Al Amad *et al. Conflict and Health* (2025) 19:26
https://doi.org/10.1186/s13031-025-00666-0

Conflict and Health

RESEARCH Open Access

# Addressing dual deficiencies of SAM indicators; gaps and insights from inpatient admission to outpatient discharge, in conflict-affected Yemen; a retrospective study

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## Abstract

**Background** Severe acute malnutrition (SAM) remains a critical public health challenge in conflict-affected settings, where children face heightened vulnerability. Dual deficiencies in weight-for-height z-score (WHZ < -3) and mid-upper arm circumference (MUAC < 11.5 cm) indicate a more severe form of SAM, yet current admission protocols prioritize WHZ-based criteria for inpatient therapeutic feeding centers (TFCs). This approach may exclude children with MUAC deficiencies from optimal inpatient care, potentially impacting recovery outcomes in outpatient therapeutic programs (OTPs). In Yemen, prolonged conflict has exacerbated SAM burdens, leading to an expansion of TFC and OTP services since 2015. The aim is to determine whether existing WHO recovery criteria adequately support comprehensive recovery and prevent premature discharge.

**Method** A retrospective analysis was conducted using data from a prospective longitudinal study of children admitted with complicated SAM to TFCs in Sana'a City from September 2023 to November 2024. Children were categorized based on SAM diagnostic criteria (WHZ < -3, MUAC < 11.5 cm, or both) and analyzed under four discharge scenarios: (1) WHZ recovery, (2) MUAC recovery, (3) recovery by either WHZ or MUAC, and (4) recovery of both indicators. Chi-square and Kruskal-Wallis tests were used to assess differences between groups, and $P < 0.05$ was used to determine statistical significance.

**Results** Among 188 children admitted with complicated SAM, 56% (105) were female, 53% (100) were aged 6–<12 months, and 59% (111/188) presented with dual deficiencies. Admission based on WHZ criteria accounted for 82% (154/188) of admissions, of whom 72% also had MUAC < 11.5 cm. At OTP discharge, 96% met WHO recovery criteria, yet only 38% achieved full recovery (WHZ ≥ -2 and MUAC ≥ 12.5 cm). Full recovery was significantly lower among children with dual deficiencies at TFC admission than those with single deficiencies in MUAC or WHZ (31% vs. 47% and 51%, respectively, $p = 0.032$).

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**Conclusions** These findings underscore the need to integrate WHZ and MUAC into discharge criteria to prevent premature discharge and ensure comprehensive recovery. Revising WHO protocols and enhancing SAM management in conflict-affected settings are critical to improving treatment outcomes.

**Keywords** Severe acute malnutrition (SAM), Dual deficiencies, Therapeutic feeding centers (TFCs), Outpatient therapeutic program (OTP), Conflict-affected settings, Yemen

## Introduction

Severe Acute Malnutrition (SAM) is a public health problem that affects 19 million children under 5 years of age globally and contributes to approximately 400,000 child deaths each year [1]. SAM diagnosis is based on Weight-for-Height Z-score (WHZ) <-3, Mid-Upper Arm Circumference (MUAC) < 11.5 cm, and/or the presence of oedema [2]. Additionally, clinical criteria; appetite, and medical complications, are used for the decision of SAM admission either to inpatient Therapeutic Feeding Centers (TFCs) or to Outpatient Therapeutic Programs (OTPs) [3]. Practically, the existing WHO anthropometric criteria for SAM admission (WHZ < -3 or MUAC < 11.5 cm) are used for the initial admission to TFCs for children with complicated SAM or to the OTP for children presented with uncomplicated SAM. The WHO guide does not specify anthropometric criteria for admitting cases transferred from TFC, and the decision of transferring children from TFC to OTP is solely based on clinical recovery without specific anthropometric achievement [4, 5]. Children should be discharged from OTP, if they achieve WHZ ≥ -2 or MUAC ≥ 12.5 cm, the criterion used for admission is independently recommended for discharge from OTP [4, 5].

