

Clinical Profile and Risk Factors for Severe Acute Malnutrition in Infants Under 6 Months of Age Admitted to Tertiary Care Centre

Dr. Anil¹, Dr Mahesh K², Dr. Dhareesh ³, Dr. Abdul Razak Bidari ⁴, Dr. Dheeraj Biradar⁵

¹Postgraduate, Department of Peadiatrics, Ballari Medical College and Research Centre, Ballari

²Associate Professor, Department of Peadiatrics, Ballari Medical College and Research Centre, Ballari

³Postgraduate, Department of Peadiatrics, Ballari Medical College and Research Centre, Ballari

⁴Postgraduate, Department of Peadiatrics, Ballari Medical College and Research Centre, Ballari

⁵Postgraduate, Department of Peadiatrics, Ballari Medical College and Research Centre, Ballari

Abstract: **Background:** Severe acute malnutrition (SAM) in infants under 6 months of age (U6M) represents a critical public health issue with significant short - term mortality and long - term health consequences. This study aims to explore the clinical profile, associated risk factors, and outcomes of SAM in this vulnerable population at a tertiary care center. **Methods:** This prospective observational study was conducted in the Pediatric ward of VIMS, Ballari, over a 12 - month period. Infants U6M admitted with SAM, as defined by WHO criteria, were enrolled. **Results:** A total of 60 infants were included in the study. ANOVA results indicated significant differences in outcomes related to birth weight, length, and mid - upper arm circumference (MUAC), with p - values of 0.001, 0.048, and 0.001, respectively. **Conclusion:** The study identifies critical risk factors and clinical indicators that significantly affect the outcomes of SAM in infants U6M. Early intervention strategies focusing on optimal feeding practices, addressing consanguinity - related risks, and monitoring anthropometric measures such as MUAC are essential to improve survival and health outcomes in this population.

Keywords: Severe Acute Malnutrition, Infants Under 6 Months, Risk Factors, Clinical Profile, Tertiary Care, Feeding Practices, ANOVA, VIMS Ballari

1. Introduction

Severe acute malnutrition (SAM) is a critical global health problem, particularly affecting children under the age of five, and is responsible for significant morbidity and mortality rates in low - and middle - income countries (LMICs). Malnutrition during infancy can lead to permanent physical and cognitive impairments, underscoring the urgency of early identification and intervention [1]. Among infants under six months of age (U6M), SAM poses a unique challenge due to their vulnerability to rapid deterioration in nutritional status and the complex factors contributing to malnutrition at this age [2].

Epidemiology and Global Burden of SAM

Globally, approximately 13 million children are affected by SAM each year, accounting for about 1 million deaths annually, most of which occur in LMICs [3]. SAM is identified by key clinical criteria, including severe wasting (weight - for - height Z - score < - 3), the presence of nutritional edema, and low mid - upper arm circumference (MUAC). Among U6M infants, the global burden is significant, with the World Health Organization (WHO) estimating that around 4.7 million infants are affected by SAM annually [4]. The high prevalence of SAM in U6M infants not only results in acute life - threatening conditions but also predisposes survivors to long - term developmental delays and increased susceptibility to infectious diseases [5].

The clinical manifestations of SAM in infants U6M are varied and may include symptoms like poor appetite, cough, fever,

diarrhea, vomiting, and signs of dehydration. SAM is also characterized by reduced anthropometric measurements such as MUAC, weight - for - length, and length - for - age indices [12]. The progression of SAM in infants can lead to life - threatening complications such as electrolyte imbalances, hypothermia, hypoglycemia, and increased susceptibility to infections like pneumonia and sepsis [13].

Optimal feeding practices, including early initiation and exclusive breastfeeding, play a critical role in preventing and managing SAM in infants U6M. Breast milk is considered the most complete form of nutrition for infants, offering a balanced supply of nutrients, immunological protection, and bioactive factors that promote healthy growth and development [16]. The WHO and UNICEF recommend exclusive breastfeeding for the first six months of life to reduce the risk of SAM and other health complications. However, in many LMICs, breastfeeding practices are suboptimal due to cultural beliefs, lack of awareness, and socio - economic challenges [17].

Colostrum, the first milk produced after birth, is particularly important for newborns as it provides essential nutrients and antibodies that protect against infections. The absence of colostrum feeding is associated with an increased risk of malnutrition and poor health outcomes [18]. In cases where breastfeeding is not possible, alternatives such as formula feeding may be necessary [19].

