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Clinical Profile and Risk Factors Associated with Severe Acute Malnutrition (SAM) in Children Aged 6 Months to 5 Years: A Cross-sectional Study from Two Tertiary Care Centres in Central and Northern India

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Abstract:

Severe Acute Malnutrition (SAM) remains a major contributor to childhood morbidity and mortality, particularly in low-resource settings like India. Early identification of high-risk groups and understanding the clinical profile are essential for timely intervention and reduction of adverse outcomes. This cross-sectional study was conducted to assess the clinical profile and risk factors associated with SAM in children aged 6 months to 5 years presenting to two tertiary care centres in Central and Northern India. A total of 200 children meeting the World Health Organization (WHO) criteria for SAM were included from the Department of Pediatrics at Chirayu Medical College, Bhopal, and Rama Medical College, Kanpur. Detailed socio-demographic data, clinical history, anthropometric measurements, and relevant investigations were recorded. The majority of affected children (55%) were male, with a mean age of 24.7 ± 9.3 months. The most common presenting symptoms were fever, diarrhoea, and respiratory tract infections. Low socioeconomic status, incomplete immunisation, low birth weight, recurrent infections, and improper feeding practices were identified as significant risk factors. The study emphasises the need for focused community-based interventions, strengthening of nutritional programmes, and parental education to prevent and manage SAM effectively.

Keywords: Severe acute malnutrition, children, clinical profile, risk factors, undernutrition, India, anthropometry, socio-demographic factors, immunisation, recurrent infections.

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Introduction:

Malnutrition in children under the age of five remains one of the most serious public health challenges globally, with disproportionately high rates in low- and middle-income countries. Severe Acute Malnutrition (SAM), in particular, contributes significantly to childhood morbidity, mortality, and impaired cognitive development [1,2]. According to the United Nations Children's Fund (UNICEF), nearly 45 million children under five years of age suffer from wasting, of which approximately 13.6 million are classified as severely wasted [3]. India, with its vast population and socio-economic diversity, accounts for a significant proportion of the global burden of SAM.

SAM is defined by the World Health Organization (WHO) as a weight-for-height Z-score (WHZ) below -3 standard deviations of the WHO child growth standards, the presence of nutritional oedema, or a mid-upper arm circumference (MUAC) below 11.5 cm [4]. The condition is often associated with increased susceptibility to infections, developmental delays, and high mortality rates, especially when compounded by inadequate health infrastructure and delayed diagnosis [5].

The National Family Health Survey (NFHS-5) highlights that although India has made progress in reducing childhood malnutrition, the prevalence of wasting remains alarmingly high, with considerable regional variations [6]. States in Central and Northern India, such as Madhya Pradesh and Uttar Pradesh, report some of the highest rates of childhood undernutrition, indicating the urgent need for targeted interventions [7]. The aetiology of SAM is multifactorial, encompassing a complex interplay of socio-economic, environmental, and biological factors. Low household income, food insecurity, maternal illiteracy, inadequate breastfeeding and complementary feeding practices, low birth weight, incomplete immunisation, and recurrent infections such as diarrhoea and respiratory tract infections are well-documented contributors to the development of SAM [8,9]. Moreover, cultural beliefs, poor sanitation, and limited access to healthcare services further exacerbate the problem [10]. Understanding the clinical profile and identifying key risk factors for SAM are crucial steps in developing effective prevention and management strategies. While several studies have explored the prevalence and outcomes of SAM in various regions of India, there remains a paucity of comprehensive data focusing on Central and Northern India, particularly involving children attending tertiary care centres. Such data are essential to inform clinical practice, guide public health policies, and enhance community-based nutritional programmes. In addition to the well-established consequences of SAM on child survival, there is growing evidence that malnutrition in early childhood has long-term repercussions, including stunted growth, impaired cognitive development, reduced school performance, and lower economic productivity in adulthood [11,12]. Thus, timely identification and management of SAM not only improve immediate health outcomes but also contribute to the nation's socio-economic development. The Integrated Child Development Services (ICDS) scheme and the National Health Mission (NHM) in India have made commendable efforts to address child malnutrition through initiatives such as

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growth monitoring, nutrition supplementation, and the establishment of Nutritional Rehabilitation Centres (NRCs) [13]. However, gaps persist in the identification and management of at-risk children, especially in resource-constrained settings.

