

Time to Death and Predictors of Mortality among under Five Children with Severe Acute Malnutrition Hospitalized at Mulanje District Hospital in Southern Malawi: A Retrospective Cohort Study

Masuzgo Pajogo^{1,2*}, Miriam Ndhlovu², Prince Chamambala², Wongani Nyondo²

¹Department of Public Health, Kamuzu University of Health Sciences, Blantyre, Malawi; ²Department of Public Health, University of Malawi, Blantyre, Malawi

ABSTRACT

Introduction: Severe Acute Malnutrition (SAM) is a leading cause of inpatient mortality in children in Sub-Saharan Africa (SSA). In Malawi, there is limited data that explains why this is the case. Therefore, this study determined the time to death and its predictors among children under five years of age with SAM admitted at Mulanje district hospital.

Methods: We conducted a retrospective cohort study by reviewing the medical charts of 454 randomly selected children under five years of age who were admitted to Mulanje district hospital from January 2017 to February 2021. We collected data using data collection forms and analysed the data with STATA version 16. Cox proportional hazard regression was used to identify predictors of mortality. A statistical significance was declared at a p-value<0.05.

Results: A total of 7,685 children under five years of age were admitted to Mulanje district hospital between January 2017 and February 2021. We enrolled and analysed 454 cases, of which 227 were SAM children and the other 227 belonged to non-SAM children. The overall death rate was 14.8%. For SAM children, the death rate was 8.4%, compared to 21.2% for non-SAM children. The median time to death was 5 days (IQR: 2-8) for SAM and 1 day (IQR: 1-2) for non-SAM children. Among SAM children, shock (AHR: 15.3; CI: 2.08-113.42) and not having received amoxicillin (AHR: 4.15; CI: 1.24-13.90) were significant predictors of death. Among non-SAM children, shock (AHR: 2.33; CI: 1.18-4.6), diarrhoea (AHR: 2.07; CI: 1.00-2.30), oxygen therapy (AHR: 3.17; CI: 1.66-6.05) and not having received amoxicillin (AHR: 20.78; CI: 2.81-153.67) were significant predictors of death.

Conclusion: Clinical and nursing interventions should be more focused on predictors of mortality to address the high incidence of deaths among children under five years of age.

Keywords: Severe acute malnutrition; Mortality; Predictors; Diarrhoea; Children

Abbreviations: ARI: Acute Respiratory Infection; CFR: Case Fatality Rate; COMREC: College of Medicine Research and Ethics Committee; CMAM: Community-based Management of Acute Malnutrition; HIV: Human Immunodeficiency Virus; IV: Intravenous Fluids; KM: Kaplan-Maier; LMIC: Low-and Middle-Income Countries; MoH: Ministry of Health; MSF: Medecins Sans Frontieres; NGT: Nasogastric Tube; NRU: Nutrition Rehabilitation Unit; ORS: Oral Rehydration Solution; ReSoMal: Rehydration Solution for Acute Malnutrition; RUTF; : Ready to Use Therapeutic Feeds; SAM: Severe Acute Malnutrition; SSA: Sub-Saharan Africa; TB: Tuberculosis; WHO: World Health Organization

Correspondence to: Masuzgo Pajogo, Department of Public Health, Kamuzu University of Health Sciences, Blantyre, Malawi; E-mail: masuzgopajogo@gmail.com

Received: 26-Nov-2023, Manuscript No. CPOA-23-28174; **Editor assigned:** 29-Nov-2023, PreQC No. CPOA-23-28174(PQ); **Reviewed:** 13-Dec-2023, QC No. CPOA-23-28174; **Revised:** 10-Jan-2025, Manuscript No. CPOA-23-28174(R); **Published:** 17-Jan-2025, DOI: 10.35248/2572-0775.25.10.288

Citation: Pajogo M, Ndhlovu M, Chamambala P, Nyondo W (2025) Time to Death and Predictors of Mortality among under Five Children with Severe Acute Malnutrition Hospitalized at Mulanje District Hospital in Southern Malawi: A Retrospective Cohort Study. Clin Pediatr. 10:288.

Copyright: © 2025 Pajogo M, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

INTRODUCTION

Severe Acute Malnutrition (SAM) is defined by a very low weight for height (below a -3 z-score of the median World Health Organization (WHO) growth standards), visible wasting or the presence of nutritional oedema [1]. Typically, SAM manifests itself in two forms: Marasmus, characterized by severe wasting, and kwashiorkor, characterized by bilateral pitting oedema [2]. Both marasmus and kwashiorkor are associated with several comorbidities and they contribute significantly to high rates of hospital admission and mortality in childhood [3].

Globally, nearly 17 million children under five years old had SAM in 2018, of which 4.4 million were cases from sub-Saharan Africa [4]. Every year, almost one million children under five years of age die because of SAM. Meanwhile, the death rate of children under 5 years of age remains between 10%-40% in sub-Saharan Africa, including Malawi [5,6]. In 2015, the Case Fatality Rate (CFR) for SAM in Malawi was 9.6%. However, seven hospitals in Malawi, including Mulanje district hospital, had an average CFR of 11.6% and therefore failed to reach the sphere CFR standard of <10% [7].

