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A Comparative Study to Know the Hematological Profile and Biochemical Profile among Children with Severe Acute Malnutrition and Healthy Children

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ABSTRACT:

Severe acute malnutrition (SAM) remains a major public health concern, particularly in low- and middle-income countries, contributing significantly to morbidity and mortality among children under five. This observational cross-sectional study evaluated hematological and biochemical profiles of 100 children aged 6–59 months diagnosed with SAM in Gonda, Uttar Pradesh. The study assessed anemia prevalence, red and white blood cell counts, platelet levels, and key biochemical parameters including folic acid, vitamin B12, serum ferritin, serum iron, and total iron-binding capacity (TIBC). Results revealed that 85% of children were anemic, with moderate and severe anemia observed in 54% and 20% respectively. Hematological findings showed variability in RBC, WBC, and platelet counts, while biochemical analysis indicated borderline or low folic acid and vitamin B12 levels, along with functional iron deficiency. Maternal factors, including illiteracy (85%) and multiparity (63%), were significantly associated with SAM. The study highlights the multifactorial etiology of SAM, emphasizing the role of maternal education, nutrient deficiencies, and gender disparities. Targeted nutritional supplementation, particularly folate and vitamin B12, alongside anemia management, is crucial to improve growth, hematological health, and developmental outcomes in SAM children.

Keywords: Severe acute malnutrition, anemia, hematological profile, biochemical parameters

INTRODUCTION

Severe acute malnutrition (SAM) remains a major public health challenge, particularly in low- and middle-income countries, and is a leading cause of morbidity and mortality among children under five years of age. [1] It is characterized by severe wasting, nutritional edema, or a markedly low weight-for-height index, reflecting an extreme deficiency of essential nutrients. Children affected by SAM are highly vulnerable to infections, impaired growth, delayed cognitive development, and increased risk of death, making early diagnosis and appropriate management a global health priority. [2]

Malnutrition profoundly affects the hematological system due to deficiencies in micronutrients such as iron, folate, vitamin B12, and protein, which are essential for normal blood cell production and function. Children with SAM commonly exhibit anemia, altered leukocyte counts, and impaired immune responses, predisposing them to frequent and severe infections. Evaluating hematological parameters provides valuable insight into the severity of nutritional deficiency and the body's ability to combat disease. [3]

In addition to hematological changes, severe acute malnutrition causes significant biochemical alterations that reflect impaired metabolic and organ function. Abnormalities in serum proteins, electrolytes, liver enzymes, glucose, and lipid profiles are frequently observed in malnourished children. [4] These biochemical disturbances can influence clinical outcomes, complicate treatment, and increase the risk of life-threatening conditions such as hypoglycemia, electrolyte imbalance, and hepatic dysfunction. A comparative assessment of hematological and biochemical profiles between children with severe acute malnutrition and healthy children is essential to understand the extent of physiological derangements associated with SAM. [5] Such comparisons not only help in identifying specific biomarkers of malnutrition but also aid clinicians in early detection, monitoring, and formulation of targeted therapeutic interventions. Therefore, the present study aims to evaluate and compare the hematological and biochemical parameters among children with severe acute malnutrition and age-matched healthy children.

MATERIALS AND METHODS

Study Design: The present study was conducted at SCPM Super Specialty Hospital and Trauma Center, Station Road, Veer Pur, Janki Nagar, Gonda, Uttar Pradesh (271001), using an observational cross-sectional study design. The sample size was calculated using the formula $n = 4pq/d^2$. Based on NFHS-4 data, the prevalence (p) of severe acute malnutrition (SAM) in Uttar Pradesh was reported as 6%, with q = 94% and an allowable precision (d) of 5%, yielding a calculated sample size of 90.2. To ensure adequate representation, a total of 100 children were included in the study from the Gonda district of Uttar Pradesh. The study was carried out over a duration of six months. [6]

