

## Factors Influencing Recovery and Mortality in Children with Severe Acute Malnutrition (SAM): Insights from a Therapeutic Feeding Program

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### Abstract

**Background:** Severe acute malnutrition (SAM) is a major health issue in low-income countries, leading to high rates of child morbidity and mortality. Effective treatments, such as ready-to-use therapeutic foods (RUTF) like Plumpy Nut, are essential for improving recovery rates. This study examines the short-term outcomes of nutritional therapy for children with SAM at El-Obeid Specialized Pediatric Hospital in Sudan.

**Objective:** The main aim of this study was to evaluate the short-term results of nutritional therapy for children with severe acute malnutrition who were admitted to the Therapeutic Feeding Unit at El-Obeid Special Pediatric Hospital.

**Method:** This study was a descriptive cross-sectional analysis conducted from November 2022 to December 2022. A total of 100 children diagnosed with severe acute malnutrition were included. Data were collected using a checklist and analyzed with Google Forms for data management and statistical analysis.

**Results:** 100 children under five with severe acute malnutrition (SAM) were admitted to the therapeutic feeding program at El-Obeid Specialized Pediatric Hospital from November to December 2022. Of these, 63% were male, 61.6% came from rural areas, and 85.7% were aged between 7 and 24 months. Most fathers were farmers (43.4%), and many mothers were illiterate (63.9%) and housewives (48%). Before admission, 60.6% of the children had poor food quality. However, this significantly improved afterward, with 99% receiving high-quality food. The observed co-morbidities included diarrhea (57.6%), vomiting (49.5%), pneumonia (21%), and anemia (14.4%). Treatment followed national guidelines, with 75% of the children receiving Ceftriaxone, 73% receiving Zinc, and 44% receiving ReSoMal. The outcomes showed that 85% of the children were cured, 6% died, and 5% were lost to follow-up.

**Conclusion:** This study highlights the significant impact of early intervention, nutritional therapy, and the management of co-morbidities in improving outcomes for children with severe acute malnutrition (SAM). The findings underscore the importance of addressing socioeconomic factors, such as low maternal education and poor food quality, as key contributors to malnutrition. While the therapeutic feeding program at El-Obeid Specialized Pediatric Hospital showed positive results, including an 85% cure rate, there is still room for improvement in reducing mortality rates, which exceeded the recommended threshold.

**Keywords:** Therapeutic Feeding Program; Severe Acute Malnutrition; Children; Recovery; Mortality

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## 1. Introduction

Severe acute malnutrition (SAM) is a major global health challenge, especially in low- and middle-income countries, where it is one of the leading causes of child mortality and morbidity. SAM is usually marked by severe weight-for-height deficits, with or without edema, and is frequently linked to other health issues such as infections, micronutrient deficiencies, and inadequate dietary intake. Children with SAM are at high risk of life-threatening conditions, and without appropriate medical care and nutritional rehabilitation, the risk of death increases significantly [1].

Globally, 150 million children under five are underweight, with over 20 million suffering from severe malnutrition. In sub-Saharan Africa, 47 million children are stunted, including 24 million in Eastern and Southern Africa. Stunting reflects past growth failure due to poor nutrition, infections, and poverty, while wasting indicates acute malnutrition. In Sudan, 31.0% of children under five are underweight, 32.5% suffer from chronic malnutrition, and 14.8% experience global acute malnutrition. [2].

Rising malnutrition-related mortality calls for stronger government policies, greater international support, and improved public awareness of nutrition and immunization. With over 60% of Sudan's population in impoverished rural areas, women and children are most affected. Data on children under five reveal a critical crisis, especially in marginalized regions. Urgent health education and nutritional programs are needed, alongside research to highlight the issue and drive action [3].

In hospitals, F75 and F100 are therapeutic milks for treating severe acute malnutrition (SAM). F75 is used in the stabilization phase, providing 80–100 kcal/kg/day over 8–12 meals for 3–7 days, while F100 is used in rehabilitation, offering 100–200 kcal/kg/day for 3–4 weeks. Both require preparation, have high moisture content, and cannot be stored at room temperature or prepared at home. Ready-to-use foods (RUFs), such as bars or pastes, are nutrient-dense, require no preparation, and are microbially resistant due to low moisture. F75/F100 and RUFs are used alongside continued breastfeeding for optimal recovery [4]. Despite established treatment protocols, SAM remains a significant concern in many countries, especially in rural areas where access to healthcare and adequate nutrition is often limited [5].

This study assesses factors influencing recovery and mortality in children with SAM at El-Obeid Specialized Pediatric Hospital, focusing on demographics, interventions, nutrition changes, and co-morbidities to improve treatment outcomes.

