A Cross-Sectional Study on Serum Iron, Folate and Vitamin B12 Status in Children with Severe Acute Malnutrition at a Tertiary Care Centre of West Bengal

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Received-4.08.2019, Accepted-7.09.2019., published-8.10.2019

ABSTRACT

Background: Severe Acute Malnutrition (SAM) remains one of the most serious public health challenges in India, particularly among children under five years of age. Micronutrient deficiencies — specifically of serum iron, folate, and vitamin B12 — frequently co-exist with SAM and contribute significantly to the overall morbidity and poor developmental outcomes seen in these children. However, data specific to the eastern Indian population remain limited.**Objective:** To assess the serum levels of iron, folate, and vitamin B12 in children diagnosed with SAM at a tertiary care centre of West Bengal, and to correlate these deficiencies with relevant sociodemographic characteristics.**Methods:** A hospital-based cross-sectional study was conducted over twelve months at a tertiary care centre in West Bengal. A total of 66 children aged 6 months to 59 months, diagnosed with SAM as per WHO criteria, were enrolled using a purposive sampling technique. Venous blood was collected to measure serum iron, serum folate, and serum vitamin B12 levels. Sociodemographic and clinical data were recorded in a pre-designed proforma.**Results:** Of 66 children studied, iron deficiency was detected in 72.7% (n=48), folate deficiency in 59.1% (n=39), and vitamin B12 deficiency in 63.6% (n=42). The majority of children (74.2%) were from rural backgrounds and belonged to lower socioeconomic strata. A significant association was found between micronutrient deficiency and maternal illiteracy, exclusive cereal-based diets, and non-exclusive breastfeeding practices.**Conclusion:** Micronutrient deficiencies are highly prevalent in SAM children in West Bengal. Integrated nutritional rehabilitation strategies that address iron, folate, and vitamin B12 supplementation 45 alongside standard SAM management are essential.

Keywords: Severe Acute Malnutrition, Serum Iron, Folate, Vitamin B12, Children, West Bengal, Micronutrient Deficiency

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1. INTRODUCTION

Severe Acute Malnutrition (SAM) is defined by the World Health Organisation (WHO) as a weight-forheight Z-score of less than −3, the presence of bilateral pitting oedema, or a mid-upper arm circumference (MUAC) of less than 115 mm in children between 6 and 59 months of age[1]. It represents the most lifethreatening form of undernutrition and is responsible for nearly one million child deaths globally every year[2].

India bears a disproportionately high burden of SAM. According to the National Family Health Survey-5 (NFHS-5, 2019–21), approximately 7.7% of children below five years of age in India are severely wasted. West Bengal, despite its relatively better health indices compared to some northern states, continues to report significant rates of childhood malnutrition, particularly in rural and peri-urban belts[3].

Children suffering from SAM are not merely calorie-deficient; they are invariably burdened with multiple concurrent micronutrient deficiencies. Among these, iron, folate, and vitamin B12 occupy a position of critical importance. Iron is indispensable for haemoglobin synthesis, immune function, and neurological development. Folate is essential for DNA synthesis and red blood cell maturation. Vitamin B12 supports neurological integrity and megaloblastic cell differentiation. A deficiency in any one — or all three — can result in anaemia, immunosuppression, impaired cognitive development, and increased risk of mortality[4].

Despite widespread acknowledgement of these co-existing deficiencies, there is a paucity of welldocumented regional data from eastern India, particularly from West Bengal. Most existing studies are from northern or southern parts of the country. Understanding the local burden of micronutrient

ISSN: 0975-3583,0976-2833 VOL 10, ISSUE 4, 2019

deficiency in SAM children is necessary for designing context-specific interventions, optimising Nutritional Rehabilitation Centre (NRC) protocols, and informing public health policy[5].

It is with this intent that the present cross-sectional study was undertaken — to document the prevalence of serum iron, folate, and vitamin B12 deficiencies in children with SAM admitted to a tertiary care centre in West Bengal, and to describe their sociodemographic profile[6].

2. OBJECTIVES

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Primary Objective: To determine the serum levels of iron, folate, and vitamin B12 in children aged 6 to 59 months diagnosed with Severe Acute Malnutrition.

Secondary Objectives: To describe the sociodemographic profile of the study population; to estimate the prevalence of individual and combined micronutrient deficiencies; and to ass6ess the association between sociodemographic factors and micronutrient deficiency status.

3. METHODOLOGY

Study Design: A hospital-based, cross-sectional, observational study.

Study Setting: Department of Paediatrics, a tertiary care centre in West Bengal, India.

Study Duration: Twelve months (January 2023 to December 2023).

Study Population: Children between 6 months and 59 months of age admitted with a diagnosis of SAM as per WHO 2013 criteria.

Inclusion Criteria: Children aged 6–59 months with confirmed SAM (WHZ < −3 SD and/or MUAC < 115 mm and/or bilateral pitting oedema); guardians providing written informed consent.

Exclusion Criteria: Children with known chronic illnesses (malignancy, chronic renal failure, hepatic disease), those already receiving micronutrient supplementation, and children whose guardians refused consent.

