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Original research

Time to recovery and its predictors among under-five children with severe acute malnutrition in Metekele Zone, Northwest Ethiopia: A retrospective follow-up study

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ABSTRACT

Background: *Severe acute malnutrition is characterized by a weight-for-height measurement below -3 standard deviations of the World Health Organization (WHO) growth standards or a mid-upper arm circumference of less than 115 mm in children older than six months, and/or the presence of bilateral edema. Despite therapeutic programs, recovery time from severe acute malnutrition remains concerning in Ethiopia. This study assessed recovery time from severe acute malnutrition and its predictors among children under five admitted to stabilization centers in Metekele Zone, Northwest Ethiopia, 2022.*

Methods: *From May 29 to June 21, 2022, a retrospective follow-up study was conducted involving 512 participants selected through a simple random sampling technique among children admitted with severe acute malnutrition. A structured checklist was employed to extract necessary data from medical logbooks and record folders. After being entered into Epi-data and data were subsequently exported to Stata version 15.0 for analysis. Survival time was estimated using the Kaplan-Meier curve, while a Cox proportional hazards regression model identified predictors of time to recovery.*

Results*: A total of 350 children (68.36%) recovered, with an incidence rate of 6.4 per 100 child-days (95% CI: 5.75-7.09). The median time to recovery was 13 days. Predictors of time to recovery included the absence of tuberculosis (AHR=1.98, 95% CI: 1.23-3.19), HIV-negative status (AHR=2.62, 95% CI: 1.45-4.73), and intake of F-100 milk (AHR=2.41, 95% CI: 1.07-5.43).*

Conclusion*: Although the median recovery time was within acceptable limits, the overall rate did not meet Sphere standards. Clinical efforts should prioritize children with tuberculosis, HIV-positive status, or those lacking F-100 formula milk to facilitate early recovery.*

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INTRODUCTION

Malnutrition is an abnormal physiological state from an imbalance, deficiency, or excess in energy and nutrient consumption (1). This condition includes under- and over-nutrition, causing structural and functional damage with distinct physical effects (2). Childhood undernutrition involves disorders including wasting (low weight-for-height), stunting (low height-for-age), underweight (low weight-for-age), and micronutrient deficiencies(3). Severe acute malnutrition (SAM) is defined as a weight for length/height ratio less than minus three World Health Organization (WHO) growth standards for children over six months (4) caused by immediate, basic, and underlying factors (1).

SAM remains a leading cause of under-five mortality (5). In 2021, there were 149.2 million children under the age of five who were stunted, 45.4 million who were wasted, and 38.9 million who were overweight, with 1.3 million experiencing severe wasting. Two-thirds of wasted children live in Asia, and one-quarter in Africa (6).

Globally, malnutrition causes 50-60% of under-five deaths (7), with severe wasting causing 4.4% of fatalities (8,9). Children with SAM face a twelve times greater mortality risk than well-nourished children (10). Annually, 3 million children under five die from SAM worldwide (11), mostly in South Asia and sub-Saharan Africa (12). SAM accounts for over half of infant and child deaths (13) and ranks third in under-five mortality, with over 25% occurring during inpatient care (14,15). Ethiopian hospitals admit 25,000 under-five children with SAM monthly (16), comprising 20% of pediatric admissions (17).

Per Sphere standard, SAM children should recover >75% within 28 days (18). Ethiopian recovery rates range from 25.6% to 82.4% at therapeutic feeding centers (TFCs) (19,20) with recovery times of 11 days to 8.7 weeks (21,22). Recovery predictors include age (23), sex (24), residence(25), vaccination (26), breastfeeding (27), malnutrition type (24), baseline anthropometry (23), comorbidities like HIV, pneumonia, Tuberculosis (24,28), diarrhea, malaria, anemia, shock, vomiting, hypothermia, palmar pallor (29), dehydration, medications, feeding status (20) and stabilizing centers (30).

WHO developed SAM management guidelines in 1999, updated in 2013, where adherence reduces CFR by 10% in inpatient settings(4). Ethiopia piloted an outpatient therapeutic feeding program (OTP) in 2004, now nationwide. Services evolved to community-based therapeutic care (CTC), including outreach, OTP, targeted supplementary feeding (TSF), and inpatient treatment (31). Ethiopia launched the

"Seqota declaration" to end undernutrition by 2030 (32). In the country, studies on recovery time and predictors among hospitalized SAM children (25,26,33,34) were mostly limited to children above six months and single centers. The aim of the present study was to assess the recovery time and the factors predicting it in children under five years old with Severe acute malnutrition at stabilizing centers at public health centers in the Metekele Zone, Northwest Ethiopia.