In Malawi, 37% of children under five years of age are stunted, 3% are wasted and 12% are underweight and a mortality rate of up to 42% has been reported among children with SAM at Queen Elizabeth central hospital in Blantyre [8,9]. In view of this, researchers in Malawi have conducted several studies to investigate predictors of mortality in children with SAM [10-12]. Studies have identified Human Immunodeficiency Virus (HIV) infection (AOR 5.32 (95% CI 1.76-16.09)), Kwashiorkor (AOR 5.14 (95% CI 1.27-20.78)), shock (AOR 18.54 (95% CI 3.87-88.90)), and Acute Respiratory Infections (ARI) (OR 3.06, $p=0.02$) as independent risk factors for the high death rate among children with SAM [10].

In Malawi, there has been remarkable progress achieved by the Malawi government in reducing the high mortality rate among children with SAM. At the national level, the Ministry of Health (MoH) has since 2012 implemented the Community-based Management of Acute Malnutrition (CMAM) program to address acute malnutrition beyond the Nutrition Rehabilitation Unit (NRU) [13]. The program permits community volunteers to identify and treat children with acute malnutrition before they seriously get sick [14]. Besides this, in 2013, the MoH adopted the guidelines from the WHO on the management of SAM. At the hospital level, the MoH has trained healthcare providers in WHO guidelines to manage hospitalized children with complicated SAM. However, the mortality rate among hospitalized children with SAM remains high, with estimates between 14% and 49% [15,16].

In Mulanje district, the prevalence of stunting, wasting and underweight for children under five years of age is 36.5%, 4.1% and 16.7%, respectively [8]. The reports have also shown that the mortality rate among children admitted with SAM in the district has risen from 4.3% in 2014 to 8.4% in 2015 [7]. While it is well known that mortality rates among children with SAM remain high in the district, the time to death and its predictors among children under the age of five admitted to Mulanje district hospital remain unknown.

MATERIALS AND METHODS

Study area

The study was conducted in Mulanje district, a semi-urban district in the southern region of Malawi, Africa. Mulanje district covers 2056 km² and has a total population of 684,107, with 23 health centres, 1 mission hospital and 1 district hospital [17]. Mulanje district hospital has over 500 beds, of which 100 are in the paediatric ward. The paediatric ward has a special bay where patients suffering from SAM are admitted and 10 beds are set aside to serve patients suffering from SAM.

Study design and study period

This was a retrospective cohort study that was conducted from February 2021 to June 2022.

Study population

The study population consisted of children under five years of age admitted to Mulanje district hospital between January 2017 and February 2021. The exposed group contained admitted children who were diagnosed with SAM. The unexposed group contained admitted children who were never diagnosed with SAM.

Inclusion criteria

- Patients aged 0-59 months.
- Patients admitted with medical conditions in paediatric medical ward and NRU.

Exclusion criterion

- Patients with surgical and orthopaedic conditions.
- Incomplete charts.
- Patients who were not assessed for their nutrition status.
- Sample size determination.

Sample size determination

The sample size was determined using the formula for detecting a difference between two proportions. We considered the following assumptions to determine the appropriate sample size: an 11.6% mortality rate in the exposed group [5], a 4.16% mortality rate in the unexposed group [18], a 95% confidence interval, an 80% power and a 10% contingency. After calculations, the total sample size was 412. After adjusting for 10% of missing files, the final sample size was 454. The sample size among the exposed ($n_1=227$) and the sample size among the unexposed ($n_2=227$).

Data collection

We used structured data collection forms to collect data from the medical records of the children under 5 years of age who were admitted from January 2017 to February 2021. Patients' files were collected from the storage room at paediatric department. Data for SAM children was collected from the NRU. Data for non-SAM children were collected from the

paediatric medical ward. The data collection process occurred from December 2021 to February 2022. We developed data collection forms by following the format of the present paediatric admission sheet at Mulanje district hospital. The parameters in the data collection form followed the order in which information appears in the patient's records. We designed the first section of the form to collect socio-demographic data. The subsequent sections collected data on clinical characteristics, comorbidities and routine treatment. The last section collected data on treatment outcomes.

We conducted a pilot test on the data collection form and made appropriate changes as needed. During data collection, medical charts were followed up for 30 days post-admission to assess the occurrence of death. Two nurses were recruited to collect data from the medical records. Data collection was done by reviewing patients' medical charts and we collected the following information from the medical charts:

Social-demographic data: This included age, sex, referral status and date of admission.

Clinical data: This included fevers, vomiting, diarrhoea, dehydration, shock, anaemia, coughing, convulsions and oedema.

Routine treatment data: This included administered medications, oxygen therapy and NGT feeding.

Treatment outcome: This included information about treatment outcomes, including whether the patient had died or was censored.

Sampling procedure

Annually, the paediatric department at Mulanje district hospital admits approximately 3000 children. A total of 7,685 children under five years of age were admitted between January 2017 and February 2021. Of these, we drew 643 samples from NRU and 5614 samples from the paediatric medical ward, which fulfilled the inclusion criteria. 1428 patients did not fulfil inclusion criteria and therefore their charts were excluded from the study. In this study, the sampling frame was the list of children aged 0-59 months admitted at Mulanje district hospital from January 2017-February 2021 and therefore we listed a sampling frame for all eligible patients in the Excel program and then randomly selected the required sample size of 454 from the eligible patient population.