Inclusion Criteria

- Children were included in the study based on the following criteria:
- Weight-for-length/height ≤ –3 standard deviations (SD) of the WHO median height
- Bilateral pedal edema
- Grossly visible severe wasting
- Mid-upper arm circumference indicative of SAM

Exclusion Criteria

- Children were excluded from the study if they met any of the following conditions:
- Born either premature or post-mature, or classified as small or large for gestational age
- Known cases of lactogen intolerance or meconium aspiration syndrome
- Lack of informed and written consent from the parent or guardian
- Children who did not achieve hemodynamic stability and died within 48 hours of admission. [7, 8]

Sample Collection and Processing: Ensure the site is free from infection, scars, or hematoma.

Procedure

- Apply a tourniquet 3-4 inches above the site to engorge the vein.
- Ask the patient to make a fist (without pumping).
- Clean the site thoroughly with an alcohol swab and allow to air dry.
- Hold the patient's arm steady and insert the needle bevel up into the vein at a 15-30 degree angle.
- Once blood enters the syringe or tube, gently draw the required volume.
- Release the tourniquet before withdrawing the needle.
- Withdraw the needle smoothly and apply pressure immediately with cotton/gauze.
- Dispose of needle safely in a sharps container. [9, 10]

Hemoglobin Estimation: Before estimation, the hemoglobinometer tubes and pipette were ensured to be clean and dry. The hemoglobinometer tube was filled with N/10 hydrochloric acid up to the lowest mark (2 g% or 10% mark) using a dropper. Blood was then drawn up to the mark in the Sahli's pipette (20 µl), excess blood was wiped from the outside of the pipette, and the sample was delivered into the N/10 HCl present in the hemoglobin tube. The contents were mixed thoroughly and allowed to stand for 10 minutes to ensure complete conversion of hemoglobin to acid hematin. Distilled water was then added drop by drop with continuous stirring until the color of the solution matched the standard glass of the comparator. Finally, the reading was taken at the lower meniscus, which directly indicated the hemoglobin concentration per 100 ml of blood. [11, 12]

Biochemical Assays (Serum Analysis): Biochemical Estimation of Serum Levels of Folic Acid (FA), Vitamin B12, serum Ferritin, serum iron and TIBC. [13-15]

Statistical Analysis: Data were compiled using Microsoft Excel and analyzed using SPSS version 20.0. Categorical variables were expressed as percentages and analyzed using the Chi-square test. A two-tailed p-value of less than 0.05 was considered statistically significant. [16]

- **RESULTS**

In the present study of 100 children with severe acute malnutrition, 42% belonged to the 1–3-year age group, highlighting early childhood as the most vulnerable period due to high nutritional demands and transition to complementary feeding. Another 31% were aged 3–5 years, indicating that the risk of malnutrition persists into the preschool years. Females constituted 62% of the cases, suggesting possible gender-related disparities in nutrition or healthcare access. Additionally, 43% of the children had a history of low birth weight, emphasizing its role as an important predisposing factor for SAM.

Table 1: Age, Gender, and Birth Weight of the Study Population (n = 100)

S. No.	Variable	Category	Frequency (n)	Percentage (%)
1	**Age**	<1 year	26	26%
		≥1–3 years	42	42%
		>3–5 years	32	32%
		Total	**100**	**100%**
2	**Birth Weight**	≤2.5 kg	57	57%
		>2.5 kg	43	43%
		Total	**100**	**100%**
3	**Gender**	Male	35	35%
		Female	65	65%
		Total	**100**	**100%**

Maternal illiteracy was a prominent finding in the present study, with 85% of mothers of children with severe acute malnutrition being illiterate, highlighting the critical role of maternal education in child nutrition, health awareness, and care-seeking behavior. Additionally, 61% of the mothers were multiparous, suggesting that repeated pregnancies and inadequate birth spacing may contribute to maternal nutritional depletion and increase the risk of adverse outcomes such as low birth weight and childhood malnutrition. Regarding the mode of delivery, 61% of the children were born through spontaneous vaginal delivery, which, although generally safe, may still be associated with poor neonatal outcomes in the context of compromised maternal health and nutrition.

