Time to recovery from severe acute malnutrition and associated factors among under-5 children in public health centers in Jarso District, East Ethiopia: A retrospective cohort study

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ABSTRACT

Background: Severe acute malnutrition affects about 20 million children under five worldwide, and it increases the risk of morbidity and mortality with infectious diseases. Despite its therapeutic interventions, Ethiopia has the highest rate of child mortality which is about 28% of all child fatalities among under-five children. Thus, this study aimed to determine the median time to recovery from severe acute malnutrition and associated factors among children admitted to health centers in Jarso District, East Ethiopia.

Methods: A retrospective cohort study was conducted in Jarso District from March 01 to April 30, 2022, with a total sample size of 440. The pretested tools were used to collect the data. The nutritional recovery time was estimated using Kaplan-Meier analysis, and the significance of the observed difference in recovery time between various groups of predictor variables was assessed using the Log-rank test. Cox proportional-hazard regression analysis was used to determine the independent predictors.

Results: The nutritional recovery rate was 82.7%, and the median recovery time was 28 days (95% CI: 24.98–31.02). Age <24 months (AHR = 0.89, 95% CI: 0.78–0.99), daily weight gain <8 g/kg/day (AHR = 0.94, 95% CI: 0.91-0.96), not fully vaccinated (AHR = 0.12, 95% CI: 0.03-0.21), presence of pneumonia (AHR =0.93, 95% CI: 0.89–0.97), presence of stunting (AHR = 0.97, 95% CI: 0.96-0.98), presence of shock (AHR = 0.95, 95% CI: 0.93-0.98), and children received vitamin A (AHR = 1.08, 95% CI: 1.01–1.15) were the significant predictors of nutritional recovery time.

Conclusion: The nutritional recovery rate and median recovery time were found to be within the acceptable range of the minimum standard specified by the international standards value. Interventions that targeted young age children, poor daily weight gain, not fully vaccinated, pneumonia infection, stunted children, children with shock, and lack of vitamin A supplementation are required to shorten time to recover from severe acute malnutrition among under-5 children.

Keywords: Recovery time, Severe acute malnutrition, Under five children,

Citation: Tefera EM, Guye AH, Ketema K, Shukure R, Shambi DB. Time to recovery from severe acute malnutrition and associated factors among under-5 children in public health centers in Jarso District, East Ethiopia: A retrospective cohort study. *HAJHBS*. 2024, 1(1): 48–63

Edited by Dejene Hailu

Submitted: September 21, 2024 | Revised: May 02, 2025 | Accepted: June 29, 2025 | Published: August 17, 2025

BACKGROUND

Severe acute malnutrition (SAM) is the world's 3rd most common cause of death among under-five children and continues to rise at an alarming rate around the world (1,2). It significantly impairs a child's survival, health, growth, and development (1,3). It is frequently caused by a combination of poor nutrition, energy, and infection (4).

Acute malnutrition, often known as wasting, is classified by the World Health Organization (WHO), 2019) into two categories: moderate and severe acute malnutrition (SAM) based on anthropometric and clinical symptoms (5). Wasting is defined as low weight for height, and it is the most acute, obvious, and sometimes fatal kind of malnutrition due to its extreme thinness and weakened immune systems. Children who suffer from wasting are more susceptible to illness, mortality, and developmental delays (4,6,7).

According to the WHO report, approximately 20 million children under the age of five are afflicted by SAM, which raises the risk of dying from a serious illness that claims one million lives each year (8). Children with SAM have a 5–20 times higher chance of dying globally than children who receive adequate nutrition, and they are also more likely to die from a variety of illnesses like pneumonia and diarrhea (9,10).

The SAM is a major public health problem in developing countries and Sub-Saharan Africa (11). In Asia, 35.9 million children under five years old are wasted, with 12.6 million of them being seriously wasted and a high death rate (12). In Bangladesh, a research revealed that SAM caused the deaths of almost 9% among children admitted to the hospital (11). It is characterized in children aged 1 to 5 as a weight for height (WFH) measurement of less than 70%, a WHZ score of less than 3 SD from the mean, the presence of bilateral pitting edema of nutrient origin, or a MUAC of less than 11.5cm (10). Children under the age of six months who have bilateral edema, a WFH of less than 70%, or a MUAC of less than or equal to 11.5" should be admitted for SAM treatment. When the MUAC is ≥ 12.5cm, the WHZ is –2 or the edema is gone for at least 2 weeks, children under 6 months should be discharged (7,13).

Long-term malnutrition in children causes essential neurological clinical symptoms, such as learning deficits and behavioral difficulties (3,14,15). The treatment success rate for SAM is not only determined by the percentage of children who recover but also by the duration of time it takes for them to get well (4). Children who have been admitted for SAM therapy should recover as quickly as possible. The Sphere Handbook for Humanitarian Charter and Minimum Standards states that children should be recovered from SAM within 28 days of admission (16,17).

According to Ethiopian Demographic Health Survey (2019), 37% of children under five have stunted, 12% severely stunting, 7% have wasted, and 1% have severely wasted (19). The prevalence of undernourished children has steadily declined from 33% to 21% since 2020, and the rate of wasting has decreased from 12% to 7% (19).