Data quality control

We achieved data quality by creating a data collection form that was appropriate for the study's objectives. Besides this, we used two qualified nurses for data collection. We trained these nurses for two days before the data collection process. The training promoted the competence and efficiency of the research nurses during the data collection process. We closely supervised and monitored data collectors during data collection to ensure data accuracy, completeness and consistency.

Operational definitions

Severe acute malnutrition: Weight-for-height <3 SD, mid-upper arm circumference of <11.5 cm or bilateral pitting oedema.

Mortality: Any death of a child under five years of age receiving treatment in the hospital.

Time to death: Time in days from the date of admission to the date of death.

Censored: Individuals whose time to death was not observed because of the termination of the study before the occurrence of death or because subjects left the study before death had occurred.

Survival time: The number of days that an individual child had survived in the hospital over the follow-up period from the date of admission for a disease until death or censorship had occurred.

Variables

Outcome variable: The outcome variable was the "time to death" of an admitted child under five years of age.

Event of interest: Death of an admitted child under five years of age.

Primary exposure variable: Severe acute malnutrition.

Predictor variables: Predictor variables included child age, gender, referral status and vaccination status; medications administered; ReSoMal fluid; shock; blood transfusion; oxygen therapy; and NG tube; and symptoms such as fever, vomiting, diarrhoea, anaemia, coughing, convulsions, oedema, malaria, sepsis, pneumonia and HIV.

Data management

We examined the raw data for errors and omissions. We checked the data and removed incorrect, redundant and incomplete data. We cleaned up the data to maintain consensus. Besides this, we coded the data, entered it into the MS Excel spreadsheet and then stored it on a laptop in a protected folder.

Data analysis

Data from the MS Excel spreadsheet was directly imported into STATA 16 for analysis. Descriptive statistics such as frequencies, medians and percentages were used to describe the data. We used Kaplan-Maier (KM) curves and Log-rank tests to estimate survival probability and compare survival curves across distinct groups. Cox proportional hazard regression was used to identify predictors of mortality. Predictor variables with a p-value < 0.25 in the univariable Cox proportional hazard regression model were entered into the multivariable Cox proportional hazard regression model to control for confounding. In the multivariable

Cox proportional hazard model, we also included variables that demonstrated a significant association with the outcome of interest in previous studies. An adjusted hazard ratio with a 95% confidence interval presented the output of the analysis and we declared it statistically significant when the p-value was less than 0.05.

RESULTS

Participants

A total of 7,685 under-fives were admitted to Mulanje district hospital between January 2017 and February 2021. After the exclusion of children whose charts did not meet inclusion criteria, we considered 6257 children eligible. In this study, 1041 children were excluded because they had either surgical conditions or burns. A total of 387 children were excluded because their medical charts had incomplete data. Among the eligible cases, 643 belonged to SAM children, while 5614 belonged to non-SAM children. Of the 643 eligible SAM cases, 416 were excluded after simple random sampling. Similarly, of 5614 eligible non-SAM cases, 5387 were excluded after simple random sampling. Our study comprised 227 SAM children and 227 non-SAM children. We followed up with every study participant for 30 days from the day of admission and assessed whether the patient had died or not. Of 227 SAM children, 19 children had died while 208 children had not died. Of 227 non-SAM children, 48 children had died, while 179 children had not died (Figure 1).

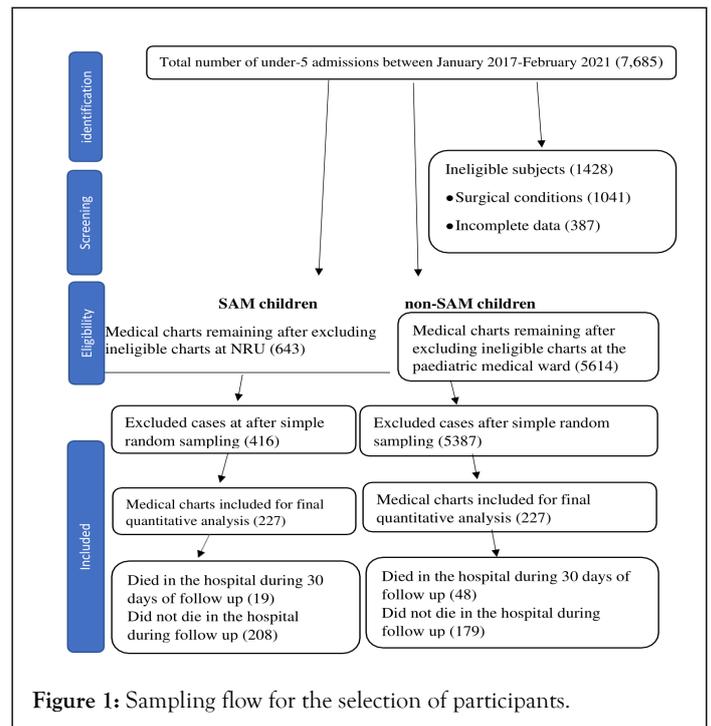


Figure 1: Sampling flow for the selection of participants.

Socio-demographic characteristics of the study participants: Of the SAM children, 117 (51.5%) were males, while 138 (60.8%) of the non-SAM children were males. Regarding referral status, 205 (90.3%) of the SAM children and 200 (88.1%) non-SAM children were self-referrals. The majority, 225 (99.1%) of SAM children and 224 (98.7%) of non-SAM children, were primary admissions (Table 1).

