International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Research Article

Study Of Clinico-Demographic Profile, Serum Electrolytes, Blood Sugar, And Albumin Levels in Children with Malnutrition

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Received: 16-08-2025
Accepted: 05-09-2025
Available online: 25-09-2025

ABSTRACT

Background: Malnutrition remains a major public health issue in India, particularly among children under five. Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) contribute significantly to pediatric morbidity and mortality through associated metabolic disturbances, infections, and poor clinical outcomes. The role of serum electrolytes, blood sugar, and albumin in evaluating malnutrition severity and outcomes is increasingly recognized.

Objectives: To study the clinico-demographic profile of children with SAM and MAM, evaluate serum electrolytes, random blood sugar (RBS), and serum albumin levels, and assess their association with short-term clinical outcomes.

Methods: This hospital-based cross-sectional observational study was conducted over 18 months in a tertiary care center. A total of 110 children aged 6 months to 5 years, diagnosed with SAM or MAM as per WHO criteria, were enrolled. Clinical, demographic, and feeding history was documented, and biochemical investigations (serum sodium, potassium, calcium, RBS, and albumin) were performed and correlated with outcomes such as recovery and mortality.

Results: SAM was more prevalent in children aged 6–36 months and among lower socioeconomic groups. SAM children had significantly lower mean RBS (54.3 ± 12.7 mg/dL) and albumin (2.4 ± 0.6 g/dL) compared to MAM. Hyponatremia (70.1%), hypokalemia (59.7%), and hypocalcemia (70.1%) were markedly higher in SAM. Mortality was significantly higher in children with albumin <2.5 g/dL. Diarrheal illness was associated with greater electrolyte imbalance.

Conclusion: SAM is linked with younger age, low SES, poor feeding, and biochemical derangements that predict adverse outcomes. Early correction of these abnormalities is essential to reduce mortality.

Keywords*: Malnutrition; Electrolyte imbalance; Hypoalbuminemia; Child nutrition disorders; Severe acute malnutrition.*

INTRODUCTION

Malnutrition remains a leading cause of childhood morbidity and mortality in low- and middle-income countries, with India carrying one of the highest burdens globally. Despite sustained public health efforts, recent estimates from the National Family Health Survey (NFHS-5) indicate that 36% of Indian children under five years are stunted, 32% are underweight, and 19% suffer from wasting, reflecting persistent nutritional deficiencies at a national level.[1] Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) not only impair physical growth but also increase vulnerability to infections, electrolyte imbalances, and metabolic disturbances.

Traditional diagnostic tools for malnutrition—such as weight-for-height, MUAC, and visible wasting—are essential but often insufficient for predicting prognosis. A growing body of evidence highlights that biochemical parameters such as serum sodium, potassium, calcium, random blood sugar (RBS), and albumin levels play a pivotal role in determining

disease severity, guiding treatment, and assessing short-term outcomes.[2,3] Electrolyte derangements, particularly hyponatremia and hypokalemia, are common in SAM and can lead to life-threatening complications including seizures, arrhythmias, and coma if left uncorrected.[4] Moreover, hypoalbuminemia is increasingly recognized as an early indicator of poor prognosis and higher mortality among malnourished children.[5]

Clinico-demographic determinants—such as age, gender, socioeconomic class, maternal literacy, breastfeeding duration, and feeding practices—strongly influence the nutritional trajectory of a child. Studies have demonstrated that children from lower socioeconomic backgrounds and those who are inadequately breastfed are disproportionately affected by SAM and its complications.[6]

This study evaluated the clinico-demographic profile and biochemical abnormalities in malnourished children and correlated them with clinical features and short-term outcomes to inform early intervention and care strategies.

MATERIALS AND METHODS

Study Design and Setting: This cross-sectional observational study was conducted in the Department of Pediatrics, Government Medical College, Haldwani, in collaboration with Dr. Susheela Tiwari Government Hospital. All children diagnosed with malnutrition and admitted to the pediatric ward or Pediatric Intensive Care Unit (PICU) were evaluated.

Study Period: The study was carried out over 18 months, from April 2022 to October 2023.

