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Original Research Article

STUDY OF ANEMIA AND ETIOLOGICAL FACTORS IN UNDER FIVE CHILDREN WITH SEVERE ACUTE MALNUTRITION

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ABSTRACT

Background: Severe acute malnutrition (SAM) and anemia are major public health concerns, significantly affecting growth and development in children under five. This study examines the clinical and etiological factors contributing to anemia in children with SAM in South Gujarat, with a focus on iron and vitamin B12 deficiencies. The aim is to document the profile of anemia and various etiological factors among children with malnutrition, 2) To evaluate iron status in severely malnourished children with anemia, and 3) To assess vitamin B12 levels in severely malnourished children with anemia.
Materials and Methods: A cross-sectional study was conducted at a tertiary care hospital in South Gujarat from June 2019 to October 2020. A total of 120 children aged 6 months to 5 years with SAM were enrolled. Anthropometric measurements, clinical evaluations, and biochemical tests for hemoglobin, serum iron, total iron-binding capacity, and vitamin B12 were performed. Anemia was classified based on hemoglobin levels, and deficiencies were identified using standard biochemical thresholds. Data were analyzed using SPSS, applying Chi-square tests for association.
Results: Of the 120 children, 61.7% had moderate anemia, and 38.3% had severe anemia. Iron deficiency was present in 46.6%, while 28.3% had vitamin B12 deficiency. Severe anemia was significantly associated with low vitamin B12 levels (52.9%; $p = 0.039$) and inadequate dietary B12 intake ($p = 0.027$). Anemia was higher among females (55%) and children from lower socioeconomic groups (63.4%).
Conclusion: Vitamin B12 deficiency is a significant contributor to anemia among children with SAM. Treatment of SAM child with anemia should also focus on vitamin B12 supplementation along with Iron and Folic acid.
Keywords: Severe acute malnutrition, anemia, iron deficiency, vitamin B12 deficiency, under-five children.

INTRODUCTION

A healthy population that can learn new skills, think critically, and actively participate in community development is essential for both economic progress and human development. A robust immune system, healthy growth, appropriate organ function, and cognitive development all depend on early childhood nutrition. Underweight (low weight for age), stunting (low height for age), wasting (low weight for height), and micronutrient deficiencies are some of the ways that undernutrition can show themselves at this crucial time.

According to the most recent data on malnutrition, in 2022, undernutrition was a contributing factor in about 45% of fatalities among children under five, 149 million of whom were stunted, and 45 million of whom experienced wasting.[1,2] In India, 35.5% of children between the ages of 6 months and 5 years are stunted, 19.3% are wasted, and 35.8% are underweight, with anemia affecting 67.1% of children, according to NFHS-5 (2019–2021). The prevalence of anemia has dramatically increased (58.6% in NFHS-4), whereas stunting and wasting have slightly decreased when compared to NFHS-4. In Gujarat, 79.7% of children are anemic, 39% are stunted, 25.1% are wasted, and 39.7% are underweight. This indicates a worrying rise in the prevalence of anemia from NFHS-4, even while there has been little progress in reducing other nutritional indicators.[3]

Reducing mortality and encouraging long-term rehabilitation to enhance quality of life are the goals of effective management techniques. However, comorbidities like anemia that frequently accompany malnutrition have a substantial impact on long-term results and survival. Nutrient shortages, worm infestations, gastrointestinal blood loss, malabsorption caused by gut shrinkage, and infection-induced bone marrow suppression are some of the reasons associated with anemia in SAM patients.[4-6]

Of these, vitamin deficiencies—especially those involving iron—continue to be a major global concern. SAM-related anemia can manifest as macrocytic, microcytic, hypochromic, or normocytic normochromic. Significant differences exist in anemia and micronutrient deficits, including vitamin B12, among impoverished children, according to studies conducted throughout India.[6,7] Specific recommendations addressing the examination and supplementation of Vitamin B12 are still unclear, despite the fact that national and WHO guidelines stress the importance of micronutrient supplementation for the management of SAM.