METHODS

Study area and period

An institution-based retrospective follow-up study was conducted among children below five years with severe acute malnutrition at stabilizing centers in Metekele Zone, Northwest Ethiopia, from May to June 2022. Metekele Zone, in Benshagul-Gumuz Region, is located 540 km from Addis Ababa. The estimated total population of the zone was 485,118 in 2007, with 78,330 children under five years. It contains eight rehabilitation and 168 OTP centers, with pediatric wards having isolated rooms for therapeutic feeding. The centers follow standard protocols for treating severe acute malnutrition. SAM cases with co-morbidities were admitted for inpatient management, while those without co-morbidities were managed as outpatients. Patients meeting discharge criteria were linked to community-based feeding programs.

Population and sampling

The study population comprised children under five years admitted with SAM at stabilizing centers in the study area from January 2017 to December 2021. Children were included if diagnosed with WFH/L <−3 Z score or MUAC <115 mm with length > 65 cm for those above six months, or bilateral pitting edema with complications. Cases with incomplete records were excluded.

Minimal sample size was estimated utilizing STATA Version 15, considering 5% significance level, 80% power, AHR of 1.36 for SAM children with anemia, recovery probability of 0.692, and 0.5 covariate variability. Adding 10% contingency, the total sample size was 528. Records from Metekele Zone stabilizing centers were merged: Pawi General Hospital (366), Bullen Health Center (64), Dangure Health Center (55), and Mandura Health Center (43). A sampling frame was prepared from selected centers' registration logbooks, and participants were selected using simple random sampling. Individual cards were retrieved using patient medical record numbers.

Data collection procedure

Data extraction tools adapted from SAM treatment protocols(4), registration logbook, monitoring charts, and literature were used to

extract patient record information. Four SAM-trained and experienced data collectors were recruited and trained for two days on collection tools and procedures. The checklist was pretested on 26 records at Jawi Hospital, with amendments made based on findings. The follow-up period was from the first SAM admission to recovery or censoring (death, default, transfer, non-response). Collected data was stored daily to minimize field data loss.

Study variables and measurement

The dependent variable was time to recover from SAM, with recovery as the event of interest. Independent variables included socio-demographic data, admission categories, clinical characteristics, SAM diagnoses, anthropometric measurements, complications, feeding types, medication, and facility type.

Severe acute malnutrition is characterized by a weight-for-height below -3 Z scores of the median WHO growth standards, the presence of bilateral pitting edema, or a mid-upper arm circumference < 115 mm for a child aged ≥6 months (4).

Time to recovery is the duration from the initiation of treatment at SC to the time at which a study participant is discharged with recovery status (24).

Recovery is identified when the child is free from medical complications, exhibits no edema, and achieves adequate weight gain for children older than six months. For infants below 6 months, it is declared when the infant demonstrates weight gain solely on breast milk following the implementation of the supplemented suckling technique, and there are no medical issues (4).

Survival time is the period of follow-up from the initial admission to SC until the child develops an event (24).

Censored refers to those children with SAM who either died, defaulted, were medically transferred to another Health facility, or did not respond to treatment (24).

An incomplete record pertains to children with SAM admitted to stabilization centers (SCs) with incomplete documentation, such as missing age, admission and discharge dates, SAM type, and treatment outcomes (35).

Data Processing and Analysis

After entering the data into EpiData 3.1, the data were exported to STATA 15 for cleaning and analysis. The event of interest (recovery) was coded “1”, whereas censored observations were coded “0”. Frequencies, percentages, median, IQR, standard deviation, and incidence density were calculated. The Kaplan-Meier survival method estimated recovery time, while the Log-Rank test assessed differences between variable categories. The Cox proportional hazard model identified recovery predictors among children under five with SAM. Variables having a p-value ≤0.25 in bi-variable analysis were included in multivariable Cox regression. Variables having a p-value <0.05 and 95% CI were considered significant predictors in the final model. Model adequacy was checked using a log-log plot, the global goodness of fit test,

and the Nelson-Aalen cumulative hazard function.