Table 1: Sociodemographic characteristics between SAM and non-SAM children (n=454).

Variable	Category	SAM children	Non-SAM children
Age	0-23 months	134 (59.0%)	128 (56.4%)
	24-59 months	93 (41.0%)	99 (43.6%)
Sex	Male	117 (51.5%)	138 (60.8%)
	Female	110 (48.5%)	89 (39.2%)
Referral status	Self-referral	205 (90.3%)	200 (88.1%)
	Health-center	22 (9.70%)	27 (11.9%)
Admission	Primary	225 (99.1%)	224 (98.7%)
	Readmission	2 (0.90%)	3 (1.30%)

Breastfeeding	Yes	105 (46.3%)	121 (53.3%)
	No	122 (53.7%)	106 (45.7%)
Vaccination	Complete	64 (28.2%)	114 (50.2%)
	Not completed	56 (28.6%)	67 (30.4%)
	Not received	8 (3.50%)	4 (1.80%)
	Unknown	90 (69.7%)	40 (17.2%)

Clinical characteristics of the study participants: The majority, 181 (79.7%) of SAM children and 216 (95.2%) of non-SAM children, had a fever. A high proportion of patients diagnosed with SAM (n=169; 74.5%) had diarrhoea compared to non-SAM

children (n=50; 22%). In terms of oedema, a high proportion of patients diagnosed with SAM (n=100; 44.1%) had oedema compared to non-SAM children (n=3; 1.3%) (Table 2).

Table 2: Comparison of clinical characteristics between SAM and non-SAM children (n=454).

Variable	Category	SAM children	Non-SAM children
Fever	Yes	181 (79.7%)	216 (95.2%)
	No	46 (20.3%)	11 (4.80%)
Vomiting	Yes	90 (39.7%)	73 (32.2%)
	No	137 (60.3%)	158 (67.8%)
Diarrhoea	Yes	169 (74.5%)	50 (22.0%)
	No	58 (25.5%)	177 (78.0%)
Anaemia	Yes	82 (36.1%)	81 (35.7%)
	No	145 (63.9%)	146 (64.3%)
Cough	Yes	89 (39.2%)	104 (45.8%)
	No	138 (60.8%)	123 (54.2%)
Convulsions	Yes	16 (7.10%)	106 (46.7%)
	No	221 (92.9%)	121 (53.3%)
Oedema	Yes	100 (44.1%)	3 (1.30%)
	No	127 (55.9%)	224 (98.7%)

Types of treatment given

Figure 2 shows a comparison of the treatment between SAM and non-SAM children. This figure shows that the majority, 223 (98.2%) of SAM children and 173 (76.2%) of non-SAM children, received IV antibiotics. In this study, the highest

proportion of non-SAM children (n=154; 67.8%) received antimalaria drugs compared to SAM children (n=79; 34.8%). Concerning oral antibiotics, most of the SAM children (n=123; 54.2%) received amoxicillin as compared to non-SAM children (n=79; 34.8%) (Figure 2).

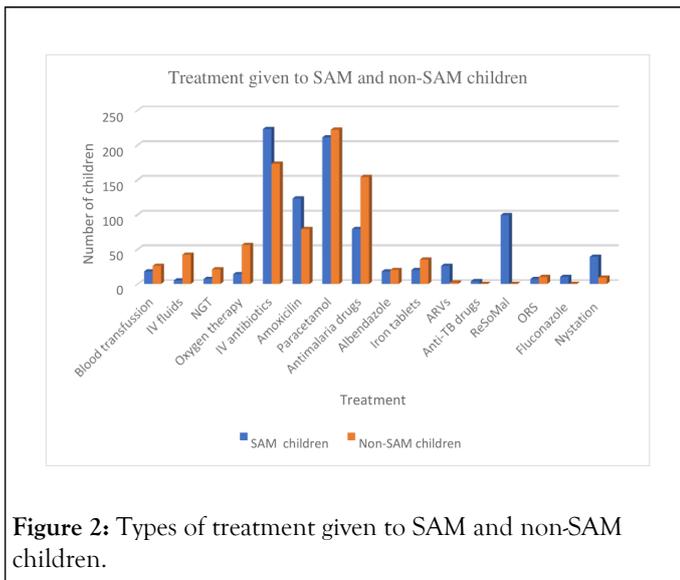


Figure 2: Types of treatment given to SAM and non-SAM children.

Summary of the follow-up: The medium follow-up time was 4 days for all under-five admissions. The median follow-up time was 7 days for SAM children and 2 days for non-SAM children. The total follow-up time for all was 2,204 days, with a median of 1666 days for SAM children and 538 days for non-SAM children.

Inpatient treatment outcomes

Table 3 shows that more deaths occurred among non-SAM children (n=48; 21.2%) as compared to SAM children (n=19; 8.4%). Regarding discharges, over one-third of the SAM children (n=171; 75.3%) and non-SAM children (n=172; 75.8%) got discharged from the hospital. SAM children had the highest proportion of absconders (n=32; 14.1%) compared to non-SAM children (n=1; 0.4%).

Table 3: Comparison of the treatment outcomes between SAM and non-SAM children (n=454).

