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Anthropometric recovery of children 6-59 months with complicated severe acute malnutrition, treated in public hospitals of Sana'a City

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ABSTRACT

Background: The management of severe acute malnutrition (SAM) in inpatient therapeutic feeding centers (TFCs) is a life-saving intervention for children 6-59 months in Yemen.

Aims: To evaluate the anthropometric recovery of children admitted to the TFCs and transferred to complete treatment in outpatient programs (OTPs) of Sana'a City Public Hospitals.

Methods: A prospective follow-up study for children admitted to TFCs from September 2023 to April 2024 was conducted. The anthropometry measurements of the Weight-for-Height Z score (WHZ) and Mid-Upper Arm Circumference (MUAC) were calculated and used to follow the progression in recovery until the discharge from OTPs.

Results: Of the total 150 children admitted to TFCs, 48 (32%) were males, and 75 (50%) were aged 6-<12 months; 99 (66%) had both WHZ <-3 and MUAC <11.5); 25 (17%) had WHZ <-3; and 26 (17%) had MUAC<11.5 cm. At the point of transfer from TFCs, 72% (108) were with SAM, and 28% (42/150) with Moderate Acute Malnutrition (MAM). At discharge from OTP, 19% (28/150) were with non-acute malnutrition (NAM); the progression to NAM was among 48% (20/42) and 7% (8/108) of children transferred with MAM and SAM, P value (<0.001).

In conclusion, 88% (132/150) of children transferred from TFCs were discharged as cured from OTP, 21% (28/132) of them were anthropometrically recovered, and 79% were prematurely discharged.

CONTENTS

1. Introduction:

Severe acute malnutrition (SAM) is a major global health problem that affects 13.6 million children under 5 years of age [1]. It is responsible for 1 in 5 deaths of children under five. Children with SAM have 9–11 times the risk of death that well-nourished children have from infectious disease-related complications [2]. SAM, with its related mortality, is a challenge to achieving the 4th Millennium Development Goal (MDG). Many efforts through different interventions and programs have been made to manage SAM and reduce children's related mortality [3].

The current WHO guideline for SAM management is based on an integrated approach between inpatient care and outpatient care services, as well as community mobilization and outreach for early detection and enrolment of children with acute malnutrition [4, 5]. The case definition for SAM in children 6-59 months of age, according to the joint statement by the WHO and UNICEF, includes three criteria used independently to detect children with SAM at a community or health facility. These are low Weight-for-Height Z score (WHZ<-3), low Mid-Upper-Arm Circumference (MUAC < 11.5 cm), and/or bilateral edema (nutritional edema) [6]. Upon the state of the additional criteria of appetite and medical complications, children are admitted for treatment either to an inpatient or outpatient therapeutic feeding program [7]. According to the updated WHO guidelines, children with SAM should only be discharged from treatment when their WHZ is ≥ −2 or MUAC is ≥ 12.5 cm and they have had no nutritional edema for at least two weeks [8]. The anthropometric indicator (MUAC or WHZ) used to confirm SAM at admission should be used to assess nutritional recovery and end treatment: children admitted under MUAC should be discharged under MUAC, and children admitted under WHZ should be discharged under WHZ [9]. While the WHO does not specify what criteria should be applied for discharging children who meet both MUAC and WHZ on admission, the guidelines and supporting evidence suggest a comprehensive approach to using both indicators [10].

According to the current WHO guideline for the management of complicated SAM, in inpatient care the management focuses on clinical recovery, and when medical complications are resolved and the appetite is returned, children are transferred to continue rehabilitation until full recovery at outpatient care (OTPs) [5]. Monitoring both WHZ and MUAC velocities during inpatient treatment and outpatient rehabilitation is essential for a comprehensive assessment of nutritional recovery and growth in children with complicated SAM [11]. A child discharged with complete anthropometric recovery is a proxy indicator of complete immune recovery that helps in reducing susceptibility to infectious morbidity as well as mortality that achieves the goals of SAM management [12]. In contrast, premature discharge with anthropometric deficiency puts them at high risk of relapse, infections, and death [13].