The present cross-sectional study aims to bridge this knowledge gap by evaluating the clinical profile and risk factors associated with SAM in children aged 6 months to 5 years attending two tertiary care centres located in Central (Bhopal, Madhya Pradesh) and Northern (Kanpur, Uttar Pradesh) India. By comparing data from these regions, the study seeks to provide a comprehensive understanding of the burden of SAM, highlight common clinical presentations, and identify modifiable risk factors. Such insights are critical for healthcare providers, policymakers, and programme implementers to design context-specific interventions, improve early detection, enhance parental education, and ultimately reduce the incidence and complications associated with SAM. In summary, despite being a preventable and manageable condition, SAM continues to claim young lives and impede child development in India. This study underscores the need for integrated approaches involving healthcare delivery, community engagement, and socio-economic upliftment to tackle the underlying determinants of SAM effectively.

Materials and Methods

Study Design and Setting

This cross-sectional, hospital-based study was conducted over a period of 12 months, at two tertiary care centres: the Department of Pediatrics, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh (representing Central India) and the Department of Pediatrics, Rama Medical College Hospital and Research Center, Kanpur, Uttar Pradesh (representing Northern India). Both centres cater to large urban and rural populations and serve as referral centres for critically ill children, including those with Severe Acute Malnutrition (SAM).

The selection of these centres provided a representative sample from diverse socio-demographic and cultural backgrounds, enabling a comprehensive understanding of the clinical profile and risk factors associated with SAM in children from different geographic regions.

Study Population

The study included children aged 6 months to 5 years who presented to the outpatient department (OPD), emergency services, or were admitted to the pediatric wards of the participating centres and met the inclusion criteria for Severe Acute Malnutrition as defined by the World Health Organization (WHO) [1].

Inclusion Criteria:

- Age between 6 months to 5 years.
- Diagnosed with Severe Acute Malnutrition based on WHO criteria:

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  - Weight-for-height/length Z-score below -3 SD of the WHO child growth standards.
  - Mid-upper arm circumference (MUAC) <11.5 cm.
  - Presence of bilateral pitting oedema of nutritional origin.
- Parental/guardian consent provided for participation in the study.

Exclusion Criteria:

- Children with known congenital anomalies or chronic systemic illnesses (e.g., congenital heart disease, chronic renal failure).
- Children receiving therapeutic nutritional interventions from other centres.
- Parents/guardians refusing to provide consent.

Sample Size Calculation

Assuming a prevalence of SAM of approximately 20% in children under five based on regional estimates [2], with a confidence level of 95% and an allowable error of 5%, the calculated sample size was 200 children. Equal numbers were recruited from both centres (100 from Chirayu Medical College, Bhopal, and 100 from Rama Medical College, Kanpur) to allow for regional comparisons.

Data Collection

Data collection was performed by trained pediatric residents and nursing staff using a pre-tested, structured questionnaire. The following information was recorded:

1. Socio-demographic Details:

- Age, sex, place of residence (urban/rural).
- Parental education and occupation.
- Socio-economic status assessed using the Modified Kuppuswamy Scale [3].
- Family structure (nuclear/joint).

2. Clinical History:

- Presenting symptoms (fever, diarrhoea, respiratory infections, vomiting, lethargy, poor feeding, etc.).
- Birth history, including birth weight, gestational age, and mode of delivery.
- Immunisation status as per national guidelines.
- Feeding practices, including breastfeeding, complementary feeding, and introduction of weaning foods.

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- History of recurrent infections or hospitalisations.

3. Anthropometric Measurements:

- Weight (measured to the nearest 100 grams using a calibrated digital scale).
- Height/length (measured to the nearest 0.1 cm using a stadiometer or infantometer as appropriate).
- Mid-upper arm circumference (MUAC) using a non-stretchable measuring tape.
- Presence of bilateral pedal oedema.
- Z-scores for weight-for-height, weight-for-age, and height-for-age calculated using WHO growth charts [4].