Study Population: Children aged >6 months to ≤5 years admitted with a diagnosis of Moderate Acute Malnutrition (MAM) or Severe Acute Malnutrition (SAM) were included. Diagnosis was made using WHO anthropometric criteria.

Inclusion Criteria

- Children aged 6 months to 5 years
- Diagnosed with MAM or SAM as per WHO criteria
- Informed consent obtained from parents or guardians

Exclusion Criteria

- Children aged <6 months or >5 years
- Children with known kidney disease or on diuretic therapy
- Those not meeting WHO diagnostic criteria
- Parental refusal to participate

Sample Size: The sample size was determined to be 110 children.

Diagnostic Criteria

- **SAM**: weight-for-height/length < −3 SD, or MUAC <115 mm, or bilateral pitting edema, or visible wasting.
- **MAM**: weight-for-height/length < −2 SD without edema.

Biochemical Investigations: Venous blood samples were collected to evaluate serum sodium, potassium, calcium, random blood sugar (RBS), and serum albumin levels. These markers were then correlated with clinical severity and short-term outcomes such as recovery, referral, or mortality.

Data Collection: Demographic and clinical data were collected through a structured case record form. Parameters recorded included age, gender, socioeconomic status, literacy level, immunization status, feeding practices, and medical history. Nutritional intake was assessed using the 24-hour dietary recall method.

RESULTS

Table 1: Age and SES Distribution

SAM was significantly more prevalent in 6–12-month-olds and lower SES (p=0.001), while MAM was more common in 1–3-year-olds and middle SES (Table 1).

Variable	Category	SAM (n = 67, %)	MAM (n = 43, %)	p-value
Age Group	6–12 months	24 (35.8%)	5 (11.6%)	0.001
	1–3 years	34 (50.7%)	27 (62.8%)	
	3–5 years	9 (13.5%)	11 (25.6%)	
SES Class	Lower (IV–V)	52 (77.6%)	17 (39.5%)	0.001
	Middle (III)	13 (19.4%)	22 (51.2%)	
	Upper (I–II)	2 (3.0%)	4 (9.3%)	

The study population showed male predominance, with 57.3% males and 42.7% females (See Figure 1).

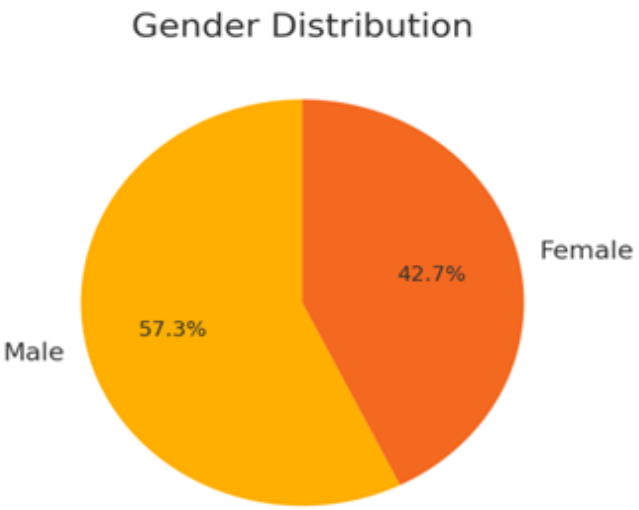

Figure 1: Gender Distribution

Table 2: Feeding & Immunization

Shorter breastfeeding (<6 months), fewer meals (<3/day), and partial immunization were significantly associated with SAM and infections (p<0.05) (Table 2).

Variable	Category	SAM (n=67)	MAM (n=43)	p-value
Breastfeeding Duration	<6 months	41 (61.2%)	18 (41.9%)	0.04
	≥6 months	26 (38.8%)	25 (58.1%)	
Meal Frequency	< 3 meals/day	60 (89.6%)	20 (46.5%)	0.001
	≥ 3 meals/day	7 (10.4%)	23 (53.5%)	
Immunization Status & Complications		**Infections (n=49)**	**No Infections (n=61)**	**p-value**
	Fully immunized	22 (44.9%)	45 (73.8%)	0.002
	Partially/Unimmunized	27 (55.1%)	16 (26.2%)	

Clinical features were more prevalent in SAM than MAM, with higher rates of pedal edema, hypothermia, hepatomegaly, skin and hair changes, while MAM had more cases without clinical signs. Among children with MUAC <11.5 cm, 89.6% were classified as WHZ < -3SD, indicating severe malnutrition, while 23.3% fell in the WHZ -2 to -3SD range, suggesting overlapping classification (See Figure 2 & 3).

