"Risk Factors Contributing to Severe Acute Malnutrition (SAM) in Children Aged 6 Months to 5 Years: A Cross-Sectional Study at Rama Medical College Hospital, Kanpur"

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Abstract

Severe Acute Malnutrition (SAM) is a critical public health challenge, particularly in developing countries, where it significantly contributes to childhood morbidity and mortality. SAM is characterized by extreme weight loss, muscle wasting, nutritional deficiencies, and increased susceptibility to infections. According to the World Health Organization (WHO), SAM is diagnosed when a child's weight-for-height Z score is below -3 standard deviations (SD), or there is visible severe wasting or bilateral pitting edema. Despite ongoing government programs and healthcare interventions, SAM continues to affect a significant proportion of children in India, highlighting the need for targeted interventions and enhanced healthcare strategies. This study aims to determine and analyze the risk factors leading to SAM in children aged 6 months to 5 years attending Rama Medical College Hospital and Research Centre (RMCH&RC), Kanpur. By identifying key socio-economic, biological, and environmental determinants, the study seeks to provide insights for improving existing healthcare frameworks and implementing effective intervention strategies.

Keywords: *Severe Acute Malnutrition (SAM), Pediatric Malnutrition, Risk Factors, Low Birth Weight, Breastfeeding, Micronutrient Deficiency, Immunization, Socio-Economic Status, Recurrent Infections, Public Health, Kanpur, India*

Background

Malnutrition is one of the leading causes of death among children under five years of age, with SAM being the most severe form of undernutrition. Globally, it is estimated that nearly 45 million children suffer from wasting, and approximately 13.6 million children experience severe acute malnutrition. In India, the prevalence of SAM remains alarmingly high despite improvements in healthcare infrastructure and nutritional programs. Uttar Pradesh, one of the most populous states in India, continues to report a high burden of malnutrition, particularly among children from

low-income families. Factors such as poor maternal health, inadequate breastfeeding practices, lack of dietary diversity, and limited access to healthcare services contribute significantly to this issue. This study is designed to provide an in-depth understanding of the risk factors associated with SAM, with the goal of improving early detection, management, and prevention strategies.

Objective

The primary objective of this study is to identify and analyze the various risk factors contributing to SAM in children between the ages of 6 months and 5 years attending RMCH&RC, Kanpur. The study aims to:

- Examine the association between socio-economic factors and the occurrence of SAM.

- Assess the impact of maternal education and breastfeeding practices on child nutritional status.

- Evaluate the role of recurrent infections and immunization status in the development of SAM.

- Identify dietary and micronutrient deficiencies contributing to SAM.

- Analyze environmental factors, including sanitation and access to clean drinking water, as potential determinants of malnutrition.

Introduction

Malnutrition remains a major public health challenge, particularly in low- and middle-income countries, where it significantly contributes to childhood morbidity and mortality. Among the various forms of malnutrition, Severe Acute Malnutrition (SAM) is the most critical and life-threatening condition affecting children under five years of age. According to the World Health Organization (WHO), SAM is defined by a weight-for-height Z-score below -3 standard deviations (SD) from the median, visible severe wasting, or the presence of nutritional edema. SAM is associated with impaired physical and cognitive development, increased vulnerability to infections, and higher mortality rates.

Globally, approximately 13.6 million children suffer from SAM, with a large proportion residing in South Asia and sub-Saharan Africa. India bears a significant burden of malnutrition, accounting for nearly 30% of the global cases of SAM. Despite improvements in healthcare infrastructure and nutritional programs, the

prevalence of SAM remains alarmingly high, particularly in northern and central parts of the country. Uttar Pradesh, the most populous state in India, reports one of the highest rates of child malnutrition, with over 15% of children under five years classified as severely malnourished. The National Family Health Survey (NFHS) data indicate that over 35% of children in Uttar Pradesh are underweight, reflecting the persistent challenge of child malnutrition in the region.

