DS (Child) H J 2024; 40(1): 12-17

ORIGINAL ARTICLE

Assessment of Anaemia among Children Suffering from Severe Acute Malnutrition

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Abstract

Background: *Severe anaemia is a major cause of morbidity, hospitalization, and mortality in children suffering from severe acute malnutrition. Severe acute malnutrition (SAM) with anaemia leads to greater mortality rates compared to SAM without anaemia.*

Objective: *To assess anaemia in children suffering from severe acute malnutrition.*

Methods: *The cross-sectional observational study was conducted at the SAM corner under the Department of Pediatrics, Gastroenterology, Hepatology, and Nutrition of Bangladesh Shishu Hospital & Institute from January 2020 to December 2022. A total of 60 children aged 6 to 59 months with a diagnosis of SAM were included in the study as cases. Another 60 children were enrolled in the study as controls. Controls were taken from children who were in the same age range and socioeconomic background and admitted to the hospital due to causes other than SAM or its complications. The study excluded children with primary hematological diseases.*

Results: *A total of 64 (53.3%) are male and 56 (46.6%) are female. Anemic status: normochromic normocytic 21 (35%) in SAM and 23 (38.3%) in control; normochromic normocytic anaemia 17 (28.33%) in SAM and 28 (46.67%) in control; iron deficiency anaemia 18 (30%) in SAM and 7 (11.6%) in control; and megaloblastic anaemia 4 (6.6%) in SAM and 2 (3.3%) ($p < 0.05$). A significant relation was found between the mean hematological parameter between SAM and control.*

Conclusion: *This study highlights that anaemia is widespread among malnourished children, with microcytic hypochromic anaemia being the most commonly observed type. It also revealed marked hematological changes, including significant alterations in white blood cell and platelet counts.*

Keyword: *Hematological impact, Anaemia, macrocytic, severe acute malnutrition.*

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Received: 2 January 2024; **Accepted**: 2 April 2024

Introduction

Anaemia is where there is a deficiency in red blood cells or the hemoglobin concentration within them falls below the normal levels.[1] This blood disorder, characterized by a reduced hemoglobin level, poses a significant public health threat to individuals in both developed and developing nations.[1] Severe acute malnutrition (SAM) remains a critical public health issue, particularly in resource-limited settings, significantly impacting child morbidity and mortality. Malnutrition adversely affects hematopoiesis, leading to anaemia, leukocyte abnormalities, and thrombocytopenia, which further compromise immune function and increase susceptibility to infections.[2]

SAM children are different from non-SAM children in that the physiology of the body itself undergoes major changes, and common infections like pneumonia and diarrhea, which by themselves are not very harmful, may prove to be fatal in children with SAM. These physiological changes extend to major systems in the body and are different in pathological phenotypes of SAM. The main reasons for death in children with SAM include changes in the body that reduce its ability to adapt, weakened immune systems, unusual electrolyte levels, and treatment methods such as giving intravenous fluids early and providing high-calorie diets at the start. The degree of wasting in SAM positively correlates with death.[3]

Severe anaemia is a leading cause of pediatric morbidity, hospitalization, and mortality, and it is a very important comorbidity in children with severe acute malnutrition.[4-8] Severe acute malnutrition (SAM) with anaemia has been shown to have higher mortality as compared to SAM with no anaemia.[9,10] In children, anaemia can increase susceptibility to infections and have adverse effects on physical growth, motor and cognitive development, productivity and school performance, thus impairing their growth while also increasing the risk of other health-related problems.[11] Anaemia and iron deficiency anaemia (IDA) remain a high burden and a malnutrition challenge in the Eastern Mediterranean Region, particularly among children and women.[12]

Investigating and measuring these changes in impacted children is vital given the significant effects of severe acute malnutrition on hematological markers. Improved management techniques, targeted intervention, and early diagnosis can all benefit from an understanding of the particular hematological alterations linked to SAM. This study aims to evaluate the hematological profiles of children with severe acute malnutrition, shedding light on the extent of hematopoietic dysfunction and its potential clinical repercussions. By systematically analyzing these parameters, the research seeks to contribute to the growing body of evidence guiding nutrition-related health policies and interventions.