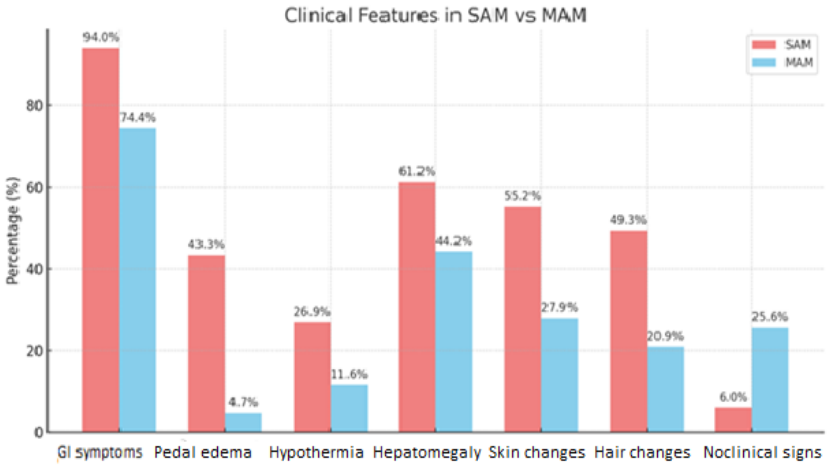

Figure 2: Clinical Features

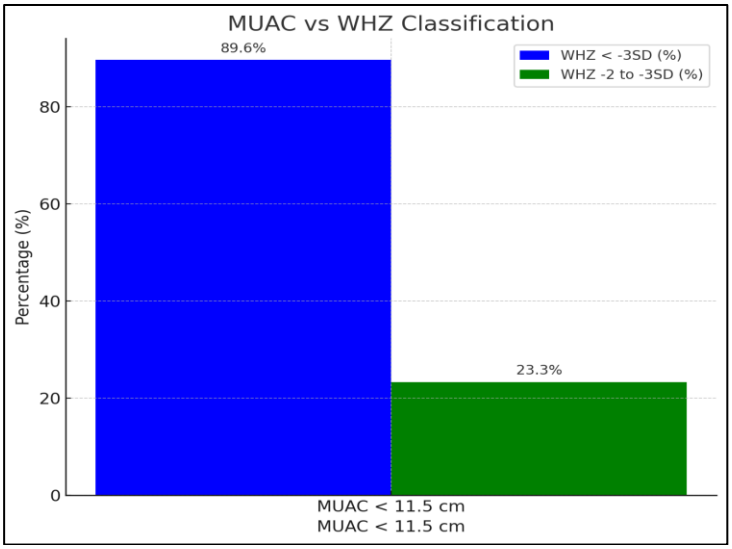

Figure 3: MUAC vs. WHZ Classification

Table 3: Biochemical Parameters

SAM showed more abnormalities in hemoglobin, liver enzymes, electrolytes, and calcium than MAM, reflecting greater metabolic disturbances (Table 3)