Ethics approval

Ethical clearance (IHRPGY/576/22) was obtained from Jimma University's Institute of Health. A support letter was obtained from the Metekele Zone health department. Participant privacy was maintained by excluding names, and data was not shared with third parties.

RESULTS

Sociodemographic characteristics

Of 528 under-five children with SAM admitted, 512 (97%) had complete records. About 357 (69.7%) were from General Hospital, with 173(33.79%) of children aged 12-23 months. In addition, 330 (64.45%) were from rural areas, with a mean age of 21 months (±13.8).

Table 1. Baseline characteristics of participants, Metekele Zone, NW Ethiopia, 2022.

Variables	Characteristics	Frequency	Percent
Gender	Male	260	50.78
	Female	252	49.22
Age in months	0-5	30	6.05
	6 -11	87	16.80
	12-23	173	33.79
	24-35	101	19.73
	36-47	75	14.65
	48-59	46	8.98
Residence	Urban	182	35.55
	Rural	330	64.45
Health facility	Hospital	357	69.73
	Health centers	155	30.27

Clinical presentation

In this study, 394(76.95%) had at minimum of one medical complication at admission (figure 1). During admission, 158(69.14%) had altered respiratory rate, 81(15.82%) had altered body temperature, and 202 (39.45%) had vomiting (Table 2).

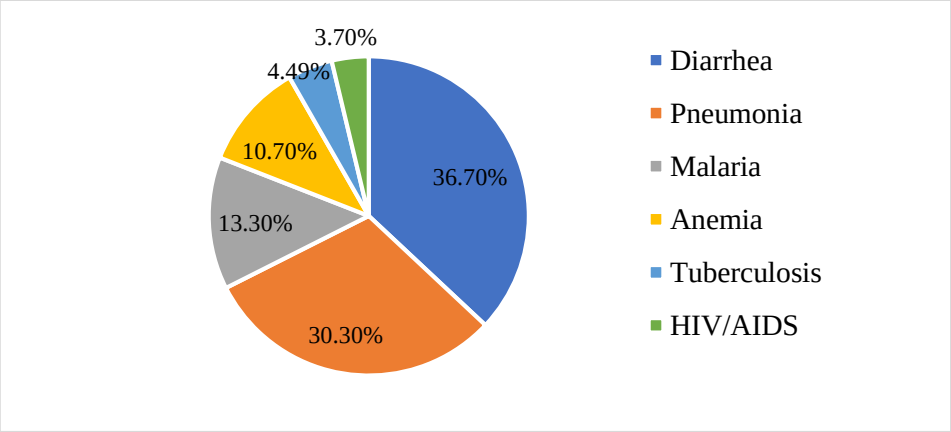

Figure 1. Major medical complications among study participants, Metekele Zone, 2022.

Table 2. Baseline clinical presentation of participants at public health facilities, Metekele Zone, Ethiopia, 2022.

Variables	Characteristics	Frequency	Percent
Vomiting	Yes	202	39.45
	No	310	60.55
Hypoglycemia	Yes	56	10.94
	No	456	89.06
Temperature	Altered	81	15.82
	Normal	431	84.18
Pulse rate	Altered	89	17.68
	Normal	423	82.62
Respiratory rate	Normal	354	69.14
	Altered	158	30.86
Level of consciousness	Conscious	481	93.95
	Impaired	31	6.05
Palmar pallor	Present	57	11.13
	Absent	455	88.87
Conjunctiva	Pink	441	86.13
	Pale	71	13.87
Dehydration	Yes	44	23.28
	No	144	76.72
Shock	Yes	10	1.95
	No	502	98.05
Skin lesion	Present	45	8.79
	Absent	467	91.21

Key (Altered**:** bradycardia or tachycardia for respiratory and pulse rate), (alter: hypothermia or hyperpyrexia for temperature)

Anthropometric characteristics

In the current study, 289 (56.45%) of SAM children had WFH less than -3 Z-scores. At admission, the mean MUAC was (±28.2) mm. For admitted SAM children types, 299 (58.39%) were marasmus, 110 (21.68%) marasmic-kwashiorkor, and 103 (20.31%) kwashiorkor (Table 3).