A study conducted in Zambia showed that the prevalence of severe acute malnutrition among under-five children was 27% (18), whereas stunting fell by a factor of more than half (from 28% to 12%) and stunting reduced from 51% to 37% between 2005 and 2019 (19). There is a wide range of stunting and wasting in the country overall. In Ethiopia, Tigray Region has the highest percentage of stunted children (48%), followed by Afar Region (42%), and the Amhara Region (42%). Somalia Region (21%) has the highest percentage of wasting children, followed by Afar Region (14%), and the Gambela Region (13%) (20). As a result, Ethiopia has one of the worst rates of illness and mortality for children under five with malnutrition contributing to 28% of all child fatalities (8,20).

The Ethiopian government has undertaken several initiatives to reduce the burden of undernutrition and the number of SAM-related fatalities among children in the country (15). The recently endorsed 2019 Food and Nutrition Policy (FNP)aims to achieve optimal nutritional status throughout the life cycle through the coordinated implementation of interventions

that are specific and sensitive to nutrition. As part of the Seqota Declaration, Ethiopia has also committed to eradicating undernutrition among children under the age of two by 2030. The NNP I (2008–2015), and NNP II (2016–2020) were implemented by the country to expedite the reduction of malnutrition. The programs place a strong emphasis on multisectoral coordination of nutrition interventions (19,20).

The mortality rate from SAM is still reported to be high, and little is known about the recovery time and its determinants from SAM, particularly in children under the age of five who are admitted to inpatient therapeutic feeding centers (ITFCs) (17). Even though SAM has been provided at the hospital or health center level across the country its consequences have been investigated by local researchers (5,6,13,21).

Despite all the impacts of prolonged hospitalization, the recovery time from SAM is not well studied. The time of recovery from hospitalization in different studies is also widely diverse (12,15,17,20,22,23). Even if some studies conducted in previous time, there is no sufficient information about the time to recover from severe acute malnutrition, and the researchers are interested in assessing how long time it takes for children less than five years to recover from SAM, and the determinants for the length of hospitalization in the study area. Thus, the study aimed to assess the time to recovery from severe acute malnutrition and associated factors among children admitted to health centers in Jarso District, East Hararghe, Ethiopia, 2022.

METHODS

Study design, setting and period

Institution-based retrospective cohort study design was conducted in Jarso District of East Hararghe Zone of Oromia Region, Ethiopia from March 01 to April 30, 2022. The zone consists of an estimated population of 170,005 with a total under-five child of 27,932 (Jarso District Health Office, 2022). According to the district health office, 1660 under-five children were admitted for SAM treatment in health facilities from January 2019 to December 2021 in the district. The district has 5 public health centers, 21 health posts, and 3 private clinics. Currently, all health centers in Jarso District provides inpatient SAM care services. The health centers have qualified health workers who are working in the management of SAM and using a standardized management protocol for SAM that was updated by Ministry of Health in 2019 (20,22). All records of under-five children who were admitted for SAM treatment in the health centers in Jarso District between January 2019 and December 2021 were used as the source and study population.

Inclusion and exclusion criteria

All records of children under the age of five years who received treatment for SAM in health centers in Jarso District and those records of SAM with complete information were included in the study. Children with SAM who did not have proper records (incomplete records) or missing charts in the logbook and who had been diagnosed and started treatment at other health facilities for treatment were also excluded.

Sample size calculation

The sample size was calculated using STATA/SE version 14 by considering the following assumptions: 95% confidence level, 80% estimation power, and 82% cumulative occurrence of cure rate and 1.78 HR (24). Finally, a total of 440 children with SAM were enrolled to this study from the treatment records.

Sampling procedures

Initially, all the health centers were listed and four health centers were selected among five health centers found in Jarso District using a lottery method. The selected health centers are Ejersa Goro Health Center, Alle Health Center, Ahmed Imam Health Center, and Kora Mite Health Center. Subsequently, a checklist for the management of severe acute malnutrition was created using the typical treatment procedure. The therapeutic feeding unit registration book was used to collect all cases of SAM starting from the most recent month backward, based on the sequence of their card number. Open-Epi software version 6.4 was used to generate

random numbers from the sampling frame (medical registration number). The first serial number or a unique SAM number was extracted from children's registration and entered from small to the highest into software to select a sample of 440 complete records. A systematic random sampling technique was used to select the samples until the desired sample size was obtained. During the three years, 1660 children under the age of five years were admitted to SAM. By calculating the interval from the sampling frame N and sample size n (k=N/n), the entire sample size for each year for each health center is proportionally allocated (Fig 1). Each year, the interval is approximately four for all selected health centers (k=4), which is similar. The first number to be used was chosen at random by lottery method.

Data collection tools and procedures

The data were collected using a pretested structured data abstraction tool and consisted of socio-demographic, comorbidities, feeding, and treatment-related factors, which were adopted and modified from different previous studies (2,22,24,25). Two trained health professionals with a Bachelor of Science (BSc) degree from each health center were recruited as data collectors. They were selected through a document review process based on a set of criteria for reviewing medical charts and severe acute malnutrition management protocol guidelines., In addition, one health care professional with a master's degree holder was recruited as supervisor per each health center. Data were gathered for baseline characteristics like socio-demographic data, immunization status, and baseline anthropometric data; type of malnutrition; comorbidities; routine medications, supplements, and therapeutic feedings such as F-75 and F-100 therapeutic milk, and Ready-to-use Therapeutic Food (RUTF); treatment outcome status, and recovery time.

