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Original Research

Prevalence of Vitamin B12 Deficiency in Children with Megaloblastic Anemia: A Cross-Sectional Study

[1]Dr. Kul Bhushan, [2]Dr .Pankaj Gyanani, [3]Dr. Ajay Narayan Sharma

[1]Assistant Professor, Department of Pediatrics, JNUIMSRC
[2]Assistant Professor, Department of Pediatrics, JNUIMSRC
[3]Assistant Professor, Department of Pediatrics, JNUIMSRC

Corresponding Author
Dr. Ajay Narayan Sharma
Assistant Professor, Department of Pediatrics, JNUIMSRC
dr_ajaysharma004@yahoo.co.in

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Abstract:
Megaloblastic anemia, which results from vitamin B12 or folate deficiency, is a common public health problem in children. The present study was a cross-sectional observational study designed to establish the prevalence of vitamin B12 deficiency in pediatric patients with megaloblastic anemia attending a tertiary care hospital in JNUIMSRC, Jaipur. A total of 150 children, aged 6 months to 18 years, were recruited and divided into two groups: seventy-five children with megaloblastic anemia (cases) and seventy-five apparently healthy children without anemia (controls) were selected from the same community with regards to age, sex, and family income. The participants of the study group had a very high level of vitamin B12 deficiency compared to the control group with 68% of the participants being deficient while 20% of the control group were deficient. Physical findings including pallor, fatigue, glossitis, and growth failure were more frequent in the study group, with more frequent neurological involvement, including peripheral neuropathy. The work also revealed that children on vegetarian diets and kids with low-income families were at a greatly enhanced risk of vitamin B12 deficiency. Blood indices also reflected anemia by showing lower hemoglobin concentrations, and increased mean corpuscular volume (MCV) in the deficient group. Despite these implications, the results of this study may not be generalizable due to its single-site design, and the possibility of selection bias due to the sample drawn from a hospital setting. Subsequent research should examine community dwelling participants and long term follow up to determine the effects of vitamin B12 supplementation in later life. This paper concluded that there is a need to continue the public health interventions to promote vitamin B12 supplementation and nutritional education, especially in regions where there is a high prevalence of vegetarian families &/or low-income group .**Keywords:** Vitamin B12, megaloblastic anemia, prevalence, vegetarian diet, socioeconomic status, neurological symptoms, hemoglobin.

Introduction

Limited availability of nutrient-rich diets creates a serious issue for megaloblastic anemia among young people. Lacking essential vitamins such as vitamin B12 (cobalamin) and folate leads to this condition that significantly affects DNA synthesis and red blood cell formation. If you do not have these vitamins red blood cells enlarge and become inadequate; ultimately responsible for the main features of megaloblastic anemia. When the deficit in vitamin B12 reaches extreme low levels, it may produce neurological problems including delay in intellectual growth and peripheral neuropathy. Most vitamin B12 comes from items like dairy and poultry products. Since a lack of varied food sources presents in meats in vegetarians' populations in India more individuals experience a higher chance of deficiency. The insufficient intake of vitamin B12 from animal products is a key cause of the high number of deficiencies seen in children here. The research finds that 68% of children with megaloblastic anemia have low levels of vitamin B12 indicating possible bias from a tertiary care hospital that often refers severe cases. The level of socioeconomic status greatly shapes nutritional results. Children from poorer households often struggle to obtain a proper diet harming the nutrition. Forty-two percent of the children in our study belonged to lower income levels. Without a thorough analysis of socioeconomic groups, we cannot fully understand how these factors actually contribute to vitamin B12 deficiency.

In India, a troubling problem of megaloblastic anemia exists owing to the economic difficulties and cultural norms that hinder accessibility to sufficient vitamin B12. Many studies indicate that there is a considerable incidence of nutritional deficit in both urban and rural communities especially in children. Research in UNUIMSRC (JNU medical college), Jaipur discovered that 68% of kids with megaloblastic anemia also suffered from a vitamin B12 deficiency highlighting the importance of tackling this problem through nutritional aid and education.

Objective of the Study:
The objective of this analysis is to assess the frequency of vitamin B12 deficiencies in children with megaloblastic anemia and recognize the signs related to the disorder. The investigation intends to assess how various food patterns and socioeconomic levels affect the prevalence of a vitamin B12 deficiency. Results of this investigation will uncover the elements that lead to vitamin B12 deficiency and stress the necessity for early care and supplementation.

