 days or >1 year were excluded.

After obtaining Institutional Ethics Committee approval and written informed consent from parents, demographic and socioeconomic data were collected using a predesigned proforma. Clinical evaluation included detailed history, anthropometric measurements, and general and systemic examination.

Laboratory investigations for infants included complete blood count with peripheral smear, serum vitamin B12, and serum ferritin levels. Maternal investigations included serum vitamin B12 and ferritin levels. Approximately 5 mL of venous blood was collected from each mother–infant pair. Serum vitamin B12 and ferritin levels were measured using direct chemiluminescence immunoassay (DIASORIN). Vitamin B12 levels <180 pg/mL and serum ferritin levels <12 ng/mL were considered deficient. Infant values were correlated with maternal levels.

Data were analysed using SPSS (IBM) version 24. Categorical variables were analysed using Chi-square or Fisher's exact test. Continuous variables were tested for normality using the Shapiro–Wilk test and analysed using Student's t-test or Wilcoxon signed-rank test as appropriate. Logistic regression was used to calculate odds ratios with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

Results

Table 1: Socio-demographic variables and Vit B12, IDA deficiency

		VitB12 deficiency	IDA deficiency	Both	None	TOTAL	p-value
Age	29 Days-3 Month	15(5.4%)	1(0.4%)	20(7.1%)	13(4.6%)	49(17.5%)	0.251
	4-6 Month	21(7.5%)	10(3.6%)	36(12.9%)	5(1.8%)	72(25.7%)	
	7-9 Month	35(12.5%)	10(3.6%)	34(12.1%)	8(2.9%)	87(31.1%)	
	10-12 Month	21(7.5%)	15(5.4%)	27(9.6%)	9(3.2%)	72(25.7%)	
Sex	Male	52(18.6%)	26(9.3%)	68(24.3%)	18(6.4%)	164(58.6%)	0.132
	Female	40(14.3%)	10(3.6%)	49(17.5%)	17(6.1%)	116(41.4%)	
Religion	Hindu	82(29.3%)	32(11.4%)	97(34.6%)	25(8.9%)	236(84.3%)	0.153
	Muslim	10(3.6%)	4(1.4%)	20(7.1%)	10(3.6%)	44(15.7%)	
Socio-Economic Status	I	0(0%)	0(0%)	0(0%)	1(0.4%)	1(0.4%)	0.175
	II	10(3.6%)	4(1.4%)	7(2.5%)	1(0.4%)	22(7.9%)	
	III	32(11.4%)	11(3.9%)	51(18.2%)	15(5.4%)	109(38.9%)	
	IV	38(13.6%)	18(6.4%)	49(17.5%)	16(5.7%)	121(43.2%)	
	V	12(4.3%)	3(1.1%)	10(3.6%)	2(0.7%)	27(9.6%)	
Total		92(32.9%)	36(12.9%)	117(41.8%)	35(12.5%)	280(100%)	

A total of 280 anaemic infants aged 29 days to 1 year were included in the study. Of these, 164 (58.6%) were males and 116 (41.4%) were females. Most infants belonged to lower socioeconomic strata, with 38.9% in SES III and 43.2% in SES IV according to the modified Kuppuswamy scale. The majority of infants were aged 7–9 months (31.1%), followed by 4–6 months and 10–12 months (25.7% each). No statistically significant association was observed between age, sex, religion, or socioeconomic status and type of nutritional deficiency ($p > 0.05$).

Table 2: Descriptive statistics showing grades of anaemia and vit B12 and IDA deficiency

	Vit B12 deficiency	IDA deficiency	Both	None	Total	p-value
Mild Anaemia	26(9.2%)	3(1.0%)	28(10%)	10(3.6%)	67(23.9%)	**0.047***
Moderate Anaemia	45(16.1%)	22(7.9%)	67(23.9%)	17(6.1%)	151(53.9%)	
Severe Anaemia	21(7.5%)	11(3.9%)	22(7.9%)	8(2.9%)	62(22.1%)	
Total	92(32.9%)	36(12.9%)	117(41.8%)	35(12.5%)	280(100%)	

Chi-square test, *- statistically significant

Overall, vitamin B12 deficiency was present in 92 infants (32.9%), iron deficiency anaemia (IDA) in 36 (12.9%), and combined vitamin B12 and IDA deficiency in 117 (41.8%), while 35 infants (12.5%) had no biochemical deficiency. Based on severity, 151 infants (53.9%) had moderate anaemia, 67 (23.9%) had mild anaemia, and 62 (22.1%) had severe anaemia. Combined vitamin B12 and IDA deficiency was most commonly observed across all grades of anaemia.

A statistically significant association was found between severity of anaemia and type of deficiency ($p = 0.047$)

Table 3: Descriptive statistics of mother vit b12 deficiency and IDA deficiency and both deficiency and no deficiency with their infant vit b12 deficiency and IDA deficiency and both deficiency and no deficiency.

Infant		Vit B12 deficiency	IDA deficiency	Both	None	P-VALUE
Mother	**Vit B12 deficiency**	55(19.6%)	0(0%)	41(14.6%)	7(2.5%)	**0.011***
	IDA deficiency	0(0%)	3(1.1%)	9(3.2%)	3(1.1%)	
	Both	4(1.4%)	0(0%)	27(9.6%)	1(0.4%)	
	None	33(11.8%)	33(11.8%)	40(14.3%)	24(8.6%)	

***- Statistically significant**

Table 3 shows the correlation between maternal and infant deficiencies of vitamin B12 and iron. The association was statistically significant ($p = 0.011$).