Outcome	SAM children	Non-SAM children
Died	19 (8.4%)	48 (21.2%)
Recovered	171 (75.3%)	172 (75.8%)
Absconded	32 (14.1%)	1 (0.4%)
Referred	5 (2.2%)	6 (2.6%)

Outcomes by admission and discharge characteristics

The most common condition aside from SAM was malaria. Out of 454 children under five years of age, 227 (50%) had SAM and

144 (31.7%) had severe malaria. Among the children that died, severe malaria registered more deaths (n=28; 41.8%), followed by SAM (n=19; 28.4%) (Table 4).

Table 4: Outcomes by admission and discharge characteristics for the entire paediatric admissions.

Variable	Survival status		
	Censored	Died	Total
Acute bronchiolitis	1 (0.3%)	1 (1.5%)	2 (0.4%)
Acute gastroenteritis	7 (1.8%)	6 (9.0%)	13 (2.9%)
Diabetes Mellitus (DM)	0 (0.00)	1 (1.5%)	1 (0.2%)
Effective endocarditis	1 (0.3%)	0 (0.00%)	1 (0.4%)
Meningitis	1 (0.3%)	1 (1.5%)	2 (0.4%)
SAM	208 (53.8%)	19 (28.4%)	227 (50%)
Sepsis	20 (5.2%)	2 (3.0%)	22 (4.9%)
Severe asthma attack	2 (0.5%)	0 (0.00%)	2 (0.4%)
Severe pneumonia	30 (7.7%)	8 (11.9%)	38 (8.37%)

Severe malaria	116 (30.0%)	28 (41.8%)	144 (31.7%)
Ventricular septal defect	0 (0.00%)	1 (1.5%)	1 (0.2%)
Typhoid	1 (0.26%)	0 (0.00%)	1 (0.2%)

The time to death

The overall inpatient mortality among all paediatric admissions for children under-five was 14.8%. The median time to death for SAM children was 5 days (IQR: 2-8), while the median time to death for non-SAM children was 1 day (IQR: 1-2).

Overall survival function and the comparison of survival curves

The overall KM estimate showed that the probability of survival for children under five years of age was high in the first 12 days of admission, and dropped moderately as the follow-up time increased. The overall median survival time was 22 days (Figure 3). Separate graphs of the KM survival functions showed that the KM curve for SAM children was consistently higher in the first 9 days of admission than the KM curve for non-SAM children. These figures indicate that SAM children had a better survival time during the first days of admission than non-SAM children (Figure 4).

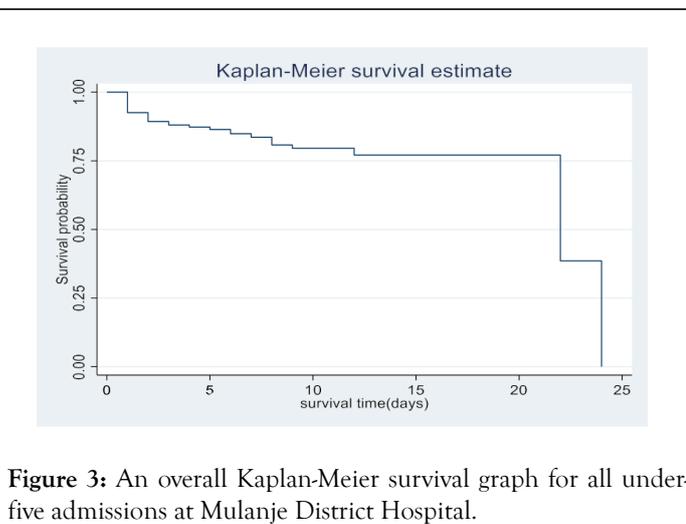


Figure 3: An overall Kaplan-Meier survival graph for all under-five admissions at Mulanje District Hospital.

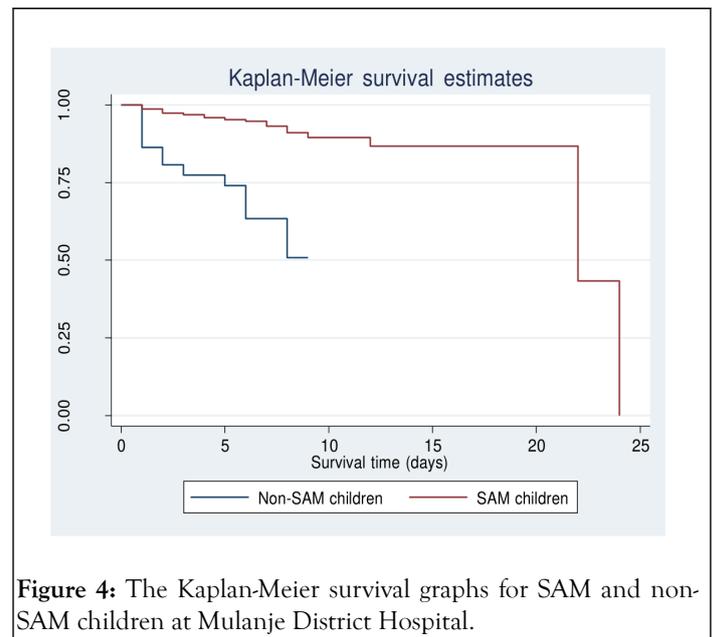


Figure 4: The Kaplan-Meier survival graphs for SAM and non-SAM children at Mulanje District Hospital.

