ORIGINAL ARTICLE

Assessing the Frequency of Vitamin B12 Deficiency in Pediatric Anemia: A Descriptive Study

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Abstract

Background: The overall contribution of vitamin B12 deficiency to the global burden of anemia in infants and children is probably higher. Early identification of B12 deficiency will result in their timely management and prevention of a lot of consequences, including social and economic burden.

Objective: To determine the frequency of vitamin B12 deficiency in pediatric patients admitted with anemia in a public sector tertiary care hospital.

Methods: This was a descriptive cross-sectional study conducted at the department of pediatrics, Fazaia Ruth Pfau Medical College during the period of three months from October 2024 to December 2024. All patients of either gender aged 6 months to 3 years of age (sample size=129) who were admitted to the pediatric ward with anemia were enrolled. A serum vitamin B12 level greater than 300 pg/mL was considered normal. Levels falling between 200 and 300 pg/mL were classified as borderline, whereas Vitamin B12 levels below 200 pg/mL indicated a deficiency. Statistical analysis was done using SPSS version 23.

Results: Of 129 patients, the mean age was 1.96 ±0.69 years. Gender distribution showed 67 (51.9%) males and 62 (48.1%) females. The mean weight of the patients was 13.68 ±3.15 kg. The mean vitamin B12 level of the patients was 245.09 ±69.06 picogram per ml. The frequency of vitamin B12 level deficiency was found to be 47 (36.4%).

Conclusion: The frequency of vitamin B12 deficiency was found considerably higher in pediatric patients admitted with anemia, in a tertiary care Hospital.

Keywords: *Vitamin B12, deficiency, pediatric patients, anemia, cobalamin.*

INTRODUCTION

Vitamin B12, also known as cobalamin (Cbl), is a vital water-soluble nutrient involved in the production of neurotransmitters, DNA, and RNA, which are essential for cell replication and repair [1]. Vitamin B12 is predominantly present in animal-derived foods such as meat, fish, poultry, eggs, and dairy products, and the advised daily intake for this vitamin is 2.4 micrograms [2]. Vitamin B12 deficiency is frequently seen in our community, primarily due to an unbalanced diet and insufficient intake of B12-rich foods [3].

In Pakistan, the prevalence of vitamin B12 deficiency has been reported to range from 10% to 52%, according to various studies conducted by researchers [4, 5]. The main causes of vitamin B12 deficiency in the general population are anemia and gastritis, which both lead to impaired absorption of vitamin B12 [6]. Clinical consequences are often severe and they are an important cause of morbidity and mortality, especially in pediatrics [7]. Cobalamin (vitamin B12) deficiency in infants often presents with vague symptoms, leading to possible delays in diagnosis. Common early signs include poor growth, vomiting, increased irritability, muscle weakness, and difficulty transitioning to solid foods. Since vitamin B12 plays a crucial role in brain development, neurological symptoms frequently occur. Affected individuals may exhibit symptoms such as feeding difficulties, reduced muscle tone, developmental delays or regression, tremors, involuntary movements, and seizures [8].

In older children, severe deficiency may cause skin pigmentation changes, particularly on the fingers, toes, underarms, arms, and inner thighs [9]. Additional symptoms can include numbness, unsteady movements, abnormal motor function, tongue inflammation, and behavioral changes [6]. The better-known neurological manifestations of vitamin B12 deficiency, such as paresthesia and ataxia, may also be present in infants, but remain undetected as the infant is too young to communicate such specific symptoms. A practical way to detect vitamin B12 deficiency early is by assessing serum B12 levels before noticeable symptoms develop. Studies have highlighted an association between B12 deficiency and neuropsychiatric disorders, even when anemia or macrocytosis is not present [10].