Parameter	Mean ± SD	Normal Range	Normal (Count & %)	Abnormal (Count & %)
Hemoglobin (Hb)	SAM: 7.2 ± 1.5, MAM: 8.9 ± 1.3	11–14 g/dL	SAM: 13 (19.4%) MAM: 22 (51.2%)	SAM: 54 (80.6%) MAM: 21 (48.8%)
TLC (Total Leukocyte Count)	SAM: 8,200 ± 2,100, MAM: 9,800 ± 2,300	4,000–11,000 cells/mm³	SAM: 40 (59.7%) MAM: 30 (69.8%)	SAM: 27 (40.3%) MAM: 13 (30.2%)
SGOT (Serum Glutamic-Oxaloacetic Transaminase)	SAM: 68.3 ± 22.1, MAM: 45.2 ± 18.7	0–40 U/L	SAM: 20 (29.9%) MAM: 22 (51.2%)	SAM: 47 (70.1%) MAM: 21 (48.8%)
SGPT (Serum Glutamic-Pyruvic Transaminase)	SAM: 54.7 ± 19.8, MAM: 38.4 ± 15.2	0–41 U/L	SAM: 17 (25.4%) MAM: 19 (44.2%)	SAM: 50 (74.6%) MAM: 24 (55.8%)
Urea	SAM: 38.2 ± 12.4, MAM: 28.7 ± 9.6	13–43 mg/dL	SAM: 42 (62.7%) MAM: 38 (88.4%)	SAM: 25 (37.3%) MAM: 5 (11.6%)
Creatinine	SAM: 0.9 ± 0.3, MAM: 0.7 ± 0.2	0.6–1.2 mg/dL	SAM: 40 (59.7%) MAM: 34 (79.1%)	SAM: 27 (40.3%) MAM: 9 (20.9%)
Sodium (mEq/L)	SAM: 128.5 ± 5.2, MAM: 134.2 ± 4.8	135–145 mEq/L	SAM: 20 (29.9%) MAM: 22 (51.2%)	SAM: 47 (70.1%) MAM: 21 (48.8%)
Potassium (mEq/L)	SAM: 3.1 ± 0.6, MAM: 3.8 ± 0.5	3.5–5.0 mEq/L	SAM: 27 (40.3%) MAM: 26 (60.5%)	SAM: 40 (59.7%) MAM: 17 (39.5%)
Calcium (mg/dL)	SAM: 7.9 ± 1.1, MAM: 8.8 ± 0.9	8.5–10.5 mg/dL	SAM: 20 (29.9%) MAM: 26 (60.5%)	SAM: 47 (70.1%) MAM: 17 (39.5%)

Table 4: Blood Sugar, Albumin & Outcomes

SAM had lower RBS and albumin (p=0.001), with low albumin (<2.5 g/dL) linked to higher mortality and poorer recovery (Table 4).

Variable	Category	SAM	MAM	p-value
Blood Sugar & Albumin	RBS (mg/dL)	54.3 ± 12.7	72.8 ± 15.4	
	Albumin (g/dL)	2.4 ± 0.6	3.1 ± 0.5	0.001
Short-Term Outcomes	Mortality	8 (11.9%)	1 (2.3%)	Overall Pearson χ^2 (2): 7.37 p = 0.025
	Recovery	44 (65.7%)	38 (88.4%)	
	Other/Still Admitted	15 (22.4%)	4 (9.3%)	
Correlation of Albumin with Outcomes	**Albumin (g/dL)**	**Mortality (n, %)**	**Recovery (n, %)**	
	< 2.5	8 (11.9%)	44 (65.7%)	0.001
	≥ 2.5	1 (2.3%)	38 (88.4%)	

Table 5: Diarrhea & Electrolytes

Diarrhea was significantly associated with electrolyte imbalances—hyponatremia, hypokalemia, and combined deficits ($p<0.01$) (Table 5).

Parameter	With Diarrhea (n=58)	Without Diarrhea (n=52)	p-value
Any Electrolyte Imbalance	51 (87.9%)	28 (53.8%)	0.001
Hyponatremia (<135 mEq/L)	42 (72.4%)	18 (34.6%)	0.001
Hypokalemia (<3.5 mEq/L)	39 (67.2%)	22 (42.3%)	0.008
Both Na+ & K+ deficits	30 (51.7%)	12 (23.1%)	0.002
Normal Electrolytes	7 (12.1%)	24 (46.2%)	0.001

Co-morbid infections like gastrointestinal infection, pneumonia, UTI, and sepsis were significantly more common in SAM children compared to MAM, who had a higher rate of no infection (60.5%) (See Figure 4).