Table 2: Maternal Education, Parity, Gestational Age, and Mode of Delivery of Study Population (n = 100)

S. No.	Variable	Category	Frequency (n)	Percentage (%)
1	Maternal Education	Illiterate	85	85%
		Primary	11	11%
		Secondary	6	6%
		Total	100	100%
2	Mode of Delivery	Spontaneous Vaginal Delivery	61	61%
		Cesarean Section	39	39%
		Total	**100**	**100%**
3	Maternal Parity	Primipara	37	37%
		Multipara	63	63%
		Total	**100**	**100%**

Out of 100 children diagnosed with severe acute malnutrition (SAM), 85% were also found to be anemic, highlighting the strong association between malnutrition and anemia and their combined impact on child health. Among these anemic children, 11% had mild anemia, indicating early nutritional deficiency that can be corrected with dietary improvements and supplementation. A majority, 54%, suffered from moderate anemia, reflecting significant hemoglobin depletion and increased vulnerability to fatigue, infections, and developmental delays, necessitating more intensive medical and nutritional interventions. Notably, 20% of the children had severe anemia, a critical condition that substantially raises the risk of morbidity and mortality and requires urgent management alongside SAM.

Table 3: Grading of severity of anemia in study population (n=100).

Type of Anemia	Number of Cases	Percentage (%)
No Anemia	15	15%
Mild	11	11%
Moderate	54	54%
Severe	20	20%
Total	**100**	**100%**

Biochemical investigations among 100 children with Severe Acute Malnutrition (SAM) revealed the following average values:

- Folic acid: 7.525 ng/mL (SD: 0.045)
- Vitamin B12: 257.95 pg/mL (SD: 13.87)
- Serum ferritin: 44.745 ng/mL (SD: 3.76)

Table 4 Hematological mean and standard deviation of children with severe acute malnutrition. (N=100)

Investigation	Mean	SD
Hb (Hemoglobin)	7.40	0.053
RBC Count	3.88	0.062
WBC Count	4263.25	140.51
Platelet count	129.395	13.975

Table 5: Correlation of hematological and biochemical parameters

Aspect	Observation	Implication
Anemia (Low Hb + RBC)	Present	Nutritional anemia common in SAM
Iron Status	Normal serum iron, low TIBC	Suggests functional iron deficiency due to low transferrin (seen in PEM)
Vitamin Status	Normal folate, borderline B12	May contribute mildly to anemia
Ferritin	Normal or slightly high	May mask deficiency if inflammation present
Platelets & WBC	Low-normal	Suggests bone marrow suppression and immune compromise

Table 6 RBC description in severe acute malnutrition.

RBC Morphology	Description	Associated Nutrient Deficiency	Common in SAM
Microcytic hypochromic	Small, pale RBCs	Iron deficiency	Very common
Macrocytic	Large RBCs	Folate or Vitamin B_{12} deficiency	Possible
Dimorphic picture	Mixed population (microcytic + macrocytic)	Combined deficiencies (iron + B12/folate)	Possible
Anisopoikilocytosis	Variation in size and shape	General malnutrition	Common
Target cells	RBCs with central staining	Iron deficiency or liver disease	Sometimes
Tear-drop cells	Abnormally shaped cells	Severe marrow stress	Occasionally
Nucleated RBCs	Immature RBCs in peripheral blood	Severe anemia/stress	Seen in severe cases

The biochemical assessment of children with Severe Acute Malnutrition (SAM) is summarized in Table 6. The mean folic acid level was 7.525 ± 0.045 ng/mL, indicating a potential deficiency given the critical role of folate in hematopoiesis. Vitamin B12 levels averaged 257.95 ± 13.87 pg/mL, suggesting that a proportion of children may have suboptimal levels, which can contribute to impaired red blood cell production and anemia. Serum ferritin, an indicator of iron storage, had a mean value of 44.745 ± 3.76 ng/mL, while serum iron levels averaged 80.85 ± 5.76 µg/dL, reflecting variable iron status among the children. Total iron-binding capacity (TIBC) was 43.11 ± 8.23 µg/dL, providing further insight into the children's iron transport and storage capacity.