Medication-related characteristics

In this study, 482 (94.14%) received formula milk F-75, and 359 (70.12%) received F-100. Of participants, 363 (70.90%) received medication orally, while 149 (29.10%) received it through a nasogastric tube. In addition, 364 (71.09%)

received amoxicillin, and 285 (55.66%) received Vitamin A (Table 4).

Table 3. Baseline nutritional status study participants, Metekele Zone, Ethiopia, 2022.

Variables	Characteristics	Frequency	Percent
Nutritional edema	Yes	213	41.61
	No	299	58.39
Grade of edema	Grade 1	13	6.10
	Grade 2	45	21.13
	Grade 3	155	72.77
MUAC	<115mm	345	67.38
	≥115mm	137	26.76
WFH z-score	Z score <-3	289	56.45
	Z score ≥ -3	223	43.55
SAM type	Kwashiorkor	103	20.31
	Marasmus	299	58.20
	Marasmic-Kwashiorkor	110	21.68
Admission type	New	451	88.09
	Re-admission	61	11.91

Table 4. Nutritional therapy and medication distribution for study participants, Metekele Zone, Ethiopia, 2022

Variables	Characteristics	Frequency	Percent
F-75 formula milk	Yes	482	94.14
	No	30	5.86
F-100 formula milk	Yes	383	74.80
	No	129	25.20
Means of feed	Orally	363	70.90
	NGT	149	29.10
Plumpy nut	Yes	360	70.31
	No	152	29.69
Vitamin A	Yes	285	55.66
	No	277	44.34
Deworming	Yes	237	46.29
	No	275	53.71
Folic acid	Yes	89	17.38
	No	423	82.62
Antimalarial	Yes	79	15.43
	No	433	84.57
Amoxicillin	Yes	364	71.09
	No	148	29.91
IV antibiotic	Yes	495	96.68
	No	17	3.32
Resomal	Yes	44	8.59
	No	468	91.41
Blood transfusion	Yes	34	6.64
	No	478	93.36

Time to recovery

The study followed 512 SAM children between January 1, 2017, and December 30, 2021, with follow-up ranging from 1 to 44 days. Of these, 350 children recovered (68.36%, 95% CI: 64.32-72.40) while 162(31.64%) were censored. The total observation time was 5,479 days, with a recovery incidence rate of 6.4 (95%:5.75-7.94) per 100 child-days. Cumulative

recovery probability at 1st, 2nd, 3rd, and 4th weeks were 96%, 43%, 10%, and 0.3%.

The median time to recovery and follow-up period was 13days (IQR=10-16) and 10 days (IQR: 6-14), respectively. Median time to recovery was significantly different across categories of HIV status, TB status, and F-100 milk consumption status (Figure 2A, 2B, and 2C).