Dietary patterns have an impact on micronutrient status and differ greatly throughout India's various regions.[8] There is insufficient information available on the local nutritional and micronutrient composition, especially in southern Gujarat. Closing this gap is essential to creating solutions that work. In order to provide useful information for future management strategies, this study intends to record the anemia profile, its contributing variables, and the nutritional status- with a particular focus on iron and vitamin B12- among malnourished children in southern Gujarat.

Given the regional dietary variations and the lack of data from southern Gujarat, there is a need to evaluate the local situation. The current study aims to document the profile of anemia and its contributing factors among malnourished children. Specifically, the study objectives are to: 1) To document the profile of anemia and various etiological factors among children with malnutrition, 2) To evaluate iron status in severely malnourished children with anemia, and 3) To assess vitamin B12 levels in severely malnourished children with anemia.

MATERIALS AND METHODS

This observational, cross-sectional study was conducted at a tertiary care hospital in South Gujarat from June 2019 to October 2020. The study aimed to examine anemia and its etiological factors in children under five years of age with severe acute malnutrition. The study setting included the Nutritional Rehabilitation Centre (NRC) and pediatric wards. The study population consisted of pediatric patients aged 6 months to 5 years, diagnosed with severe acute malnutrition according to the WHO Z score weight-for-height criteria. The study included 120 children, selected through convenient purposive sampling. All participants were evaluated for nutritional status using anthropometric measures such as weight, height, mid-upper arm circumference, and head circumference. Children with severe acute malnutrition and clinical signs of anemia, including palmar pallor and hemoglobin levels below 11 g/dL, were enrolled in the study after obtaining informed consent from their guardians. Blood sample for CBC 1ml was taken on day of admission and then collected sample in EDTA processed by 3-part differential system XN 1000(Japan) automatic analyzer. Blood sample for s. Iron and TIBC (Total Iron Binding Capacity) were collected in plain vacuette(2ml) and then processed for serum separation and tested by Ferrozine method and blood sample for s. Vitamin B12 was collected in plain vacuette then processed for serum separation and tested under chemiluminescence assay using ADIVA centaur s. Vitamin B12 assay. Anemia was classified as mild, moderate, or severe based on hemoglobin levels. Iron deficiency was diagnosed when serum iron levels were below 40 µg/dl, while vitamin B12 deficiency was identified when serum vitamin B12 levels were below 200 pg/ml. The study adhered to ethical guidelines, with approval from the scientific review and human research ethical committees of the institute. Confidentiality was maintained, and patients were assigned unique identity numbers. Data analysis was conducted anonymously, and children diagnosed with anemia received appropriate treatment before discharge, including iron supplements and injectable vitamin B12. Data were analyzed using the Chi-square test, with all information recorded and processed in MS Excel spreadsheets.

RESULTS

The purpose of the study was to describe the anemic profile and pinpoint a number of potential contributing factors in children under five who suffer from severe acute malnutrition. Between June 2019 and October 2020, 3,279 children were admitted to the pediatric ward, 1,295 of them were within the 6-month to 5-year age range. Following a nutritional status screening of all 1,295 children, 202 were found to have severe acute malnutrition according to WHO standards. These kids were brought to the department's Nutritional Rehabilitation Center. Clinical anemia was identified in 135 of the 202 children who suffered from severe acute malnutrition. Of them, 120 kids satisfied the requirements for inclusion and were included to the study. All participants underwent thorough clinical tests, medical records reviews, and parent interviews.

Microsoft Excel spreadsheets were used to enter the acquired data, and SPSS version 20 was used for analysis. This analysis was used to determine the study's findings.