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## 2. Methodology

This descriptive, cross-sectional study was conducted at El-Obeid Specialized Pediatric Hospital, located in El-Obeid, the capital of North Kordofan State, Sudan. The hospital serves as a key health facility for the region and provides specialized care for children, including the management of severe acute malnutrition (SAM). El-Obeid is approximately 588 km southwest of Khartoum, making the hospital a critical resource for pediatric care in the area.

The study focused on children under five years of age diagnosed with SAM and admitted to the hospital between November 2022 and December 2022. A total of 103 children's records were reviewed, based on the availability of complete medical information. Inclusion criteria included children under five diagnosed with SAM during the study period, while children with incomplete records (e.g., missing anthropometric measurements such as weight, height, and mid-upper arm circumference (MUAC), as well as missing data on age, gender, or discharge outcomes) were excluded from the study. Additionally, children with secondary malnutrition caused by other health conditions (such as infections or metabolic disorders) or those with edema unrelated to SAM were excluded to ensure the study focused exclusively on primary severe acute malnutrition cases.

### 2.1. Data Collection and Analysis

Data were gathered from the children's medical records using a structured checklist that captured critical information on anthropometric measurements (weight, height, MUAC), age, gender, SAM diagnosis, and discharge outcomes. This checklist ensured that all relevant variables were captured for each child admitted for SAM treatment. After collection, the data were manually cleaned, coded, and entered into Google Forms, where further analysis was conducted.

Statistical analysis was performed to identify trends and correlations between demographic factors (age, gender) and the severity of SAM, as well as the outcomes of treatment. Descriptive statistics were used to summarize the data, including frequencies and percentages for categorical variables and mean  $\pm$  standard deviation for continuous variables.

The results were analyzed to determine common factors associated with SAM in the region and to assess treatment outcomes.

## 2.2. Ethical Considerations

Ethical approval was obtained from the University of Kordofan's Faculty of Medicine and the North Kordofan State Ministry of Health Ethics Committees. Caregivers were fully informed about the study's objectives and methods, and written informed consent was obtained. The study adhered to strict ethical standards, ensuring anonymized and confidential data, with all information stored securely in compliance with data protection protocols.

## 3. Results

A total of 100 children under five years old diagnosed with severe acute malnutrition (SAM) were admitted to the Therapeutic Feeding Unit at El-Obeid Specialized Pediatric Hospital between November and December 2022. Among these children, 63% were male, and 61.6% came from rural areas. Most of the children were in the 7-24 months age range (85.7%), while 14.3% were in the 25-59-month age group. Notably, no children under six months were admitted. In terms of family structure, 39.2% of the children came from families with 3-4 children, and 21.6% had more than four siblings (Table 1).

The fathers of the children were primarily farmers (43.4%), followed by unskilled workers (34%) and teachers (22.7%). In terms of education, 48.5% of fathers were illiterate, and 63.9% of mothers had no formal education. A significant portion of mothers (48%) were housewives, with 39% working as farmers (Table 2).

Before admission, 60.6% of children were consuming poor-quality food. However, after admission, the quality of food improved drastically, with 99% of the children receiving high-quality nutrition (Table 3). Edema was present in 41% of the children, and common comorbidities included diarrhea (57.6%), vomiting (49.5%), pneumonia (21%), anemia (14.4%), tuberculosis (12.5%), and a small proportion (0.5%) with heart failure (Table 4).

**Table 1** Demographic Characteristics of Children with Severe Acute Malnutrition

Characteristic	Frequency (%)
Gender	
Male	63%
Female	37%
Geographic Location	
Rural	61.6%
Urban	38.4%
Age Group	
7-24 months	85.7%
25-59 months	14.3%
Number of Children in Family	
1-2 Children	12.4%
3-4 Children	39.2%
>4 children	21.6%

The therapeutic management involved Ceftriaxone (75%), Zinc supplements (73%), and ReSoMal (44%). A smaller proportion of children received Benzyl Penicillin (14%) and Metronidazole (14%). Notably, no children received iron or folic acid supplements (Table 5). Regarding outcomes, 85% of the children were successfully cured, 6% died, and 5% were lost to follow-up.

**Table 2** Parental Occupation and Education Level

Characteristic	Frequency (%)
Father's Occupation:	
Farmer	43.4%
Non-skilled worker	34%
Teacher	22.7%
Father's Education Level	
Illiterate	48.5%
Primary school	20.6%
Secondary school	22.7%
University	8.2%
Mother's Occupation	
Housewife	48%
Farmer	39%
Teacher	11.2%
Mother's Education Level	
Illiterate	63.9%
Primary school	23%
University	9.8%

**Table 3** Quality of Food Before and After Admission

Food Quality	Frequency (%)
Before Admission	
Poor	60.6%
Good	19.4%
After Admission	
Good	99%
Poor	1%

**Table 4** Prevalence of Co-morbidities Among SAM Children

Co-morbidity	Frequency (%)
Diarrhea	57.6%
Vomiting	49.5%
Pneumonia	21%
Anemia	14.4%
Tuberculosis (TB)	12.5%
Heart failure	0.5%

**Table 5** Medications used in the treatment of SAM children

Medication/Therapy	Frequency (%)
Ceftriaxone	75%
Benzyl Penicillin	14%
Metronidazole	14%
Zinc	73%
ReSoMal (ORS)	44%

#### 4. Discussion

This study assessed the short-term outcomes of nutritional therapy in children with severe acute malnutrition (SAM) admitted to the Therapeutic Feeding Unit (TFU) at El-Obeid Specialized Pediatric Hospital. The findings highlight key factors influencing recovery and mortality rates in children with SAM and provide insights into the management practices that could improve the outcomes of these vulnerable children.