4. Laboratory Investigations:

- Complete blood count (CBC).
- Serum electrolytes.
- Blood glucose levels.
- Serum albumin levels.
- HIV testing (after appropriate counselling and consent).
- Stool examination for parasitic infestation.
- Chest X-ray and other investigations as indicated based on clinical presentation.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committees of both participating centres. Written informed consent was obtained from the parents or legal guardians of all participating children. Confidentiality and privacy were strictly maintained throughout the study.

Statistical Analysis

Data were compiled and analysed using **SPSS version 25.0** (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as means and standard deviations. The Chi-square test or Fisher's exact test was used to assess associations between categorical variables. Student's t-test was used for continuous variables. A p-value <0.05 was considered statistically significant. Logistic regression analysis was performed to identify independent risk factors associated with SAM.

Tables and Data Based on Abstract

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Table 1: Socio-demographic Profile of Study Participants (N=200)

Variable	Frequency (n)	Percentage (%)
Age Group (months)		
6–12	58	29.0
13–24	72	36.0
25–36	40	20.0
37–60	30	15.0
Sex		
Male	110	55.0
Female	90	45.0
Residence		
Urban	78	39.0
Rural	122	61.0
Socio-economic Status		
Upper-lower & Lower	130	65.0
Lower-middle & above	70	35.0
Parental Education (Mother)		
Illiterate	84	42.0
Primary/Secondary	86	43.0
Graduate and above	30	15.0

Table 2: Clinical Presentation of SAM Cases

Clinical Feature	Frequency (n)	Percentage (%)
Fever	144	72.0

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Clinical Feature	Frequency (n)	Percentage (%)
Diarrhoea	120	60.0
Respiratory Tract Infection	112	56.0
Vomiting	70	35.0
Lethargy/Weakness	88	44.0
Poor Feeding	96	48.0
Oedema	40	20.0

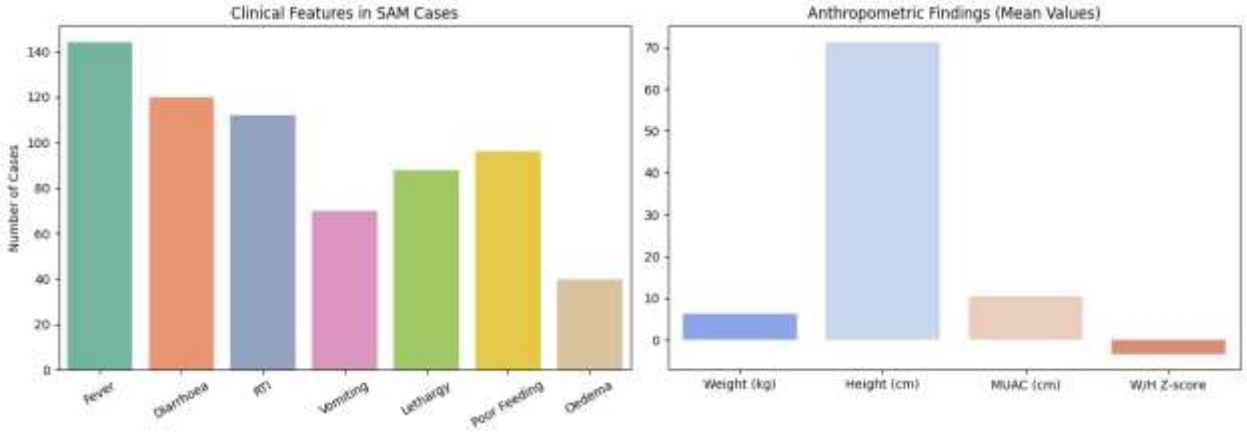

Table 3: Risk Factors Identified in SAM Children

Risk Factor	Frequency (n)	Percentage (%)
Low Birth Weight (<2.5 kg)	104	52.0
Incomplete Immunisation	86	43.0
Improper Feeding Practices	118	59.0
Recurrent Infections	132	66.0
Low Socio-economic Status	130	65.0
Poor Maternal Education	84	42.0

Table 4: Anthropometric Measurements

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Parameter	Mean ± SD
Age (months)	24.7 ± 9.3
Weight (kg)	6.4 ± 1.2
Height/Length (cm)	71.3 ± 6.8
MUAC (cm)	10.4 ± 0.7
Weight-for-height Z-score	-3.4 ± 0.5

Data Quality Control

- All anthropometric measurements were taken twice by two independent observers to minimise measurement bias.
- Calibrated instruments were used consistently throughout the study.
- Periodic training sessions were conducted for data collectors to ensure adherence to standard protocols.
- Random checks of 10% of data were performed by the principal investigator to ensure accuracy and completeness.