In Yemen, as a response to humanitarian crises since 2015, with the support of international organizations, the functioning inpatient therapeutic feeding centers (TFCs) reached 149 sites; 110 sites are supported by WHO, 34 by UNICEF, and 5 sites are supported by other organizations [14, 15]. Despite the increased number of inpatient TFCs as well as the beneficiaries of the services, limited studies in such settings have been carried out. A study conducted in Al-Sadaka General Teaching Hospital in Aden City revealed mortality of 5.2%, 25.2% discharge against medical advice (DAMA), 17.6% cured, and 59% shifted to complete rehabilitation in OTP [16].

However, despite the good provided information by this study and the good performance indicators of the four TFCs in Sana'a city, there is still a gap in the information related to the anthropometric recovery of children transferred from TFCs to complete rehabilitations in OTP.

This study aimed to evaluate the anthropometric recovery of children 6-59 months admitted to the TFCs and transferred to complete treatment in outpatient programs (OTPs) of Sana'a City Public Hospitals

2. Methods

Study setting: The study was conducted in the TFCs of Al-Sabeen and Al Zubairi Hospitals, which are the main hospitals that provide the services of TFCs in Sana'a City. Al-Sabeen Hospital was the first hospital in which TFC was initiated in Yemen with the support of UNICEF, while the TFC at Al Zubairi Hospital was established with the support of WHO during the period of war in Yemen.

Study design and period: A facility-based prospective follow-up study was conducted. All children who were admitted with complicated SAM from September 2023 to April 2024 in the two hospitals were followed at three points: at the point of admission to TFCs, at the point of transfer and admission to OTPs, and at the point of discharge from OTPs.

Study population: Children aged between 6 and 59 months, suffering from complicated SAM, and admitted to the two hospitals in Sana'a city

Study sample: All children admitted to inpatient care and who have been transferred to outpatient care in the same hospitals from September 2023 to April 2024 were included.

Inclusion and exclusion criteria: All hospitalized children aged between 6 and 59 months who have been admitted to TFC per WHO criteria—(a) a weight-for-height z-score (WHZ) less than -3 on WHO growth standards, or (b) a mid-upper arm circumference (MUAC) of less than 11.5 cm—and whose parents or caregivers agreed to participate were included. Children who did not meet the admission criteria of WHO or out of the targeted age group, children who were admitted to ICU before admission to TFCs, or had disability disorders, or transferred to OTP sites out of the targeted hospitals, or whose parents/caregivers refused to participate, were excluded. Since the study aimed to assess anthropometric recovery, children admitted to TFCs with bilateral oedema were also excluded from the analysis.

Data collection tools and procedures

A valid semi-structured questionnaire and abstraction form adopted from updated WHO guidelines were used for data collection through face-to-face interviews and records review by well-trained data collectors and professional nurses. The data collectors visited the pediatric ward daily, assessed the eligibility of children who were admitted to TFCs, and confirmed that SAM and anthropometry were measured following WHO guidelines. An electronic scale to the nearest 0.01 kg, a rigid height board to the nearest 0.1 cm, and a standard insertion tape to the nearest 0.1 cm were used to measure weight, height, and MUAC, respectively, by qualified health personnel who have been trained in facility-based management of SAM.

At the same time, children who were previously recruited were followed until they were discharged from inpatient care based on decisions made by the treating clinicians.

The data related to anthropometric measurements at the points of transfer from inpatient and admission to outpatient care were obtained from patients' records or transferred cards as well as the follow-up weekly visits and treatment outcomes in TFCs or OTP: recover, defaulted, non-respondent, died, and cured.

As for data quality, before the initiation of data collection, one day of training for data collectors regarding the ethics and process of data collection was carried out by the principal investigator. A pretest for 10 children was performed before the actual data collection was performed. The principal investigator revised the collected questionnaires and directly entered the data into Epi Info and checked for the completeness and consistency of the collected data each week.