The starting point for the retrospective follow-up study was the time from the first admission date and the endpoint date of recovery and censored. The recovery status of the children was obtained from the medical records. Recovery time was calculated as the time between the dates of admission to the date of recovery, censored. All clinical information of severely acute malnourished under-five children that fulfill the admission standards were admitted to TFU health centers from the first of January, 2019 to December 30th, 2021 retrospectively reviewed.

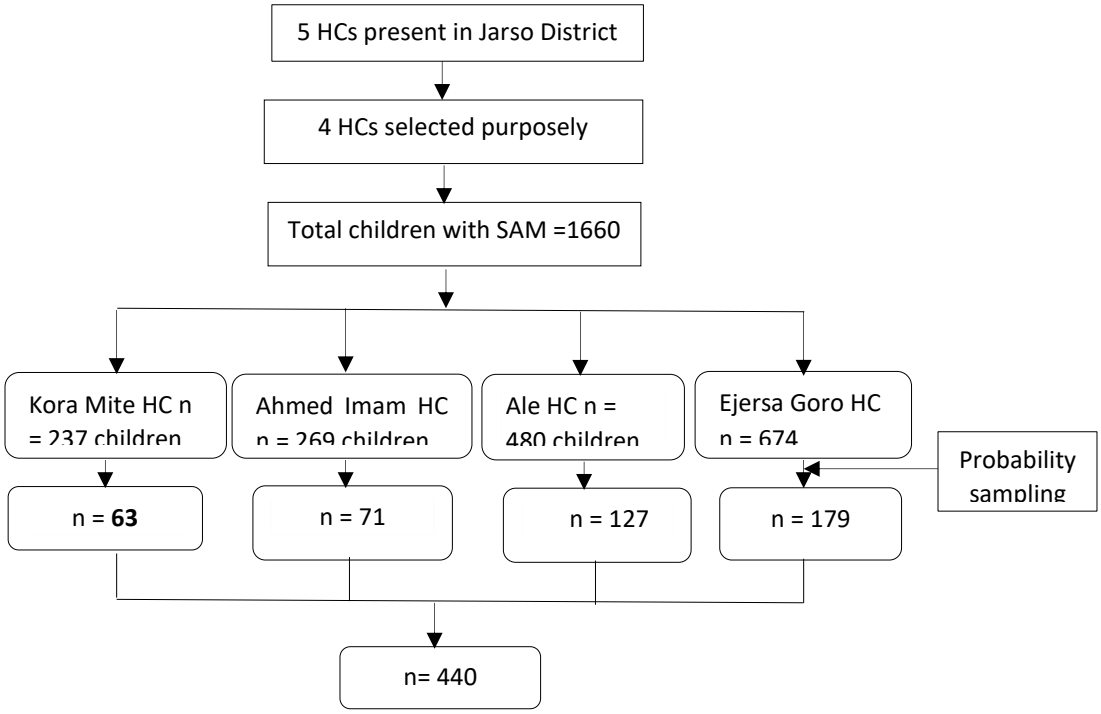

Figure 1: Sampling procedures of the study on time to recover from severe acute malnutrition among admitted children in Health Centers in Jarso District, Ethiopia, 2023.

Data quality assurance

Data quality was assured by designing proper data extraction tools and expertise assessed the adopted data extraction tools. A pretest was conducted on 5% of the sample size using a structured checklist at Aneno Health Center before starting the actual study period. Then, necessary corrections were made, unrecorded variables were removed, and others were arranged according to medical records. Training was provided for data collectors and supervisors before data collection. The actual data was collected under close supervision. After proper collection, supervisors regularly checked the information for completeness and consistency until data collection was completed. The investigator carried out systematic data-cleaning procedures to ensure the quality of both categorical and continuous variables. Subsequently, the investigators checked and verified variables with respective checklists if they were identified as unexpected or extreme. Lastly, the investigators conducted further cleaning by randomly selecting 10% (40 cards) from the total number of participants.

Data processing and analysis

Data were checked for completeness, accuracy, and missing values. After being coded, the data were imported into Epi-Data version 4.6 and exported to SPSS version 26 for analysis. Missing data were checked, and frequency calculation and cross-tabulation were used. The descriptive data were reported using graphs and frequency tables. Recovery time from SAM was estimated using Kaplan-Meier, and the Log-rank test was used to determine the significance of the observed recovery time difference between multiple groups of predictor variables. Before running the Cox proportional hazard regression model, multicollinearity was examined using the Variance Inflation Factor (VIF) and pairwise correlation. The proportional hazard assumption and the goodness-of-fit test were both confirmed using the log-likelihood value. Using variables from the bivariable analysis with a p-value of less than 0.25, the multivariable Cox proportional hazards regression model was constructed and fitted for every explanatory variable. Statistical significance predictors and the strength of association were determined using the hazard ratio (HR) with 95% CI and P-value <0.05.

RESULTS

Socio-demographic characteristics

The study included the records of 440 participants with 100% record complete rate of under-5 children diagnosed with severe acute malnutrition and admitted in three consecutive years (2019, 2020, and 2021) at TFU of health centers, Jarso District, Ethiopia. Of the total of 440 children in the cohort, 285 (64.8%) were female. The age of children ranges from 6 months to 57 months with a median age of 12 months and more than two-thirds 325 (73.9%) were older than 24 months. Concerning the WFAZ score of the children at admission, 183 (41.6%) of the children were in WFA Z score of <-2z score. About 333 (75.7%) of the children had in WFH Z score of >-3z score (Table 1).