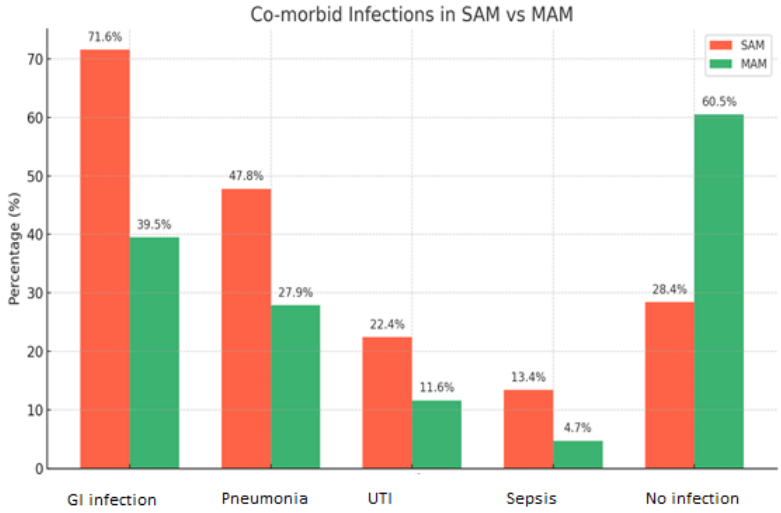

Figure 4: Co-morbid Infections

DISCUSSION

The present study showed a male predominance in malnourished children (57.3%), similar to findings by Khan S[7] and Pandurangi R[8], possibly reflecting gender bias in care-seeking. Children aged 1–3 years constituted the highest burden in both SAM and MAM groups, aligning with Haldar P[9], who linked early childhood with heightened nutritional vulnerability due to improper weaning. Most SAM cases belonged to lower socioeconomic strata (77.6%), reaffirming poverty as a critical determinant, as supported by Cossa-Moiane[10] and Thakur S[11].

Shorter breastfeeding duration (<6 months) was more frequent among SAM children (61.2%) compared to MAM. Meal frequency <3 times/day was reported in 89.6% of SAM children, reinforcing previous findings by Khan S[7] and Chowdhury NR[12] that inadequate caloric intake contributes to malnutrition severity. Immunization status was significantly associated with infection risk; only 44.9% of infected children were fully immunized, similar to the studies by Mahajan A[13].

Clinical signs like hepatomegaly (61.2%), skin/hair changes (55.2%, 49.3%), and pedal edema (43.3%) were prominent in SAM. The correlation between MUAC <11.5 cm and WHZ <-3SD further validated the concordance of anthropometric markers, consistent with Sharma IK et al[14].

Laboratory findings revealed higher anemia in SAM (80.6%) than MAM (48.8%). SGOT and SGPT were elevated in 70–75% of SAM cases, reflecting hepatic stress. Electrolyte imbalances such as hyponatremia (70.1%), hypokalemia (59.7%), and hypocalcemia (70.1%) were significantly more common in SAM.

Co-morbid infections were markedly more prevalent in SAM (71.6%) than MAM (39.5%), particularly pneumonia (47.8% vs 27.9%) and UTI (22.4% vs 11.6%), reflecting findings from Chowdhury NR et al.[12]. Blood sugar levels were significantly lower in SAM (54.3 ± 12.7 mg/dL), while albumin levels were also reduced (2.4 ± 0.6 g/dL), similar to Chowdhury NR et al[12]. Mortality was notably higher in SAM (11.9%), and lower albumin levels (<2.5 g/dL) correlated strongly with poorer recovery and higher death rates.

Electrolyte disturbances were significantly more common in children with diarrhea (87.9%), especially hyponatremia (72.4%) and hypokalemia (67.2%), confirming the impact of diarrheal losses, as reported by Owais MJ et al[15]. Conversely, 46.2% of non-diarrheal children had normal electrolyte levels—an observation unique to this study.

The limitations of the study include its single-center setting, small sample size, and recall bias due to caregiver-reported data, which may affect generalizability.

The strengths of the study include detailed clinical and biochemical assessment with direct SAM–MAM comparison, offering valuable insights into hospital-based malnutrition patterns.

CONCLUSION

Severe acute malnutrition in children is significantly associated with younger age, low socioeconomic status, inadequate breastfeeding, and poor meal frequency. Biochemical abnormalities like hypoalbuminemia, hypoglycaemia and electrolyte imbalances were strongly linked to adverse clinical outcomes. Prompt nutritional support, infection control, and early correction of metabolic disturbances are vital for improving recovery and reducing mortality in malnourished children.

Conflict of Interest: *None.*

Funding: *None.*

Ethical Approval: *Obtained.*

Consent: *Written consent secured.*

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