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Original Research Article

Risk factors of mortality in hospitalized children with severe acute malnutrition

Momotaj Begum[1]*, Wahida Khanam[2], Lalima Lima[3], Elbia Jahan[4], M. Arman Hossain[5]

[1]Department of Pediatrics, Eastern Medical College and Hospital, Cumilla, Bangladesh
[2]Department of Pediatrics, Institute of Child and Maternal Health, Matuail, Dhaka, Bangladesh
[3]Upazila Health Complex, Savar, Dhaka, Bangladesh
[4]Institute of Child and Mother Health, Matuail, Dhaka, Bangladesh
[5]Department of Pediatric Surgery, US Bangla Medical College and Hospital, Dhaka, Bangladesh

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***Correspondence:**
Dr. Momotaj Begum,
E-mail: momotajbegum87@gmail.com

ABSTRACT

Background: Severe acute malnutrition (SAM) significantly contributes to morbidity and mortality in children globally. Identifying the factors associated with mortality is essential for reducing SAM-related deaths. This study aimed to identify the risk factors for mortality in hospitalized children with SAM.
Methods: A case-control study was conducted at the SAM unit of the department of pediatrics, Institute of Child and Mother Health, Matuail, Dhaka, from January to December 2021. Children who died during hospitalization were classified as cases, while those who survived were controls. Data on socio-demographic, clinical, and laboratory parameters were collected. Statistical analyses were performed using SPSS version 22, employing student's t-test and chi-square test for comparison, and univariate and multivariate logistic regression analyses to identify independent risk factors, with significance set at $p<0.05$.
Results: The mean age of the subjects was 6.38±3.45 months for cases and 10.90±10.00 months for controls, indicating higher mortality in younger children. Mortality was more prevalent among males (61.5% versus 54.6%) and in families with a monthly income <10,000 Tk (53.8% in cases versus 21.9% in controls). Significant risk factors included dermatosis (46.2% versus 4.9%), oral ulcers (46.2% versus 5.5%), hypoglycemia (46.2% versus 3.8%), severe anemia (38.5% versus 2.2%), and septicemia (76.9% versus 29.5%). Multivariate analysis revealed hypoglycemia (OR=9.17, 95% CI 1.44-58.29) and severe anemia (OR=13.42, 95% CI 1.42-126.13) as strong predictors of mortality.
Conclusions: Hypoglycemia and severe anemia are significant contributors to mortality among hospitalized children with SAM.

Keywords: Anthropometry, Dermatosis, Hypoglycemia, Severe anaemia, Severe acute malnutrition, Septicemia

INTRODUCTION

Severe acute malnutrition (SAM) is a serious public health concern in low- and middle-income countries. Worldwide, SAM affects an estimated 16.6 million children under the age of 5 years.[1] It is highly associated with childhood morbidity and mortality, affecting about 50 million children under five years of age globally, including 48 million in Africa and Asia.[2] Undernourished children can be classified as moderately malnourished (moderate acute malnutrition or MAM) or severely malnourished (severe acute malnutrition or SAM).[3] Complicated SAM, which includes medical complications such as systemic or respiratory infections and severe diarrhoea, necessitates inpatient treatment.[4]

In low- and middle-income countries, SAM impairs cognitive and neurodevelopmental outcomes in children. Prognosis depends on the type of malnutrition, with uncomplicated SAM exhibiting a mortality rate below 5%, whereas complicated SAM shows mortality rates between 10% and 40%.[2] Children with SAM often show atypical signs of serious infections, such as absent fever, tachycardia, or tachypnoea, which may lead to under-recognition of disease severity.[1] Several risk factors are associated with SAM, including very low anthropometry, oedema, and gastrointestinal dysfunction that can result in severe diarrhoea.[4] The gut microbiota plays a crucial role in gastrointestinal health; studies have shown that malnourished children frequently have an "immature" microbiota characterized by low microbial diversity.[4]