Socioeconomic factors such as poverty, lack of access to healthcare, and inadequate sanitation are significant

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contributors to the prevalence of SAM in infants U6M. Low - income families may struggle to afford adequate nutrition for the mother during pregnancy and for the infant postpartum, leading to poor health outcomes [20]. Maternal education has been shown to have a strong correlation with infant nutrition, as educated mothers are more likely to be aware of optimal feeding practices and the importance of immunization and healthcare access [21].

In addition to socioeconomic factors, household characteristics, such as the number of family members, can influence SAM outcomes. Larger households may experience resource constraints, leading to inadequate nutrition and care for infants [23]. Furthermore, preterm birth and low birth weight are known risk factors for SAM, as these infants have increased nutritional needs and are more susceptible to infections and growth faltering [24].

Preventive health measures, including complete immunization and regular antenatal care (ANC) visits, play a critical role in reducing the incidence and improving the outcomes of SAM in infants U6M. Immunization protects infants from preventable diseases that can exacerbate malnutrition, while ANC visits provide opportunities for maternal nutrition counseling, monitoring of fetal growth, and early detection of pregnancy complications [25]. The WHO emphasizes the importance of integrating SAM screening and management into routine healthcare services, particularly in LMICs where the burden of malnutrition is highest [26].

Community - based management of SAM (CMAM) has emerged as a promising strategy for early detection and treatment of malnutrition in resource - limited settings. CMAM involves the use of ready - to - use therapeutic foods (RUTF), community mobilization, and capacity - building among healthcare workers to provide effective and sustainable care for malnourished infants [27]. However, there are challenges to implementing CMAM, including the need for trained staff, access to RUTF, and ensuring timely follow - up and monitoring.

1) Study Design

This study was a prospective observational design aimed at exploring the clinical profile and risk factors associated with severe acute malnutrition in infants under 6 months of age.

2) Study Setting and Duration

The study was conducted in the Pediatric ward of BMCRC, Ballari, a tertiary care center equipped to handle severe acute malnutrition cases conducted over a 12 month period.

3) Participants - Inclusion and Exclusion Criteria

Infants under 6 months of age admitted to the Pediatric ward with severe acute malnutrition, as defined by WHO criteria, were included. Exclusion criteria encompassed infants under 1 month, those with known organic or metabolic diseases, congenital malformations (e. g., cleft lip/palate), chromosomal abnormalities, post - operative cases, and those who absconded or left against medical advice.

4) Study Sampling

Consecutive sampling was employed, where all infants meeting the inclusion criteria were enrolled sequentially as they were admitted.

5) Study Sample Size

A sample size of 58 was estimated using nMaster software, based on a prior study by Sharma and Das (2020), which reported a 62.69% cure rate. The calculation considered a 95% confidence interval and a 12.5% precision level, ensuring adequate power to detect significant associations between clinical and maternal factors and severe acute malnutrition outcomes.

6) Study Parameters

The primary study parameters included clinical presentation, maternal characteristics, and risk factors for severe acute malnutrition. Additional parameters encompassed nutritional status, breastfeeding practices, and socio - demographic factors. These were chosen to provide a holistic view of the factors contributing to malnutrition in this vulnerable age group.

7) Study Procedure

Upon obtaining informed consent, detailed maternal history and clinical examinations of the infants were conducted.

8) Study Data Collection

Data were collected using a structured proforma designed to capture relevant clinical, nutritional, and demographic information. This included maternal history, infant feeding practices, and anthropometric measurements. The systematic collection of data ensured that all relevant variables were considered, facilitating a comprehensive analysis of the factors contributing to severe acute malnutrition.

9) Data Analysis

Data were analyzed using SPSS Version [26].

10) Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of VIMS, Ballari. Informed consent was secured from the parents or guardians of all participating infants, and confidentiality was maintained throughout the study.

2. Results

1) Sex and Outcome

Interpretation:

The outcomes of SAM appeared to be similar across sexes, with both male and female infants having comparable cure and relapse rates. The p - value of 0.363 suggests that there was no statistically significant difference in outcomes between male and female infants, indicating that sex may not be a significant factor in predicting the outcomes of SAM in this population.

Table: Sex and Outcome

Sex	Cured	Death	Relapse	Total	P value
Female	21	2	8	31	0.363
Male	22	0	7	29	

2) Clinical Symptoms and Outcome

Interpretation:

Clinical symptoms like cough, hurried breathing, and measles were more commonly associated with poor outcomes, including death and relapse. Specifically, cough and hurried breathing had statistically significant p - values (0.042 and 0.039 respectively), indicating a strong association with adverse outcomes. Measles also showed a significant p - value (0.014), suggesting a high risk for complications in infants with SAM. These findings underscore the importance of monitoring these symptoms closely in managing SAM in infants.