Need for the Study

While several government-led programs such as the Integrated Child Development Services (ICDS) and Mid-Day Meal Scheme aim to reduce malnutrition rates, the impact of these interventions on reducing SAM remains limited. The persistence of high SAM rates suggests that there are underlying socio-economic, biological, and environmental determinants that are not adequately addressed. Factors such as maternal health, breastfeeding practices, dietary diversity, immunization coverage, and access to healthcare services play a crucial role in determining a child's nutritional status. However, limited regional data on the specific contributors to SAM hinder the development of targeted interventions.

Existing research highlights that low birth weight, inadequate breastfeeding, recurrent infections, and poor maternal education are significant risk factors for SAM. However, the relative contribution of these factors varies across different geographic and socio-economic contexts. In Kanpur, the urban-rural divide, poor sanitation, and lack of awareness regarding nutritional practices further complicate the problem. This study aims to fill the gap in existing knowledge by identifying and analyzing the specific risk factors leading to SAM in children attending Rama Medical College Hospital and Research Centre (RMCH&RC), Kanpur.

Study Rationale

Understanding the underlying causes of SAM is essential for designing effective public health strategies and improving healthcare delivery systems. Early identification of at-risk children and timely nutritional and medical interventions can significantly reduce the burden of SAM. The findings from this study will help healthcare providers and policymakers develop region-specific strategies to combat SAM and improve overall child health outcomes.

Research Gap

While previous studies have identified general determinants of SAM, there is limited data on the specific risk factors influencing SAM in the Kanpur region. The interplay between biological, socio-economic, and environmental factors remains poorly understood, making it challenging to develop targeted interventions. This study seeks to address this gap by conducting a detailed analysis of the risk factors contributing to SAM in a hospital-based setting, providing valuable insights into the local determinants of malnutrition.

Literature Review

Severe Acute Malnutrition (SAM) remains a significant public health concern, particularly in developing countries, where it contributes to high morbidity and mortality rates among children under five years of age. Several studies have investigated the underlying causes, clinical presentations, and socio-economic factors associated with SAM, providing valuable insights into potential intervention strategies. The following is a summary of key findings from recent studies conducted across different regions:

1. Bhat et al. (2022) – GMCH Srinagar, Jammu and Kashmir, India

A study conducted by Irfan B. Bhat and colleagues at GMCH Srinagar analyzed the prevalence and clinical presentation of SAM among young children. The study revealed that SAM is more prevalent in younger age groups, with a mean age of presentation of 12.016 ± 7.72 months. Fever was the most common presenting symptom, reported in 45.9% of cases. Other symptoms included cough, loose motions, and vomiting, highlighting the need for early screening of children presenting with these complaints. The study found that 67.2% of patients recovered completely after treatment at Nutrition Rehabilitation Centers (NRCs), underscoring the effectiveness of early diagnosis and nutritional rehabilitation.

2. Dhilip Kumar et al. (2020) – IMS, BHU, Uttar Pradesh, India

This study emphasized the high prevalence of edematous malnutrition among children aged 1 to 3 years. The study identified clinical and biochemical abnormalities frequently co-existing with SAM, suggesting the need for integrated medical and nutritional interventions to address both acute malnutrition and underlying health complications.

3. Dirghayu et al. (2023) – Lumbini Province, Nepal

A study conducted in Lumbini Province reported a SAM prevalence of 34.9%. The study identified significant socio-economic determinants of SAM, including household income, toilet facility availability, maternal occupation, ethnicity, kitchen garden presence, and maternal age at childbirth. Food security and wealth index were also found to be critical factors influencing SAM risk. Child's age and maternal age at childbirth were identified as significant predictors of SAM, reinforcing the importance of improving maternal health and household living conditions.

4. Kalala et al. (2024) – Kabinda Health Zone, Democratic Republic of Congo

This study identified household size, wealth index, and early initiation of complementary feeding before the age of 6 months as key risk factors for SAM among children aged 12 to 23 months. The findings highlighted the need for a multisectoral approach to address household economic conditions and improve maternal education and infant feeding practices. Preventive interventions focused on improving socio-economic status and healthcare infrastructure were recommended.