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Two groups of patients should be considered for diagnostic testing for B12 deficiency. The first group comprises those with clinical evidence of B12 deficiency, including macrocytic anemia and/or neurological symptoms. In such patients, laboratory tests may help to confirm the diagnosis, but a firm clinical suspicion of B12 deficiency warrants immediate treatment with B12 [11]. The other, much larger group of patients who experience nonspecific symptoms, quite often not including anemia, presents a greater challenge. This group includes elderly individuals, individuals on a diet with limited amounts of B12, such as vegans, individuals with impaired fertility, patients with gastrointestinal diseases, and patients with non-characteristic and unexplained hematological or neurological symptoms [12]. Serum B12 level is usually the first-line test. In general, a value well below the lower limit of the reference interval is indicative of probable B12 deficiency, whereas a value well above this limit indicates a sufficient B12 status. Important exceptions may occur in the presence of circulating antibodies against intrinsic factor in patients with pernicious anemia, in whom spuriously normal B12 levels have been reported [13].

If the patient was found deficient, they were given specific management along with dietary counselling, in addition to treatment of the primary disease, for admission. Patients newly diagnosed with B12 deficiency are usually given 1000 mcg of the vitamin by intramuscular injection once a week for four weeks, then once a month as maintenance therapy [14]. This study aimed to evaluate the prevalence of vitamin B12 deficiency in pediatric patients admitted with anemia.

MATERIALS AND METHODS

This was a descriptive cross-sectional study conducted at the Department of Pediatrics, Fazaia Ruth Pfau Medical College during the period of three months from October 2024 to December 2024. The study was started after approval of the synopsis was obtained from the Ethical Committee of the institute (Ref. No.: FRPMC-IRB-2024-77).

Children with the age between six months to three years of either gender and admitted in pediatric ward with anemia were included in this study whereas patients with recent history of blood transfusion within 3 months, taking oral vitamin B12 supplement in any dose, third grade of Protein-Calorie Malnutrition, primary disease such as hepatic disease, multiple myeloma, chronic kidney disease, malabsorption syndrome, chronic diarrhea and patients on chemotherapeutic or immunosuppressive drugs were excluded from the study.

Sample size was calculated by using the OpenEpi sample size calculator, taking the statistics of vitamin B12 deficiency in anemic pediatric patients as 31.2% [15]. The calculated sample size is 129 with 95% confidence interval and 8% margin of error. Non-probability, consecutive Sampling technique was used.

All children admitted to the pediatric ward fulfilling the inclusion criteria were recruited in the study after taking informed consent from their parents. After taking an adequate history, physical examination, and acute management of the problem for which the child was admitted, a venous blood sample was collected by a trained staff member in a serum bottle and sent for vitamin B12 at the lab of Civil Hospital Karachi. A serum vitamin B12 level greater than 300 pg/mL was considered normal. Levels falling between 200 and 300 pg/mL were classified as borderline, whereas Vitamin B12 levels below 200 pg/mL indicated a deficiency [16].

Statistical analysis was done using SPSS version 23. Data was analyzed in terms of frequencies and percentage for qualitative variables such as gender, vitamin B12. Mean and SD were calculated for quantitative variables such as age, weight, and vitamin B12 level. Effect modifiers like age, gender, and weight were addressed through stratification. Post-stratification Chi-square test was applied. P-value <0.05 was considered statistically significant.

RESULTS

Table **1** shows demographic characteristics of patients. Among 129 patients, 66.7% were aged less than 2 years, while 33.3% were aged more than 2 years. Gender distribution revealed 67 males (51.9%) and 62 females (48.1%). Additionally, 83 patients (64.3%) weighed less than 14 kg, while 46 patients (35.7%) weighed more than 14 kg.

Table 1: Demographic characteristics.

Variables	Frequency	Percentage
Gender		
Male	62	48.1
Female	67	51.9
Age		
≤ 2 years	86	66.7
> 2 years	43	33.3
Weight		
≤ 14 kg	83	64.3
> 14 kg	46	35.7

Table 2: Mean vitamin B12 level of the patients, in picogram /ml (n=129).

Mean ±SD	Minimum value	Maximum value
245.09 ±69.06 pg/mL	128 pg/mL	412 pg/mL

The average vitamin B12 level among the patients was found to be 245.09 picograms per milliliter, with a standard deviation of 69.06 picograms per milliliter. This indicates variability in the vitamin B12 levels across the patient population, as reflected by the standard deviation (**Table 2**).

Table 3: Comparison of vitamin B12 deficiency with respect to age.