The clinical and demographic traits of the 120 children with severe acute malnutrition (SAM) that were part of the research: The majority of children were between the ages of 6 to 12 months (31.7%) and 13 - 24 months (35%). Males (45%) were outnumbered by females (55%), suggesting that SAM is slightly more common in females. The socioeconomic vulnerability that contributes to malnutrition was reflected in the fact that the majority of children were from the lowest (26.7%) and lower-middle (36.7%) socioeconomic strata. The percentage of youngsters from the upper-middle class was just 13.3%. 96.7% of the children had pallor, while 15% had pigmentation on their knuckles. The most prevalent kind of anemia, affecting 61.7% of the children, was moderate anemia (Hb 7–9.9 g/dL), whereas 38.3% had severe anemia (Hb < 7 g/dL). [Table 1]

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristics	Frequency (%) n=120
Age group (Completed years)	
6-12 months	38 (31.7)
13-24 months	42 (35)
25-36 months	08 (6.7)
37-48 months	16 (13.3)
49-60 months	16 (13.3)
Gender	
Male	54 (45)
Female	66 (55)
Socio-economic status	
Lower	32 (26.7)
Upper lower	28 (23.3)
Lower middle	44 (36.7)
Upper middle	16 (13.3)
Total	120 (100)
Clinical sign of anemia: Pallor	
Present	116 (96.7)
Absent	04 (3.3)
Clinical sign of anemia: Knuckle pigmentation	
Present	18 (15)
Absent	102 (85)
Hemoglobin level (gm/dL)	
Mild Anemia (Hb=10-10.9)	0 (0)
Moderate Anemia (Hb=7-9.9)	74 (61.7)
Severe Anemia (Hb=<7)	46 (38.3)

Iron level in children with SAM, categorized by the degree of moderate and severe anemia. Serum Iron Levels: Of the 120 children, 56 (46.6%) children had iron deficiency anemia. out of 56 children with iron deficiency, 53.6% children had moderate Anemia and 46.4% children had severe Anemia. However, there was no statistically significant correlation between serum iron levels and anemia severity (p-value=0.08). 57.1% of children having iron deficiency were below 2 years of age. 41.6% of children had elevated TIBC (Total Iron Binding Capacity) levels, which are a sign of iron shortage. Children with raised TIBC had a higher prevalence of severe anemia (48%) than children with normal TIBC (31.4%), however the difference was not statistically significant (P = 0.06). MCV (Mean Corpuscular Volume): Microcytic anemia was indicated by the majority of children (71.6%) having lower MCV readings. Iron deficiency found in 53.6% children born with <2.5kg birth weight. and 46.6% children born with >2.5kg birth weight. Iron deficiency anemia was found in 53.6% children with late initiation of complementary feeding beyond 6months of age. A significant percentage of children (78.3%) had adequate dietary iron intake; nonetheless, severe anemia was slightly more common in those with adequate consumption than in those with inadequate intake. There was no significant correlation (P = 0.37). [Table 2]

Table 2: Iron Status in Children with Severe Acute Malnutrition

Iron Status	Moderate Anemia n (%)	Severe Anemia n (%)	Total n (%)	p-value
Serum Iron level (µg/dl)				
Normal (≥ 40)	44 (68.7)	20 (31.3)	64 (53.3)	0.08
Deficient (< 40)	30 (53.6)	26 (46.4)	56 (46.7)	
Total	74 (61.7)	46 (38.3)	120 (100)	
TIBC (Total Iron Binding Capacity) (µg/dl)				
Normal (<400)	48 (68.6)	22 (31.4)	70 (58.3)	0.06
Elevated (≥400)	26 (52.0)	24 (48.0)	50 (41.6)	
Total	74 (61.7)	46 (38.3)	120 (100)	
MCV (fL)				

Decreased (<72)	24 (55.8)	19 (44.2)	43 (76.8)	0.37
Normal (≥72)	6 (46.2)	7 (53.8)	13 (63.8)	
Total	30 (53.5)	26 (46.5)	56 (100)	
Dietary Iron Intake				
Adequate	56 (59.6)	38 (40.4)	94 (78.3)	0.37
Inadequate	18 (69.2)	08 (30.8)	26 (21.7)	
Total	74 (61.7)	46 (38.3)	120 (100)	