Study variables and operational definitions

The dependent variable of the study is the anthropometric recovery of complicated SAM, defined as the discharge of children from treatment when they have (WHZ Score ≥ -2 and MUAC ≥ 12.5 for at least two weeks based on the decision of the service provider). The independent variables included the anthropometric measurements for WHZ and MUAC and the outcome of discharge from outpatient care.

Severe acute malnutrition (SAM) was defined as a WHZ<-3 or/and MUAC <11.5 cm. Moderate acute malnutrition (MAM) was defined as -3 ≤WHZ<-2 or 11.5 ≤ MUAC < 12.5 cm. No acute

malnutrition (NAM) was defined as a WZL ≥ -2 and MUAC ≥ 12.5 cm.

SAM with medical complications in children 6-59 months old was defined as a weight-for-height z-score of less than -3 standard deviations of the WHO growth standards and/or mid-upper arm circumference (MUAC < 11.5 cm) and/or bilateral pitting edema or with any danger signs or medical complications that required admission.

Full recovery: a child who met the criteria of cure from SAM, clinically and anthropometrically (WHZ Score ≥ -2 and MUAC ≥ 12.5 cm and no edema for the past two weeks).

Progression in recovery From SAM to MAM, success improvement in anthropometric status from SAM to MAM was defined as presenting as a -3 ≤WHZ<-2 or as 5 ≤ MUAC < 12.5 cm when admitted as SAM with WHZ <-3 or MUAC < 11.5 cm, respectively.

Progression in recovery from MAM to NAM**;** Success improvement in anthropometric status from MAM to NAM was defined as presenting as WHZ ≥ 2 or as MUAC ≥ 12.5 cm when admitted as MAM with a -3 ≤WHZ<-2 or as 5 ≤ MUAC < 12.5 cm, respectively.

Failure to reach anthropometric recovery was defined per WHO recommended criteria as presenting a WHZ<-2 at the point of discharge from OTP when admitted as transferred from TFCs with SAM or MAM as defined previously.

A child was considered to have failure improvement/progression if they still at the point of discharge from OTP had MAM or SAM as defined previously.

Weight gain in TFC: the average weight gain (in g/kg/day) was calculated by calculating the weight gain expressed in g · kg body wt^{-1} d^{-1} as follows: $(W2-W1)\times 1000$ [17].

Outcome of outpatient care: Defaulted or left/discharged against medical advice (DAMA): patients who are not found for two to three consecutive days or who left the hospital contrary to medical advice offered while the child has not recovered. Transferred out is when the child moved to another health facility for further medical care.

Data processing and analysis

The collected data were coded and entered into Epi-info version 7.2.5, and then exported to STATA 14. Anthropometric z-scores were computed by the ENA SAMRT2020 program based on WHO's 2006. At each point of follow up WHZ and MUAC were categorized as SAM, MAM, and Norma, based on WHO criteria as well as Mean, minimum, and maximum values were calculated and presented in tables. Descriptive analysis was performed by using frequency and proportion for categorical variables and mean or median for continuous variables. The chi-square test and 't' test were applied and the p-value < 5% was considered as the cutoff point for statistically significant.

Ethics Approval and Consent to Participate

This study followed the Declaration of Helsinki guidelines and was approved by the research ethical committee of the Faculty of Medicine and Health Sciences, Sana'a University, Yemen. An official approval from health authorities and hospital administration was obtained. Informed consent was obtained from the parents of all subjects.

