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Original Article

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Complications and Comorbidities in Hospitalized Children with Severe Acute Malnutrition

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Abstract

Background: Severe Acute Malnutrition (SAM) remains a major cause of childhood morbidity and mortality in low- and middle-income countries, including India. Hospitalized children with SAM often present with multiple comorbidities and life-threatening complications, which significantly influence outcomes. ***Objectives:*** To evaluate the incidence, clinical profile, comorbidities, complications, and early outcomes among hospitalized children with Severe Acute Malnutrition. ***Methods:*** A hospital-based observational analytical study was conducted over one year at the Nutrition Rehabilitation Centre (NRC), Civil Hospital, Ahmedabad. Children aged 6–59 months fulfilling WHO criteria for SAM were enrolled. Sociodemographic details, feeding practices, anthropometry, clinical features, laboratory parameters, comorbidities, complications, duration of hospital stay, and outcomes were recorded and analyzed. ***Results:*** Out of 7,566 children screened, 211 (2.79%) were diagnosed with SAM. The majority were below two years of age (65%) and belonged to lower socioeconomic strata (55.92%). Inadequate exclusive breastfeeding was observed in 56.4% of children. Wasting and stunting were present in 70.14% and 49.28% respectively, with all children having MUAC <11.5 cm. Common comorbidities included nutritional anemia (73.93%), gastroenteritis (45.49%), pneumonia (29.85%), and septicemia (32.22%). Frequent complications were dehydration (48.34%), respiratory distress (39.81%), hypothermia (30.80%), and septic shock (18.95%). The mortality rate was 9.48%. ***Conclusion:*** Severe Acute Malnutrition continues to impose a substantial clinical burden among hospitalized children. Early identification, optimal feeding practices, timely management of infections, and comprehensive inpatient care are essential to reduce morbidity and mortality.

Keywords: ***Severe acute malnutrition; comorbidities; complications; pediatric malnutrition; Nutrition Rehabilitation Centre.***

Introduction

Severe Acute Malnutrition (SAM) represents the most extreme and life-threatening form of undernutrition in children under five years of age and remains a major contributor to preventable childhood morbidity and mortality worldwide. According to World Health Organization (WHO) criteria, SAM is defined by weight-for-height/length Z-score below −3 SD, mid-upper arm circumference (MUAC) <11.5 cm, or the presence of bilateral pitting edema [1-3].

The etiology of SAM is multifactorial, involving inadequate dietary intake, inappropriate infant and young child feeding practices, recurrent infections, and adverse socioeconomic conditions. Infections such as diarrhea and pneumonia both precipitate and exacerbate malnutrition, perpetuating the infection–malnutrition cycle. Physiologically, SAM is associated with immune dysfunction, impaired gut integrity, metabolic derangements, and micronutrient deficiencies, predisposing children to hypoglycemia, hypothermia, severe infections, and organ dysfunction [4-6].

In India, malnutrition remains a significant public health concern despite ongoing nutritional interventions. NFHS-5 reports a national prevalence of severe wasting of 7.7%, with wide regional and socioeconomic variations. Hospital-based studies provide valuable insights into the clinical spectrum, comorbidities, complications, and outcomes of SAM. This study was undertaken to assess these parameters among children with SAM admitted to a tertiary-care Nutrition Rehabilitation Centre [7,8].

Materials and Methods

Study Design and Setting

This was a hospital-based observational study conducted at the Nutrition Rehabilitation Centre (NRC) of a tertiary care teaching hospital. The study included children admitted for the management of Severe Acute Malnutrition (SAM) over the defined study period. The NRC functions as a specialized unit for inpatient management of complicated SAM as per World Health Organization (WHO) and Government of India guidelines.

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Study Population

All children aged 6 to 60 months admitted to the NRC during the study period and fulfilling WHO diagnostic criteria for Severe Acute Malnutrition were eligible for inclusion.