The correlation between the degree of anemia in children with SAM and their vitamin B12 level. Serum Vitamin B12 Levels: Of the 120 children, 34(28.3%) children had vitamin B12 deficiency of which 52.9% children had severe anemia. Dietary Vitamin B12 consumption: The majority of children (73.3%) had insufficient dietary vitamin B12 consumption, and only 26.7% children consume vitamin B12 containing food. This association was found statistically significant(P=0.027). 82.3% of children having vitamin B12 deficiency are below 2 years, 23.9% children with vitamin B12 deficiency had macrocytic anemia with MCV>90. Vitamin B12 deficiency was found in 70.6% children with late initiation of complementary feeding beyond 6months of age. [Table 3]

Table 3: Vitamin B12 Status in Relation to Anemia in Malnourished Children

Iron Status	Moderate Anemia n (%)	Severe Anemia n (%)	Total n (%)	P-value
Serum B12 level (picogram/dl)				
Normal (≥ 200)	58 (67.4)	28 (32.6)	86 (71.7)	0.039
Deficient (< 200)	16 (42.1)	18 (52.9)	34 (28.3)	
Total	74 (61.7)	46 (38.3)	120 (100)	
MCV (fL)				
Normal (72-90)	19 (73.1)	7 (26.9)	26 (76.4)	0.014
Increased (>90)	02 (25)	06 (75)	08 (23.5)	
Total	21 (61.8)	13 (38.2)	34 (100)	
Dietary Vitamin B12 Intake				
Adequate	16 (50)	16 (50)	32 (26.7)	0.027
Inadequate	58 (65.9)	30 (34.1)	88 (73.3)	
Total	74 (61.7)	46 (38.3)	120 (100)	
Complementary feeding				
Timely (at 6 months)	06 (60)	04 (40)	10 (29.4)	0.32
Late (after 6 months)	10 (41.6)	14 (58.4)	24 (70.6)	
Total	16 (47)	18 (53)	34 (100)	

In a nutshell, the majority of children under two years age, females and children from lower socioeconomic groups were more likely to suffer from severe acute malnutrition with anemia,. In this population, anemia was very widespread, with the most common kind being moderate anemia. Iron indicators such as TIBC and MCV did not significantly correlate with the severity of anemia, and children with moderate and severe anemia were similarly affected by iron deficiency. Severe anemia was more strongly correlated with vitamin B12 insufficiency, highlighting the part that B12 deficiency plays significant role in the severity of anemia in undernourished children. And also, inadequate vitamin B12 consumption as well as late initiation of complementary feeding play important role in causation of vitamin B12 deficiency.

DISCUSSION

During the first 1,000 days of life, children must receive enough macronutrients and vital micronutrients, such as iron and vitamin B12, to ensure proper growth, development, and especially neurodevelopment.[9] Cobalamin, often known as vitamin B12, is an essential element for DNA synthesis. Megaloblastic anemia and impaired fatty acid synthesis in myelin are the effects of this vitamin deficiency, which may lead to subacute combined degeneration of the spinal cord and the distinctive coloration of the knuckles. Neuro regression is another consequence of vitamin B12 insufficiency in newborns and young children.[10]

During the crucial time for brain development, iron deficiency anemia can cause irreversible alterations that negatively affect brain function, such as decreased dopaminergic receptors and increased opiate receptors. The indicators used to assess iron and vitamin B12 sufficiency must be carefully chosen.[11] Although serum ferritin is frequently employed as an early predictor of body iron storage, it has limitations as an acute-phase reactant, especially in children who are suffering from severe acute malnutrition and concurrent infections such pneumonia or gastroenteritis. Reliable indicators of changes in iron status in the early stages of insufficiency include serum iron and transferrin saturation.[6,12] However, due to institutional and financial limitations, serum ferritin and transferrin saturation measurements could not be carried out in this investigation.