3. Results

Baseline characteristics

A total of 150 children were recruited from the two hospitals, 48(32%) were males, and 75 (50%) were aged 6-<12 months. The mean weight was 5.6±1.2 kg, the mean height was 67.3±6.7 cm, and the mean weight for height (WHZ) was -3.5±1.04, The mean MUAC was 10.8±0.8 cm. Among these, 124 (83) children fulfilled weight for height (WHZ) criteria (<-3), and also 125 (83%) fulfilled MUAC criteria (<11.5). (Table 1)

Table 1: Baseline Characteristics and Anthropometry Measurement of Children with Complicated SAM at Admission to Inpatient Therapeutic Care, Sana'a City, 2024

	N (%)	Mean ±SD
Gender		
Male	48(32%)	-------
Female	102(68%)	-------
Age		
6-<12 months	75 (50%)	-------
12<24 months	63(42%)	-------
>=24 Months	12(8%)	-------
Weight per Kg	150(100%)	5.6±1.2
Height (cm)	150(100%)	67.3±6.7
Weight for Height		
< -3 SD	124(83%)	-3.8 ±0.66
≥-3 - <-2	17(11%)	-2.8±0.07
≥-2	9(6%)	-0.6±1.10
Total	150(100%)	-3.5±1.04
MUAC		
<11.5 cm	125 (83%)	10.6±0.7
≥11.5 and <12.5	22(15%)	11.9±0.3
≥12.5	3(2%)	12.5±0.0
Total	150(100%)	10.8±0.82

MUAC: mid-upper arm circumference, No.: Number, Cm: centimeter, SD; standard deviation WHZ: weight for height z score, Min; minimum, Max: Maximum

At the point of admission to the TFCs, however, 66% (99/150) of admitted children were in both low WHZ (<-3) and MUAC <11.5), 17% (25/150) were in WHZ <-3) alone, and 17% (26/150) had MUAC(<11.5) alone, per admission criteria recommended by WHO guidelines (WHZ < -3, or MUAC < 11.5 cm), 124 /150 (83%) children were admitted based on WHZ irrespective of MUAC, and the rest 26/150(17%) who not fulfilled WHZ criteria were admitted based on MUAC alone. Table (2) illustrates the means of anthropometry measurement with the minimum and maximum values of both WHZ and MUAC).

Table 2: Anthropometric Status and Admission Criteria of Children with Complicated SAM at Admission to TFCs, Sana'a City, 2024

	N(%)	WHZ			MUAC cm		
		Mean± SD	Min	Max	Mean± SD	Min	Max
Admission criteria (WHO)							
WHZ <-3 SD	124(83%)	-3.8±0.7	-6.1	-3.0	10.8±0.9	8.0	12.5
MUAC<11.5 cm	26 (17%)	-2.0±1.2	-2.9	0.8	11.0±0.1	10.8	11.2
Status at admission							
WHZ and MUAC	99(66%)	-3.9±0.7	-6.1	-3.0	10.5±0.7	8.0	11.4
WHZ only	25(17%)	-3.8±0.3	-4.4	-3.2	12.0±0.3	11.6	12.5
MUAC<11.5 cm	26 (17%)	-2.0±1.2	-2.9	0.8	11.0±0.1	10.8	11.2
Total	150(100%)	-3.5±1.0	-6.1	0.83	10.8±0.8	8.0	12.5

MUAC: mid-upper arm circumference, No.: Number, cm: centimeter, SD; standard deviation WHZ: weight for height z score, Min; minimum, Max: Maximum, TFCs; Therapeutic Feeding Centers

Anthropometric status at transferred from TFCs to OTP

At the point of transfer from TFCs, 28% (42/150) were transferred to OTP with MAM while 72% (108 /150) of children were transferred with ongoing SAM. The progression in recovery to MAM was significantly higher among children who had low WHZ or low MUAC at admission to TFCs compared to those who had both indicators (72% and 62% vs. 8%, P value <0.001)

The overall mean (± SD) of the hospitalization stay in the TFCs was 7.9±4.2 days and the mean (± SD) of weight gain was 7.5±5.6 grams per Kg/ day. Children with low WHZ had the highest mean (9.1±3.5) compared to children with low MUAC alone (8.3±2.0) and children with both WHZ and MUAC (6.8±6.1). (Table 3)

Table 3: Anthropometric Status for Children Transferred from Inpatient Care to Outpatient Care, Sana'a Yemen, 2024