Inclusion criteria

- Children aged 6–60 months
- Diagnosed with SAM based on any of the following WHO criteria:
  - Weight-for-height/length Z-score < −3 SD
  - Mid-upper arm circumference (MUAC) < 11.5 cm
  - Presence of bilateral pitting pedal edema
- Children whose parents or guardians provided informed consent

Exclusion criteria

- Children with incomplete clinical or laboratory records
- Children whose caregivers did not consent to participation
- Readmissions during the study period (only the first admission was considered)

Sample Size and Sampling Technique

All eligible children admitted to the NRC during the study period were included using a consecutive sampling method, ensuring complete coverage of hospitalized SAM cases. A total of 211 children meeting inclusion criteria were enrolled. No prior sample size calculation was performed, as the study aimed to include all admitted cases within the study duration.

All eligible children admitted to the Nutrition Rehabilitation Centre during the study period were included using a consecutive sampling technique, and a total of 211 children fulfilling the inclusion criteria were enrolled. After obtaining written informed consent from parents or guardians, data were collected using a pre-designed structured case record form through caregiver interviews, clinical examination, and review of hospital records. Information regarding demographic characteristics, socioeconomic status (assessed using the Modified Kuppuswamy scale), perinatal history, feeding practices including exclusive breastfeeding and timing of complementary feeding, and presenting complaints was documented. A detailed general and systemic examination was performed, along with assessment of developmental milestones using age-appropriate standards. Anthropometric measurements, including weight, length/height, and mid-upper arm circumference (MUAC), were recorded using standardized techniques and calibrated instruments, and the presence of bilateral pedal edema was noted. An appetite test using Ready-to-Use Therapeutic Food was conducted at admission as per WHO guidelines to categorize children as uncomplicated or complicated SAM. Baseline laboratory investigations including complete blood count, inflammatory markers, serum electrolytes, renal and liver function tests, random blood sugar, serum albumin, and blood gas analysis (where indicated) were performed using standard laboratory protocols. Associated comorbidities such as anemia, infections, and chronic illnesses, as well as complications including dehydration, hypothermia, hypoglycemia, septic shock, and respiratory distress, were systematically documented during hospitalization. All children were managed according to WHO and national guidelines for inpatient management of severe acute malnutrition, and the duration of hospital stay and final outcomes (discharge, death, or leave against medical advice) were recorded. Data were entered into Microsoft Excel and analyzed using descriptive statistics, with results expressed as frequencies, percentages, means, and standard deviations. The study was conducted after approval from the Institutional Ethics Committee, and confidentiality of patient information was maintained throughout.

Results

Table 1: Demographic profile

Variable	Category	n (%)
Incidence	Total screened: 7566	—
	SAM cases: 211	2.79%
Age group (months)	6–12	72 (34.28%)
	13–24	65 (30.80%)
	25–36	48 (22.74%)
	37–48	14 (6.63%)
	49–60	12 (5.68%)
Gender	Male	116 (54.98%)
	Female	95 (45.02%)
Residence	Urban	128 (60.67%)
	Rural	83 (39.33%)
Socioeconomic status	Lower	118 (55.92%)
	Upper-lower	44 (20.85%)
	Lower-middle	29 (13.74%)
	Upper-middle	20 (9.47%)
	Upper	0
Birth weight	≥2.5 kg	138 (65.40%)
	<2.5 kg	73 (34.60%)

During the study period, 7,566 children were screened, of whom 211 fulfilled WHO criteria for Severe Acute Malnutrition (SAM), yielding an incidence of 2.79%. This reflects a substantial burden of severe malnutrition among hospitalized children.

SAM was predominantly observed in younger age groups. The highest proportion was seen in children aged 6–12 months (34.28%), followed by 13–24 months (30.80%). Overall, children below two years of age constituted approximately 65% of cases, indicating increased vulnerability during infancy and early toddlerhood. A progressive decline in SAM prevalence was noted with increasing age.

There was a slight male predominance, with 54.98% males and 45.02% females. A majority of children belonged to urban areas (60.67%), while 39.33% were from rural settings. Socioeconomic assessment showed a strong association with deprivation, as 55.92% of children belonged to the lower socioeconomic class, and none were from the upper class. Although 34.60% of children were born with low birth weight, most (65.40%) had a normal birth weight, suggesting that postnatal factors played a major role in the development of SAM.