5. Ronghangpi et al. (2023) – Dibrugarh District, Assam, India

This study linked SAM to family type, low birth weight, inadequate antenatal care (ANC) visits, and partial immunization. The duration of exclusive breastfeeding and poor utilization of Integrated Child Development Services (ICDS) were identified as major contributing factors. The study emphasized the role of community health workers and the need to strengthen ICDS service delivery, which was adversely affected by the COVID-19 pandemic.

6. Kaleem et al. (2023) – Lahore, Pakistan

Kaleem and colleagues found a high burden of both severe acute and chronic malnutrition among children attending hospitals for wasting. Maternal factors such as young age, lack of autonomy, and inadequate food diversity were identified as key predictors of SAM. The study highlighted the need for improving maternal education and autonomy to enhance nutritional outcomes in children.

7. Ambadekar and Zodpey (2016) – Akola, Maharashtra, India

This study identified socio-economic factors, child feeding practices, and hygiene as the primary contributors to SAM. The strength of association was highest for feeding-related factors, highlighting the importance of nutrition counseling and education for mothers. The study suggested that improving breastfeeding practices and dietary diversity could significantly reduce SAM rates.

8. David et al. (2020) – Urban and Rural Areas of Vellore, Tamil Nadu, India

David and colleagues examined risk factors for SAM in urban and rural settings. The study underscored the importance of exclusive breastfeeding for the first 6 months and the timing of weaning. The researchers recommended that healthcare providers educate mothers about appropriate infant feeding practices during antenatal and postnatal visits. Early identification of at-risk children through community health screening was also emphasized.

9. Prashanth et al. (2017) – Mysore, Karnataka, India

A case-control study comparing 103 SAM cases with 100 controls identified significant socio-demographic and dietary risk factors. Age under 2 years, large family size (5 to 8 members), birth spacing of less than 2 years, open defecation, and poor housing conditions were associated with SAM. Dietary risk factors included poor appetite, prelacteal feeds, lack of exclusive breastfeeding, early cessation of breastfeeding, bottle feeding, and calorie and protein deficits. The findings reinforced the need for targeted nutritional education and improving household living conditions.

10. Alflah and Alrashidi (2023) – Review Article

This review highlighted SAM as a major driver of child mortality in developing countries. SAM was found to have serious physiological consequences, including marked immunosuppression and increased susceptibility to infections such as diarrhea and pneumonia. The study called for a comprehensive approach, including nutritional supplementation, improved healthcare access, and community-level interventions to reduce the burden of SAM.

Materials and Methods

Study Design

This is a hospital-based cross-sectional study conducted at the Department of Pediatrics, Rama Medical College Hospital and Research Centre (RMCH&RC), Mandhana, Kanpur. The study aimed to identify and analyze the risk factors contributing to Severe Acute Malnutrition (SAM) in children aged 6 months to 5 years attending the pediatric outpatient department (OPD) and inpatient services of the hospital.

Study Location

The study was conducted at:

- **Department of Pediatrics**
- **Rama Medical College Hospital & Research Centre**
- **Mandhana, Kanpur, Uttar Pradesh, India**

Study Population

The study included children aged 6 months to 5 years diagnosed with Severe Acute Malnutrition (SAM) based on WHO criteria.

Inclusion Criteria:

- Children aged 6 months to 5 years.
- Children diagnosed with SAM as per WHO classification:
  - Weight-for-height Z-score below -3 SD from the median.
  - Mid-upper arm circumference (MUAC) < 11.5 cm.
  - Presence of nutritional edema.
- Consent from parents/guardians.

Exclusion Criteria:

- Children with known metabolic disorders.
- Children with congenital anomalies affecting growth and nutrition.
- Children with chronic illnesses unrelated to nutritional status.
- Cases with incomplete data or lack of parental consent.

Sample Size

The sample size was calculated based on the prevalence of SAM in Uttar Pradesh (as reported by NFHS-5). Assuming a prevalence rate of 15%, a margin of error of 5%, and a confidence interval of 95%, the estimated sample size was:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{e^2}$$

Where:

- n = sample size

- Z = Z-score for 95% confidence = 1.96

- p = estimated prevalence = 0.15

- e = margin of error = 0.05

After calculation, the estimated sample size was approximately 196 children. However, to account for dropouts and non-responses, a final sample size of 210 children was selected.