Table 1: Socio-demographic characteristics of under-5 children admitted with severe acute malnutrition and treated in health centers of Jarso District from January 2019 to December 2021(N=440).

Characteristics	Categories	Frequency (n)	%
Age of the child	<24 months	115	26
	≥ 24months	325	74
Sex of the child	Male	155	35.5
	Female	285	64.5
Residence	Urban	75	17.1
	Rural	365	82.9
WFA Z score at admission	<-3 Z score	174	39.8
	-3 to -2 Z score	82	18.6
	>-2 Z score	183	41.6
WFH Z score at admission	≤-3 Z score	107	24.3
	> -3 Z score	333	75.7

Malnutrition and immunization status

Regarding nutritional status, about 124 (28.2%) of children were stunted. Of the children assessed for MUAC measurement, about 380 (86.4 %) had a MUAC of less than 11.5cm, 28 (6.4%) had a MUAC of 11.5 to 12 cm and the rest 32 (7.3%) had a MUAC of > 12cm (Fig 2). The mean weight of the children during admission was 8.97 (±2.10) Kg. Of the children admitted to the TFU, about 345 (78.4%) had marasmus, 42 (9.5%) of them had kwashiorkor and the rest 53 (12%) had marasmus kwashiorkor (Fig 2). About 144 (56%) of under-5 children were fully vaccinated for their age, 92 (35.9%) of them were partially vaccinated, and the rest 21 (8%) of children had not been vaccinated at all.

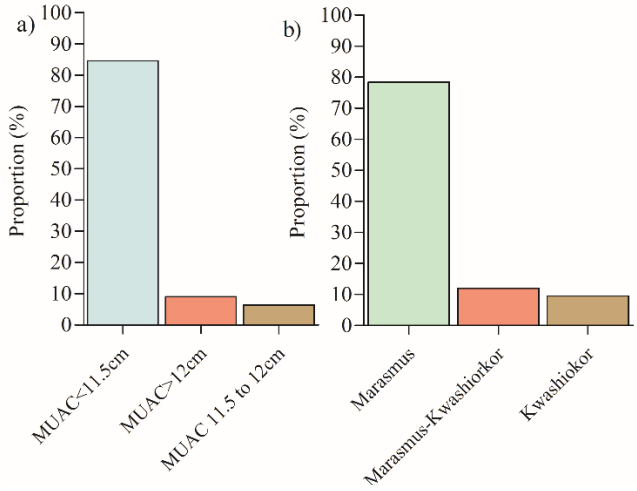

Figure 2: a) MUAC measurement representation; b) type of malnutrition among admitted under-5 children with SAM at health centers in Jarso district 2021.

Comorbid medical diseases before or after admission

Among all under-5 children included in the study, 409 (93%) of them had at least one form of comorbid disease. The most common medical comorbidities are accompanied by SAM were diarrhea and dehydration 66 (15%), fever 62 (14.1%), and shock (8.3%) (Table 2).

Table 2: Distribution of comorbid diseases among admitted children with severe acute malnutrition in Jarso District from January 2019 to December 2021 (N=440).

Characteristics	Categories	Frequency (n)	%
Dehydration	Yes	66	15
	No	374	85
Fever	Yes	62	14
	No	378	86
Axillary T^0	<38	7	11
	≥38	55	89
Congenital heart disease	Yes	66	15
	No	374	85
Tuberculosis	Yes	8	1.8
	No	432	98
Pneumonia	Yes	32	7.3
	No	408	92.7
Gastroenteritis	Yes	16	3.6
	No	424	96.4
Rickets	Yes	16	3.6
	No	424	96.4
Shock	Yes	38	8.6
	No	402	91.4

Management given

Of the children admitted for SAM management, 44 (10%) were mostly managed with prescribed routine medication with IV antibiotics (ampicillin, gentamycin, ceftriaxone) and oral antibiotics (amoxicillin, cotrimoxazole, azithromycin) 370 (84%). Concerning the deworming status of the children (≥ 2 years), about 169 (52%) of them were dewormed with Albendazole/ Mebendazole as an anthelminthic treatment. Regarding Vitamin A, 417 (94.8%) of children have received supplementation (Table 3).

Table 3: Management given to admitted children with severe acute malnutrition in Jarso District, 2021 (n = 440)

Characteristics	Categories	Frequency (n)	%
IV antibiotic/s	Yes	44	10
	No	396	90
Oral antibiotic/s	Yes	370	84
	No	70	16
Albendazole/Mebendazole	Yes	169	52
	No	156	48
	Not Applicable	115	26
IV fluid	Yes	44	10
	No	396	90
Vitamin A supplementation	Yes	417	95

	No	23	5

Treatment outcome compared to sphere project value by time series

Regarding the overall treatment outcomes of children with SAM, 364 (82.7%) of them recovered from their diseases compared to 76 (17.3%) of them whose treatment was censored. An analysis of treatment outcomes over time shows the recovery rate increased from 73.3% in 2019 to 93.2% in 2021. On the contrary, the censored rate decreased from 27% in 2019 to 2.3% in 2021 (Table 4).