Children by SAM indicators at admission		Length of stay in days	Weight gain in gram	Progression to MAM		
	N			Yes	No	P value
Both WHZ and MUAC	99	7.7±4.7	6.8±6.1	8(8%)	91(92%)	Rf.
MUAC only	26	7.7±2.3	8.3±2.0	16(62%)	10(38%)	<0.001
WHZ only	25	9.1±3.5	9.1±5.7	18(72%)	7(28%)	<0.001
Overall	150	7.9±4.2	7.5±5.6	42(28%)	108(72%)	

MUAC: mid-upper arm circumference, N: Number, WHZ: weight for height z score, MAM; Moderate acute malnutrition, SAM: Severe acute malnutrition. Re; reference

Of the group transferred with SAM, almost two-thirds 63% (68/108) were with both low WHZ (<-3) and low MUAC (<11.5 cm), 14% (15/108) with low WHZ alone (<-3), and 23% (25/108) were on a MUAC (<11.5). Of the group transferred with MAM, three quarters 74% (31/42) were with both a (-3 ≤ WHZ < -2) and (11.5 ≤ MUAC < 12.5 cm), while 21% (9/42) with a (11.5 ≤ MUAC < 12.5 cm), and only 5% (2/42) with a (-3 ≤ WHZ < -2).

The admission to OTP mainly relied on WHZ irrespective of MUAC accounting for 79% (33(/42) in the MAM group compared with 93% (100/108) in the SAM group. The rest who did not fulfill WHZ (< -2) were admitted based on MUAC for 21% (9/42) and 8(7%) of the two groups, respectively. (Table 4)

Table 4: Anthropometry Measures at Point of Transfer from Inpatient Care to Outpatient Care of SAM, Sana'a Yemen, 2024

Malnutrition type	Children	WHZ score				MUAC (cm)			
	No. (%)	Mean	SD	Min	Max	Mean	SD	Min	Max
MAM group 42 (28%)									
WHZ only	2(5%)	-2.8	0.0	-2.8	-2.8	12.5	0.0	12.5	12.5
MUAC only	9(21%)	0.0	0.9	-0.6	1.2	11.8	0.3	11.5	12.0
Both WHZ and MUAC	31(74%)	-2.5	0.3	-3.0	-2.1	11.7	0.2	11.5	12.4
Total	**42(100%)**	**-2.0**	**1.2**	**-3.0**	**1.2**	**11.7**	**0.3**	**11.5**	**12.5**
SAM Group 108 (72%)									
WHZ only	15(14%)	-3.3	0.2	-3.7	-3.1	11.9	0.4	11.5	12.5
MUAC only	25(23%)	-2.5	0.5	-2.9	-1.8	10.8	0.7	8.0	11.0
Both WHZ and MUAC	68(63%)	-3.5	0.7	-5.5	-3.0	10.5	0.6	9.5	11.3
Total	**108(100%)**	**-3.3**	**0.7**	**-5.5**	**-1.8**	**10.7**	**0.8**	**8.0**	**12.5**

MUAC: mid-upper arm circumference, No.: Number, cm: centimeter, SD; standard deviation, WHZ: weight for height z score, NAM: No acute malnutrition, MAM = Moderate acute malnutrition, SAM: Severe acute malnutrition. Min; minimum, Max: Maximum

Anthropometric status at the point of discharge from outpatient care:

At the point of discharge from OTP, as for children transferred from TFCs with MAM, 48% (20/42) progressed to NAM while 52% (22/42) remained with MAM. The progression was 100% among children who were with WHZ alone, 56% among children with MUAC alone, and 46% among children with both indicators. The failure in progression was due to not reaching the criteria of MUAC among 44% (4/9) of those who were on MUAC. For those who were in both indicators, 78% of failure was due to not reaching the criteria of MUAC compared to 22% not reaching both MUAC and WHZ criteria. (Table 5)

Table 5: Anthropometric Status at Discharge from Outpatient Care for Children Transferred from Inpatient Care with MAM, Sana'a City, 2024