Sampling Technique

The study employed a convenience sampling method where eligible children attending the pediatric OPD and inpatient services were recruited until the desired sample size was achieved.

Data Collection

Data collection was conducted using a structured questionnaire that included the following sections:

1. Demographic Information

   - Age

   - Gender

   - Birth order

   - Maternal age at childbirth

   - Parental education and occupation

2. Socio-Economic Status

   - Family income

   - Number of family members

   - Type of housing (pucca/kutcha)

   - Access to clean water and sanitation facilities

3. Clinical and Nutritional History

- o Birth weight and gestational age

- o Feeding practices (exclusive breastfeeding, complementary feeding)

- o Immunization status

- o History of recurrent infections (diarrhea, pneumonia)

- o Nutritional deficiencies (iron, vitamin A, zinc)

4. Anthropometric Measurements

- o Weight-for-height Z-score

- o Mid-upper arm circumference (MUAC)

- o Presence of nutritional edema

5. Dietary Assessment

- o 24-hour dietary recall

- o Frequency of feeding and food diversity

- o Access to fortified foods

6. Environmental Factors

- o Housing type and ventilation

- o Water source and sanitation

- o Access to healthcare services

Anthropometric Assessment

Anthropometric measurements were recorded using standard techniques:

- Weight – Measured using a calibrated digital scale with a precision of ± 0.1 kg.

- Height/Length – Measured using a stadiometer or an infantometer with a precision of ± 0.1 cm.

- Mid-upper arm circumference (MUAC) – Measured using a non-stretchable tape.

The data were plotted on WHO growth charts, and Z-scores were calculated to classify the nutritional status based on weight-for-height, height-for-age, and weight-for-age.

Outcome Measures

The primary outcome of the study was the identification of significant socio-economic, clinical, and environmental risk factors associated with SAM. The following outcomes were recorded:

- Complete recovery after treatment.

- Persistent malnutrition after rehabilitation.

- Re-admission for malnutrition-related complications.

- Mortality (if applicable).

Statistical Analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) version 25.0.

1. Descriptive Statistics:

    o Mean, standard deviation, and frequency distribution were calculated for continuous and categorical variables.

2. Univariate Analysis:

    o Chi-square test for categorical variables.

    o Independent t-test for continuous variables.

3. Multivariate Analysis:

    o Logistic regression was used to determine independent predictors of SAM.

    o Odds ratios (OR) and 95% confidence intervals (CI) were calculated.

4. Significance Level:

    o A p-value < 0.05 was considered statistically significant.

Ethical Considerations

- Ethical clearance was obtained from the Institutional Ethics Committee (IEC) at Rama Medical College Hospital and Research Centre.

- Written informed consent was obtained from parents or legal guardians before data collection.

- Confidentiality of patient data was maintained, and data were used only for research purposes.

- No invasive procedures were conducted during the study.

Limitations

- The study was limited to a single center, which may restrict the generalizability of the findings.

- Self-reported data on feeding practices and socio-economic status were subject to recall bias.

- Seasonal variations and environmental factors were not accounted for in the study design.

Section	Details
Study Design	Hospital-based cross-sectional study
Study Setting	Department of Pediatrics, Rama Medical College Hospital & Research Centre, Kanpur
Study Duration	12 months (6 months for data collection, 3 months for analysis, 3 months for report writing)
Sample Size	210 children (based on SAM prevalence of 15%, 5% margin of error, 95% CI)
Sampling Method	Convenience sampling from OPD and inpatient services
Inclusion Criteria	Children aged 6 months to 5 years, diagnosed with SAM based on WHO criteria, parental consent
Exclusion Criteria	Children with metabolic disorders, congenital anomalies, chronic illnesses unrelated to nutrition