High mortality in children admitted with SAM has been associated with WHO-identified danger signs such as lethargy, hypoglycemia, hypothermia, bradycardia, prolonged capillary refill time, weak pulse, and impaired consciousness.[5] Children with complicated SAM also often experience altered physiology across various organ systems, contributing to increased in-hospital and post-discharge mortality.[1] Additionally, large family sizes can place constraints on household resources, limiting the ability to provide adequate nutrition for each child.[6] The risk of malnutrition increases in households with many children, as individual attention and care may be reduced.[7] Children of illiterate mothers are also more susceptible to severe malnutrition due to a lack of knowledge on child nutrition.[7] However, maternal education on child nutrition, especially exclusive breastfeeding, has a protective effect against undernutrition.[7]

High mortality due to SAM in hospitalized children is often attributed to factors such as inadequate maternal involvement in feeding programs, prescription errors, and the overuse of intravenous therapies and blood transfusions.[5] Understanding these risk factors and addressing them through proper measures is critical to reducing SAM-related mortality. In Bangladesh, the prevalence of SAM is approximately 16%, as reported by ICDDRB.[8] Globally, SAM is responsible for 14.6% of all-cause mortality in children under five.[9] In Bangladesh, with the support of UNICEF and the Government of Bangladesh, several SAM treatment centers have been established in tertiary care and district hospitals to reduce child mortality.[10] In this context, the present study was conducted to identify mortality risk factors in hospitalized children with SAM in a tertiary care hospital in Bangladesh.

Objectives

General objective

To identify the risk factors of mortality in hospitalized children with severe acute malnutrition.

Specific objectives

To determine the socio-demographic risk factors of mortality among the children with severe acute malnutrition in hospital. To find out the clinical risk factors of mortality among children with severe acute malnutrition admitted in hospital. To identify the laboratory risk factors of mortality in hospitalized children with severe acute malnutrition.

METHODS

Study design

This was a case-control study conducted from January 2021 to December 2021 at the severe acute malnutrition (SAM) unit within the department of pediatrics, Institute of Child and Mother Health, Matuail, Dhaka, Bangladesh, involving children diagnosed with SAM who were hospitalized, with cases defined as those who did not survive and controls as those who survived.

Inclusion criteria

Children with severe acute malnutrition (SAM) admitted to the hospital were included. Cases were those who did not survive, while controls survived. For ages 0 to <6 months, criteria included WLZ<-3, bipedal oedema, or visible severe wasting. For ages 6 to 59 months, criteria included MUAC<115 mm, WLZ or WHZ<-3, or bipedal oedema. Both genders meeting these criteria were included.

Exclusion criteria

The study excluded children with known medical conditions that could affect the outcomes related to SAM. Exclusion criteria included cases of malignancy, preterm birth, intrauterine growth retardation (IUGR), inborn errors of metabolism, congenital anomalies, and chromosomal abnormalities. Additionally, children with cerebral palsy, other chronic diseases, or those who were referred for further management outside the study facility were excluded to ensure consistency and reliability in evaluating factors specifically related to SAM mortality.

Sample size estimation

Sample size was calculated using the following formula:

$$n = \frac{P_1(1-P_1) + P_2(1-P_2)}{(P_1-P_2)^2}(Z_\alpha + Z_\beta)^2$$

Here, n = sample size

P_1=52.38% [sepsis in children with SAM who died (Baskaran et)]

P_2=8.37% [sepsis in children with SAM who survived (Baskaran et al)]

Z_α=1.96 at a 95% confidence interval and Z_β=0.85 at an 80% power

Information of 13 dead children with SAM and 183 survived children with SAM were collected for this study.

Study procedure

The study was conducted in the SAM Unit, where cases (deceased children with SAM) and controls (survived children with SAM) were selected based on their survival status during hospitalization. Relevant data, including socio-demographic variables (e.g., age, sex, mother's age, residence, family socio-economic status, and family size), clinical variables (e.g., temperature, heart rate, respiratory rate, skin changes, oral ulceration, and comorbidities such as diarrhea, pneumonia, and sepsis), and laboratory variables (e.g., hemoglobin percentage, capillary blood glucose, and serum electrolytes), were collected from patient medical records by the researcher. Variables such as age (infancy), sex, economic status, presence of systemic illness, sepsis, severe anemia, pneumonia, and diarrhea were investigated as predictors of mortality.