MAM Indicators at Admission to OTP		**Anthropometric status at discharge**			
		NAM	**MAM**	MAM Indicators	
MAM indicators	Number	N (%)	N(%)	MUAC N (%)	Both N (%)
WHZ alone	2	2(100%)	-------	-------	-------
MUAC alone	9	5(56%)	4(44%)	4(100%)	-------
Both WHZ and MUAC	31	13(42%)	18(58%)	14(78%)	4(22%)
Total	**42**	20(48%)	22(52%)	18(82%)	4(18%)

MUAC: mid-upper arm circumference, N: Number, WHZ: weight for height z score, NAM: No acute malnutrition, MAM = Moderate acute malnutrition, Severe acute malnutrition. Min; minimum, Max: Maximum

For the SAM group; Only 7% (8/108) of children with SAM progressed to NAM, the progression was varied based on the initial anthropometric indicators: children with low WHZ alone or low MUAC alone had 47% (7/15) and 1% (1/25) progression to NAM, respectively, while children with both low MUAC and low WHZ did not show progression to NAM.

Among children who did not progress to NAM, 40% (43/108) progressed to MAM and 53% (57/108) remained in SAM, the failure in the progression in the two groups was attributed to not reaching the criteria of MUAC among children admitted with MUAC. For children with both low MUAC and low WHZ. Among those who regressed to MAM, 79% (19/24) of the failure was attributed to MUAC and 21% (5/24) to WHZ and MUAC. Similarly, among those who remained in SAM, 84% (37/44) of the failure in progression was attributed to MUAC, and 16% (7/44) to WHZ and MUAC. (Table 6)

Table 6: Anthropometric Status at Discharge from Outpatient Care for Children Transferred from Inpatient Care with SAM, Sana'a City, 2024

Indicators of		Anthropometric status and indicators at discharge						
SAM at admission		NAM	MAM	MAM Indicators		SAM	SAM Indicators	
	N	N (%)	N (%)	MUAC, N(%)	Both N(%)	N (%)	MUAC N(%)	Both N(%)
WHZ alone	15	7(47)	8(53)	----------	6(75)	-------	-------	-------
MUAC only	25	1(4)	11(46)	11(100)	-------	13(54)	13(100)	-------
Both	68	0(0)	24(35)	19(79)	5(21)	44(65)	37(84)	7(16)
Total	108	8(7)	43(40)	32(74)	11(26)	57(57)	50(88)	7(12)

MUAC: mid-upper arm circumference, N; Number, WHZ; Weight for height z score, NAM: No acute malnutrition, MAM = Moderate acute malnutrition, SAM; Severe acute malnutrition. Min; minimum, Max: Maximum

In general, at the point of discharge from OTP, 28 (19%) of children were with NAM, 65(43%) with MAM and 57 (38%) with SAM. Of the MAM group, 77% (50/65) did not reach the discharge criteria of MUAC and 23% (15/65) did not reach the criteria of both (MUAC and WHZ). Of the SAM group, 88% (50/57) did not reach MUAC and 12% (7/57) did not reach the criteria of both (WHZ and MUAC).

As for the outcome of the outpatient program, 88% (132/150 were discharged as cured and 12% (18/150) were defaulted. Of the total 132 children discharged cured, 43(33%) and 61(46%) were from MAM and SAM groups while 28 (21%) were from the NAM group, accounted 79% prematurely discharged and 21% completely recovered, respectively. (Table 7)

Table 7: Anthropometric Status, and Outcome of Outpatient Program for Children Transferred from Inpatient Care, Sana'a City, 2024

Anthropometry status			Program outcome		Measurement at discharge							
					WHZ				MUAC (cm)			
Overall status; n(%)	Indicator	N(%)	Default18(12%)	Cure132(88%)	Mean	SD	Min	Max	Mean	SD	Min	Max
SAM 57(38%)	Both	7(12%)	7(100%)	----------	-3.7	0.4	-4.2	-3.3	10.8	0.7	9.7	11.4
	MUAC	50(88%)	7(14%)	43(86%)	-0.5	1.2	-2.0	2.0	10.8	0.5	9.4	11.4
MAM 65(43%)	MUAC	50(77%)	1(2%)	49(98%)	0.0	1.2	-2.0	3.6	11.9	0.3	11.5	12.3
	Both	15(23%)	3(20%)	12(80%)	-2.4	0.3	-3.0	-2.1	11.9	0.3	11.6	12.4
NAM 28(19%)	Both	28(100%)	0(0%)	28(100%)	0.2	1.2	-1.6	2.2	13.0	0.5	12.5	14.6