Table 4: Treatment outcomes of children with severe acute malnutrition admitted in health centers of Jarso District 2021 (n = 440)

Variables		Frequency (n)	%
Outcomes of Treatment 2019	Recovered	143	73.3
	Censored	52	27
Outcomes of Treatement 2020	Recovered	152	88.9
	Censored	19	11.1
Outcomes of Treatement 2021	Recovered	69	93.2
	Censored	5	2.3
Overall	Recovered	364	82.7
	Censored	76	17.2

Kaplan-Meir survival estimates for severe acute malnutrition recovery time

Regarding the nutritional recovery rate of the admitted children, about 367 (82.7%) of them were among the entire subjects in the cohort. A total of 440 children were followed for different periods with a minimum of 11 days and a maximum of 81 days. The median nutritional recovery time for the children under 24 months was 28 days (95% CI: 26.1–29.9) while for the children over 24 months, it was 38 days (95% CI: 361–39.9). Regarding children's vaccination status, the median recovery time differed significantly between those who had full vaccinations for their age at 32 days (95% CI: 28.1–35.9) and those who did not receive any vaccinations at all (36 days; 95% CI: 34.4–37.6). In the same way, there was a significant nutritional recovery time difference between stunted children of 40 days, (95% CI: 37.8–42.2) and their counterparts of 22 days, (95% CI: 20.9–23.1) (Fig 3).

Children with pneumonia had a substantially different median nutritional recovery time, ranging from 35 days (95% CI: 32.2–37.8) to 28 days (95% CI: 24.9–31.1). Children who experienced shock complications at 36 days (95% CI: 34.3–37.7) and those who did not at 28 days (95% CI: 24.9–31.1) recovered at significantly different rates. Concerning Vitamin A supplementation, a notable difference in recovery time has been noted among children who received vitamin A for 18 days (95% CI: 17.0–20.1) and those who received it for 32 days (95% CI: 30.8–33.9). Children who received deworming, IV and PO antibiotics, various vitamins, and therapeutic feedings had been recovered significantly faster than their counterparts. Children who gained ≥8g/Kg of weight per day for 28 days (95% CI: 24.9–31.1) and those who gained < 8g/Kg for 55 days (95% CI: 38.1–70.0) showed a significant difference in recovery time (Table 5). The overall median

nutritional recovery time was 28 days (95% CI: 25.0–31.0).

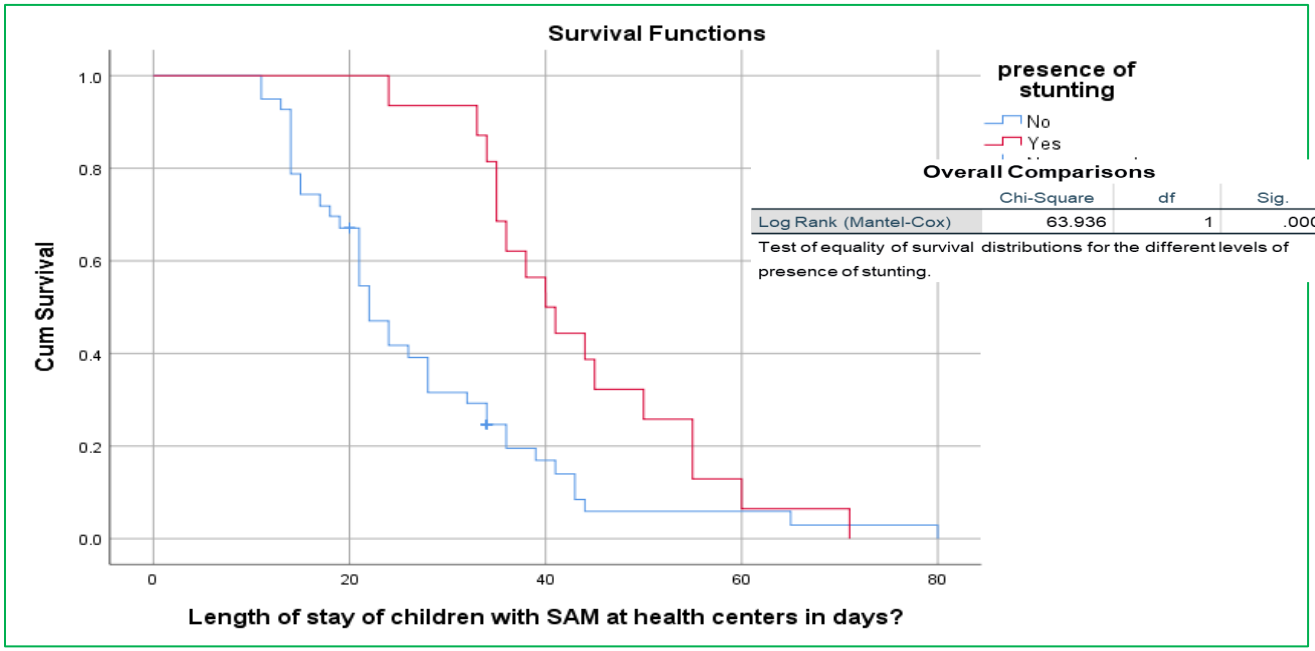

Figure 3: Kaplan-Meier survival curves comparing recovery time from severe acute malnutrition among under-5 children in Jarso district, Ethiopia, 2021

Table 5: Kaplan-Meir survival estimates for recovery time from severe acute malnutrition among admitted children in Jarso District from January 2019 to December 2021 (N=440)