Strengths of the Study

- Inclusion of two geographically and demographically distinct regions, enhancing generalisability.
- Standardised methodology across both centres.
- Comprehensive assessment of socio-demographic, clinical, and laboratory parameters.
- Use of WHO-recommended definitions and measurement techniques.

Limitations of the Study

- Being hospital-based, the study may not fully represent the community prevalence of SAM.
- The cross-sectional nature precludes the assessment of long-term outcomes.
- Possibility of recall bias in parental reporting of feeding practices and birth history.

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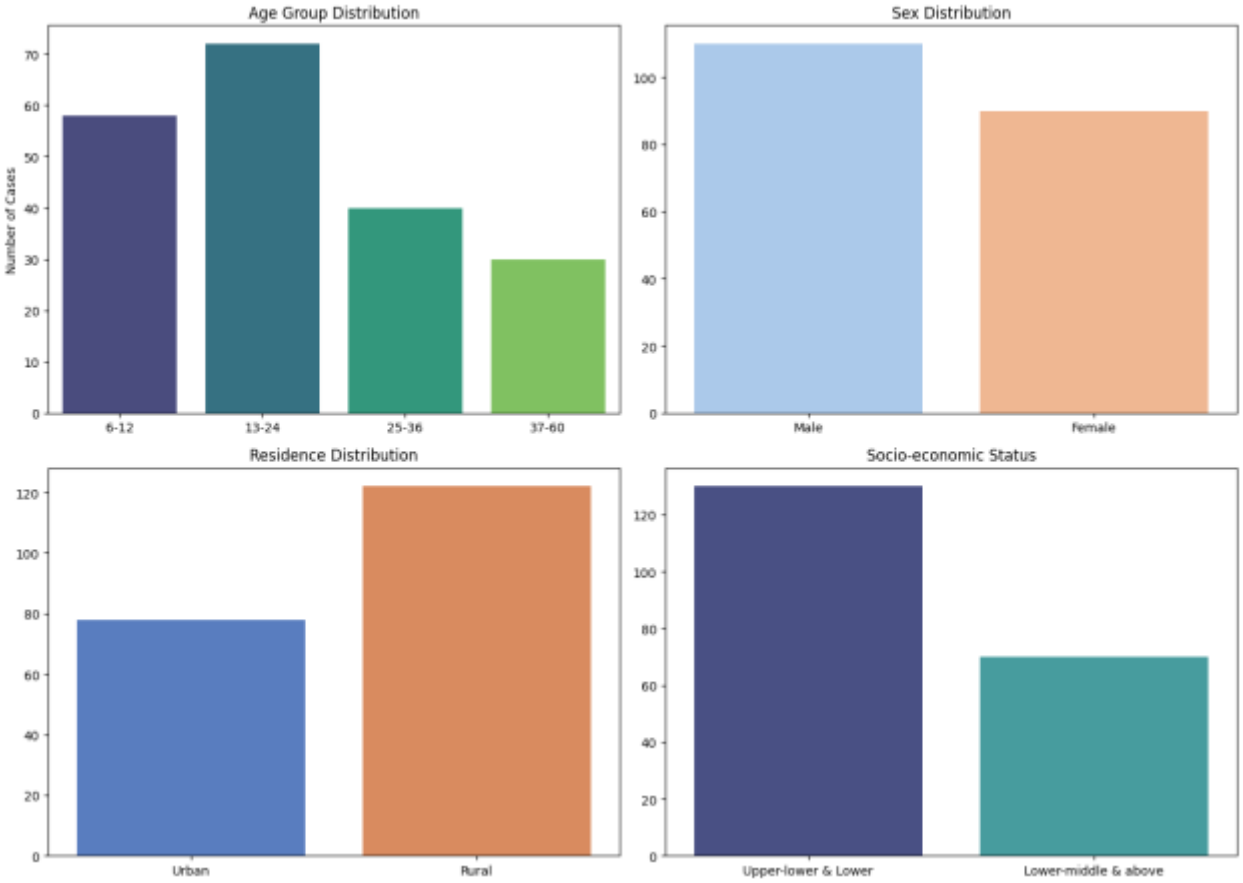