Variable	Vitamin B12 Deficiency		Total n(%)	p-value
	Yes n(%)	No n(%)		
Age				
≤2 years	31 (36.0)	55 (64.0)	86 (100)	0.897
>2 years	16 (37.2)	27 (62.8)	43 (100)	
Weight				
≤14 Kg	28 (33.7)	55 (66.3)	83 (100)	0.392
>14 Kg	19 (41.3)	27 (58.7)	46 (100)	

Vitamin B12 deficiency, defined as levels less than 200 picograms per milliliter, was observed in 47 patients (36.4%) in Fig. **(1)**.

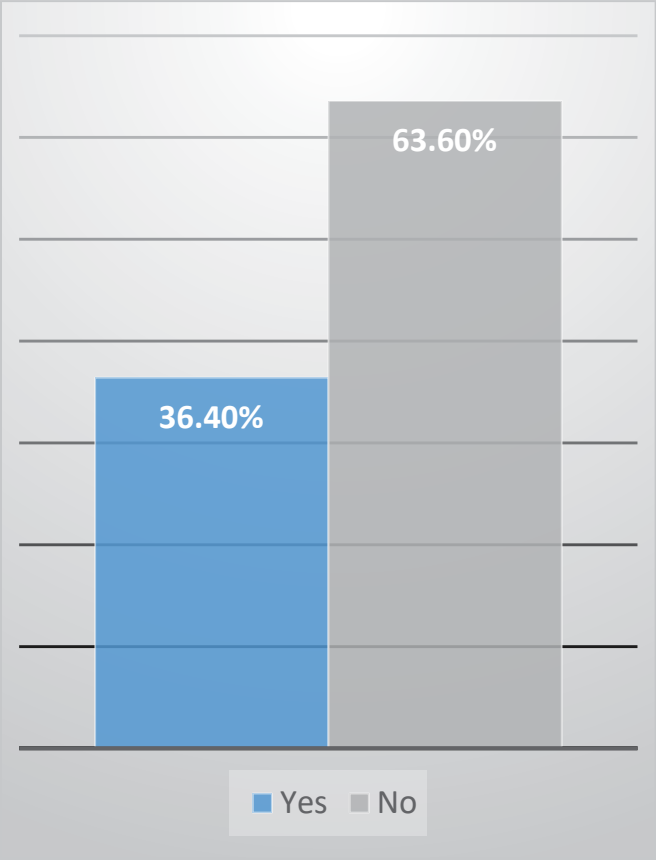

Fig. (1): Frequency of vitamin B12 deficiency.

In Table **3**, the comparison of vitamin B12 deficiency with general characteristics revealed no significant relationship with age (p=0.897). On stratification, there was no significant association found between vitamin B12 deficiency and weight (p=0.392).

DISCUSSION

This study evaluates the prevalence of vitamin B12 deficiency and its association with anemia in children aged six months to three years. The findings highlight the extent of vitamin B12 deficiency in this age group and its potential role in contributing to anemia. In a study, it was reported that vitamin B12 deficiency was identified in 8.16% (8/98) of anemic children, while a combined deficiency of vitamin B12 and iron was found in 3.06% (3/98) of cases [17]. Whereas in this study, the frequency of vitamin B12 level deficiency was found to be 47 (36.4%) of anemic patients. Another study reported a prevalence of vitamin B12 deficiency of 13.8% among preschool children [18]. Pasricha *et al.* analyzed the micronutrient status of 396 children aged 12-23 months in rural Karnataka, South India, focusing on vitamin B12, folate, iron, and vitamin A. Their study found that 65.6% of the children had at least one micronutrient deficiency, underscoring the need to prioritize breastfeeding children aged 1-2 years in supplementation programs [19].

However, this study is not representative of the entire state and does not account for regional differences or associated factors. In comparison, nationally representative surveys from other countries have reported lower prevalence rates of vitamin B12 deficiency, such as 7.7% in children aged 1-6 years in Mexico [20] and 34% in school-aged children in North East Ethiopia [21]. According to the national nutrition survey in India, the prevalence of vitamin B12 deficiency was 14%, 17% and 31% among pre-school children, school-age children, and adolescents, respectively [22]. Vitamin B12 deficiencies may primarily arise from inadequate dietary intake or malabsorption; however, factors like gender, age, genetic predisposition, ethnicity, and sociocultural influences are also likely to impact vitamin status [23]. While in this study, vitamin B12 deficiency was not found to be associated with age and weight of the patients.