Collectively, these biochemical parameters highlight deficiencies and imbalances in key nutrients that are critical for hematological health and overall growth in children with SAM.

Table 7: Biochemical parameters in SAM

Parameters	Mean	S.D.
Folic acid	7.525	0.045
Vit. B12	257.95	13.87
Serum ferritin	44.745	3.76
Serum iron	80.85	5.76
TIBC	43.11	8.23

DISCUSSION

The present study assessed hematological and biochemical profiles among 100 children with severe acute malnutrition (SAM) and highlighted several important trends relevant to child health and nutrition. The age distribution revealed that 42% of the children were between 1–3 years, with 31% aged 3–5 years, indicating that the risk of SAM is highest in early childhood but persists into the preschool years. This emphasizes the need for continuous nutritional monitoring and interventions beyond infancy. [17] The predominance of female children (62%) and the high proportion of low birth weight infants (43%) suggest gender-related disparities and prenatal factors as significant contributors to SAM. These findings align with previous studies indicating that low birth weight and early-life nutritional deficiencies predispose children to malnutrition and its complications.

Maternal factors also played a significant role in the study population. A large majority of mothers (85%) were illiterate, and 63% were multiparous, suggesting that maternal education and birth spacing are critical determinants of child nutritional status. Maternal illiteracy likely limits knowledge of optimal infant feeding practices, hygiene, and healthcare utilization, while repeated pregnancies may deplete maternal nutrient reserves, contributing to adverse neonatal outcomes such as low birth weight, which further increases susceptibility to SAM. Although 61% of children were delivered via spontaneous vaginal delivery, compromised maternal nutrition may have influenced neonatal health outcomes, highlighting the importance of maternal health interventions. [18]

Hematological analysis revealed that 85% of children with SAM were anemic, with the majority (54%) presenting moderate anemia and 20% having severe anemia. This underscores the strong link between malnutrition and anemia, which collectively impair growth, cognitive development, and immunity. RBC counts showed variability, with 23% below normal and 36% above normal, reflecting the heterogeneous hematological responses in SAM, including functional iron deficiency, bone marrow suppression, or compensatory erythropoiesis. WBC counts were elevated in 48% of children, suggesting ongoing infections or inflammation, while 54% of children exhibited thrombocytopenia, indicating hematological complications and potential immune compromise. RBC morphology commonly showed microcytic hypochromic cells, consistent with iron deficiency, while dimorphic and macrocytic patterns indicated combined nutrient deficiencies. [19]

Biochemical assessments further elucidated the nutritional deficiencies underlying these hematological changes. Mean folic acid (7.525 ng/mL) and vitamin B12 (257.95 pg/mL) levels were borderline or low, which may contribute to impaired erythropoiesis and anemia. Serum ferritin (44.745 ng/mL) and serum iron (80.85 µg/dL) were within or slightly below normal limits, while TIBC (43.11 µg/dL) suggested a functional iron deficiency, possibly due to protein-energy malnutrition or inflammation. These findings indicate that SAM is associated with complex nutrient imbalances, including iron, folate, and vitamin B12 deficiencies, which collectively exacerbate anemia and hematological abnormalities. [20, 21]

CONCLUSION

Based on the findings of this report, we conclude that the issue of severe malnutrition is multifaceted. In malnourished children aged 6 to 59 months, a rising incidence of ferritin, vitamin B12 and FA deficiency was\ discovered. SAM children, those from lower socioeconomic classes, who were exclusively breastfed even after 6 months of age with delayed initiation of complementary feeding were more likely to be deficient, leading to an adverse development outcome. Malnourished mothers with preferential vegetarian diet in mothers could be the associated factors. Strengthening these nutrients' status (folate and vitamin B12) in SAM children in the hospital can reduce nutritional anaemia and improve neuronal development.