The WHZ and MUAC often identify distinct subsets of malnourished children and their overlap representing a small proportion of the population [6]. Some studies have reported a relatively high overlap ranging from 39 to 61.2% among children with SAM [7–9]. Yet, the current protocols do not address the unique challenges of children with dual deficits (i.e. WHZ<-3 and MUAC < 11.5 cm) [10]. The WHZ < -3 reflects depletion of body fat and overall body mass and the MUAC < 11.5 cm indicates muscle depletion. Children who present with both deficits are considered to have a more severe form of SAM due to the compounded loss of both fat and muscle reserves [11]. Children with dual deficiency have a markedly increased risk of death, with some reporting an eightfold higher hazard of mortality compared to those with only one deficit [12, 13]. During treatment, they often require longer treatment durations to reach full nutritional recovery as the WHZ recovery tends to be faster, as body weight responds more quickly while MUAC recovery lags behind WHZ as it reflects muscle and fat stores [14, 15]. Discharging those children based on only one anthropometric indicator may leave partially recovered children vulnerable to relapse, particularly in resource-limited settings with persistent food insecurity [16].

In Yemen, acute malnutrition driven by ongoing conflict, displacement, poverty, food insecurity, and limited access to healthcare services remains one of the highest in the world [17]. The prolonged humanitarian crisis has significantly worsened the burden of SAM. As of 2022 an estimated 2.2 million children under the age of five suffered from acute malnutrition including nearly 538,000 children suffering from SAM representing 34% percent increase from 2021 [18, 19]. The number of functional TFC sites for complicated SAM, primarily supported by WHO, reached149 sites, complemented by 4,622 OTPs supported by UNICEF for uncomplicated cases [20]. TFCs provide inpatient care and stabilization using therapeutic milk formulas (F-75 and F-100) following WHO guidelines [21]. While OTPs offer community-based treatment using ready-to-use therapeutic food (RUTF) for children with uncomplicated SAM [22]. Despite this scale-up, the adequacy of current admission and discharge practices, particularly for children with dual anthropometric deficits, remains unclear. This study aimed to examine these gaps and to evaluate how varying discharge criteria influence recovery classification among children with complicated SAM.

## Methods

### Study design and population

This study is a retrospective analysis based on secondary data collected from a prospective longitudinal study conducted among children with complicated SAM admitted to Therapeutic Feeding Centers (TFCs) of Al-Sabeen and Al-Zubairi Hospitals in Sana'a City between September 2023 and November 2024.

This original cohort involved children aged between 6 and 59 months, suffering from complicated SAM per WHO definition, admitted to the TFC of the targeted hospitals during the study period. All children enrolled were not admitted to the intensive care unit before admission to TFC or suffering from chronic or congenital disability disease (e.g., cerebral palsy). The cohort of 334 were followed prospectively from TFC admission through transfer to /discharge from OTP based on program criteria and into a 12-month post- TFC discharge.

### Sample selection, inclusion and exclusion criteria

All children admitted to the targeted TFCs during the study period and continued through OTP until discharge per program criteria were included for the retrospective analysis. Children not transferred from TFC to OTP (i.e. defaulted, no respondents or transferred to another institution), or not discharged from OTP as cured per program criteria were excluded. Additionally, to ensure the integrity of the anthropometric analysis, children admitted with nutritional edema (rather than anthropometric criteria) and those with implausible WHZ values (< -5 or > 5) were excluded.

Of the 334 children originally enrolled, 190 met the inclusion criteria. Two cases were excluded due to implausible WHZ values, resulting in a final analytic sample of 188 children. A flowchart detailing participant inclusion and follow-up is provided in Supplementary Fig. 1. To assess the representativeness of the analytic sample, we compared baseline anthropometric characteristics and admission criteria between the full cohort ($n = 334$) and the analytic sample ($n = 188$), presented in Supplementary Table 1.

### Data collection and procedures (original cohort)

The data used in this retrospective analysis were originally collected for the prospective cohort study, where a valid semi-structured questionnaire and an abstraction form adapted from updated WHO guidelines for collecting data. Face-to-face interviews and medical record reviews by well-trained data collectors and professional nurses.