Table 2: Feeding and Nutritional practices

Variable	Category	n (%)
Exclusive breastfeeding up to 6 months	Yes	92 (43.60%)
	No	119 (56.40%)
Age of complementary feeding	<6 months	22 (10.42%)
	6–9 months	128 (60.67%)
	9–12 months	41 (19.43%)
	>1 year	20 (9.48%)
Appetite Test	Pass	191 (90.52%)
	Fail	20 (9.48%)

Infant and young child feeding practices were suboptimal in a large proportion of cases. Exclusive breastfeeding up to six months was reported in only 43.60% of children, while 56.40% had either early cessation or non-exclusive feeding.

Complementary feeding was initiated between 6–9 months in 60.67% of children. However, deviations from recommended practices were common: 10.42% received complementary feeds before six months, while 28.91% experienced delayed initiation beyond nine months, including 9.48% introduced after one year of age. These inappropriate feeding practices likely contributed to nutritional deficits and susceptibility to infections.

The appetite test was passed by 90.52% of children, indicating that the majority had uncomplicated SAM and were suitable for oral therapeutic feeding at admission.

Table 3: Developmental and Anthropometric Profile

Variable	Category	n (%)
Developmental milestones	Normal	131 (62.08%)
	Motor delay	50 (23.69%)
	Global developmental delay	18 (8.53%)
	Speech delay	12 (5.68%)
Anthropometry	Wasting (<–2 SD WHZ)	148 (70.14%)
	Stunting (<–2 SD HAZ)	104 (49.28%)
	MUAC <11.5 cm	211 (100%)
WHO SAM Criteria (Clinical)	W/H < –3 SD	148 (70.14%)
	MUAC <11.5 cm	211 (100%)
	Bilateral pedal edema	45 (21.32%)

Assessment of developmental milestones revealed that 62.08% of children had age-appropriate development, while 37.92% showed developmental delays. Motor delay was the most common abnormality (23.69%), followed by global developmental delay (8.53%) and speech delay (5.68%), highlighting the adverse neurodevelopmental impact of severe malnutrition.

Anthropometric evaluation demonstrated a high burden of both acute and chronic malnutrition. Wasting was present in 70.14% of children, and stunting in 49.28%, indicating coexistence of acute and long-standing nutritional deprivation. All children (100%) had a MUAC <11.5 cm, confirming MUAC as a consistent and reliable screening tool for SAM.

According to WHO criteria, 70.14% of children had weight-for-height <−3 SD, while 21.32% presented with bilateral pedal edema, representing edematous or mixed forms of SAM.

Table 4: Clinical Profile at Admission

Variable	Category	n (%)
Symptoms	Fever	142 (67.29%)
	Loose stools	135 (63.98%)
	Cough/Cold	100 (47.39%)
	Vomiting	98 (46.44%)
	Weight loss/Not gaining	90 (42.65%)
	Loss of appetite	80 (37.91%)
	Abdominal distension	40 (18.95%)
	Rash	18 (8.53%)
Vitals	Abnormal temperature	81 (37.91%)
	Tachycardia	79 (37.44%)
	Hypotension	67 (31.75%)
	Hypoglycemia	21 (9.95%)
	Oxygen saturation <90%	19 (9%)
Clinical signs	Visible wasting	148 (70.14%)
	Hair changes	123 (58.29%)
	Skin changes	101 (47.86%)
	Dehydration	89 (42.18%)
	Pallor	78 (36.97%)
	Eye changes	61 (28.90%)
	Nail changes	61 (28.90%)
	Edema	45 (21.32%)
	Bow legs	32 (15.16%)
	Wrist widening	36 (17.06%)
	Open anterior fontanel	27 (12.79%)
	Jaundice	23 (10.90%)
	Cyanosis	9 (4.26%)
	Clubbing	12 (5.68%)
Systemic findings	Crepitations/Wheeze	70 (33.17%)
	Hepatomegaly	56 (26.54%)
	Irritability	40 (18.95%)
	Systolic murmur	17 (8.06%)

Children with SAM presented with a wide range of symptoms, reflecting significant multisystem involvement. The most frequent symptoms were fever (67.29%) and loose stools (63.98%), followed by cough/cold (47.39%) and vomiting (46.44%), indicating a high burden of infectious morbidity. Nearly 42.65% had poor weight gain or weight loss, and 37.91% reported loss of appetite.