Characteristics	Category	Median recovery time in days			
		Estimate X2-value	95%CI	Log-rank	P-Value
Age group	<24	28.00	26.13-29.87	7.87	0.005
	≥24	38.00	36.09-39.91		
Vaccination Status	Fully vaccinated	32.00	28.09-35.91	6.34	0.04
	Partially vaccinated	26.00	23.79-28.21		
	Not vaccinated	36.00	34.38-37.62		
Pneumonia	Yes	35.00	32.23-37.77	21.21	0.001
	No	28.00	24.88-31.13		
Stunting	Yes	40.00	37.82-42.18	63.93	0.001
	No	22.00	21.06-22.94		
Vitamin A	Yes	21.0	17.01-20.12	18.45	0.001
	No	32.0	29.29-34.71		
Shock	Yes	34.00	31.41-36.59	5.870	0.015
	No	24.00	23.14-24.87		
Daily weight gain	<8g/Kg/d	55.00	38.05-71.95	60.96	0.001
	≥8g/Kg/d	28.00	24.91-31.09		

Overall	28.00	24.98-31.02

Factors associated with time to recovery from SAM

Of all assessed factors associated with recovery time from severe acute malnutrition, thirty-four variables were analyzed in the Cox-proportional hazard analysis with the dependent variable. Ten variables with a p-value <0.25 in the bivariable Cox proportional hazard regression analysis was entered into multivariable Cox proportional hazard regression analysis after adjusting for confounders. Seven variables such as age, vaccination status, vitamin A supplementation, pneumonia, stunting, presence of shock during admission, and daily weight gain were significantly associated with the recovery time from severe acute malnutrition. The study revealed that, those children with an age <24 months were 11% times less likely to recover from severe acute malnutrition than those with an age group of ≥24 months (AHR=0.89, 95% CI: 0.78-0.99). Another result of this study showed that those under 5 children who had not been fully vaccinated for their age were 88% times less likely to recover from severe acute malnutrition than fully vaccinated children (AHR=0.12, 95% CI: 0.03-0.21). Children who had received vitamin A were 1.1 times more likely to recover from SAM than those children who had not received Vitamin A (AHR=1.08, 95% CI: (1.01-1.15). Those children who had developed pneumonia were 7% times less likely to recover from SAM than those children who did not develop pneumonia (AHR =0.93, 95 % CI: 0.89-0.97). This study also showed that stunted children were 3% times less likely to recover from SAM than their counterparts (AHR =0.97, 95 % CI: 0.96-0.98). Another result of this study signifies that those children who developed shock were 5% times less likely to recover from SAM than their counterparts (AHR = 0.95, 95 % CI:0.93-0.98). Those under -5 children who gained an average daily weight gain of <8g/Kg were 6% times less likely to recover from SAM than children who gained an average daily weight gain of >8g/Kg (AHR = 0.94, 95 % CI:0.91-0.96) (Table 6).

Table 6: Factors associated with recovery time from severe acute malnutrition among under-5 children admitted in health centers of Jarso District (N=440)

Covariates	Category	Recovery status		CHR (95%CI)	AHR (95%CI)	p-value
		Recovered	Censored			
Age	Age <24 months	309 (95%)	16 (4.9%)	0.75 (0.59-0.93)	0.89 (0.78-0.99)	0.008
	Age ≥24 months	86 (75%)	29 (25%)	1	1	
Residence	Rural	319 (97.9%)	7 (2.1%)	0.76(0.62-1.96)	0.99 (0.98-1.99)	0.201
	Urban	105 (92.1%)	9(7.9)	1	1	
Vaccination status	Fully vaccinated	249 (96.9%)	8 (3.1%)	1	1	
	Not fully vaccinated	175 (95.6%)	8 (4.4%)	0.79 (0.64-0.97)	0.12 (0.03-0.21)	0.024
Pneumonia	Yes	19 (59%)	13 (41%)	0.411(0.27-0.63)	0.93 (0.89-0.97)	<0.001
	No	392 (96.1%)	16 (3.9)	1	1	
Gastroenteritis	Yes	6 (38%)	10 (62%)	0.57 (0.14-1.95)	0.97 (0.94-1.99)	0.230
	No	409 (96%)	16 (3.9%)	1	1	
Stunting	Yes	86 (69%)	38 (31%)	0.44 (0.36-0.55)	0.97 (0.96-0.98)	<.001
	No	300 (94.9%)	16 (5.1%)	1	1	
Shock	Yes	16 (42%)	22 (58%)	0.64 (0.46-0.90)	0.95 (0.93-0.98)	0.011
	No	386 (96%)	16 (4%)	1	1	

deworming	Yes	100 (59%)	69 (41%)	1.14 (0.94-1.39)	1.085(0.965-1.221)	0.192
	No	255 (94%)	16 (5.9%)	1	1	
Vitamin A	Yes	209 (98%)	8 (1.9%)	2.96 (1.73-5.06)	1.08 (1.01-1.15)	<0.001
	No	15 (65.2%)	8 (34.8%)	1	1	
Daily weight gain	≤8g/Kg/d	264 (69%)	121(31%)16(	0.22 (0.15-0.35)	0.94 (0.91-0.96)	<0.001
	≥8g/Kg	39 (71%)	29.1%)	1	1	

Keynote: CHR=Crude Hazard Ratio, AHR= Adjusted Hazard Ratio (the model is adjusted for confounders by restricting the variables using p-value <0.25 in bivariable analysis and statistical significance declared at p-value <0.05 in multivariable analysis

DISCUSSION

In this study, about 82.7% of children were recovered. The median recovery time of the entire cohort was 28 days (95%CI: 24.98-31.02). The main contributing factors related to the recovery time were age, presence of stunting, presence of pneumonia, taking Vitamin A, daily weight gain, presence of shock, and immunization status. The nutritional recovery rate in this study was higher than those conducted in Zambia, Indonesia, Bahir Dar City, Ayder Hospital, Gedeo Zone-Health, Wolaita Zone, Debre Markos and Finote Selam Hospitals, Dilchora Dawa, and North Shoa Zone (3,8,15,17,19,22,25–28).