- Data collectors visited the TFCs daily to identify eligible children and follow up with previously recruited participants until discharge from inpatient care, as determined by treating clinicians.
- Anthropometric measurements were taken by professionals working in the respective facilities at admission to and transfer /discharge from TFC and OTP.
- A generic hospital-grade digital baby scale (Model EBSA-20, China) was used for weighing infants and small children in a lying or sitting position. For children able to stand, weight was measured using a SECA 874 electronic scale (Germany), with measurements recorded to the nearest 0.01 kg. The height/length was measured using a UNICEF/WFP rigid wooden height/length board to the nearest 0.1 cm; and MUAC was measured using a standard non-stretchable UNICEF insertion tape to the nearest 0.1 cm. The mean values from duplicate measurements were used as the final recorded values.
- The Weight-for-Length Z-score (WLZ) for children aged 6 to 23 months, and WHZ for children aged 24 to 59 months, were also calculated by data collectors in accordance with WHO guidelines.

Training sessions for data collectors were conducted, emphasizing ethical considerations (e.g., obtaining informed consent, and maintaining confidentiality) and anthropometric measurement techniques. Post-training evaluations to ensure data collectors met quality standards. Before the data collection commenced, a pilot test involving 10 children was conducted to assess the feasibility of the data collection tools. Based on the pilot, minor updates were made to refine the questionnaire and abstraction form. The pilot test participants were excluded from the final analysis to avoid bias.

The principal investigator reviewed all completed questionnaires weekly for completeness and consistency. Data were entered into Epi Info 7.2.5 using a check code to minimize errors, and any discrepancies identified were resolved collaboratively with the data collectors.

Anthropometric z-scores were computed using the STAT ZSCORE06 module based on WHO 2006 Child Growth Standards [23]. Implausible z-score values (e.g., WHZ < -5 or > 5) were flagged as outliers and excluded from the analysis.

### Data processing and analysis (retrospective analysis)

#### *Admission to TFCs*

Children were categorized into two distinct frameworks. Classification based on SAM admission criteria implemented in TFC by the program, and classification based on SAM diagnostic criteria (actual anthropometric presentation), including WHZ < -3, MUAC < 11.5 cm, and dual deficiency (WHZ < -3 and MUAC < 11.5 cm). This dual categorization aimed to reflect both programmatic practices and actual clinical presentation, especially given the absence of specific guidelines for managing children with dual deficits, who may exhibit greater vulnerability.

#### *Discharge scenarios*

Four discharge scenarios were applied to assess recovery and discharge practices. These scenarios include: Discharge solely based on WHZ recovery (WHZ ≥ -2), MUAC recovery (MUAC ≥ 12.5 cm), WHZ or MUAC recovery (WHZ or MUAC), and both WHZ and MUAC recovery criteria (WHZ and MUAC). Each scenario was applied separately to the same group of 188 children under both categorization frameworks. The comparisons were exploratory and descriptive, aiming to illustrate inconsistencies in discharge classification rather than test statistical hypotheses. This approach allowed us to identify programmatic gaps and highlight implications for

children with varying anthropometric presentations at admission.

### Statistical analysis

Descriptive statistics were used to summarize baseline characteristics and recovery outcomes. Mean WHZ and MUAC values with 95% confidence intervals (CIs) were calculated at TFC admission and OTP discharge. The distribution of continuous variables was assessed using the Shapiro-Wilk test for normality. Based on the data distribution and number of groups: Independent samples *t*-tests were used to compare means between two groups when data were normally distributed. One-way ANOVA was used to compare means across more than two groups when assumptions of normality and homogeneity of variances were met. Kruskal-Wallis tests were applied as a non-parametric alternative when the assumptions for ANOVA were not met. Chi-square tests were used for categorical variables. A two-sided $p$ value < 0.05 was considered statistically significant. All analyses were conducted using Stata version 14.

### Ethics approval and consent to participate

The prospective cohort study was approved by the Research Ethical Committee at the Faculty of Medicine and Health Sciences, Sana'a University, Yemen, (Letter no.389, date 31/7/2023). Official approval from health authorities and hospital administration was obtained. Informed consent was obtained from all subjects and/or their legal guardian(s). all data were anonymized to ensure patient confidentiality. The authors confirm that all methods performed following relevant guidelines and county regulations.