The findings indicated that the majority of children admitted to the TFU were males (63%), with most being between 7 and 24 months old (85.7%). This aligns with prior research demonstrating that severe malnutrition disproportionately impacts children under two years of age, especially males [6]. However, a study by Tafesse et al. in Ethiopia reported an equal distribution between the sexes [7]. Malnutrition in early childhood is particularly concerning due to the critical period of growth and development, with long-term consequences on cognitive and physical development [8]. The predominance of rural children (61.6%) is also in line with global patterns, where children from rural and remote areas are at greater risk of malnutrition due to limited access to nutritious food and healthcare services [9].

The socioeconomic status of the children's families also seems to play a role in the nutritional status of the children. A significant proportion of fathers were farmers (43.4%), and most mothers were illiterate or had only primary education (63.9%), suggesting that lower levels of education and occupation related to lower income may contribute to higher rates of SAM. This aligns with evidence that parent education and socioeconomic status are key determinants of childhood nutrition and health. Additionally, poor food quality before admission (60.6%) indicates inadequate food intake, which could be a significant contributing factor to the children's malnutrition. Studies have shown that the quality and diversity of food available to children, particularly in households with lower income, strongly correlate with the risk of SAM [10].

Regarding the clinical aspects, edema was present in 41% of cases, which is a significant indicator of severe malnutrition and fluid imbalance. Children with edema are at higher risk for complications, including infections and electrolyte imbalances, which can complicate treatment and recovery [11]. The presence of comorbidities, such as diarrhea (57.6%), vomiting (49.5%), pneumonia (21%), and anemia (14.4%), further exacerbates the challenges in managing SAM. These comorbidities are often seen in children with malnutrition and contribute to delayed recovery and higher mortality rates. Diarrhea is a leading cause of malnutrition-related morbidity and mortality, especially in settings with inadequate sanitation and limited access to healthcare [12,13].

The therapeutic interventions used in this study, which included SAM-specific medications and nutritional supplements such as Plumpy' Nut, appeared to align with standard treatment guidelines. The use of specialized therapeutic foods for children with SAM, including ready-to-use therapeutic foods (RUTF), has effectively improved their nutritional status [14]. The administration of antibiotics (75% received Ceftriaxone) and zinc (73%) also aligns with recommended practices for managing infections and enhancing nutritional rehabilitation [15,16]. However, the lack of iron and folic acid supplementation in this cohort is a limitation, as these micronutrients are essential for improving recovery in children with SAM, especially those with anemia [13].

In terms of outcomes, 85% of children were cured, 6% died, and 5% were lost to follow-up. The mortality rate observed in this study (6%) is within the range reported in other therapeutic feeding units in low-resource settings [17]. However, it still falls above the Sphere Standards minimum acceptable cut-off for SAM treatment programs, which recommend a mortality rate below 5% [18]. This suggests that while the therapeutic feeding program is effective, there is still room for improvement in reducing mortality and ensuring better recovery rates.

The predictors for a higher cure rate identified in this study include the presence of edema, HIV positivity, and the use of Plumpy' Nut. These findings are consistent with other studies showing that children with edema or co-morbidities, such as HIV, require more intensive management and monitoring to ensure recovery. Moreover, Plumpy' Nut, a ready-to-use therapeutic food, has improved outcomes in children with SAM, particularly in reducing recovery time and preventing complications [15,17,19].

## 5. Conclusion

In conclusion, this study emphasizes the critical role of early intervention, nutritional therapy, and effective management of co-morbidities in improving outcomes for children with severe acute malnutrition (SAM). The results highlight the importance of addressing socioeconomic factors, such as low maternal education and poor food quality, which contribute significantly to malnutrition. Although the therapeutic feeding program showed positive outcomes, with an 85% cure rate, there is still potential for improvement, particularly in reducing mortality rates, which surpassed the recommended threshold

### *Recommendations*

To improve SAM management, healthcare staff should receive proper training, and therapeutic feeding with micronutrients must be ensured. Strengthening the monitoring of SAM progress and promoting community-based prevention is essential. Additionally, improving access to food, healthcare, and education, supporting micronutrient supplementation for affected children, and enhancing data collection will help inform better future interventions.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

The authors declare no conflict of interest.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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