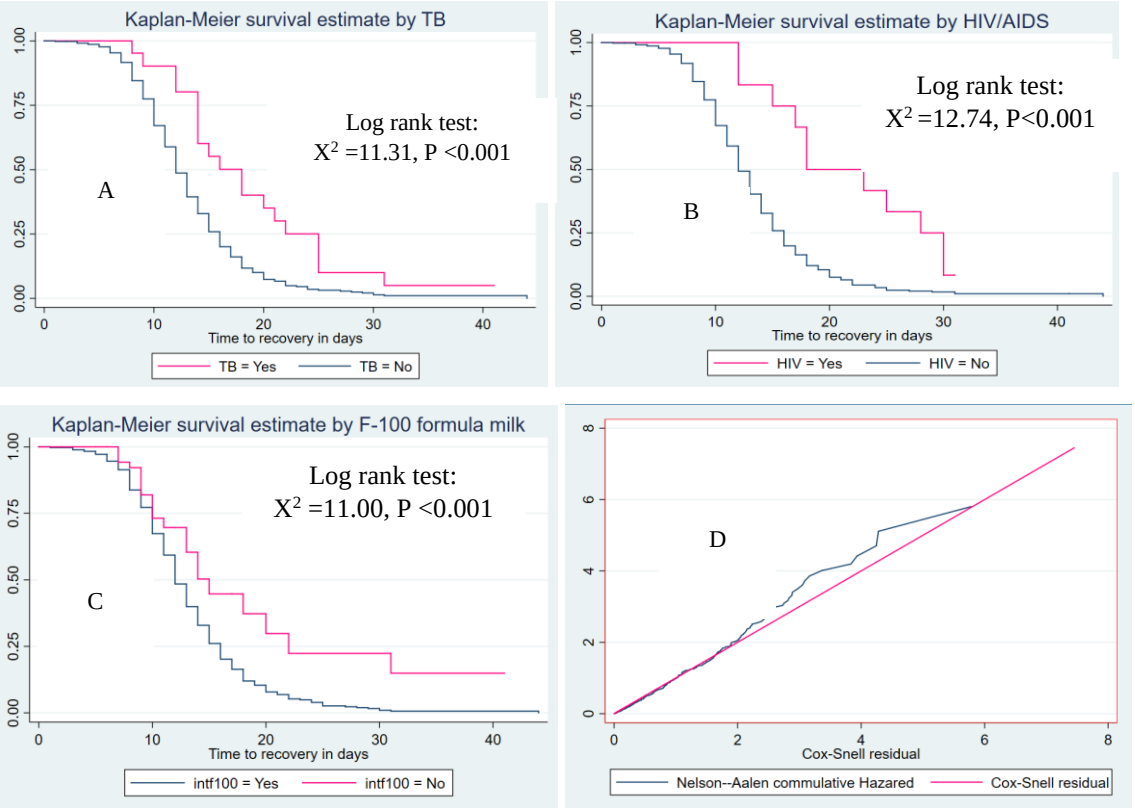

Figure 3. Kaplan-Meier survival estimate across categories of predictors and model adequacy, Metekel Zone, Ethiopia, 2022

Predictors of time to recovery

Variables with p-value <0.25 in bivariable Cox proportional hazard regression were entered into multivariable Cox regression analysis, including residence, bottle feeding history, TB, HIV/AIDS, F-100 formula milk, plumpy nut intake, feeding means, vitamin-A, deworming, folic acid, intravenous fluid, and blood infusion. After controlling for confounders, children without HIV (AHR:2.62, 95% CI: 1.45-4.73), children without TB (AHR: 1.98, 95%CI: 1.23-3.19), and children taking F-100 milk (AHR=2.41: 95% CI: 1.07-5.43) have higher recovery probability than their counterparts (Table 5). Figure 2D illustrates that the Cox-Snell residuals closely follow the 45-degree reference line, indicating that the model provides a good overall fit to the data

Table 5. Predictors of time to recovery from SAM, Metekel Zone, Ethiopia, 2022

Variables		Survival status		P-value	Crude Hazard Ratio	Adjusted Hazard Ratio (95%CI)	P-value
		Recovery	Censored				
HIV/ AIDS	Yes	12	7		Reference	Reference	
	No	338	155	0.001	2.76(1.50-5.08)	2.62(1.45-4.73)	0.001*
Tuberculosis	Yes	19	4		Reference	Reference	
	No	331	158	0.003	2.04(1.28-3.25)	1.98(1.23-3.19)	0.005*
Bottle feeding	Yes	37	15		Reference	Reference	
	No	313	147	0.23	1.23(0.88-1.74)	1.20(0.85-1.71)	0.31
Residence	Urban	120	62	0.02	0.78(0.62-0.97)	0.82(0.65-1.03)	0.09
	Rural	230	100		Reference	Reference	
Plumpy nut	Yes	334	26	0.003	2.53(1.53-4.20)	1.10(0.61-2.01)	0.74
	No	16	136		Reference	Reference	
Means of feed	Orally	296	67	0.08	0.77(0.58-1.03)	0.99(0.69-1.41)	0.97
	NGT	54	95		Reference	Reference	
Vitamin A	Yes	246	39	0.09	1.22(0.96-1.53)	0.97(0.73-1.29)	0.84
	No	104	123		Reference	Reference	
Intake of F-100 milk	Yes	341	42	0.001	3.13(1.60-6.13)	2.41(1.07-5.43)	0.033*
	No	9	120		Reference	Reference	
Deworming	Yes	212	25	0.05	1.24(1.01-1.54)	1.15(0.89-1.48)	0.26
	No	138	137		Reference	Reference	
IV-fluid	Yes	3	15	0.07	0.35(0.11-1.08)	0.33(0.10-1.07)	0.06
	No	347	147		Reference	Reference	
Folic acid	Yes	47	42	0.15	0.79(0.59-1.09)	0.86(0.61-1.22)	0.41
	No	303	120		Reference	Reference	
Blood transfusion	Yes	16	18	0.22	0.73(0.44-1.20)	0.91(0.53-1.56)	0.72
	No	334	144		Reference	Reference	