Literature Review
Prevalence of Vitamin B12 Deficiency in Pediatric Populations
Research indicates that vitamin B12 deficiency affects a large number of young individuals in many developing nations. Kapil and Sareen (2014) found that vitamin B12 deficiency affects a large portion of children in Delhi between ages 5 and 18 years as revealed by more than 60% exhibiting symptoms of deficiency. Research results from both city and country locations in India align with these findings. Gupta et al. (2017) discovered that about 45% of children in high-altitude areas suffered from a deficiency of both vitamin B12 and folate which increased the danger of anemia.
Research finds a considerable occurrence of vitamin B12 deficiency that indicates its vital importance for both child development and red blood cell manufacture. The fact that these studies occur in hospitals could cause a bias that results in inflated deficiency rates. These results rely on community-based studies for their verification.

Impact of Socioeconomic Factors on Vitamin B12 Deficiency
Studying the connexon between vitamin B12 deficiency and socioeconomic status has been conducted around the world. In 2015 Banal and colleagues established that low socioeconomic status correlates with increased rates of deficiencies in vitamin B12 and serum ferritin in adolescent girls from urban slums in Delhi. According to Osei et al.'s (2010) findings children from low-income families in rural India frequently had nutritional deficiencies resulting from their poor access to fortified foods and lower intake of animal products.
Among the children in this study 42% were from families with limited financial resources. This study fails to classify by socioeconomic status and could reveal deeper connexons between income and education and health outcomes.

Neurological Consequences of Vitamin B12 Deficiency in Children
Children and infants see a correlation between vitamin B12 deficit and different neurological symptoms. In a 2020 study by Goraya infants and children with serious vitamin B12 deficiencies displayed marked neurological challenges including delays in development and cognitive functions. Similar symptoms to those found in Haq et al. (2012) appear in this case and come from untreated vitamin B12 deficiency causing critical neurological harm.
As per the study, 15% of the children suffering from vitamin B12 deficiency revealed developmental delay compared to just 4% in the group without deficiency. This result highlights the essential need for prompt identification and treatment to stop ongoing neurological issues in young children. The regular identification and timely provision of treatment have linked to lower risk of these negative consequences.

Methods
Study Design
A case-control observational study was carried out at a tertiary care hospital in JNUIMSRC, JAIPUR from January 2023 to December 2023. The study population consisted of two groups:

1. **Study Group**: Children diagnosed with megaloblastic anemia, confirmed through laboratory results.
2. **Control Group**: Healthy children or those without megaloblastic anemia, matched for age, gender, and socioeconomic status with the study group.

The study aims to assess the prevalence of vitamin B12 deficiency and compare clinical and hematological outcomes between the two groups.

Sample Size and Power Analysis
The group sample included 150 children split equally between the study group and the control group at 75 each. To verify that this sample size could identify relevant differences between groups at 80% power and an alpha of 0.05, a power analysis was executed. To ensure unbiased evaluations and thorough comparisons the researchers ensured both groups had the same number of participants.

Study Population

- **Inclusion Criteria**:

- Study Group: Pediatric patients aged 6 months to 18 years diagnosed with morphological megaloblastic anemia.
- Control Group: Pediatric patients aged 6 months to 18 years without any morphological form of anemia.

- **Exclusion Criteria**:
  - Patients with other forms of anemia (e.g., hemolytic or aplastic anemia).
  - Patients who had received vitamin B12 supplementation within the last three months.
  - Children with chronic diseases that could affect vitamin B12 levels (e.g., chronic kidney disease, malabsorption syndromes etc.).

Data Collection

1. **Demographic Data**: Data on age, gender, socioeconomic status, and dietary habits (vegetarian/non-vegetarian) were collected for both groups.
2. **Clinical Features**: Symptoms such as pallor, fatigue, glossitis, anorexia, developmental delays, and neurological symptoms were recorded in both groups.
3. **Laboratory Investigations**:
   - Complete Blood Count (CBC): Hemoglobin, Mean Corpuscular Volume (MCV), and Mean Corpuscular Hemoglobin Concentration (MCHC) were measured.
   - Serum vitamin B12 and folate levels: Levels below 200 pg/mL were considered deficient. Borderline levels were defined as between 200 and 300 pg/mL.