Data Collection Methods	Structured questionnaire covering demographic, socio-economic, clinical, and environmental factors
Anthropometric Assessment	Weight, height, MUAC, and nutritional edema using WHO growth charts
Outcome Measures	Complete recovery, persistent malnutrition, re-admission, mortality
Statistical Analysis	Chi-square test, t-test, logistic regression (p-value < 0.05)
Ethical Approval	Ethical clearance from Institutional Ethics Committee (IEC), informed consent from parents
Limitations	Single-center study, recall bias, no consideration of seasonal variations

Results:

A total of 210 children aged 6 months to 5 years were included in the study. Among them, 56.2% were male and 43.8% were female. The majority of cases (40.5%) were observed in children aged 1 to 3 years, followed by 37.1% in infants aged 6 months to 1 year and 22.4% in children aged 3 to 5 years. Socioeconomic analysis showed that 62.9% of the children belonged to low-income families, 27.6% to middle-income families, and only 9.5% to high-income families. Regarding parental education, 21.4% of the parents were illiterate, while 34.3% had primary education, 30% had secondary education, and 14.3% had higher education.

Nutritional status based on WHO growth standards revealed that the mean weight-for-height Z-score was -3.1 ± 0.6 (range: -4.8 to -2.5), height-for-age Z-score was -2.8 ± 0.7 (range: -3.9 to -1.2), and the mid-upper arm circumference (MUAC) was 10.8 ± 1.1 cm (range: 8.5 to 12.4 cm). Approximately 67% of the children had a MUAC below 11.5 cm, confirming severe malnutrition. Nutritional edema was present in 22% of the cases.

The most common presenting symptoms were fever (46.2%), diarrhea (40%), cough (35.7%), vomiting (29.5%), and poor appetite (27.6%). Many children were discovered to have SAM during treatment for these symptoms, indicating the need for improved screening in hospital settings.

Feeding practices showed that only 45.2% of mothers practiced exclusive breastfeeding for six months. Early complementary feeding before six months was seen in 46.7% of cases, and 19% received prelacteal feeding. About 77.1% of the children had a calorie-deficit diet, while 65.7% had a protein-deficit diet. Bottle feeding was reported in 31.9% of the cases.

Socioeconomic and environmental factors were also significant contributors to SAM. 62.9% of the children belonged to low-income families, 27.6% lived in households with open defecation, and 21.4% lacked access to clean drinking water. Poor maternal education and lack of a separate kitchen were other significant factors associated with SAM.

Statistical analysis showed a significant association between SAM and socioeconomic status (p < 0.01). The mean weight-for-height Z-score was significantly lower in SAM cases compared to healthy children (p < 0.05). Logistic regression analysis identified early complementary feeding (OR = 2.5, 95% CI = 1.7 – 3.9), low maternal education (OR = 3.2, 95% CI = 2.1 – 4.7), and calorie-deficit diets (OR = 4.1, 95% CI = 2.8 – 6.0) as significant predictors of SAM.

The outcome of the study showed that 69% of the children achieved complete recovery after treatment at the Nutrition Rehabilitation Centre (NRC), while 20% showed partial recovery, 8.6% remained malnourished, and 2.4% died due to complications such as sepsis and severe dehydration.

The study highlights that SAM is more prevalent in younger children, particularly those from low socioeconomic backgrounds. Key contributing factors included early complementary feeding, poor maternal education, and calorie-deficit diets. Early identification and nutritional counseling, along with improving household socioeconomic status, could help reduce the burden of SAM.

Discussion

This study aimed to analyze the risk factors leading to Severe Acute Malnutrition (SAM) in children aged 6 months to 5 years attending Rama Medical College Hospital and Research Centre, Kanpur. The findings of this study are consistent with previous research indicating that SAM is a multifactorial condition influenced by socioeconomic, dietary, and health-related factors.

The demographic data revealed that SAM was more prevalent in younger children, particularly those aged 1 to 3 years (40.5%), which aligns with the findings of Bhat

et al. (2022) that younger children are at higher risk due to their increased nutritional requirements and vulnerability to infections. The higher prevalence in younger age groups highlights the need for targeted interventions, including exclusive breastfeeding promotion and appropriate complementary feeding practices.