Data processing and analysis

Data were meticulously compiled, screened, and verified for completeness. SPSS version 22 (IBM Corp., Armonk, NY) was used for statistical analysis. Categorical data were presented as frequencies and percentages, while continuous variables were reported as means with standard deviations. Student's t-test was used to compare continuous variables, while the chi-square test was used for categorical variables. Univariate analysis identified factors associated with mortality, and multivariate logistic regression was then applied to isolate significant independent risk factors. A p value of less than 0.05 was considered statistically significant.

Ethical consideration

The study was approved by the institutional review board (IRB) of the Institute of Child and Mother Health (ICMH), Matuail. All study objectives, methods, potential risks, and benefits were explained to the guardians in the local language, and written informed consent was obtained. The confidentiality of all information was assured, and the data obtained aimed to contribute to informed clinical practices for SAM case management.

RESULTS

This case control study was conducted in the SAM unit, department of pediatrics, ICMH from January 2021 to December 2021 over a period of one year to identify the risk factors of mortality in hospitalized children with severe acute malnutrition. A total of 13 children with SAM who died in hospital were enrolled as case and simultaneously 183 survived children with SAM were enrolled as control. The results were as follows:

The average age of children with SAM who died was 6.38±3.45 months, and 10.90±10.00 months for those who survived. Death was more common in younger children. Percentage of death was more (61.5% versus 54.6%) in male. Mortality was more common in family income <10,000 Tk/month, 53.8% in case group and 21.9% in control group. Mean age of mother was 19.23±0.60 years and 21.78±4.78 years in death and survived group.

Table 1: Socio-demographic risk factors of the study children with SAM.

Socio-demographic risk factors	Case (n=13)	Control (n=183)	P value
Age (months)			
<6	7 (53.8)	68 (37.2)	0.232
6-59	6 (46.2)	115 (62.8)	
Mean±SD	6.38±3.45	10.90±10.00	[b]0.036
Gender			
Male	8 (61.5)	100 (54.6)	[a]0.629
Female	5 (38.5)	83 (45.4)	
Residence			
Urban	8 (61.5)	136 (74.3)	[a]0.313
Rural	5 (38.5)	47 (25.7)	
Monthly family income (Tk./month)			
<10,000	7 (53.8)	40 (21.9)	[a]0.009
≥10,000	6 (46.2)	143 (78.1)	
Mother's age (years)	19.23±0.60	21.78±4.78	[b]0.056
Number of family members	5.00±0.82	5.37±1.34	[b]0.323

[a]Chi-square test and [b]unpaired t-test was done.

Table 2: Clinical and laboratory risk factors of the study children with SAM.

Clinical and laboratory risk factors	Case (n=13)	Control (n=183)	P value
Hypothermia	0	0	
Tachycardia	13 (100.0)	183 (100.0)	
Tachypnea	13 (100.0)	183 (100.0)	
Dermatosis	6 (46.2)	9 (4.9)	<0.001
Oral ulcer	6 (46.2)	10 (5.5)	<0.001
Hypoglycemia	6 (46.2)	7 (3.8)	<0.001
Severe anemia	5 (38.5)	4 (2.2)	<0.001
Diarrhoea	5 (38.5)	77 (42.1)	0.798
Pneumonia	5 (38.5)	81 (44.3)	0.684
Septicemia	10 (76.9)	54 (29.5)	<0.001

Chi-square test was done.

Table 3: Factors associated with the mortality among children with SAM using binary logistic regression.

	B	S.E.	P value	OR	95% CI for OR	
					Lower	Upper
Age (years)	0.052	0.066	0.428	1.053	0.926	1.198
Family income (<Tk. 10,000)	-0.753	0.822	0.360	0.471	0.094	2.360
Dermatosis	-1.658	1.101	0.132	0.191	0.022	1.648
Oral ulcer	-0.016	1.097	0.989	0.984	0.115	8.447
Hypoglycaemia	2.216	0.943	0.019	9.174	1.444	58.290
Severe anemia	2.597	1.143	0.023	13.424	1.429	126.128
Septicemia	-1.355	0.865	0.117	0.258	0.047	1.405

None of the study subjects had hypothermia. All the study subjects had tachycardia and tachypnea. Dermatosis (46.2% versus 4.9%), oral ulcer (46.2% versus 5.5%), hypoglycemia (46.2% versus 3.8%), severe anemia (38.5% versus 2.2%), septicemia (76.9% versus 29.5%) in case and control group respectively.