**Table 1** Baseline characteristics of children with complicated SAM at admission to inpatient therapeutic care, Sana'a City, Yemen

| Children's Characteristics at Admission | | Frequency | Percent |
|---|---|---|---|
| Gender | Male | 83 | 44% |
| | Female | 105 | 56% |
| Age at admission | 6 -<12 M | 100 | 53% |
| | 12 -<24 M | 68 | 36% |
| | > 24 M | 20 | 11% |
| Breastfeeding | No | 104 | 55% |
| | Yes | 84 | 45% |
| Vaccination status | Not /partially vaccinated | 117 | 62% |
| | Vaccinated | 71 | 38% |
| Health status two weeks before admission | Cough | 73 | 39% |
| | Fever | 115 | 61% |
| | Diarrhea | 21 | 11% |

## Result

Of 188 children included in the analysis, 56% (105) were females, 53% (100) were aged from 6-<12 months at admission to TFC, 45% (84) were breastfed, and 38% (71) were vaccinated. During the two weeks before admission, 61% (115) suffered from fever while 39% (73) and 11% (21) suffered from cough and diarrhea, respectively (Table 1).

### Anthropometric criteria at admission

#### *Criteria used for SAM diagnosis*

Among 188 children with complicated SAM, 111(59%) children were presented at admission to TFCs with a dual deficiency (WHZ <-3 and MUAC < 11.5 cm), had a mean WHZ of -3.96 and a mean MUAC of 10.27 cm, 43(23%) presented with only WHZ deficiency had a mean WHZ of -4.01 and a mean MUAC of 11.84 cm. Those with MUAC deficiency had a mean WHZ of -2.50 and a mean MUAC of 11.05 cm.

#### *Criteria used for admission*

154 (82%) children were admitted based on WHZ among whom (72% (111/154) had MUAC < 11.5. Generally, they had a mean WHZ of -3.97 and a mean MUAC of 10.71 cm. The 34(18%) children who were admitted based on MUAC < 11.5 cm had a mean WHZ of -2.50 and a mean MUAC of 11.05 cm The difference in WHZ between groups was significant ($p < 0.001$), while the difference in MUAC was not ($p = 0.065$) (Table 2).

### Anthropometric status at discharge from OTP

At discharge from OTP, the overall mean of WHZ for the whole cohort ($n = 188$) was – 0.84, while the mean MUAC was 12.01 cm. Based on diagnosis criteria, there was a highly significant difference in MUAC P value < 0.001) but not for WHZ ($p = 0.056$). Children presented with WHZ-deficits ($n = 43$) had a mean WHZ of -1.03 and a mean MUAC of 12.57 cm. Children presented with MUAC-deficits only ($n = 34$) had a mean WHZ of -0.51 and a mean MUAC of 12.16 cm. Those with dual deficits ($n = 111$) were discharged with a mean WHZ of -0.87 and a mean MUAC of 11.75 cm (Table 3).

Based on the admission criteria: there was a significant difference in the WHZ of children admitted based on WHZ compared to those admitted based on MUAC (mean WHZ: [-0.92) vs. -0.51, $p = 0.023$]. In contrast, there was no significant difference in their MUAC, they achieved similar levels of MUAC recovery $p = 0.332$).

Weight gain and length of stay, differed across children's presentation criteria (Supplementary Table 2). Children presented with both WHZ and MUAC deficits demonstrated significantly greater mean weight gain (2.1 kg) and longer treatment duration (77.7 days) compared to children admitted with either WHZ or MUAC

**Table 2** Anthropometric status at admission among children with complicated SAM, categorized by diagnostic and programmatic admission criteria, Sana'a City, Yemen

| SAM Indicators at Admission *n* (%) | | WHZ at admission | | MUAC at admission | |
|---|---|---|---|---|---|
| | | Mean | 95% CI | Mean | 95% CI |
| Diagnosis Criteria | | | | | |
| WHZ & MUAC | 111(59%) | -3.96 | -4.1 to -3.82 | 10.27 | 10.10–10.44 |
| WHZ only | 43(23%) | -4.01 | -4.22 to -3.81 | 11.84 | 11.73–11.95 |
| MUAC only | 34(18%) | -2.50 | -2.66 to -2.33 | 11.05 | 10.93–11.16 |
| P value * | | < 0.001 | | 0.065 | |
| Criteria used for admission | | | | | |
| †WHZ | 154(82%) | -3.97 | -4.09 to -3.86 | 10.71 | 10.54–10.88 |
| MUAC | 34(18%) | -2.50 | -2.66 to -2.33 | 11.05 | 10.93–11.16 |
| P value ** | | < 0.001 | | 0.065 | |
| Total | 188(100%) | -3.71 | -3.83 to -3.58 | 10.77 | 10.63–10.91 |