The discrepancy in recovery rates between Indonesia, Zambia, and Ayder Referral Hospital may be due to variations in sample size, sociodemographics, and healthcare infrastructure. However, compared to research conducted in Ghana, India, and Wolisso St. Luke Catholic Hospital, the recovery rates for the current study were lower (14,29,30). Perhaps because of the larger sample size, St. Luke Catholic Hospital has a higher recovery rate (14). The higher recovery rates in Ghana and India, however, may be attributable to factors such as differences in socioeconomic position, the standard of health care offered in each hospital, health-seeking behavior, and the availability of different drugs and therapeutic foods to treat SAM.

The median nutritional recovery time is similar to the median recovery time reported from the study conducted in the cities of Woliso, Bahir Dar, Dilla University referral hospital, and Zambia (22,23,25,29). It exceeded, nonetheless, a report of the nutritional recovery time from research conducted in India, Zambia, Dilchora Referral Hospital, Hadia Zone, and North Shewa Zone (12,19,26,28,31). It might be because of low socioeconomic status, along with treatment and caring practices of the low nutritional recovery times in India and Zambia, while high displacement rates and low socioeconomic status in the study area may be the cause of Ethiopia's longer nutritional recovery times compared to other settings.

However, the nutritional recovery time was higher than in some studies conducted in Gambia, Gedeo Zone, and Ayder Referral Hospital (8,30,32). In this study, very high nutritional recovery time differences have been observed in under-5 children with shock, and without shock which were 34 days and 24 days respectively, and; between under-5 children who have taken vitamin A and those who were not received Vitamin A were 21 days and 32 days respectively.

Concerning the predictors of nutritional recovery time, from all socio-demographic characteristics, age was the only significant factor for nutritional recovery time. The study showed that, those children with an age <24 months were 11% times less likely to recover from severe acute malnutrition than those with an age group of ≥24 months. The scientific rationale for this may be related to those children below 24 months being more vulnerable due to the immaturity of their immunity and sometimes incorrect supplemental feeding habits and the cessation of nursing as children become severely ill. The study is consistent with research conducted in Northern India, hospitals in Debre Markos, and

Finote Selam (33, 40). However, research conducted in Malawi, Wolisso, the Gamo-Gofa Zone, and the Shebedido District outpatient program (OTP) center contradicts with these findings (13,23,33,34). Variations in the research design and the healthcare setting could be the cause of this difference.

The result of the study revealed that under-5-year-olds who were not fully immunized for their age were less likely to recover from severe acute malnutrition than their counterparts. Without vaccinations, kids were unable to defend themselves against major ailments including measles, pneumonia, diarrhea, and malaria. A child's immune suppression issue is made worse when they are undernourished. As a result, the child needs extra time to recover from some childhood illnesses (9,35). The results of this study corroborate those of a study conducted in Bahir Dar (2). Pneumonia and shock were the two comorbidities that had the greatest impact on how quickly patients recovered from SAM. Children with pneumonia had less likely to recover from severe acute malnutrition than their non-pneumonia counterparts. This might be explained in terms of how pneumonia and malnutrition interact. Children with respiratory infections like pneumonia may exhibit tachypnea, retractions, and other signs of respiratory distress, whereas SAM patients do not exhibit these signs. Because of this, health professionals could miss the detection and treat patients while they are still in health centers.

The study is consistent with a retrospective cohort analysis conducted at Mehal Meda Primary Hospital, Debre Berhan Referral Hospital, and Enat General Hospital (26,28,29). Retrospective cohort research conducted in Southern Ethiopia, the Wolaita Zone, and Bahir Dar City found that pneumonia was not a reliable indicator of the length of time needed for nutritional recovery (12,21,22). Since pneumonia is hospitalized for malnutrition in those hospitals, it might be recognized and treated earlier than it is in the current study environment.

Those stunted children had less recovery time from severe acute malnutrition than those children who were not stunted. The management of severe acute malnutrition is the same whether or not there is stunting, but the most stunted children have the highest risk of failing to react to therapy and stay longer in the health center, which may account for this link due to this may occur during intrauterine growth restriction or perinatal malnutrition. About 28% of under five children in this study were stunted, but, none of the studies done in Bahir Dar City, Debre Markos and Finote Selam, Debre Berhan Referral, Enat General Hospital, and Mehal Meda Primary Hospital included stunting as a co-factor for nutritional recovery time (13,22,28).

This study showed that those children who were in shock during treatment were less likely to recover from SAM than children who were not. Unless it is prevented and detected early, shock could compromise many vital organs including the brain, heart, and kidney, especially when children are under starvation of cellular energy (27,34).