These risk factors were significantly higher in death group compared to survived group.The logistic regression analysis identifies hypoglycaemia (OR=9.174; p=0.019) and severe anemia (OR=13.424; p=0.023) as significant risk factors for mortality in children with severe acute malnutrition (SAM), indicating that these conditions greatly increase the likelihood of death. Age, family income below Tk. 10,000, dermatosis, and oral ulcers show no significant impact on mortality, suggesting that children from lower-income families may have reduced odds of dying, while dermatosis might even have a protective effect (OR=0.191). Septicemia also lacks significance (OR=0.258; p=0.117). Overall, the findings emphasize the critical need for interventions targeting hypoglycemia and severe anemia in this vulnerable population.

DISCUSSION

Severe acute malnutrition (SAM) remains a critical public health issue in low- and middle-income countries, affecting an estimated 16.6 million children under the age of five globally.[11] This condition is strongly linked to increased morbidity and mortality rates, particularly in acute cases that affect around 50 million children, with a significant concentration in Africa and Asia.[12]

SAM can be classified into moderate acute malnutrition (MAM) and SAM, with complicated cases requiring inpatient treatment due to associated medical issues like systemic infections and severe diarrhea.[13] In low- and middle-income settings, SAM adversely impacts cognitive and neurodevelopmental outcomes.[11]The prognosis varies significantly between uncomplicated and complicated SAM, where mortality rates are under 5% for uncomplicated cases but can soar to 10-40% for complicated cases.[12,14]

Notably, children with SAM may not exhibit the typical clinical signs of severe illness, leading to potential under-recognition of their condition, which complicates management.[11,13] Risk factors such as low anthropometry, edema, and gastrointestinal dysfunction are prevalent, contributing to the high mortality associated with SAM.[13,15]

Gastrointestinal dysfunction is exacerbated by alterations in gut microbiota, which in malnourished children show decreased microbial diversity, underscoring the importance of addressing these factors in treatment strategies.[15] The World Health Organization (WHO) has identified key danger signs indicative of severe cases, including lethargy, hypoglycemia, and hypothermia,

alongside physiological changes that increase in-hospital and post-discharge mortality.[16]

Socioeconomic factors also play a crucial role; larger household sizes can strain resources, making it difficult to provide adequate nutrition.[11] Children from families with more children or with illiterate mothers face higher risks of developing SAM due to limited access to nutritional knowledge.[17]

Improved maternal understanding of nutrition, including practices such as exclusive breastfeeding, is essential for mitigating risks associated with undernutrition.[17] High mortality rates among hospitalized children with SAM are often linked to factors such as inadequate maternal participation in feeding programs, clinical management errors, and inappropriate use of treatments like intravenous therapies.[16]

Addressing these risk factors is vital for reducing mortality rates in this vulnerable population. In Bangladesh, the prevalence of SAM is reported to be around 16%, and SAM accounts for 14.6% of all-cause mortality in children under five.[11,12]

Initiatives supported by UNICEF and the Government of Bangladesh are underway in tertiary care and district hospitals to reduce mortality associated with SAM.[12] This study aimed to identify specific risk factors contributing to mortality in hospitalized children with SAM at a tertiary care hospital in Bangladesh.

Like any other scientific study, the present study is not without limitations. This study was conducted in a single center. So, it does not reflect the whole population of the country.

CONCLUSION

Hypoglycemia and severe anemia were the main contributing factors of mortality among the children with severe acute malnutrition in hospital.

Recommendations

Early identification and prompt management of hypoglycemia and severe anaemia contributing to death can reduce the mortality due to SAM in hospital. Clinician should be more vigilant about immediate care of severe acute malnutrition children with complication after admission.

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