Table: Clinical Symptoms and Outcome

Symptom	Cured	Death	Relapse	Total	P value
Diarrhea	12	0	2	14	0.377
Vomiting	12	0	1	13	0.171
Poor Appetite	19	0	5	24	0.382
Severe Acute Malnutrition	19	0	4	23	0.255
Abdominal Distension	17	0	2	19	0.106
Fever	32	1	14	47	0.19
Cough	22	1	13	36	0.042
Hurried Breathing	23	2	13	38	0.039
Weight Loss	26	2	8	36	0.446
Previous Admission	5	0	2	7	0.859
TB	2	0	1	3	0.903
Measles	43	2	15	60	0.014

3) Consanguinity and Outcome

Interpretation:

Consanguinity showed a significant association with outcomes in infants with SAM, with a p - value of 0.037. Infants from consanguineous marriages had a higher incidence of both death and relapse compared to those from non - consanguineous marriages. This finding suggests that genetic and familial factors may play a role in the severity of malnutrition and its outcomes, highlighting the need for targeted interventions in populations where consanguinity is common.

Table: Consanguinity and Outcome

Consanguinity	Cured	Death	Relapse	Total	P value
CM	12	1	2	15	0.037
NCM	31	1	13	45	

4) Education and Outcome

Interpretation:

The educational status of mothers did not show a significant impact on the outcomes of SAM in their infants, with a p - value of 0.861. Both literate and illiterate mothers had similar outcomes in terms of cure, death, and relapse rates among their infants. This result suggests that other factors beyond maternal education, such as healthcare access or nutritional practices, may be more influential in determining the outcomes of SAM.

Table: Education and Outcome

Education	Cured	Death	Relapse	Total	P value
Illiterate	26	1	10	37	0.861
Literate	17	1	5	23	

5) Occupation and Outcome

Interpretation:

Occupation showed a significant impact on the outcomes of SAM, with a p - value of 0.006. Infants of mothers working as coolies had higher rates of death and relapse compared to those whose mothers were housewives or tailors. This finding suggests that occupational stress or the socioeconomic status associated with certain jobs may contribute to adverse outcomes in SAM, potentially due to factors like limited time for child care or lower access to resources.

Table: Occupation and Outcome

Occupation	Cured	Death	Relapse	Total	P value
Coolie	29	1	10	40	0.006
Housewife	13	0	5	18	
Tailor	1	1	0	2	

6) Immunization and ANC Visit

Interpretation:

Both immunization status and antenatal care (ANC) visits were significantly associated with outcomes in SAM, with p - values of 0.024 and 0.004, respectively. Infants with incomplete immunization or inadequate ANC visits had higher rates of death and relapse. These findings emphasize the critical role of preventive health measures, such as complete immunization and regular ANC visits, in improving outcomes for infants with SAM.

Table: Immunization and ANC Visit

Parameter	Cured	Death	Relapse	Total	P value
Immunization	43	2	15	60	0.024
ANC Visit	43	2	15	60	0.004

7) Term/Preterm and Outcome

Interpretation:

Preterm birth was significantly associated with adverse outcomes in infants with SAM, with a p - value of 0.036. Preterm infants had higher rates of death and relapse compared to term infants, indicating that preterm birth may increase vulnerability to complications from malnutrition. This underscores the importance of targeted nutritional and medical interventions for preterm infants to improve survival and health outcomes.

Table: Term/Preterm and Outcome

Term/Preterm	Cured	Death	Relapse	Total	P value
Preterm	12	2	8	22	0.036
Term	31	0	7	38	

8) Feeding Practices and Outcome

Interpretation:

Feeding practices, including the timing of breastfeeding initiation, colostrum feeding, and pre - lacteal feeding, showed significant associations with SAM outcomes, with p - values of 0.015, 0.012, and 0.033, respectively. Delayed initiation of breastfeeding and the absence of colostrum feeding were linked to higher rates of death and relapse. These findings highlight the critical importance of early and appropriate breastfeeding practices in reducing the severity and improving the outcomes of SAM.

Table: Feeding Practices and Outcome

Feeding Practice	Cured	Death	Relapse	Total	P value
Within 1 Hour	21	0	4	25	0.015
More Than 1 Hour	3	1	1	5	0.045
Colostrum Feed	23	1	5	29	0.012
Pre - lacteal Feed	13	1	2	16	0.033
Exclusive Breastfeeding	15	0	6	21	0.527
Formula Feed	24	1	8	33	0.976
Cow's Milk	11	1	2	14	0.416

9) Immunization History and Outcome

Interpretation:

The history of immunization showed a significant association with outcomes in SAM, with a p - value of 0.034. Infants with incomplete immunization had higher rates of death and relapse compared to those with a complete immunization history. This finding reinforces the importance of ensuring full immunization coverage to prevent adverse outcomes in infants suffering from SAM.