Van der Westhuyzen *et al.* conducted a study to assess the prevalence of anemia and deficiencies in iron, folate, and vitamin B12 among 140 Black preschool children aged 3-5 years from five villages in the Letaba region near Tzaneen. Their findings indicated that 39.2% of the children were anemic, with hemoglobin levels below 11.1 g/dL, while around 10% exhibited iron deficiency [24]. Additionally, in Guatemala, 33.5% children had low red cell folate levels and 50% children were vitamin B12 deficient, emphasizing the need for community-based interventions, such as fortifying maize meal with folic acid [25]. In the Pakistani context, recent studies have highlighted the coexistence of iron and vitamin B12 deficiencies in malnourished children despite meat-based diets being common. This may be attributed to poor absorption, infections, and dietary gaps in maternal nutrition during pregnancy and lactation [26].

This study has several limitations. Firstly, since it was conducted on hospitalized patients, the findings may not accurately reflect the overall population. Secondly, vitamin A levels were not assessed, despite research indicating a link between iron deficiency anemia and low serum retinol levels [27]. Consequently, its potential role in nutritional anemia was not examined. Thirdly, the absence of quantitative CRP testing limited the ability to distinguish between true and inflammation-induced elevations in serum ferritin. Ferritin levels close to the cutoff value may have been influenced by acute

inflammation [28]. This study did not include detailed maternal or nutritional history (*e.g.*, breastfeeding practices, weaning, or dietary patterns). Future studies should incorporate nutritional questionnaires to explore causative factors in greater depth, especially exclusive breastfeeding duration and complementary feeding practices. This study did not include height or length measurements necessary to calculate WHO weight-for-age or weight-for-height Z-scores, which would have allowed more accurate classification of children's nutritional status. The use of an absolute weight cutoff (≤14 kg and >14 kg) may not reflect true undernutrition in this age group due to developmental variability. Symptoms specific to vitamin B12 deficiency, such as developmental regression, hypotonia, and neurological findings, were not systematically assessed, which may have underestimated the clinical burden of deficiency. Lastly, the small sample size restricts the generalizability of these findings, even though the hospital serves patients nationwide. Further research is necessary to develop policies for the effective management of nutritional anemias.

CONCLUSION

The frequency of vitamin B12 deficiency was found to be relatively high among pediatric patients admitted with anemia at a tertiary care public hospital. These findings underline the importance of routine screening and nutritional surveillance in hospitalized anemic children. To better understand the public health impact of vitamin B12 deficiencies, it's important to use consistent diagnostic standards for defining deficiency. While this study primarily focused on measuring vitamin B12 levels, possible contributing factors such as exclusive breastfeeding without maternal supplementation, low socioeconomic status, and poor complementary feeding practices may underlie many of the identified cases. Future studies should investigate these associations in depth.

ETHICS APPROVAL

All procedures involving human participants were conducted in accordance with the ethical standards of the institutional review board of Fazaia Ruth Pfau Medical College (Ref. No: FRPMC-IRB-2024-77), and in compliance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments.

CONSENT FOR PUBLICATION

Informed oral consent was secured from the parents or legal guardians of all study participants after explaining the purpose, methods, and potential implications of the study, including the publication of anonymized data.

AVAILABILITY OF DATA

The data of this study are available from the corresponding author upon reasonable and documented request, subject to institutional and ethical data sharing policies.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

Sania Sehar: Principal Investigator, Design, writing, and editing of manuscript

Madiha Abid: Conceiving of study idea, writing, and editing of manuscript

Sidra Hassan: Collection of data, literature search and writing of manuscript

Nimra Aziz Qazi: Data analysis, literature review, writing of results

Shireen Bham: Collection of data and literature review

Mehak Gul Khan: Writing, and editing of manuscript

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GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors used ChatGPT (GPT-4, OpenAI) in a limited manner for language refinement and minor editing in selected sections. All revisions were verified by the authors, who remain fully accountable for the manuscript's content.

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