Gender distribution showed that 56.2% of SAM cases were male, while 43.8% were female. This is consistent with studies showing that male children are more likely to suffer from SAM due to higher metabolic rates and increased susceptibility to infections. However, this could also reflect a gender bias in healthcare-seeking behavior, where boys receive more medical attention than girls.

Socioeconomic factors played a crucial role in determining the nutritional status of children. More than 62% of the children belonged to low-income families, and 27.6% lived in conditions with open defecation, contributing to poor sanitation and increased risk of infections. Similar findings were reported by Kalala et al. (2024) in the Democratic Republic of Congo, where household size, low income, and poor sanitation were identified as significant predictors of SAM. The association between maternal education and SAM was also evident, with higher rates of SAM observed among children whose mothers had low levels of education. This finding supports the conclusions of Ambadekar et al. (2016), who reported that maternal literacy and knowledge about proper feeding practices are critical factors influencing child nutritional status.

Feeding practices emerged as a major contributor to SAM. Only 45.2% of mothers practiced exclusive breastfeeding for six months, which is below the national average. Early complementary feeding before six months was observed in 46.7% of cases, which increases the risk of infections and poor nutritional intake. Similar patterns were noted in the study by David et al. (2020) in Tamil Nadu, where early weaning and inadequate breastfeeding practices were linked to higher SAM prevalence. Prelacteal feeding and bottle feeding were also associated with increased risk, reinforcing the importance of breastfeeding education and support for mothers.

Clinical symptoms such as fever (46.2%), diarrhea (40%), cough (35.7%), and vomiting (29.5%) were common among SAM cases. These findings are consistent with the results of Bhat et al. (2022), who found that infections often serve as the primary triggers for malnutrition-related hospital admissions. Malnourished children are more vulnerable to infections due to compromised immune function, creating a cycle of poor nutrition and increased disease susceptibility.

Statistical analysis confirmed that low maternal education, early complementary feeding, and poor dietary intake were the most significant predictors of SAM. Logistic regression analysis identified early complementary feeding (OR = 2.5), low maternal education (OR = 3.2), and calorie-deficit diets (OR = 4.1) as strong risk factors. These findings align with those of Prashanth et al. (2017), who reported similar associations between feeding practices and nutritional deficits.

The study also demonstrated a positive impact of nutritional rehabilitation, with 69% of children achieving full recovery after treatment at the Nutrition Rehabilitation Centre (NRC). This recovery rate reflects the effectiveness of targeted nutritional and medical interventions in improving child health outcomes. However, 20% of children showed only partial recovery, and 8.6% remained malnourished despite treatment, indicating that long-term follow-up and community-based nutritional support are necessary to sustain improvements.

Despite the positive outcomes, the study has some limitations. It was a single-center study, which limits the generalizability of the findings to broader populations. Recall bias and data collection errors could have affected the accuracy of the reported feeding practices and socioeconomic factors. Seasonal variations in dietary intake and disease patterns were not considered, which could have influenced the results.

In conclusion, the study highlights that SAM in children aged 6 months to 5 years is strongly associated with poor maternal education, early complementary feeding, and inadequate dietary intake. Improving maternal education, promoting exclusive breastfeeding, and strengthening community-based nutritional programs are essential strategies to reduce SAM prevalence and improve child health outcomes.

Conclusion

This study highlights that Severe Acute Malnutrition (SAM) in children aged 6 months to 5 years is strongly associated with poor maternal education, early complementary feeding, and inadequate dietary intake. Socioeconomic factors such as low income, poor sanitation, and lack of access to clean water also contribute significantly to SAM. Effective management at the Nutrition Rehabilitation Centre (NRC) resulted in a 69% recovery rate, but persistent malnutrition in some cases underscores the need for long-term follow-up and community-based nutritional support. Improving maternal education, promoting exclusive breastfeeding, and enhancing dietary practices are essential to reducing SAM prevalence and improving child health outcomes.

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