Materials and Methods

The cross-sectional observational study was conducted at the SAM corner under the Department of Pediatric Gastroenterology, Hepatology, and Nutrition of Bangladesh Shishu Hospital & Institute from Jan 2020 to Dec 2022. A total of 60 children aged 6 to 59 months with a diagnosis of SAM were included in the study as cases. Another 60 children were enrolled in the study as controls. In the present study, consecutive sampling was done among the admitted patients from the hospital. Controls were taken from children who were of the similar age range and socioeconomic background and admitted to the hospital due to causes other than SAM or its complications. Children with primary hematological disease were excluded from the study.

Data regarding their age, sex, place of origin, and other presenting complaints were recorded in a predesigned pro forma. Data collected from the mothers included age, sex, birth order, birth weight, education, and occupation of the father. Using standard methods, a single observer measured children's weight, height/length, and head and mid-arm circumferences. Venous blood of the child was drawn under aseptic precautions after due consent in the first week of admission in SMTU. Autoanalyzer's were used to measure blood counts. Blood smear was analyzed by the pathology consultant of the institute and recorded for all patients with anaemia. Based on the above methodology and definitions, both cases and controls were classified, and mean values of various hematological indices were studied. Parents were explained the purpose of the study, and a written informed consent was obtained.

Severe acute malnutrition (SAM) is described by the World Health Organization (WHO) as having any of these conditions: a weight-for-height/length Z-score that is more than 3 standard deviations below the average of the WHO child growth standards, a mid-upper arm circumference (MUAC) of less than 115 mm, or swelling in both legs. Anaemia in children aged 6 to 59 months is defined according to WHO criteria as a hemoglobin (Hb) level below 11 g/dL. Nutritional anaemia refers to a condition in which normal hemoglobin levels cannot be maintained by erythropoiesis due to deficiencies in one or more essential nutrients. Morphologic classification of anaemia is based on the size of red blood cells, assessed using the mean corpuscular volume (MCV), along with hemoglobin (Hb) concentration. Microcytic anaemia is characterized by an MCV value less than -2 standard deviations (SD) below the normal range for age. Normocytic anaemia occurs when the MCV falls within the normal range for age, while macrocytic anaemia is defined by an MCV greater than +2 SD above the normal range. In some cases, patients may present with dimorphic anaemia, which shows both microcytic and macrocytic features, often resulting from multiple coexisting causes of anaemia. In addition to morphological classification, anaemia can also be categorized based on hemoglobin levels. Mild anaemia is defined as a hemoglobin concentration between 10 and 10.9 g/dL, moderate anaemia as 7 to 9.9 g/dL, and severe anaemia as a hemoglobin level less than 7 g/dL. Leukopenia and thrombocytopenia were defined according to the normal values for the age of the child. Based on the above methodology and definitions, both cases and controls were classified, and mean values of various hematological indices were studied. Data were entered in Excel spreadsheets and analyzed using SPSS 25.0. Qualitative variables were compared using the chi-square test, and quantitative variables were examined using the student t-test. Mean values of quantitative variables were studied, and the standard error of the mean was calculated. A p-value less than 0.05 was considered significant.

Results

The demographic characteristics as classified include the following. The mean age was 13.7±2.47 months. Males were predominant at 53.3%, and 35.8% of respondents came from rural areas, while 77 respondents, or 64.2%, live in urban cities. The majority, 55.8%, are from middle-class families. Finally, the level of parental education was 50.9% completed secondary education, and 40 (33.3%) completed graduate level (Table I).