MUAC: mid-upper arm circumference, N: Number, cm: centimeter, WHZ: weight for height z score, NAM: No acute malnutrition, MAM = Moderate acute malnutrition, SAM; Severe acute malnutrition. Min; minimum, Max: Maximum

4. Discussion:

The management of complicated SAM in inpatient care as a life-saving intervention is crucial, particularly in conflict- and war-torn countries such as Yemen. Medical care and therapeutic feeding are provided for children 6-59 months at TFCs, and when medical complications are resolved mostly within 7-10 days, children are often transferred to continued rehabilitation in outpatient therapeutic programs until full anthropometric recovery, which is considered supreme importance for the effectiveness of this intervention. The current study tried to assess the anthropometric recovery among children 6–59 months admitted with complicated SAM to the TFCs in the public hospitals of Sana'a city.

The finding of this study reveals that the majority of children at the point of admission to TFCs were between 6 months and less than two years old, and the majority fulfilled the two criteria for SAM admission: low WHZ and MUAC. This result indicates the severity of malnutrition among this age group that requires more attention and care either from their families or health authorities. Children with both indicators are considered to be at a higher risk of severe malnutrition and associated complications and may require more intensive treatment and monitoring to address their nutritional needs. The WHO and UNICEF guidelines recommend a comprehensive approach to SAM management, considering both WHZ and MUAC for admission and discharge [18].

The result shows that, however, the majority of children fulfilled the two criteria for SAM admission; children were admitted based on WHZ, irrespective of MUAC. This might be due to the fact that, in the context of complicated SAM, weight is closely monitored during the stabilization phase to assess water movements for clinical management purposes [11]. WHZ based on the children's weight concerning their height is commonly used in inpatient settings; it is more sensitive than MUAC to short-term changes in nutritional status and is used to guide initial treatment and as a key indicator to track progress and identify children with failure to respond during hospitalization [19].

At the point of transfer from TFCs, the result of this study indicated a similar length of hospitalization stay to the result of a previous study conducted in Yemen [20] that meets the

recommended stay for the stabilization center recommended by WHO (5-10 days) [21, 22]. The overall weight gain per kg/day was within the range of weight gain velocities recently reported by a prospective study in Uganda [11].

Furthermore, our findings revealed that the majority of children were transferred with ongoing SAM and a small proportion with MAM. It was in line with the result of a previous study conducted in Aden City [16]. However, the treatment of children with complicated SAM in inpatient care focuses on clinical recovery; irrespective of anthropometric recovery, the anthropometric status might be improved due to various factors, including changes in hydration status, response to treatment, nutritional rehabilitation, and changes in initial anthropometric indicators [23]. The result of this study indicated a progression from SAM to MAM, and based on admission indicators, a higher improvement was among children with a single criterion—low WHZ or low MUAC—compared to children with both. This result was in line with many studies conducted elsewhere that showed that children with SAM based on both WHZ and MUAC had slower recovery rates compared to those with SAM based on a single indicator [23, 24].

The result of our study showed that irrespective of SAM admission criteria, the transferred children either with SAM or with MAM were admitted to OTP, and two-thirds of children in the SAM group compared to three-quarters in the MAM group were presented with dual indicators (WHZ and MUAC). Practically, the criteria for SAM admission applies either for admitting children with complicated SAM to inpatient care or children with uncomplicated SAM who are directly admitted to OTP. WHO does not specify anthropometric criteria for admitting children transferred from TFCs, and according to the WHO recommendation, when the medical complications of admitted children to TFCs are resolved, as well as their appetite is returned, they should be transferred to complete rehabilitation at OTP until full recovery (NAM) [5].