Vital sign abnormalities were common. Abnormal temperature was noted in 37.91%, tachycardia in 37.44%, and hypotension in 31.75%, suggesting physiological instability. Hypoglycemia (9.95%) and oxygen saturation <90% (9%) were observed in a smaller but clinically significant proportion.

On physical examination, visible wasting (70.14%) was the most common sign, followed by hair changes (58.29%), skin changes (47.86%), dehydration (42.18%), and pallor (36.97%). Edema was present in 21.32%, indicating edematous SAM. Skeletal signs of chronic malnutrition included wrist widening (17.06%), bow legs (15.16%), and open anterior fontanel (12.79%).

Systemic examination revealed respiratory crepitations or wheeze in 33.17%, hepatomegaly in 26.54%, and irritability in 18.95%. A systolic murmur was detected in 8.06%, likely related to anemia or underlying cardiac conditions.

Table 5: Laboratory Profile of SAM Patients

Parameter	Mean ± SD	Abnormality (%)
Hemoglobin	10.8 ±1.6 g/dL	—
WBC	8500 ±450 /µL	—
RBC	3.98 ±0.16 million/µL	—
Platelets	165,000 ±1,800 /µL	—
CRP	89.5 ±6.2 mg/L	Elevated in majority
ESR	22.5 ±1.9 mm/hr	—
Serum creatinine	0.4 ±0.01 mg/dL	Low-normal
Sodium	138 ±8.8 mmol/L	Variable
Potassium	3.9 ±0.7 mmol/L	Variable
Chloride	99 ±6.2 mmol/L	Variable
Calcium	8.9 ±0.9 mg/dL	—
Phosphate	4.2 ±0.3 mg/dL	—
RBS	128 ±11.5 mg/dL	—
SGPT	24.5 ±1.2 U/L	—
SGOT	29.3 ±1.4 U/L	—
Bilirubin	0.8 ±0.02 mg/dL	—
Hypoalbuminemia	—	78 (36.96%)
Metabolic acidosis	—	34 (16.11%)

The mean hemoglobin level was 10.8 ± 1.6 g/dL, indicating a high prevalence of mild to moderate anemia. Mean leukocyte, red blood cell, and platelet counts were within low-normal ranges.

Inflammatory markers were markedly elevated, with a mean CRP of 89.5 ± 6.2 mg/L and ESR of 22.5 ± 1.9 mm/hr, suggesting a high burden of infection or systemic inflammation. Renal parameters showed a low-normal mean serum creatinine, likely reflecting reduced muscle mass rather than intrinsic renal disease.

Mean serum electrolytes were largely within reference ranges but showed inter-individual variability. Liver function tests were predominantly normal. However, hypoalbuminemia was present in 36.96%, and metabolic acidosis in 16.11%, indicating significant metabolic and protein deficits in a substantial proportion of children.

Table 6: Comorbidities and Complications

Comorbidities		Comorbidities
Nutritional anemia	156 (73.93%)	Nutritional anemia
Gastroenteritis	96 (45.49%)	Gastroenteritis
Septicemia	68 (32.22%)	Septicemia
Pneumonia	63 (29.85%)	Pneumonia
UTI	54 (25.59%)	UTI
Skin infections	48 (22.74%)	Skin infections
Tuberculosis	20 (9.47%)	Tuberculosis
Chronic kidney disease	20 (9.47%)	Chronic kidney disease
Congenital heart disease	15 (7.10%)	Congenital heart disease
Guillain–Barré syndrome	16 (7.58%)	Guillain–Barré syndrome
Pyogenic meningitis	15 (7.10%)	Pyogenic meningitis
Thalassemia	13 (6.16%)	Thalassemia
Malaria	10 (4.73%)	Malaria
HIV	10 (4.73%)	HIV
Cerebral palsy	8 (3.79%)	Cerebral palsy
Complications		Complications
Dehydration	102 (48.34%)	Dehydration
Respiratory distress	84 (39.81%)	Respiratory distress
Hypothermia	65 (30.80%)	Hypothermia
Severe anemia	63 (29.85%)	Severe anemia
Septic shock	40 (18.95%)	Septic shock
Hypoglycemia	30 (14.21%)	Hypoglycemia
Encephalitis	12 (5.68%)	Encephalitis
CCF	10 (4.73%)	CCF
Hepatic failure	7 (3.31%)	