Table I
Socio-demographic characteristics of patients (n=120)

Subjects	Number	Percentage
Age in years		
Up to 12 month	58	48.3
1-2 years	35	29.2
2-5 years	27	22.5
Mean ±SD	13.76 ±2.47	
Gender		
Male	64	53.3
Female	56	46.7
Residency		
Rural	43	35.8
Urban	77	64.2
Family Socioeconomic status		
Poor income	29	24.2
Middle income	67	55.8
Upper-income	24	20.0
Parental Education		
Primary School	19	15.8
Secondary School	61	50.9
Bachelor	40	33.3

Among the study population 56(47%) were on mix feeding, 51(42%) were breast feeding and 13(11%) top feeding (Fig-1).

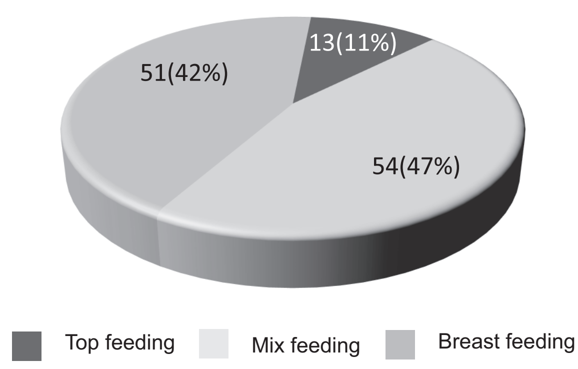

Fig.-1 *Feeding status of the study population (n=120)*

Regarding anemic status no anaemia 6(10%) in SAM and 11(18.4%) in control, mild anaemia 12 (20%) in SAM and 26(43.3%) in control, moderate anaemia 35(58.3%) in SAM and 20(33.3%) in control and severe anaemia 7(11.7%) were in SAM and 3(5.0%) ($p<0.05$) (Table II).

Table II
Comparison of type of anaemia between severe acute malnutrition (SAM) and control

Anemic status	Study group		Total	p value
	SAM n=60	Control n=60		
No anaemia	6(10.0)	11(18.4)	17	0.006
Mild anaemia	12(20.0)	26(43.3)	38	
Moderate Anaemia	35(58.3)	20(33.3)	55	
Severe anaemia	7(11.7)	3(5.0)	10	
Total	60(100)	60(100)	120	

Microcytic hypochromic anaemia was found in 31 cases (57.4%) of the SAM group and 17 cases (34.7%) of the control group, showing a meaningful difference ($p < 0.05$). Normocytic normochromic anaemia was seen in 19 cases (35.2%) of the SAM group and 30 cases (61.2%) of the control group, also showing a meaningful difference ($p < 0.05$). Macrocytic anaemia was present in 4 cases (7.4%) of the SAM group and 2 cases (4.1%) of the control group, which was not a meaningful difference ($p > 0.05$) (Table III).

Table III
Morphologic classification of anaemia in study groups (n=103)

Anemic status	Study group		Total	p value
	SAM n=54	Control n=49		
Normochromic Normocytic Anaemia	19(35.2)	30(61.2)	49	0.008
Microcytic hypochromic Anaemia	31(57.4)	17(34.7)	48	0.02
Macrocytic anaemia	4(7.4)	2(4.1)	6	0.47
Total	54(100.0)	49(100.0)	103	

Comparison of mean hematological parameter between SAM and control, Hemoglobin (gm/dl) 8.13±1.09 vs 10.87±1.26 (p<0.001), HCT (%) 25.07±3.34 vs 31.88±4.72 (p<0.001), RBCs (10 10^6/L) 3.98±0.69 vs 4.17±0.53 (p>0.05), MCV (Fl) 61.48±5.81 vs 71.35±6.28 (p<0.001), MCH (PG) 19.71±2.98 vs 25.72±3.15 (p<0.001), MCHC (g/dl) 31.27±2.63 vs 33.91±2.81 (p<0.001), WBC (10^3/UL) 6.98±2.41 vs 8.46±5.17 (p<0.05) and Platelets (10^6/L) 267.37±87.22 vs 302.11±12.15 (<0.001), RDW 22.75(±1.85) and 17.31(±1.94) respectively (Table IV).