The age group most frequently impacted in this study was 6 months to 2 years, which is in line with a study done in Kangra in July 2018 by **Vaid A et al.**[13] However, research by Isaac Mathai et al,[14] (Kerala, 2017) and **Yaikhomba et al**,[15] (October 2014) found that the age group of 6 to 12 months was the most affected. In contrast to the findings of **Dwivedi**

D et al. (Madhya Pradesh, 2017) and **Vaid A et al**. (Kangra, 2018), which showed that males were mostly affected, the gender distribution in this study showed that females were more affected (55%) than males (45%).[13,16] The geographic distribution of populations and differences in sample size could be the cause of this discrepancy. Children from lower-middle socioeconomic backgrounds had the highest prevalence of anemia (36.7%), followed by those from lower socioeconomic backgrounds, according to socioeconomic study.

Studies by **Dwivedi D et al**. and **Taneja et al**., which also emphasized the incidence of anemia among economically disadvantaged individuals, are consistent with our findings.[12,16]

Particularly among children aged 6 months to 2 years (57.1%), those born weighing less than 2.5 kg (53.6%), those who were primarily breastfed (82.1%), and those who started supplemental feeding later (53.6%), iron deficiency anemia (IDA) was the most prevalent type found in this study.[16,17] Vitamin B12 deficiency was found to be more common in age group of 6months to 2years (82.3%), children born with birth weight >2.5kg (64.7%), exclusively / predominantly breastfed (82.4%) children and children with late initiation of complementary feeding (70.6%) after 6 months of age.

These results highlight how crucial it is to treat micronutrient deficiencies, especially those involving iron and vitamin B12, during the crucial first 1,000 days of life because they are essential for promoting healthy growth, development, and neurodevelopment. According to the findings, this vulnerable age group needs focused, evidence-based treatments to improve their nutritional health.

In present study, most common Anemia was found to be iron deficiency anemia followed by Vitamin B12 deficiency anemia (28.3%). Vitamin B12 deficiency is documented to be more common compare to iron deficiency in **Yaikhomba et al** in October 2014.[15] The proportion of children with vitamin B12 deficiency are almost similar in current study as in Taneja et al,[12] in North India 2007, **Yaikhomba et al** in October 2014,[15] while **Vaid et al** in Kangra July 2018,[13] documented very high proportion of vitamin B12 deficiency.

All these studies done across the country are from different regions, reflecting more or less similar scenario existing across the country for vitamin B12 deficiency. Documentation of high proportion of existing vitamin B12 deficiency among children with severe malnutrition can explained the need for routine evaluation of all children with severe malnutrition for vitamin B12 status and treating them with therapeutic dose regimen of vitamin B12 instead of routine multivitamin supplements which are given currently as per existing severe acute malnutrition treatment guidelines.

CONCLUSION

Malnutrition as a both undernutrition and overnutrition are associated with short and long-term complications. Anemia is common morbidity in children with severe acute malnutrition. As in our study, 46.6% children with severe acute malnutrition had iron deficiency anemia. 28.3%children with SAM showed low serum vitamin B12 level and they were deficit with vitamin B12 containing food in their diet and had late initiation of complementary feeding.

These results demonstrate how important it is to identify and treat iron and vitamin B12 deficiency in children who are extremely malnourished in order to effectively manage anemia and enhance general nutritional status.

Recommendations

Improvement in maternal nutritional status during pregnancy and thereafter during lactation with special focus on iron supplementation along with optimal nutritional management of low-birth-weight infants to prevent development of iron deficiency during first 2 years of life (1000days) is the need of hour.

Community awareness is required about timely initiation of complementary feeding and ensuring optimum quality and quantity, especially inclusion of vitaminB12 rich food.

All severe acute malnourished children need to be evaluated for vitamin B12 status, so that adequate therapeutic regimen could be offered to deficit children instead of routine multivitamin supplement which is being given at present as per existing nutritional regimen guidelines.

Limitations

The circumstances in the larger community might not be reflected in this hospital-based investigation. It excluded older children and only covered those between the ages of six months and five years. Because of institutional and financial limitations, serum ferritin and transferrin saturation, two more sensitive markers of iron status were not measured. Furthermore, the amounts of other micronutrients, such folate, were not assessed.

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