At the point of discharge from OTP, the result revealed that, however, the improvement in the anthropometric status of nearly half of the children transferred with MAM or SAM was predominantly among those with single indicators (WHZ, or MUAC) compared to those with two indicators, but reaching the full anthropometric recovery was more among those with WHZ alone compared to those with MUAC only. This result indicated a better recovery rate based on WHZ compared to MUAC. This result might be due to relying on the proportional weight gains criterion to discharge children from OTP or relying solely on WHZ for admission and discharge from OTP, as reported by many studies conducted elsewhere. **A study in rural Nepal** found that children discharged based solely on WHZ criteria often had MUAC measurements below the recommended discharge thresholds [25]. A study from South Sudan compared WHZ with MUAC showed that taller children diagnosed with SAM by WHZ are more likely to appear normal by MUAC; this discrepancy indicates that using WHZ alone might not adequately capture all cases of malnutrition, particularly among shorter or stunted children [26].

Similar to the result of a study conducted in Malawi, it showed that MUAC is a reliable criterion for discharge and is associated with better recovery outcomes when used alongside WHZ [27]. The result of our study revealed that children with both MUAC and WHZ indicators in both MAM and SAM groups exhibited a higher failure to reach full anthropometric recovery (NAM), and the failure for this subgroup was linked to not meeting the MUAC criterion.

This result might be because of the quick improvement of WHZ due to nutritional rehabilitation at TFCs. This result was in line with a result reported by a previous study that showed that children exhibit significant improvements in WHZ without corresponding increases in MUAC [26, 28]. It was also in line with the result of a clinical trial study that indicated that children with low WHZ and

MUAC had the lowest probability of nutritional recovery and the worst anthropometric recovery [27].

The result of our study indicated premature discharge of more than three-quarters of children discharged from OTP as cured. The inconsistencies between discharge and admission criteria may contribute to premature discharge that contributes to the risk of relapse, infectious morbidity, as well as mortality [29, 30]. This result emphasizes the need for integrated approaches in SAM management to facilitate post-discharge monitoring and support for prematurely discharged children to achieve their complete nutritional rehabilitation.

However, this study is a prospective cohort study; it has focused on MUAC and WHZ only and did not assess hospital-related factors, such as quality of service and skill of profession, that could have an impact on the outcome variable and need to be investigated. Nevertheless, this study provides information that could be used by health programmers and policymakers to formulate recommendations for establishing national guidelines that address the various aspects related to linking inpatient care to the outcomes of outpatient care.

5. Conclusion

At the point of transfer from TFCs, a progression in anthropometric recovery from SAM to MAM of 28% varied based on initial admission criteria (72% and 62% vs. 8% of children with WHZ and MUAC alone compared to children with both). At the point of discharge from outpatient care, the progression to NAM among all children was (19%), higher (48%) among children transferred with MAM than 7% among children transferred with SAM (P value <0.001). However, the higher proportion (88%) of children discharged as cured from outpatient care, 21% of them were anthropometrically recovered, and 79% were prematurely discharged. Children transferred from TFCs with both indicators (WHZ and MUAC) exhibit higher failure to achieve an improvement in recovery from SAM to MAM as well as to NAM, and the majority were linked to not meeting the MUAC criterion.

Recommendations

This result highlights the importance of monitoring both WHZ and MUAC, and more attention during inpatient care should be given to children admitted with both indicators, as well as the specific needs and consistency between admission and discharge criteria in OTP should be considered to achieve the full spectrum of nutritional recovery. To improve the program in terms of effectiveness and efficacy, a national protocol based on the Yemen context should be adopted to link TFCs with OTPs; consistency between admission and discharge criteria may contribute to decreasing premature discharge, as well as integrated approaches in SAM management to facilitate post-discharge monitoring and support for prematurely discharged children to achieve their complete nutritional rehabilitation. Further research to assess the outcomes and studies to explore other factors that have not been identified in this study is highly recommended.

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