Among 280 mother–infant pairs, 55 (19.6%) pairs had vitamin B12 deficiency**,** 27 (9.6%) had both vitamin B12 and IDA deficiency**,** and 3 (1.1%) pairs had IDA deficiency. Infants of mothers without deficiencies showed varied deficiency patterns, including isolated vitamin B12 deficiency, IDA, or combined deficiencies.

These findings highlight a strong association between maternal and infant nutritional status, particularly for vitamin B12 and iron.

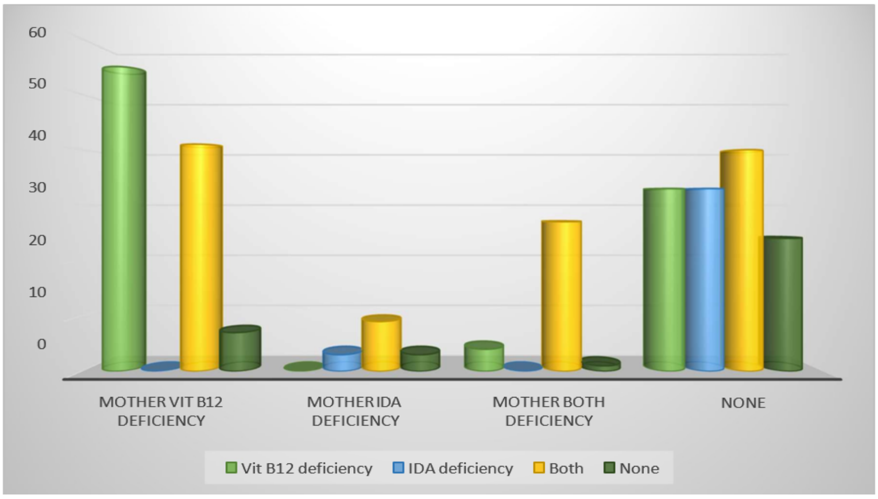

Figure 1: Descriptive statistics of mother vit b12 deficiency and IDA deficiency and both deficiency with their infant vit b12 deficiency and IDA deficiency and both deficiency and no deficiency.

Graph showing descriptive statistics of mother vit b12 deficiency and IDA deficiency and both deficiency with their infant vit b12 deficiency and IDA deficiency and both deficiency and no deficiency.

Table 4: Anthropometric measurements and VitB12 deficiency, IDA deficiency, both and none

	Vit B12 deficiency	IDA Deficiency	Both	None	P-Value
HEIGHT	64.39±6.54	66.95±6.12	64.41±8.70	62.37±8.66	0.100
WEIGHT	5.84±1.69	6.20±1.28	6.60±5.03	5.37±2.13	0.225
HC	41.27±3.39	43.06±2.11	41.46±4.08	40.52±4.73	**0.035***
MUAC	12.12±1.78	12.25±0.91	12.53±2.78	12.13±1.43	0.545

***- Statistically significant**

Table 4 present anthropometric measurements in infants with vitamin B12 deficiency, IDA, both deficiencies, or no deficiency. Head circumference differed significantly among groups ($p = 0.035$), with lower mean values observed in infants with vitamin B12 deficiency (41.27 ± 3.39 cm) and combined deficiencies (41.46 ± 4.08 cm) compared to IDA alone (43.06 ± 2.11 cm) and no deficiency (40.52 ± 4.73 cm). Differences in height, weight, and mid-upper arm circumference were not statistically significant ($p > 0.05$).

Discussion

Childhood anemia is a significant public health problem, especially in infants under two years, where it reflects maternal nutritional status. In this study of 280 infants aged 1 month to 1 year, 23.9% had mild anemia, 53.9% moderate, and 22.1% severe anemia, consistent with previous studies in India. Iron deficiency was more prevalent in male infants, and lower socioeconomic status was associated with higher anemia prevalence, supporting global evidence that poverty and malnutrition increase the risk of anemia.

Maternal nutritional status strongly influenced infant deficiencies. Vitamin B12 deficiency in mothers was associated with a higher prevalence of deficiency in infants, and combined deficiencies of vitamin B12 and iron were observed in both mothers and infants. This highlights the critical role of maternal nutrition in infant hematological health, as reported in prior studies. Exclusive breastfeeding was associated with higher rates of vitamin B12 and iron deficiencies compared to top feeding, emphasizing the need for maternal supplementation and complementary feeding strategies. Biochemical and hematological analysis revealed expected patterns: macrocytosis and hypersegmented neutrophils were common in vitamin B12 deficiency, while microcytosis and anisopoikilocytosis predominated in iron deficiency or combined deficiencies. Anthropometric measures, especially head circumference, were significantly affected in infants with deficiencies, highlighting the impact on growth and development.

Overall, our findings underscore the importance of assessing maternal and infant nutritional status, addressing socioeconomic disparities, and implementing targeted interventions, including supplementation and dietary education, to prevent anemia and micronutrient deficiencies in early childhood.

Conclusion

Iron deficiency anemia remains the leading cause of anemia in children (69.3%). In our study, dimorphic anemia was the most common type (41.8%), followed by isolated vitamin B12 deficiency (32.9%) and iron deficiency anemia (12.9%). Infants often mirror their mother's deficiencies, emphasizing the importance of maternal nutrition.

Vitamin B12 deficiency, linked to low maternal intake of animal proteins, contributes to severe anemia. Peripheral smear and vitamin B12 measurement are essential in evaluating all anemic children, as CBC alone may be insufficient.

Supplementation during pregnancy and lactation is recommended.

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