†Of the 154 children admitted based on WHZ, 111 (72%) also had MUAC < 11.5 cm. MUAC: Mid-upper arm circumference, n.: Number, cm: centimeter, SD; standard deviation WHZ: weight for height z score, TFCs; Therapeutic Feeding Centers, CI; confidence interval

*p-values calculated using Kruskal–Wallis test for comparisons across diagnostic categories

**p-values calculated using independent t-test for comparison between admission criteria groups

**Table 3** WHZ and MUAC for children with complicated SAM categorized by diagnostic and programmatic admission criteria, Sana'a City, Yemen

| SAM Indicators (*n* = 188) | | WHZ at discharge | | MUAC at discharge | |
|---|---|---|---|---|---|
| | | Mean | 95% CI | Mean | 95% CI |
| Diagnosis Criteria at Admission | | | | | |
| Both | 111 | -0.87 | -1.05 to -0.69 | 11.75 | 11.56–11.93 |
| WHZ only | 43 | -1.03 | -1.28 to -0.78 | 12.57 | 12.35–12.79 |
| MUAC only | 34 | -0.51 | -0.89 to -0.12 | 12.16 | 11.90–12.41 |
| P value* | | 0.056 | | < 0.001 | |
| Criteria used for admission | | | | | |
| †WHZ | 154 | -0.92 | -1.06 to -0.77 | 11.98 | 11.82–12.13 |
| MUAC | 34 | -0.51 | -0.89 to- -0.12 | 12.16 | 11.90–12.41 |
| P value** | | 0.028 | | 0.332 | |
| Total | 188 | -0.84 | -0.98 to -0.70 | 12.01 | 11.87–12.15 |

†Of the 154 children admitted based on WHZ, 111 (72%) also had MUAC < 11.5 cm. MUAC: Mid-upper arm circumference, n.: Number, cm: centimeter, SD; standard deviation WHZ: weight for height z score, TFCs; Therapeutic Feeding Centers, CI; confidence interval

*p-values calculated using Kruskal–Wallis test for comparisons across diagnostic categories

**p-values calculated using independent t-test for comparison between admission criteria groups

**Table 4** Discharge scenarios by SAM criteria at admission to TFCs, Sana'a City, Yemen

| Children by SAM criteria at admission (*n* 188) | | Recovered Children by Discharge Scenarios | | | |
|---|---|---|---|---|---|
| | | WHZ ≥ 2SD | MUAC ≥ 12.5 cm | WHZ or MUAC | WHZ and MUAC |
| | | *n*(%) | *n*(%) | *n*(%) | *n*(%) |
| Diagnosis Criteria | | | | | |
| WHZ & MUAC | 111 | 103(93%) | 36(32%) | 105(95%) | 34(31%) |
| WHZ only | 43 | 40(93%) | 25(58%) | 43(100%) | 22(51%) |
| MUAC only | 34 | 33(97%) | 16(47%) | 33(97%) | 16(47%) |
| P Value* | | 0.661 | 0.01 | 0.272 | 0.032 |
| Admission Criteria | | | | | |
| WHZ | 154 | 143(93%) | 61(30%) | 148(96%) | 56(36%) |
| MUAC | 34 | 33(97%) | 16(47%) | 33(97%) | 16(47%) |
| P value* | | 0.364 | 0.424 | 0.791 | 0.245 |
| Total | 188 | 176(94%) | 77(41%) | 181(96%) | 72(38%) |

MUAC: Mid-upper arm circumference, No.: Number, cm: centimeter, WHZ: weight for height z score, TFCs; Therapeutic Feeding Centers, *Chi-square test used for group comparisons. No adjustment for multiple comparisons was applied

deficit alone ($p = 0.006$ for weight gain, $p = 0.048$ for length of stay).