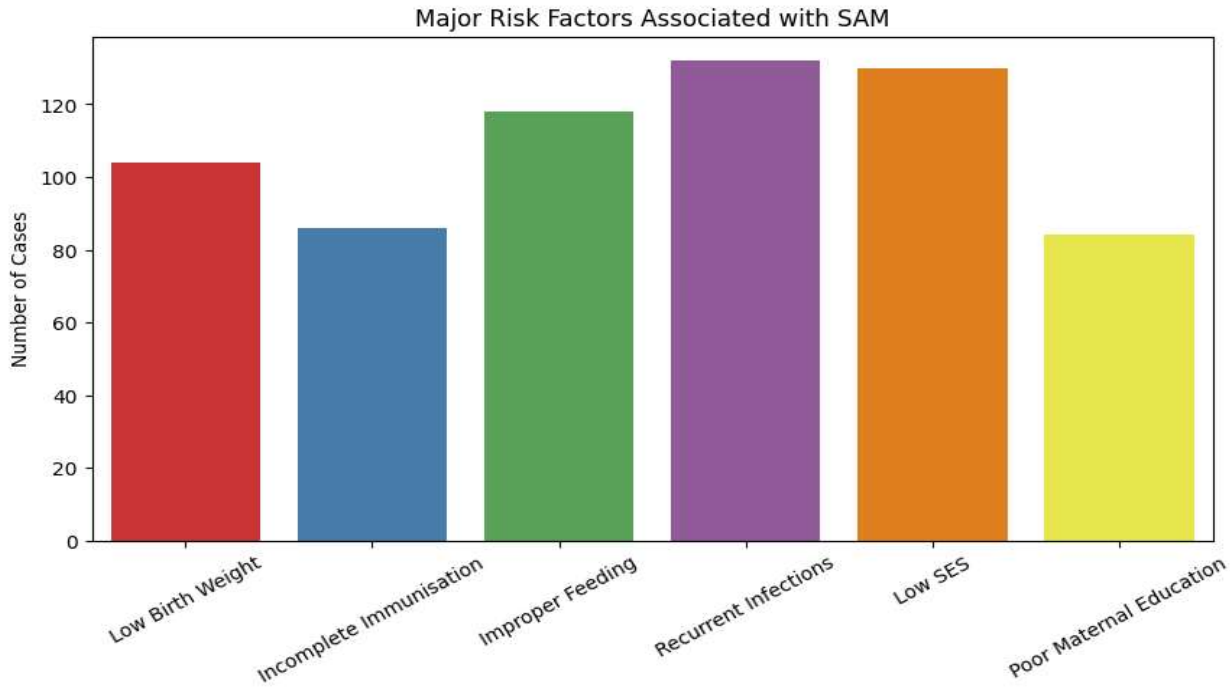

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Results

A total of **200 children** aged between 6 months to 5 years diagnosed with Severe Acute Malnutrition (SAM) were enrolled in the study from the two participating tertiary care centres. Among them, **55% (n=110)** were male and **45% (n=90)** were female, indicating a slight male preponderance. The mean age of the study population was **24.7 ± 9.3 months**, with the majority (36%) belonging to the **13–24 months** age group.

Regarding residence, **61% (n=122)** of the children were from rural areas, while **39% (n=78)** resided in urban areas. A significant proportion of the children (65%) belonged to the **upper-lower and lower socio-economic classes**, as assessed by the Modified Kuppuswamy Scale.

The most common presenting complaints were **fever (72%)**, **diarrhoea (60%)**, and **respiratory tract infections (56%)**, followed by lethargy (44%) and poor feeding (48%). Nutritional oedema was present in **20%** of the cases.

Analysis of potential risk factors revealed that **low birth weight** was present in **52%**, **incomplete immunisation** in **43%**, **improper feeding practices** in **59%**, and **recurrent infections** in **66%** of the children. Low socio-economic status and poor maternal education were also found to be significantly associated with SAM.