Testing the inequality of survival functions

Table 5 depicts a comparison of the survival functions for different categorical variables for both SAM and non-SAM children. Among SAM children, there was a significant difference in survival function for categorical variables, including oral candidiasis, not having received amoxicillin, shock and NGT. Among non-SAM children, there was a significant difference in survival function for several categorical variables such as breastfeeding status, diarrhoea, dehydration, not having received amoxicillin, shock, NGT and oxygen therapy.

Table 5: Comparison of the survival functions for different categorical variables for SAM and non-SAM children (n=454).

Variable	Category	SAM children		Non-SAM children	
		X ²	P value	X ²	P value
Gender	Male	0.15	0.697	0.04	0.851
	Female	1		1	
Breastfeeding	Yes	1.86	0.172	13.80***	0
	No	1		1	
Referral status	Self	0.09	0.764	1.49	0.221

	Health center	1		1	
Oral candidiasis	Yes	5.28*	0.021	2.29	0.129
	No	1		1	
Diarrhoea	Yes	0.08	0.779	20.42***	0
	No	1		1	
Dehydration	Yes	1.59	0.208	9.94**	0.001
	No	1		1	
Not having received amoxicillin	Yes	9.08**	0.002	30.48***	0
	No	1		1	
Shock	Yes	36.4***	0	24.50***	0
	No	1		1	
NGT	Yes	4.52*	0.033	21.83***	0
	No	1		1	
Oxygen therapy	Yes	2.55	0.11	30.16***	0
	No	1		1	

Note: *p-value<0.05, **p-value<0.01 and ***p-value<0.001

Predictors of mortality

The results of the bivariable Cox proportional hazard regression model showed that not having received amoxicillin and shock were independent predictors of mortality among SAM children, while referral status, diarrhoea, dehydration, shock, not having received amoxicillin, NGT and oxygen therapy were independent predictors of mortality among non-SAM children. We conducted a multivariable analysis to control for potential confounders such as age, sex and HIV. In multivariable analysis, shock (AHR: 15.37 (95% CI: 2.08-113.4)) and not having

received amoxicillin (AHR: 4.15 (95% CI: 1.24-13.90)) were predictors of mortality among SAM patients. Among non-SAM children, diarrhoea (AHR: 2.07 (95% CI: 1.00-4.30)), shock (AHR: 2.33 (95% CI: 1.18-4.60)), oxygen therapy (AHR: 3.17 (95% CI: 1.66-6.05)) and not having received amoxicillin (AHR: 20.78 (95% CI: 2.81-153.67)) were significant predictors of mortality (p-value<0.05) (Table 6).

Table 6: Predictors of mortality among SAM and non-SAM children (n=454).

Variable	Category	SAM children				Non-SAM children			
		CHR (95%CI)	P value	AHR (95%CI)	P value	CHR (95%CI)	P value	AHR (95%CI)	
Gender	Male	1.2	0.699	1.67	0.351	1.05	0.859	0.75	
	Female	(0.47-3.04)		(0.56-4.91)		(0.58-1.88)		(0.39-1.40)	
Age	0-23 months	0.62	0.338	1.16	0.84	1.13	0.674	1.21	
	24-59 months	(0.24-1.62)		(0.25-4.27)		(0.63-2.01)		(0.26-5.60)	
Breastfeeding	Yes	0.52	0.181	0.57	0.444	1.41	0.249	1.24	

	No	(0.20-1.35)		(0.14-2.36)		(0.78-2.53)		(0.27-5.69)
Referral status	Self	0.79	0.765	0.53	0.476	0.32	0.001	0.5
	Health center	(0.18-3.49)		(0.11-3.14)		(0.16-0.63)		(0.23-1.06)
HIV	Yes	1.32	0.655	1.81	0.41	1.46	0.706	1.92
	No	(9.38-4.63)		(0.45-7.28)		(0.20-10.65)		(0.22-16.24)
Diarrhoea	Yes	0.86	0.781	0.41	0.145	3.25	0	2.07
	No	(0.30-2.45)		(0.12-1.35)		(1.83-5.78)		(1.002-4.30)*
Dehydration	Yes	1.87	0.217	1.41	0.574	2.89	0.004	1.21
	No	(0.69-5.06)		(0.42-4.73)		(1.39-5.99)		(1.45-3.22)
Not receiving Amoxicillin	Yes	4.06	0.006	4.15	0.021	25.08	0.001	20.78
	No	(1.54-14.29)		(1.24-13.90)*		(3.46-181.8)		(2.81-153.6)*
Shock	Yes	17.9	0	15.37	0.007	3.65	0	2.33
	No	(4.87-65.70)		(2.08-113.4)*		(2.05-6.50)		(1.18-4.60)*
NGT	Yes	4.3	0.052	2.78	0.27	3.9	0	1.51
	No	(0.98-19.11)		(0.45-17.17)		(2.05-7.42)		(0.69-3.29)
Oxygen therapy	Yes	2.89	0.12	0.65	0.668	4.12	0	3.17
	No	(0.75-11.08)		(0.02-4.45)		(2.31-7.33)		(1.66-6.05)*

Note: *p-value<0.05, **p-value<0.01 and ***p-value<0.001

DISCUSSION

In this study, the inpatient mortality rate for all under-five admissions was 14.8%. This rate is disproportionately high compared to those observed in studies done in Iran and South Sudan, whose mortality rates were 1.35% and 5.7%, respectively. The higher incidence of mortality in the present study could be attributed to several factors, including inadequate case management, late presentation, delayed initiation of care and treatment, inadequate staffing and a lack of essential medical supplies.