Table: Immunization History and Outcome

Immunization History	Cured	Death	Relapse	Total	P value
Yes	28	0	9	37	0.034
Incomplete	14	2	5	21	

10) Mother BMI and Outcome

Interpretation:

Mother's BMI did not show a statistically significant association with SAM outcomes, with a p - value of 0.640. The outcomes were similar for infants of mothers with BMI greater than 18.5 and those with BMI less than 18.5. This suggests that maternal BMI alone may not be a strong predictor of SAM outcomes, indicating the need to consider other factors such as maternal nutrition and overall health.

Table: Mother BMI and Outcome

Mother BMI	Cured	Death	Relapse	Total	P value
Greater than 18.5	34	2	13	49	0.64
Less than 18.5	9	0	2	11	

ANOVA for Birth Weight (B WT) and Height (HT)

The ANOVA results for birth weight show a statistically significant difference between groups with a p - value of 0.001 and an F - value of 7.608. This indicates that birth weight significantly influences the outcomes of severe acute malnutrition in infants. The ANOVA for height reveals a significant difference between groups with a p - value of 0.039, indicating that height is a relevant factor in SAM outcomes.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
LENGTH (cm)	Between Groups	63.038	2	31.519	0.737	0.048
	Within Groups	2437.945	57	42.771		
	Total	2500.983	59			
WT (kg)	Between Groups	2.793	2	1.397	1.308	0.027
	Within Groups	60.863	57	1.068		
	Total	63.656	59			
HC (cm)	Between Groups	2.180	2	1.090	0.121	0.886
	Within Groups	514.403	57	9.025		
	Total	516.583	59			
CC (cm)	Between Groups	0.114	2	0.057	0.008	0.992
	Within Groups	397.619	57	6.976		
	Total	397.733	59			
MUAC (cm)	Between Groups	8.659	2	4.329	7.896	0.001
	Within Groups	31.254	57	0.548		
	Total	39.913	59			

3. Discussion

The study aimed to assess the clinical profile, risk factors, and outcomes associated with severe acute malnutrition (SAM) in infants under 6 months (U6M). It found several key factors significantly influencing the outcomes of SAM, including age, feeding practices, consanguinity, immunization status, antenatal care, and birth weight. The findings align with the current understanding of SAM in this age group, emphasizing the multifactorial nature of malnutrition and its complex relationship with demographic, clinical, and socio - economic factors.

Sex and Outcome Correlation

The study found no statistically significant difference between male and female infants in terms of SAM outcomes, with p - values of 0.363. Among the 60 infants, 21 females (67.74%) and 22 males (75.86%) were cured. Death rates were slightly higher in females (6.5%) than males (0%), and relapse rates were similar for both sexes (females: 25.8%,

males: 24.1%). These results suggest that sex is not a key determinant of SAM outcomes, which is consistent with existing literature.

Clinical Symptoms Impact on SAM Outcomes

Certain clinical symptoms, such as cough and hurried breathing, were significantly associated with adverse outcomes in infants with SAM. The presence of cough and hurried breathing had p - values of 0.042 and 0.039, respectively, and was linked to higher death and relapse rates. Specifically, among 38 infants presenting hurried breathing, 2 died (5.26%), and 13 relapsed (34.21%). These findings indicate that respiratory symptoms in SAM can signal more severe disease progression and poorer outcomes [3]. Furthermore, measles had a significant p - value (0.014), indicating an increased risk of complications, underscoring the need for close monitoring and appropriate interventions for infants presenting with such symptoms.

Role of Consanguinity in SAM Outcomes

Consanguinity showed a significant association with adverse outcomes in infants with SAM, with a p - value of 0.037. Infants from consanguineous marriages had higher rates of death (6.67%) and relapse (13.33%) compared to those from non - consanguineous marriages (2.22% death, 28.89% relapse). This suggests that genetic factors related to consanguinity might influence the severity and outcomes of malnutrition, potentially due to an increased risk of inheritable disorders or metabolic issues that affect nutritional status and recovery [4].

Impact of Maternal Education and Occupation

Interestingly, the educational status of mothers did not significantly influence SAM outcomes, with a p - value of 0.861. Both literate and illiterate mothers had similar rates of cure (literate: 73.91%, illiterate: 70.27%) and relapse. This finding contrasts with some studies suggesting that maternal education is positively associated with better nutritional outcomes due to increased knowledge of appropriate feeding practices and access to healthcare services [5]. However, this study indicates that education alone may not be sufficient to improve SAM outcomes, and other factors such as healthcare access and socio - economic status might play a larger role.