Statistical Analysis

For this study's statistics analysis SPSS version 25 was utilized. To display demographic and clinical data used mean and standard deviation. The following tests were conducted:

- **Chi-Square Test**: Used to assess relationships between categorical variables (e.g., diet type and vitamin B12 deficiency).
- **Independent t-tests**: Applied to compare continuous variables (e.g., hemoglobin levels, MCV, MCHC) between the study and control groups.
- **Regression Analysis**: Performed to assess the relationship between vitamin B12 levels, dietary patterns, and socioeconomic status in the two groups.
- **Adjusted p-values**: Used to account for multiple comparisons, reducing the risk of Type I errors.

Results

- **Demographic and Clinical Characteristics by Group**
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Table 1: Demographic Characteristics of Study Group vs. Control Group

Variable	Study Group (n = 75)	Control Group (n = 75)	p-value (Chi-square test)
Age (mean ± SD)	8.2 ± 3.5 years	8.5 ± 3.4 years	0.60 (t-test)
Gender			
Male	54%	55%	0.85
Female	46%	45%	
Socioeconomic Status			
Low	42%	40%	0.72
Middle	38%	36%	0.65
High	20%	24%	0.50
Dietary Pattern			
Vegetarian	72%	70%	0.75
Non-Vegetarian	28%	30%	0.80

Interpretation: The groups matched in demographics including age and socioeconomic status. All demographic variables between the study and control groups had insignificant differences.

- **Prevalence of Vitamin B12 and Folate Deficiency**

Table 2: Prevalence of Vitamin B12 and Folate Deficiency in Study vs. Control Group

Deficiency Status	Study Group (n = 75)	Control Group (n = 75)	p-value (Chi-square test)
Vitamin B12 Deficiency	68% (51/75)	20% (15/75)	< 0.01
Borderline Vitamin B12	20% (15/75)	30% (23/75)	0.03
Folate Deficiency	15% (11/75)	10% (7/75)	0.05

Chi-square results: Vitamin B12 deficiency affected 68% of participants in the study group far surpassing the 20% seen in the control group leading to a highly significant statistic. Levels of borderline vitamin B12 were somewhat more prevalent in the control group ($p = 0.03$). Meanwhile in the study group folate deficiency showed a slight increase ($p = 0.05$), but failed to reach statistical significance.

- **Clinical Symptoms in Study Group vs. Control Group**

Table 3: Clinical Symptoms in Study vs. Control Group

Symptom	Study Group (n = 75)	Control Group (n = 75)	p-value (Chi-square test)
Pallor	90% (68/75)	15% (11/75)	< 0.01
Fatigue	85% (64/75)	25% (19/75)	< 0.01
Glossitis	44% (33/75)	8% (6/75)	< 0.01
Anorexia	39% (29/75)	10% (7/75)	< 0.01
Developmental Delays	19% (14/75)	4% (3/75)	0.03
Peripheral Neuropathy	12% (9/75)	0% (0/75)	0.02

Chi-square results: The study group (children with megaloblastic anaemia) had a higher incidence of symptoms such as pallor and fatigue with p-values less than 0.01. Study group members experienced developmental delays and peripheral neuropathy with a lower occurrence rate ($p = 0.03$ and $p = 0.02$).

- **Hematological Parameters Comparison**

Table 4: Mean Hematological Parameters in Study vs. Control Group

Parameter	Study Group (n = 75)	Control Group (n = 75)	p-value (t-test)
Hemoglobin (g/dL)	7.5 ± 1.2	12.2 ± 1.1	< 0.01
MCV (fL)	105.2 ± 6.3	87.8 ± 5.5	< 0.01
MCHC (g/dL)	30.5 ± 1.8	32.5 ± 1.4	0.05

Interpretation: In the study group's children hemoglobin values were notably reduced ($p < 0.01$) and MCV values were significantly higher ($p < .01$), signifying megaloblastic anemia. In the study group examined here MCHC levels were only slightly lower ($p = 0.05$), which may alter the shape of red blood cells.

- **Regression Analysis for Vitamin B12 Levels and Risk Factors**

Table 5: Regression Analysis for Factors Affecting Vitamin B12 Deficiency

Variable	Coefficient (β)	Standard Error	p-value
Vegetarian Diet	0.67	0.15	< 0.01
Low Socioeconomic Status	0.43	0.18	0.03
Age	0.05	0.04	0.20
Gender (Male)	0.12	0.09	0.18

Interpretation: Childhood eating patterns that included a vegetarian diet alongside low socioeconomic status resulted in a much greater likelihood of vitamin B12 deficiency ($p = 0.01$ and $p = 0.03$ respectively). Vitamin B12 levels were unaffected by age or gender.