Our study revealed that SAM children had a longer median time to death (5 days) as compared to non-SAM children (1 day). The possible justification for this could be the fact that non-SAM children had a higher caseload surge compared to SAM children. According to a study done in Iran, a higher caseload surge causes the incorrect allocation of patients to bays where nurses and clinicians are less familiar with the patient's condition and less likely to detect early danger signs. In this study, we suggested that life-threatening danger signs were detected and managed earlier among SAM children as compared to non-SAM children. This prevented early deaths in SAM and

therefore a longer time to death among SAM children as compared to non-SAM children.

Gender is a potential predictor of mortality in children with SAM. A previous study done in Ethiopia found that male children with SAM had an increased risk of death compared to females. Evidence has shown that males are biologically weaker than females and therefore more susceptible to life's risks, including death. However, the present analysis showed that gender was not a predictor of mortality for both SAM and non-SAM patients (AHR: 1.67 (95% CI: 0.56-4.91) vs. AHR: 0.74 (95% CI: 0.39-1.40)). The possible causes of this variation could be differences in sample size, study setting or the severity of the disease.

In line with other studies, our study showed that age was not a predictor of mortality for SAM and non-SAM children (AHR: 1.16 (95% CI: 0.25-4.27) vs. AHR: 1.21 (95% CI: 0.26-5.60)). This is inconsistent with studies done in Egypt and Ethiopia where age was a significant predictor of mortality. According to an Ethiopian study, children who were <24 months old were 2.8 times more likely to die compared to those >24 months (AHR: 2.84 (95% CI: 1.10-7.73)). Literature has shown that infants

possess weak and underdeveloped immune systems and are therefore more vulnerable to serious diseases and deaths.

The predictive effect of breastfeeding on mortality among children with SAM has been reported in several sub-Saharan studies. In a study done in Ethiopia, the findings showed that hospitalized children with SAM who were breastfed were 59% less likely to die compared to non-breastfed children (AHR: 0.41 (95% CI: 0.29-2.37)). In the present study, our results showed that breastfed children with SAM were 43% less likely to die than their non-breastfed counterparts (AHR: 0.57 (95% CI: 0.14-2.36)). This differs from non-SAM children, where breastfeeding increased the risk of death by 1.24 folds (AHR: 1.24; 95% CI: 0.27-5.69). However, both of these results were not statistically significant.

The association between HIV infection and mortality in SAM has been reported in several studies. Meanwhile, research has aligned this association with nutritional acquired immune deficiency syndrome, which worsens the fragility of a deteriorating immune system. According to a study done in Malawi, HIV-infected children with SAM are three times more likely to die as compared to HIV-negative children. However, the present study showed that HIV was not a significant predictor of mortality for SAM and non-SAM children. The possible causes of this difference could be differences in the study setting, patient management or sample size.

Consistent with other studies, our study showed that shock was significantly associated with mortality among SAM and non-SAM children. In the present study, SAM children with shock had a 15.3-fold increased hazard of death than those without shock (AHR: 15.37 (95% CI: 2.08-113.4)). Among non-SAM children, having shock increased the risk of death by 2.3 folds (AHR: 2.33 (95% CI: 1.18-4.60)). This might be caused by a reduction in the amount of blood transported to different parts of the body, including vital organs, hence causing multi-organ failure. Therefore, we suggested that nurses and clinicians should always assess the signs of shock in sick children and provide appropriate management in accordance with treatment guidelines.

It is scientifically known that antibiotics, including amoxicillin, reduce mortality in children with SAM. This study also observed that children who did not receive amoxicillin had an increased risk of death. SAM children who did not receive amoxicillin had a 4.15 increased hazard of dying compared to those who received amoxicillin (AHR: 4.15 (95% CI: 1.24-13.90)). Among the non-SAM children, those who did not receive amoxicillin had a 20.78 times increased hazard of mortality compared to those who did (AHR: 20.78; 95% CI: 2.81-153.67). The possible reason to explain this could be the fact that amoxicillin, just like any other antibiotic, improves the clinical response to life-threatening infections, therefore reducing the risk of mortality.

Contrary to the results observed among SAM children, having received oxygen therapy was a predictor of time to death among non-SAM children. Our study showed that non-SAM children who received oxygen therapy were 3.1 times more likely to die than those patients who had not received oxygen therapy (AHR: 3.17 (95% CI: 1.66-6.05)). This could be attributed to the fact

that patients were placed on oxygen therapy in critical situations. This could also be attributed to excessive oxygen supplementation, which caused oxygen toxicity, which led to multiorgan failure. A similar relationship was found in a study done in the United States of America where oxygen therapy was associated with increased inpatient mortality in children because of hyperoxia. To avoid oxygen toxicity, our study suggested that nurses and clinicians should use oxygen therapy with greater caution, particularly on critically ill children.

Strengths and limitations

In this study, we applied the right sampling technique, the right sample size and accurate research procedures. We used a simple random sampling technique, therefore preventing selection bias. Besides this, our sample size was large and representative of the target population, hence strengthening the power of the study. However, we acknowledged the presence of a few limitations. Our study was affected by unmeasured confounding from the unmeasured variables. In this study, we did not investigate the predictive effects of biochemical and health system factors.