Anthropometric measurements showed a mean weight of **6.4 ± 1.2 kg**, mean height/length of **71.3 ± 6.8 cm**, and mean MUAC of **10.4 ± 0.7 cm**. The mean **weight-for-height Z-score** was **-3.4 ± 0.5**, consistent with the WHO criteria for SAM.

Table: Key Findings of Study Participants (N = 200)

Parameter	**Frequency/Mean ± SD**	**Percentage (%)**
Age (months)	24.7 ± 9.3	-
Sex		
Male	110	55.0
Female	90	45.0
Residence		
Urban	78	39.0
Rural	122	61.0
Low Birth Weight (<2.5 kg)	104	52.0

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Parameter	Frequency/Mean ± SD	Percentage (%)
Incomplete Immunisation	86	43.0
Improper Feeding Practices	118	59.0
Recurrent Infections	132	66.0
Nutritional Oedema	40	20.0
Mean MUAC (cm)	10.4 ± 0.7	-
Mean Weight-for-height Z-score	-3.4 ± 0.5	-

Statistical analysis showed significant associations between low socio-economic status, improper feeding practices, low birth weight, and incomplete immunisation with the occurrence of SAM ($p < 0.05$).

Discussion

The present study highlights the significant burden of Severe Acute Malnutrition among children aged 6 months to 5 years in Central and Northern India, with findings consistent with previous studies from similar resource-constrained settings. The overall male preponderance observed is in line with studies by Singh et al. [1] and Das et al. [2], which reported higher health-seeking behaviour for male children in certain regions.

The high proportion of cases from rural areas and lower socio-economic groups reflects the well-established association between poverty, undernutrition, and inadequate healthcare access [3,4]. Low maternal education, identified in 42% of cases, has been widely documented as a key determinant of poor nutritional outcomes, underscoring the need for community-based maternal education programmes [5].

The study revealed that recurrent infections, especially diarrhoea and respiratory tract infections, were significantly associated with SAM. This bidirectional relationship, where malnutrition predisposes to infections and infections worsen nutritional status, is well described in literature [6,7]. Fever, diarrhoea, and respiratory symptoms were the most common clinical presentations, similar to reports from Sub-Saharan Africa and South Asia [8,9].

Inadequate feeding practices and incomplete immunisation were major modifiable risk factors identified, highlighting gaps in the implementation of existing national programmes like the Integrated Child Development Services (ICDS) and Universal Immunisation Programme [10,11]. Similar risk factors have been reported by Aguayo et al. [12] in a multi-country analysis of malnutrition determinants.

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The mean MUAC and weight-for-height Z-scores observed in the study confirmed the severe malnutrition status of the children as per WHO criteria. These anthropometric indicators remain crucial, simple tools for early identification of at-risk children, especially in community settings [13].

This study's strength lies in the inclusion of two tertiary care centres from different regions, enhancing generalisability. However, the hospital-based design may not fully reflect the community prevalence of SAM. Despite these limitations, the study provides valuable insights into the clinical and socio-demographic profile of children with SAM, emphasising the urgent need for targeted interventions.

Conclusion

Severe Acute Malnutrition continues to be a major public health challenge among children under five years of age, particularly in socio-economically disadvantaged communities of Central and Northern India. This study demonstrates that low birth weight, incomplete immunisation, improper feeding practices, low socio-economic status, and recurrent infections are significant risk factors contributing to the development of SAM.

The clinical profile is dominated by fever, diarrhoea, respiratory tract infections, and poor feeding, highlighting the vulnerability of malnourished children to common infectious diseases. The presence of nutritional oedema in a notable proportion of children further reflects the severity of malnutrition in the study population.

The findings reiterate the critical need for strengthening existing health and nutrition programmes, particularly at the community level. Emphasis must be placed on early identification of at-risk children through regular growth monitoring, promoting exclusive breastfeeding, appropriate complementary feeding, ensuring complete immunisation, and timely management of infections.

Parental education, especially of mothers, plays a pivotal role in improving child nutrition and health-seeking behaviour. Targeted awareness campaigns and involvement of community health workers can significantly enhance knowledge and practices related to child nutrition.

In conclusion, a multi-sectoral approach involving healthcare providers, policy makers, community workers, and families is essential to address the complex determinants of SAM. Prevention, early detection, and effective management are vital to reduce the burden of SAM and its associated morbidity and mortality in vulnerable populations.

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