Table IV
Hematological parameter in severe acute malnutrition (SAM) and control group (n=120)

CBC parameter	Study group		Total
	SAM (n=60) mean ±SD	Control (n=60) mean ±SD	
Hemoglobin (gm/dL)	8.13±1.09	10.87±1.26	<0.001
HCT (%)	25.07±3.34	31.88±4.72	<0.001
RBCs (10^6/L)	3.98±0.69	4.17±0.53	0.09
MCV (Fl)	61.48±5.81	71.35±6.28	<0.001
MCH (PG)	19.71±2.98	25.72±3.15	<0.001
MCHC (g/dL)	31.27±2.63	33.91±2.81	<0.001
WBC (10^3/UL)	6.98±2.41	8.46±5.17	0.04
Platelets (10^6/L)	267.37±87.22	302.11±12.15	<0.001
RDW	22.75 (±1.85)	17.31 (±1.94)	<0.001

Discussion

The study observed that 64 (53.3%) of the participants are male and 56 (46.6%) are female. Al-Haddad et al[1] reported that the male children counted 36% and the female children 64%. The mean age of their patients was 11.8 months, with an SD equal to 12.1 months. Dwivedi et al[13] reported males were predominant, with a mean age of 15.85 (±1.039) months. In our study, the mean age was 13.76 ± 2.47 months.

In this study, it was observed that a maximum of 56(47%) were mix feeding, 51(42%) were breastfeeding, and 13(11%) were top feeding. A similar observation was found by Mugheri et al.[2] They observed feeding practices among the participants' mothers and showed that 39% exclusively breastfed their children, 9% relied solely on top feeding, while 52% practiced a combination of breastfeeding and top feeding. According to Dwivedi et al[13], nearly 70% of children (6–59 months) with SAM have anaemia. Out of which, 26% mild anaemia, 40% moderate anaemia, and 3% severe anaemia. In our study, a very high percentage (90%) of malnourished children were found to be anemic.

The current study observed microcytic hypochromic anaemia in 31 cases (57.4%) of the SAM group and 17 cases (34.69%) of the control group, showing a statistically significant difference ($p < 0.05$). Normocytic normochromic anaemia was present in 19 cases (35.1%) of the SAM group and 27 cases (61.2%) of the control group, also showing a significant difference ($p < 0.05$). Macrocytic anaemia was found in 4 cases (7.4%) of the SAM group and 2 cases (4.0%) of the control group, which was not statistically significant ($p > 0.05$). In Dwivedi et al [13] study, very high percentages (85%) of malnourished children were found to be anemic. The majority of SAM children had moderate anaemia (42%). The most common type of anaemia in cases was macrocytic, followed by microcytic, and normochromic normocytic was more common in controls. This finding was not in accordance with previous studies where studies have shown microcytosis[8,9] as the main type of anaemia. Also, operational guidelines for SAM management put more stress on treating microcytic anaemia, while macrocytic anaemia is ignored.[7]

The present study showed that the mean hematological levels were significantly lower in children with SAM compared to the control group. However, in the study by Dwivedi D et al[13] this difference was not found to be statistically significant. The total RBC count was lower in children with SAM. The mean MCV and MCH were also significantly lower in the SAM group compared to controls, indicating a statistically significant difference. However, no significant difference was observed in MCHC between the two groups. In contrast, Dwivedi et al[13] reported significantly higher MCV and MCH values in SAM children compared to controls. RDW was substantially higher in SAM cases than in controls in the current study. Mugheri et al[2] also found that children with SAM had lower hemoglobin and hematocrit levels, along with low MCV and MCH values, which matches what we found in our study. The decline in red blood cell indices including MCV, MCH, and MCHC reflects the hematological impact of malnutrition. Additionally, platelet abnormalities were observed, with the mean platelet count being lower in malnourished children compared to controls.[2]

Conclusion

This study highlights that anaemia is widespread among malnourished children, with microcytic hypochromic anaemia being the most commonly observed type. It also revealed marked hematological changes, including significant alterations in white blood cell and platelet counts.

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