CONCLUSION

From the study, it is established that diarrhoea, shock, having not received amoxicillin and oxygen therapy were independent predictors of mortality. To address the high incidence of deaths among children under the age of five, clinical and nursing interventions should place a greater emphasis on these predictors of mortality. We also suggested that an analytical study that includes multidimensional predictors of mortality is needed to prevent confounding effects originating from unmeasured confounders.

ETHICAL CONSIDERATIONS

This study (protocol number: P.06/20/3077) was reviewed and approved by the college of medicine research and ethics committee. Since we used secondary data, it was impractical to get individual patient consent. Therefore, we got an approval to use secondary data from the Mulanje district research coordinating committee. In this study, we used codes to identify subjects instead of collecting specific personal identifiers, thereby maintaining confidentiality. Since we used pre-existing data, there was no physical harm to the subjects.

AVAILABILITY OF DATA AND MATERIALS

The corresponding author will make data materials available to interested parties upon reasonable request.

CONSENT FOR PUBLICATION

Not applicable.

REFERENCES

1. World Health Organization. Community-based management of severe acute malnutrition: A joint statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund. World Health Organization. 2007.
2. Bain LE, Awah PK, Geraldine N, Kindong NP, Siga Y, Bernard N, et al. Malnutrition in Sub-Saharan Africa: Burden, causes and prospects. *Pan Afr Med J.* 2013;15(1):120.
3. Ubesie AC, Ibeziako NS, Ndiokwelu CI, Uzoka CM, Nwafor CA. Under-five protein energy malnutrition admitted at the University of in Nigeria teaching hospital, Enugu: A 10 year retrospective review. *Nutr J.* 2012;11:1-7.
4. UNICEF WHO. The World Bank group joint child malnutrition estimates-levels and trends in child malnutrition. World Health Organization. 2019.
5. Modjadji P, Mashishi J. Persistent malnutrition and associated factors among children under five years attending primary health care facilities in Limpopo Province, South Africa. *Int J Environ Res Public Health.* 2020;17(20):7580.
6. Tickell KD, Denno DM. Inpatient management of children with severe acute malnutrition: A review of WHO guidelines. *Bull World Health Organization.* 2016;94(9):642-651.
7. Food and Nutrition Technical Assistance III Project (FANTA). Applying the model for improvement to strengthen the care for children with Severe Acute Malnutrition (SAM) and Medical Complications in Malawi. Washington, DC. 2018.
8. National Statistical Office (NSO) Malawi, ICF International. Malawi demographic and health survey 2015-16. Zomba: National Statistical Office (NSO). 2017.
9. Kerac M, Bunn J, Chagaluka G, Bahwere P, Tomkins A, Collins S, et al. Follow-up of post-discharge growth and mortality after treatment for severe acute malnutrition (FuSAM study): A prospective cohort study. *PLoS One.* 2014;9(6):e96030.
10. Vonasek BJ, Chiume M, Crouse HL, Mhango S, Kondwani A, Ciccone EJ, et al. Risk factors for mortality and management of children with complicated severe acute malnutrition at a tertiary referral hospital in Malawi. *J Paediatr Child Health.* 2020;40(3):148-157.
11. Nkosi-Gondwe T, Calis J, Boele van Hensbroek M, Bates I, Blomberg B, Phiri KS. A cohort analysis of survival and outcomes in severely anaemic children with moderate to severe acute malnutrition in Malawi. *Plos One.* 2021;16(2):e0246267.
12. Versloot CJ, Attia S, Bourdon C, Richardson SE, Potani I, Bandsma RH, et al. Intestinal pathogen clearance in children with severe acute malnutrition is unrelated to inpatient morbidity. *Clin Nutr.* 2018;24:109-113.
13. Ministry of Health (MOH). Guidelines for community-based management of acute malnutrition. 2nd Edition, Lilongwe, Malawi. MOH. 2016.
14. Food and Nutrition Technical Assistance III Project (FANTA). Training guide for Community-Based Management of Acute Malnutrition (CMAM). Washington, DC. FHI 360/FANTA. 2018.
15. Preidis GA, McCollum ED, Mwansambo C, Kazembe PN, Schutze GE, Kline MW. Pneumonia and malnutrition are highly predictive of mortality among African children hospitalized with human immunodeficiency virus infection or exposure in the era of antiretroviral therapy. *J Pediatr.* 2011;159(3):484-489.
16. Kerac M, Bunn J, Chagaluka G, Bahwere P, Tomkins A, Collins S, et al. Follow-up of post-discharge growth and mortality after treatment for Severe Acute Malnutrition (FuSAM study): A prospective cohort study. *PLoS One.* 2014;9(6):e96030.
17. Kanyuka M, Ndawala J, Chirwa I, Makwemba M, Phiri RA, Singano C, et al. Malawi population and housing census technological trajectory: Unpacking 2018 experience. *Statistical J IAOS.* 2020;36(1):57-65.
18. Karunaratne R, Sturgeon JP, Patel R, Prendergast AJ. Predictors of inpatient mortality among children hospitalized for severe acute malnutrition: A systematic review and meta-analysis. *Am J Clin Nutr.* 2020;112(4):1069-1079.