Nutritional anemia was the most common comorbidity, affecting 73.93% of children. Infectious comorbidities were frequent, including gastroenteritis (45.49%), septicemia (32.22%), pneumonia (29.85%), and urinary tract infection (25.59%). Chronic conditions such as tuberculosis (9.47%) and chronic kidney disease (9.47%) were also observed.

Several children had underlying neurological or chronic disorders, including Guillain–Barré syndrome (7.58%), congenital heart disease (7.10%), thalassemia (6.16%), and cerebral palsy (3.79%), which may contribute to feeding difficulties and poor nutritional status.

Acute complications were common during hospitalization. Dehydration (48.34%) and respiratory distress (39.81%) were most frequent, followed by hypothermia (30.80%) and severe anemia (29.85%). Life-threatening complications included septic shock (18.95%) and hypoglycemia (14.21%).

Table 7: Hospital Stay and Outcome

Variable	Category	n (%)
Duration of Hospital Stay	≤7 days	15 (7.1%)
	8–14 days	147 (69.66%)
	15–21 days	29 (13.74%)
	>21 days	20 (9.47%)
Outcome	Discharged	176 (83.41%)
	Death	20 (9.48%)
	LAMA	15 (7.10%)

Most children (69.66%) required hospitalization for 8–14 days. Thirteen point seven four percent stayed for 15–21 days, and 9.47% required prolonged hospitalization beyond 21 days.

Overall, 83.41% of children were successfully discharged. The mortality rate was 9.48%, reflecting the severity of illness in hospitalized SAM children. Additionally, 7.10% left against medical advice, highlighting challenges related to socioeconomic constraints and caregiver compliance.

Discussion

Severe Acute Malnutrition (SAM) continues to be a major cause of pediatric morbidity and mortality in hospitalized children. In this study, 211 out of 7,566 screened children were diagnosed with SAM, giving an incidence of 2.79%, which is almost identical to the 2.8% reported by Pravati J *et al.,*[8] This similarity suggests a comparable inpatient burden in tertiary-care settings. In contrast, Varsha G *et al.,*[9] reported a higher incidence (8.7%), likely reflecting regional variation, referral bias, or differences in study methodology.

The age distribution in the present study showed a clear clustering of SAM in early childhood, with 34.28% of cases occurring in the 6–12-month age group and 30.80% in the 13–24-month group. Thus, nearly 65% of SAM cases occurred below two years of age, highlighting the vulnerability of children during the weaning and early complementary feeding period. This pattern is consistent with findings by Bhaskaran *et al.,*[11] and Susheel K S *et al.,*[10] both of whom reported the highest burden of SAM during infancy and the second year of life. The decline in prevalence beyond two years in all studies may be attributed to improved dietary diversity, immune maturation, and better caregiver awareness with increasing age.

A slight male predominance (54.98%) was observed, which is comparable to the observations of Susheel K S *et al.,*[10] and Bhaskaran *et al.,*[11] This may reflect biological susceptibility in male children or sociocultural differences in healthcare-seeking behavior. Regarding residence, 60.67% of children in the present study were from urban areas, which aligns with Chama GC *et al.,*[12] suggesting a growing burden of SAM in urban slums due to poverty, overcrowding, poor sanitation, and food insecurity. This contrasts with Bhaskaran *et al.,* who reported a rural predominance, highlighting regional differences in population characteristics and referral patterns.