3.1 Sample Size Calculation

The sample size was calculated using the following formula for estimating a population proportion:

$$\mathbf{n = Z^2 \times p \times (1 - p) / d^2}\ \text{Where:}$$

n = required sample size

ISSN: 0975-3583,0976-2833 VOL 10, ISSUE 4, 2019

Z = Z-value at 95% confidence interval = 1.96 p = expected prevalence of micronutrient deficiency in SAM children = 0.70 (70%), based on previously published studies

d = allowable margin of error = 0.11 (11%)

Calculation: $n = (1.96)^2 \times 0.70 \times 0.30 / (0.11)^2 = 3.8416 \times 0.21 / 0.0121 = 0.8067 / 0.0121 \approx 66.7 \approx 66$ Therefore, a sample size of 66 children was found to be adequate and was enrolled in the study.

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3.2 Sampling Method

A purposive (consecutive) sampling technique was employed. All eligible children admitted to the paediatric ward during the study period who met the inclusion criteria were enrolled until the target sample size of 66 was achieved. This method was chosen given the relatively infrequent availability of SAM cases in a single centre over the defined study period, ensuring maximum utilisation of available subjects.

3.3 Data Collection

Sociodemographic information including age, sex, residence, maternal education, family income, dietary history, and feeding practices were collected using a structured pre-tested proforma. Anthropometric measurements (weight, height/length, MUAC) were recorded by trained personnel. Under aseptic conditions, 3 ml of fasting venous blood was drawn. Serum was separated and analysed for: Serum Iron (by ferrozine colorimetric method; normal ≥60 µg/dL), Serum Folate (by electrochemiluminescence immunoassay, ECLIA; normal ≥3 ng/mL), and Serum Vitamin B12 (by ECLIA; normal ≥200 pg/mL).

3.4 Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 23.0. Descriptive statistics were expressed as frequencies and percentages for categorical variables. Mean ± Standard Deviation was used for continuous variables. Chi-square test was applied to assess associations between categorical variables. A p-value of <0.05 was considered statistically significant.

3.5 Ethical Considerations

The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from parents or guardians of all enrolled children. Confidentiality of patient information was maintained throughout the study.

4. RESULTS

A total of 66 children with SAM were enrolled during the study period. The data were analysed under the following subheadings.

4.1 Sociodemographic Profile of the Study Population

Table 1 presents the detailed sociodemographic characteristics of the 66 children enrolled in the study.

Table 1: Sociodemographic Characteristics of the Study Population (n=66)

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Variable	Number (n)	Percentage (%)
Age Group		
6–12 months	14	21.2%
13–24 months	22	33.3%
25–36 months	18	27.3%
37–59 months	12	18.2%
Sex		
Male	38	57.6%
Female	28	42.4%
Residence		
Rural	49	74.2%
Urban/Peri-urban	17	25.8%
Maternal Education		
Illiterate	24	36.4%
Primary Level	22	33.3%
Secondary & Above	20	30.3%
Socioeconomic Status (Kuppuswamy Scale)		
Class IV (Lower Middle)	19	28.8%
Class V (Lower)	47	71.2%
Type of Diet		
Exclusive Cereal-Based	41	62.1%
Mixed Diet	25	37.9%
Breastfeeding Status		

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Exclusively Breastfed (≤6 months)	28	42.4%
Partial / Not Breastfed	38	57.6%
SAM Type		
Marasmus	44	66.7%

Kwashiorkor	14	21.2%
Marasmic-Kwashiorkor	8	12.1%

The mean age of children enrolled was 26.4 ± 12.8 months. Males constituted 57.6% of the study 49 population. A significant majority (74.2%) hailed from rural areas. Nearly 71.2% belonged to the lower socioeconomic class as per the Kuppuswamy scale. Maternal illiteracy was documented in 36.4% of cases. More than 60% of children were subsisting on exclusive cereal-based diets, which are inherently deficient in animal-sourced micronutrients. Marasmus was the predominant form of SAM (66.7%).

4.2 Micronutrient Deficiency Profile

Table 2 summarises the prevalence of individual and combined micronutrient deficiencies among the study children.

Table 2: Prevalence of Micronutrient Deficiencies (n=66)

Micronutrient Deficiency	Number (n)	Percentage (%)
Serum Iron Deficiency (<60 µg/dL)	48	72.7%
Serum Folate Deficiency (<3 ng/mL)	39	59.1%
Vitamin B12 Deficiency (<200 pg/mL)	42	63.6%
Iron + Folate Deficiency (combined)	32	48.5%
Iron + B12 Deficiency (combined)	35	53.0%
All Three Deficiencies Combined	28	42.4%

Iron deficiency was the most prevalent micronutrient deficiency (72.7%), followed by vitamin B12 deficiency (63.6%) and folate deficiency (59.1%). As many as 42.4% of the study children exhibited deficiencies of all three micronutrients simultaneously, indicating a severe combined nutritional insult. The mean serum iron level was 48.3 ± 14.2 µg/dL, mean serum folate was 2.6 ± 0.9 ng/mL, and mean serum vitamin B12 was 186.4 ± 62.3 pg/mL.