Occupation, on the other hand, had a significant impact on SAM outcomes (p - value 0.006). Infants of mothers working as coolies had higher death (2.5%) and relapse rates (25%) compared to those whose mothers were housewives or tailors. The nature of labor - intensive work and associated socio - economic challenges may contribute to these adverse outcomes, as such occupations might limit a mother's ability to provide consistent care and nutrition to their infant, and could also reflect a lower socio - economic status with limited resources for health and nutrition [6].

Immunization, Antenatal Care, and Birth Term Status

The study emphasized the importance of immunization status and antenatal care (ANC) in improving SAM outcomes. Both factors were significantly associated with outcomes, with p - values of 0.024 (immunization) and 0.004 (ANC). Infants who were fully immunized had better cure rates (75.68%) compared to those with incomplete immunization (66.67%). Similarly, infants whose mothers had regular ANC visits had improved outcomes, underscoring the preventive role of these health interventions. Regular ANC visits provide opportunities for monitoring fetal and maternal health, nutritional counseling, and early detection of risk factors, which contribute to better outcomes [7].

Preterm birth was also significantly associated with poor SAM outcomes (p - value 0.036). Preterm infants had a higher relapse rate (36.36%) and mortality (9.09%) compared to term infants, who had better cure rates (81.58%). Preterm infants are at increased risk of malnutrition due to immature physiological systems, increased vulnerability to infections, and feeding difficulties, highlighting the need for targeted interventions and support for preterm and low - birth - weight infants [8].

Feeding Practices and Nutritional Status

Feeding practices, including the timing of breastfeeding initiation, colostrum feeding, and pre - lacteal feeding,

showed significant associations with SAM outcomes. Early initiation of breastfeeding within one hour of birth was linked to better outcomes (cure rate: 84%) with a significant p - value of 0.015. Delayed initiation (more than one hour) was associated with poorer outcomes (cure rate: 60%, death rate: 20%, p - value 0.045). Colostrum feeding had a significant protective effect, with a p - value of 0.012, while pre - lacteal feeding was associated with adverse outcomes (p - value 0.033). These findings emphasize the critical importance of breastfeeding practices in reducing the risk of malnutrition and improving recovery in infants with SAM [9].

Anthropometric Measures and ANOVA Results

The study utilized ANOVA to examine the impact of various anthropometric measures on SAM outcomes. The analysis of birth weight revealed a highly significant association with outcomes (p - value 0.001), with infants with lower birth weights experiencing worse outcomes. Height (HT) and length also showed significant associations (p - value 0.039 and 0.048, respectively), suggesting that stunting and poor linear growth are key indicators of poor nutritional status and outcomes in infants with SAM [10]. However, weight alone did not show a significant relationship with outcomes (p - value 0.840), suggesting that while weight is an important measure, it may not be as reliable as height and MUAC in predicting recovery in infants with SAM.

The study highlighted the mid - upper arm circumference (MUAC) as a particularly important anthropometric measure, with significant differences in outcomes based on MUAC values (p - value 0.001). This supports the current practice of using MUAC as a simple, quick, and effective screening tool for identifying SAM and monitoring recovery in infants [11].

Maternal BMI and Household Characteristics

The study found no significant association between maternal BMI and SAM outcomes (p - value 0.640). This result suggests that maternal BMI alone may not be a strong predictor of SAM in infants, and other factors such as maternal nutrition, overall health status, and feeding practices may be more influential. This finding is consistent with some previous research indicating that while maternal BMI can be an indicator of maternal health, its relationship with child malnutrition is complex and influenced by multiple socio - economic and behavioral factors [12].

The number of household members showed a minor but statistically significant effect on outcomes (p - value 0.040). Larger household sizes may lead to resource constraints, impacting the quality and quantity of nutrition and care provided to infants, thereby affecting SAM outcomes. This highlights the need for family - based interventions and support to ensure adequate care and nutrition for infants in larger households [13].

4. Conclusion

The study provides valuable insights into the complex factors influencing SAM outcomes in infants U6M. Early breastfeeding practices, consanguinity, maternal occupation, and immunization status emerged as significant determinants of outcomes. The use of anthropometric measures such as MUAC in routine screening and follow - up is essential for

timely identification and management of SAM in infants. The rationale for this study stems from the critical need to better understand the multifactorial etiology and outcomes of severe acute malnutrition (SAM) in infants under 6 months (U6M), a particularly vulnerable demographic with high morbidity and mortality rates.

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