Socioeconomic deprivation emerged as a major determinant of SAM. More than half of the children (55.92%) belonged to the lower socioeconomic class, similar to the findings of Bhaskaran *et al.,* who reported an even higher proportion. Although Susheel K S *et al.,*[10] reported fewer cases in the lowest socioeconomic category, all studies collectively underscore the strong association between poverty and severe malnutrition. The presence of SAM even among upper-middle socioeconomic groups in the present study suggests that factors such as inappropriate feeding practices, neglect, and chronic illnesses also play an important role.

Despite low birth weight being a recognized risk factor, 65.40% of children with SAM in this study had a normal birth weight, a finding comparable to Bhaskaran *et al.,*[11] This indicates that postnatal factors–particularly feeding practices, recurrent infections, and environmental conditions are critical contributors to the development of SAM. Although immunization coverage was relatively better in the present study (66.35% fully immunized) compared to Susheel K S *et al.,* and Bhaskaran *et al.,* incomplete immunization in one-third of children remains concerning, as it increases susceptibility to infections that precipitate malnutrition.

Feeding practices were suboptimal, with exclusive breastfeeding up to six months reported in only 43.60% of children–markedly lower than reported by Susheel K S *et al.,*[10] and Bhaskaran *et al.,*[11] Delayed initiation of complementary feeding was also common, predisposing children to growth faltering and micronutrient deficiencies. Developmental delays were observed in 37.92% of children, reinforcing the bidirectional relationship between malnutrition and impaired neurodevelopment, as also noted by Bhaskaran *et al.,*

Anthropometric assessment revealed a high burden of both acute and chronic malnutrition, with wasting in 70.14%, stunting in 49.28%, and MUAC <11.5 cm in all children, supporting the utility of MUAC as a simple and effective screening tool. Compared with Abeje AT *et al.,* and Bhaskaran *et al.,* variations in wasting and stunting likely reflect differences in referral severity and population characteristics. Clinically, infections dominated the presentation, with fever, diarrhea, and respiratory symptoms being most common. Nutritional anemia, gastroenteritis, septicemia, and pneumonia were the leading comorbidities, similar to patterns reported by Bhaskaran *et al.*

The majority of children required 8–14 days of hospitalization. The discharge rate (83.41%) and mortality rate (9.48%) were comparable to those reported by Bhaskaran *et al.* indicating that despite standardized inpatient management, SAM continues to carry a significant risk of death. The 7.10% LAMA rate highlights the importance of caregiver counseling and strengthened follow-up mechanisms.

Conclusion

Severe Acute Malnutrition continues to pose a serious threat to child health. Children from socioeconomically disadvantaged backgrounds are particularly vulnerable and frequently present with multiple comorbidities and complications. Strengthening preventive strategies, improving infant and young child feeding practices, and ensuring timely and comprehensive inpatient management are essential to improve outcomes.

Recommendations

Early community-based identification of SAM, strengthening infant feeding counseling, adherence to WHO management protocols, caregiver education, and structured follow-up after discharge are recommended to reduce morbidity and mortality.

Limitations

Being a single-center hospital-based study, findings may not be generalizable to the community. Long-term post-discharge outcomes were not assessed.

Disclosures

Ethical Approval

The study was reviewed and approved by the Institutional Ethics Committee, B. J. Medical College and Civil Hospital, Ahmedabad, registered under the Ministry of Health & Family Welfare, Government of India. Ethical clearance was granted vide IEC Reference No. 242/2024, dated 13 September 2024, for the project titled “A Study of Complications and Comorbidities in Hospitalized Severe Acute Malnutrition Patients”. The approval is valid for a period of two years. Written informed consent was obtained from parents or legal guardians of all participating children, and confidentiality of patient data was strictly maintained in accordance with the Declaration of Helsinki.

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None

Conflict of Interest Statement

The authors declare no conflict of interest.

Author Contributions

DG: Conceptualization (lead); Supervision; Writing – review and editing (supporting).
GHP: Methodology (lead); Clinical oversight; Writing – review and editing (lead); Data analysis (supporting).
AVR: Data acquisition (lead); Data analysis and software (lead); Writing - original draft (lead); Writing - review and editing (lead).

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