* (significant at p-value <0.05)

DISCUSSION

In this study, 68.36% of children recovered from severe acute malnutrition, aligning with studies from Hawassa (68%), Nekemet (66.8%), Assossa (64.5%), and Gondar (69.2%) (20,36–38). This was higher than studies in Felege-Hiwot (51.9%), Aksum (56%), Afar (62.89%), and Bahir-Dar (58.4%) (25,28,29,34), possibly due to socio-demographic variations, patient load, and adherence to guidelines

The finding is lower than humanitarian charter standards and national SAM protocol (>75%) (18), and studies from East Amhara (74.5%)(74.5%), Waghimra (80.4%), Jimma (73.1%), and Debre-Markos (77.9%) (22,26,33,39). This discrepancy may occur from variations in settings, healthcare setup, patient load, late presentation, and comorbidities. High numbers of defaulted and deceased SAM children in TFUs contributed to the low recovery rate. Additionally, pastoralist residents have limited treatment center access, and maternal decision-making ability impacts outcomes (2).

The median recovery time of 13 days meets international standards (<28 days) (18) and is consistent with findings from Hawassa (12 days) (20). This is faster than studies in Malawi (49 days) (40), Bahir Dar (16 days)

(28), Jimma Hospital (26 days) (19), Felege-Hiowt (18 days) (34), and Afar (21 days) (25), possibly due to differences in study settings and severity of cases.

The nutritional recovery time exceeds studies from East Amhara, Debere-markos, Gondar, and Waghimra Zone (11 days) (22,35,36,39). This difference may be due to underlying co-morbidities, complications, healthcare practices, facility setup, and socioeconomic variations.

Children without tuberculosis at admission were 1.78 times more likely to recover than those with tuberculosis, consistent with studies from the Amhara region, St. Paul's Hospital, Gondar, and Ayder Hospital (24,36,41,42). Malnutrition facilitates TB infection progression due to immunosuppressive effects, creating a cycle of worsening illness and nutritional status (43).

SAM children without HIV/AIDS were 2.65 times more likely to recover than those with HIV/AIDS, supported by studies from Debre-Markos, Amhara, Bahir-Dar, and Assosa (24,28,38,39). Malnutrition and HIV have a synergistic relationship, causing immune system damage. HIV increases nutritional requirements while reducing nutrient absorption through gastrointestinal complications (44). Malnutrition accelerates HIV progression by decreasing CD4 T cells and altering immune responses (45).

In the current study, SAM children receiving F-100 milk had 2.41 times higher chance of recovery compared to others, supported by studies at St. Paul's Hospital, Ayder Hospital, and Southern Ethiopia (41,42,46). F-100's higher calories (100 kcal/100 ml) increase daily weight gain and improve treatment outcomes (46). F-100 formula milk helps restore normal physiology after reductive adaptation, achieving catch-up growth and target weight (47).

Strengths and limitations

This study covered multiple treatment centers in Metekel Zone; it has limitations. First, incomplete secondary data may produce bias from excluded records and measurement quality issues. Second, health professionals' varying skills could affect treatment and record-keeping. Finally, important variables, including parental socioeconomic status and perception of caregivers on the therapeutic feeding program, were not included due to the nature of the data source.

CONCLUSION

The nutritional recovery rate from severe acute malnutrition in Metekele Zone was below the minimum sphere standard and the national protocol. Median recovery time met national and international standards. Absence of tuberculosis, HIV negative status, and F-100 milk intake were predictors of recovery

time. Clinical efforts should prioritize children with tuberculosis, HIV-positive status, or those lacking F-100 formula milk to facilitate early recovery.

Declarations

Abbreviations

AHR: adjusted hazard ratio, CHR: crude hazard ratio, CI: confidence interval, MUAC: mid-upper arm circumference, MAM: moderate acute malnutrition, SAM: severe acute malnutrition, SC: stabilizing center, TFC: therapeutic feeding center, WFH: weight for height.

Consent for publications

Not applicable

Availability of data and materials

The corresponding author can provide the necessary data upon reasonable request.

Competing interests

No declared conflicts of interest

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