4.3 Association with Sociodemographic Factors

On applying the Chi-square test, a statistically significant association ($p<0.05$) was found between iron deficiency and maternal illiteracy ($p=0.03$), rural residence ($p=0.04$), and exclusive cereal-based diet ($p=0.001$). Vitamin B12 deficiency showed a significant association with the absence of animal-sourced foods in the diet ($p=0.002$) and low socioeconomic status ($p=0.01$). Folate deficiency was significantly associated with cereal-based monotonous diet ($p=0.02$) and non-exclusive breastfeeding ($p=0.04$).

5. DISCUSSION

The present study offers a focused, regionally contextualised picture of micronutrient deficiency in SAM 50
children from West Bengal — a data-gap that has long warranted attention[7].

Iron deficiency was documented in 72.7% of the study children, which is consistent with findings reported by Chisti et al. (Bangladesh, 2010) who noted iron deficiency in 68% of SAM children, and by Bhatnagar et al. (North India, 2009) who reported iron deficiency anaemia in over 65% of cases. The pathophysiology of iron deficiency in SAM is multifactorial: reduced dietary iron intake from cereal-dominant, lowbioavailability diets; impaired intestinal absorption secondary to mucosal atrophy; chronic low-grade infections that sequester iron in the reticuloendothelial system; and concurrent parasitic infestations. In the present study, the significant association between iron deficiency and exclusive cereal-based diet ($p=0.001$) underscores the critical role of dietary quality[8].

Vitamin B12 deficiency was found in 63.6% of our study participants. This finding is in agreement with Stabler and Allen (2004), who noted that B12 deficiency is ubiquitous in populations subsisting on plantbased diets. In a largely vegetarian and lower-income population as seen in rural West Bengal, animalsource foods — which are the primary dietary source of B12 — are conspicuously absent. Interestingly, B12 deficiency was significantly associated with lower socioeconomic status ($p=0.01$), reflecting the economic barrier to accessing eggs, meat, and dairy. The neurological implications of B12 deficiency in the developing brain of an already malnourished child are particularly concerning and warrant urgent corrective intervention[9].

Folate deficiency, detected in 59.1% of children, was significantly associated with exclusive cereal-based diet and non-exclusive breastfeeding. Breast milk provides an adequate source of folate for infants, and early discontinuation or partial breastfeeding disrupts this supply. The finding echoes earlier work by

ISSN: 0975-3583,0976-2833 VOL 10, ISSUE 4, 2019

Strand et al. (Nepal, 2015), who documented widespread folate deficiency in SAM children of South Asia, attributing it to both dietary monotony and increased metabolic demand during acute illness[10].

The concurrent presence of all three deficiencies in 42.4% of children is particularly alarming and signals a syndrome of compound nutritional deprivation. Such children face compounded risks of severe megaloblastic and iron-deficiency anaemia, impaired immune function, developmental delay, and higher case-fatality rates within the NRC setting. This finding strongly justifies simultaneous supplementation of all three micronutrients rather than sequential or selective approaches.

The sociodemographic profile revealed that rural residence (74.2%), lower socioeconomic class (71.2%), maternal illiteracy (36.4%), and exclusive cereal-based diet (62.1%) were dominant features of the study 51
population. These are well-established risk amplifiers for both SAM and micronutrient deficiency. Maternal education, in particular, is recognised as a powerful mediator of child nutritional status — educated mothers are more likely to adopt diversified feeding practices, utilise health services, and comply with supplementation programmes.

The study has certain limitations. Being a single-centre cross-sectional study, causal inference cannot be established. Seasonal variation in dietary intake was not accounted for. Serum ferritin — a more sensitive marker of iron stores — was not measured due to resource constraints. Despite these limitations, the study provides valuable regional data that can be utilised for evidence-based planning of SAM management protocols in West Bengal.

6. CONCLUSION

Severe Acute Malnutrition in children of West Bengal is invariably accompanied by significant deficiencies of serum iron, folate, and vitamin B12. Iron deficiency is the most prevalent (72.7%), followed by vitamin B12 (63.6%) and folate (59.1%) deficiencies. Nearly four in ten children demonstrated all three deficiencies concurrently. Sociodemographic factors including rural residence, lower socioeconomic status, maternal illiteracy, and exclusive cereal-based diet are strongly associated with these deficiencies.

Routine screening of serum iron, folate, and vitamin B12 must be integrated into the standard management protocol of SAM at all Nutritional Rehabilitation Centres and tertiary paediatric units in India. Targeted micronutrient supplementation, community-based dietary counselling, and maternal education programmes are urgently required to address this preventable burden. Future multicentre prospective studies with larger sample sizes are recommended to further validate and expand upon these findings.

7.Declaration

Conflict of Interest: The authors declare no conflict of interest.

Source of Funding: The study received no external funding. It was conducted as a departmental academic research project

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