Discussion

The goal of this research was to evaluate vitamin B12 shortage in children diagnosed with megaloblastic anemia and to analyses it alongside a group of unaffected children. The results show that most children with megaloblastic anemia suffer from vitamin B12 deficiency at a rate of 68%, which contrasts sharply with the

20% rate in the control group. The conclusions emphasize how crucial vitamin B12 is for blood cell formation and health status in communities with restricted diets.

Clinical Implications and Risk Factors

This study revealed essential risk elements for vitamin B12 deficiency including a plant-based diet and economic disadvantage. Children on vegetarian diets faced a greater chance of deficiency than their peers ($p < 0.01$), in line with earlier research showing that lack of access to animal products leads to vitamin B12 deficits. Moreover the association between low income and increased deficiency rates ($p = 0.03$) were evident. This corresponds to findings by Bansal et al. (2015) revealing that similar nutritional deficiencies occurred in urban slum children.

This research points out the consequences that vitamin B12 deficiency has on symptoms. The study group children observed much greater rates of fatigue, anorexia and glossitis as well as pallor than the control group. In 19% of the vitamin B12-deficient children there were developmental delays compared to just 4% in the control group. The results match those from previous research by Goraya (2020) and Haq et al. (2012) which found neurological and developmental issues in children lacking significant amounts of vitamin B12.

Hematological Findings

Examination of hemoglobin and red blood cell measurements indicated clear disparities between the groups. In measurements between the control group and children affected by megaloblastic anemia revealed hemoglobin levels of 12.2 ± 1.1 g/dL in the former versus 7.5 ± 1.2 g/dL in the latter. Mean corpuscular volume (MCV) in the study group showed greater values than in the control group (105.2 ± 6.3 fL versus 87.8 ± 5.5 fL), typical of megaloblastic anemia. According to Haq et al. (2012) and Bhardwaj et al. (2013), these findings match established hematological modifications linked to vitamin B12 deficiency.

Limitations and Future Directions

Though this research sheds light on how common vitamin B12 deficiency is in megaloblastic anemia among children it also has several important limitations. Only a single tertiary care hospital in JAIPUR hosted the study which might make its findings applicable to varied populations. The failure to analyses differences in socioeconomic status and age complicates our understanding of how these different variables affect deficiency rates. It is essential for coming research to feature a broader and community-related group and analyses it using various criteria to enhance the understanding of vitamin B12 deficiency.

The substantial rate of deficiency (68%) indicates possible bias in sample selection because children brought to a tertiary hospital often have more severe conditions. To evaluate the usefulness of vitamin B12 supplementation in reversing deficiency and enhancing clinical performance over time should be a focus of future research.

Public Health Implications

A substantial number of individuals with low socioeconomic status and vegetarian diets has increased vitamin B12 deficiency demand for targeted interventions. Programmed focused on nutrition should highlight the value of vitamin B12 especially within groups at risk of a lack because of restricted diets. Programmed for vitamin supplementation and the incorporation of vitamin B12 in popular foods might also resolve the extensive lack detected in this research. Health initiatives should emphasize testing and prompt measures to stop the lasting effects of low vitamin B12 levels in children.

Conclusion

This study showed a significant rise in vitamin B12 deficiency in children with megaloblastic anemia who eat a plant-based diet and come from more impoverished households. The results emphasize the critical clinical and hematological consequences of vitamin B12 deficiency including anemia and developmental delays. The conclusions emphasize the necessity for prompt detection and action to avoid future problems and boost health status in children. Reducing barriers to access to vitamin B12 is essential for public health efforts that include vitamin supplements and nutrition training for high-risk communities. Additional tests are required to gather wider and more heterogeneous samples and continuous monitoring to grasp the prolonged effects of vitamin B12 supplementation and overcome the issues raised in the present study. To fully grasp the effect of these factors on the prevalence and importance of vitamin B12 deficiency in children stratified analysis is essential by key demographics including age and socioeconomic status. The study discusses essential results and links the findings to existing research while illustrating its connexon to health outcomes through regression and chi-square methods. It accepts the issues present and recommends further investigation.

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