In contrast, research conducted in two hospitals found in Wolaita was not significantly associated with the shock status and recovery time from severe acute malnutrition (21). The difference might be due to the fact that healthcare providers at some hospitals were able to identify and treat the underlying causes of shock early which shortened the length of time children needed to be in the hospital. However, since the current study was conducted at a health center, it is possible that the medical staff lacked the necessary skills to treat and manage shock, resulting in a prolonged hospital stay.

Concerning the treatments, supplements, and therapeutic feedings, vitamin A supplementation was the only significant factor for the nutritional recovery time of under-5 children. Under-5 children who received vitamin A had more recovery time from severe acute malnutrition than those who did not receive it. The scientific description for this report could be that giving children extra vitamin A helped them recover faster by boosting their immunity (2).

However, research conducted in Bahir Dar City, Shebedino District, and South West Ethiopia found no link between vitamin A supplementation and the length of time needed for nutritional recovery (22,27,34). The most likely reason for the difference might be a smaller number of sample size and small proportion of children received vitamin A in these studies, as a result, the association with nutritional recovery time could not be met.

The daily weight gain/Kg was calculated for 345 (78% of the total) marasmic children. One-hundred-sixty (46.3%) children gained <8g/Kg/day and the rest 185 (53.7%) children gained an average weight of ≥8g/Kg/day. Children with an average daily weight gain of <8g/Kg were around 77.6% less likely to get well faster than children whose average daily weight gain was >8g/Kg. The scientific basis of the association is clear: since gaining weight is one of the requirements for discharge, a certain amount of daily weight gain is necessary for children with marasmic syndrome to recover as quickly as possible. The study is consistent with a study done in Bahir Dar City (22), but other findings do not incorporate weight gain as a co-factor (27,28). These might be due to the factors related to socioeconomic, nutritional status, and study population.

Strengths and limitations of the study

A key strength of this study is that it included 80% of health centers in the study area to increase representativeness and incorporate more covariates like stunting and shock during admission which were not included in previous retrospective cohort studies. As a limitation of the study, since the study was retrospective and depended on secondary sources of data other parental socio-economic factors were not examined in the study. Lack of dietary data and nutrient intake information were also another limitation of the study.

Conclusions

Both the overall recovery rate and the nutritional recovery time fell within the range of the acceptable minimum standard specified by the sphere project/international standards value. Child age, daily weight gain, not fully vaccinated children, presence of pneumonia, presence of stunting, presence of shock, and Vitamin A supplementation were the predictors of time to recovery from severe acute malnutrition among under-5 children. The district health office and concerned stakeholders should work on child nutrition activities and the management of acute malnutrition, as per national protocol, to improve the recovery time from SAM with appropriate weight gain among under-five children. In addition, working on early detection and management of children with SAM, treatment of secondary complications of malnutrition and provision of Vitamin A supplementation are the recommended activities to improve recovery time from SAM.

Future researchers should use a prospective cohort study design because this analysis of secondary data was conducted using health facility-based retrospective data and does not account for other factors such as parental sociodemographic and socioeconomic characteristics, the educational status of the health workers, or caregivers' perceptions towards severe acute malnutrition.

Acronym and abbreviations

AGE-Acute Gastro Enteritis, AHR-Adjusted Hazard Ratio, CD-Co-morbid Diseases, CHD-Congenital Heart Diseases, CHR-Crude Hazard Ratio, DHN-Dehydration, EDHS-Ethiopian Demographic and Health Survey, FA-Folic Acid, FMOH-Federal Ministry of Health, IV-Intravenous, KM-Kaplan-Meier, MUAC-Mid Upper Arm Circumference, NGO-Non-Governmental Organization, OTP-Out Patient Program, ReSoMal- Rehydration Solution for Malnutrition, RCT-Randomized Control Trial, RUT-Ready to Use Therapeutic Food, SAM-Severe Acute Malnutrition, SD-Standard Deviation, TB-Tuberculosis, TFC-Therapeutic Feeding Center, TFU-Therapeutic Feeding Unit, UNICEF-United Nations International Children's Emergency Fund, WFA-Weight -for –Age, WFH-Weight- for –Height, WHO-World Health Organization, WHZ-Weight-for -Height Z score

Ethical considerations

The ethical approval was obtained from the Ethical Review Committee of Salale University and a permission letter was obtained from all health centers in the Jarso District Health Office. Additionally, at the selected study unit, the assigned health personnel as data collectors obtained informed written consent to extract the child's medical records and the necessary information before the commencement of the study from all selected health centers. Privacy and confidentiality of the study participants were maintained by making the data concept form retrospectively and anonymously before giving training for data collectors on how to keep the data confidential.

Acknowledgements

We would like to express our sincere appreciation and thanks to Salale University for giving us the chance and the funding. We would also like to extend our sincere gratitude to the data collectors, managers, study subjects, and the Jarso District Health Office for their kind assistance while conducting this study.

Authors' contributions

EMT and AHG participated in conceptualization, data curation, formal analysis, investigation, funding acquisition, methodology, project administration, resources, software, supervision, and validation, visualization, writing original draft, writing review & editing the manuscript. KK, RS, and DBS are involved in the methodology, resources, data curation, supervision, validation, review, and editing of the manuscript.

Funding

The financial fund was covered by Salale University on behalf of the Oromia Health Bureau.

Availability of data and materials

All data generated during and/or analyzed during the study are available from the corresponding author upon reasonable request.

Competing interests

The authors declared that they have no potential competing interests.

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