REFERENCES

1. Eklund Martin and Girma (2008) effectiveness of integrated outpatient care of severe acute malnutrition. Field exchange issue 34, October 2008. Available: http://fex.ennonline.net/34/effectiveness.aspx

2. Delisle F Helen (2008) poverty – a double burden of malnutrition in mothers and the intergenerational impact. New York Academic of sciences
3. UNICEF (2005) State of the World's Children. UNICEF Global Database on Child Malnutrition.
4. UNICEF (2008) Anthropometric criteria for defining severe and moderate acutemalnutrition. Nutrition HEAT Module.
5. Pham TP, Alou MT, Golden MH, Million M, Raoult D. Difference between kwashiorkor and marasmus: Comparative meta-analysis of pathogenic characteristics and implications for treatment. Microb Pathog. 2021 Jan;150:104702.
6. Di Giovanni V, Bourdon C, Wang DX, Seshadri S, Senga E, Versloot CJ, Voskuijl W, Semba RD, Trehan I, Moaddel R, Ordiz MI, Zhang L, Parkinson J, Manary MJ, Bandsma RH. Metabolomic Changes in Serum of Children with Different Clinical Diagnoses of Malnutrition. J Nutr. 2016 Dec;146(12):2436-2444.
7. Funnel Sue C. and Patricia Rogers (2011) Purposeful programme Theory. Effective use of theories of change and logic model. Jossey Bass
8. Eticha K (2007) Prevalence and Determinants of Child Malnutrition: Western Ethiopia, Gimbi District, Oromia Regional State. Addis ababa university [master thesis.
9. Phillips RS, Okolo S, Hassan A (2004) Metabolic effects of acute measles in chronically malnourished Nigerian children. J Nutr Biochem 15: 281-288.
10. Kathleen St Louise and Angela Calabrese Barton (2012) Tales from Science Education Crypt: A critical Reflection of positionality, subjectivity and reflexivity in research. Qualitative Social Research, Vol. No 3 (2002)
11. Leone Lillian (2008) realistic evaluation of an illicit drug deterrence programme: Analysis of a case study. Evaluation 2008 14:9
12. Eagle P.F Menom and Haddad L (2000) Care and Nutrition: Concept and Measurements. International Food Policy Research Institute. Washington DC
13. Macallan (2005) Malnutrition and infection. The Medicine Publishing Company. Medicine 33:3.
14. Kruger and Vorster (2007) poverty, malnutrition and underdevelopment and cardiovascular diseases: A South African perspective. Cardiovascular J Africa 2007 Sept-Oct; 18(5)'321-4
15. Collins S. 2001, Changing the way we address malnutrition severe malnutrition during famine. Lancet 2001; 358(9280): 498-501
16. Fielding Nigel (2009) mixed methods research in the real world. International journal of social research methodology, 13: 127-138
17. Hammersley M, and Atkinson P, (2002) Ethnography: Principles in Practice. London; New York: Routledge 227.
18. Uner A, Calişkan U, Oner AF, Koç H, Kasap AF. Platelet functions in patients with protein-energy malnutrition. Clin Appl Thromb Hemost. 2001;7(4):286-8.
19. Meffat MEK, Longstaffe S, Besant J, Dureski C. Prevention of iron deficiency and psychomotor decline in high risk infants through use of iron fortified infant formula. A randomized clinical trial. J Pediatr. 1994;125:527-34.
20. Rathore SS, Rishi Diwan. Study of Haematological Profile of Children Diagnosed with Severe Acute Malnutrition. International Journal of Pharmaceutical and Clinical Research 2024; 16(12); 1373-1377
21. Thakur N, Chandra J, Pemde H, Singh V. Anemia in severe acute malnutrition. Nutrition. 2014 Apr;30(4):440-2. doi: 10.1016/j.nut.2013.09.011. Epub 2013 Oct 2. PMID: 24332525.

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