The discharge scenarios based on (WHZ ≥ -2), (MUAC ≥ 12.5), combined (WHZ or MUAC), and strict combined (WHZ and MUAC) criteria resulted in discharge rates of 94% (176/188), 41% (77/188), 96% (181/188), and 38% (72/188), respectively. For WHZ ≥ -2, discharge rates were high across all groups: 93% for dual deficient, 93% for WHZ-only, and 97% for MUAC-only, with no significant differences ($p = 0.661$). For MUAC ≥ 12.5 cm, discharge rates were 32% for dual deficient, 58% for WHZ-only, and 47% for MUAC-only, showing significant differences ($p = 0.01$). The WHZ or MUAC criterion resulted in discharge rates of 95-100% across all groups with no significant differences ($p = 0.272$), while the combined WHZ and MUAC criterion led to lower rates: 31% for dual deficient, 51% for WHZ-only, and 47% for MUAC-only, with significant differences ($p = 0.032$) (Table 4).

## Discussion

The result revealed that 59% (111/188) of children with complicated SAM presented with WHZ<-3 and MUAC < 11,5 cm. This result reflects a high overlap between WHZ and MUAC, and a high prevalence of wasting and severity patterns among children with complicated SAM. The similar prevalence of dual deficits in

both the full prospective cohort (60%) and the final sample (59%) supports the representativeness of our analytical sample and strengthens the validity of our findings. The overlap reported in our study was within the line of studies conducted in Nigeria, India, and Ethiopia which reported 39%,42%, and 61.2%, respectively [7–9]. This high proportion among children with complicated SAM reflects the greater severity which might be due to the consequence of the prolonged conflict, poor living conditions, and limited access to early care in the study setting [17].

The result showed those presented with WHZ deficiency only had MUAC met the MAM criterion (between 11.5 and 12.5 cm). In contrast, children presented with MUAC had WHZ (between – 3 and – 2 SD). These results were consistent with the fact that often WHZ and MUAC identify different subsets of malnutrition [6].

The differences in the severity of wasting further highlight the heterogeneity of complicated SAM, and the higher proportion of dual deficient underscores the need for specific interventions based on specific nutritional profiles [8].

The result showed that although (72%) of children who meet WHZ (<-3) had MUAC < 11.5 cm, they were admitted based on WHZ irrespective of their MUAC. This admission approach may reflect clinical practices, the weight in the context of complicated SAM is closely monitored during the stabilization phase to assess water balance and detect edema or dehydration [24]. WHZ is more sensitive than MUAC to short-term changes in nutritional status, and the current WHO protocol emphasizes weight gain, as a primary measure of improvement in TFCs and recommends recovery in outpatient or community-based management [25]. Furthermore, the lack of management protocol for children with dual deficiencies might be the reason for this admission pattern and those factors might be the contributors.

Many studies reported that WHZ reflects the short-term responsiveness of weight-based indicators and exhibits faster recovery. MUAC recovery to rebuild muscle and fat stores requires longer-term improvements in body composition [14, 15, 26].

However, the general result of our study consistently showed more recovery in WHZ (-0.028) and partial MUAC (12.01), in contrast, the result based on the admission criteria deviated from these patterns and showed significant differences in WHZ measurements as severely among those admitted based on prioritized WHZ (P 0.028) but not on their MUAC (P 0.332). The results based on the criteria used for diagnosis were more consistent with the expected recovery pattern, as children presented with MUAC only demonstrated the fastest WHZ recovery, while children presented with WHZ had better MUAC recovery.

The WHZ mean at discharge among children who were classified based on criteria diagnosis compared to their MUAC measurements often did not meet the discharge criterion with significant differences indicating the reliance on the WHZ criterion for discharge children.

These discrepancies highlight the influence of baseline severity and dual deficits on recovery trajectories and suggest that admission criteria might mask these differences by prioritizing one indicator over the other [8].

This result might be due to the program implementation in TFC prioritizing WHZ, leading to potential exclusions of MUAC deficiencies during OTP care [27–29]. In line with this operational practice, our previous study reported that despite the good discharge cure rate from OTP (88%), more than three-quarters of children transferred from TFC were prematurely discharged from OTP [30]. This creates a gap in treatment protocols, as children discharged prematurely based on WHZ recovery alone remain vulnerable to ongoing nutritional deficiencies.

The result showed that children with dual deficits experienced greater weight gain and longer treatment duration, reflecting higher severity, greater energy demands, and the longer time needed to meet WHZ-based recovery thresholds. However, since discharge was mainly based on WHZ recovery, the longer stay also highlights the complexity of their condition and the additional time needed for full nutritional recovery [31].

The result of discharge scenarios confirmed the patterns of WHZ and MUAC recovery and showed varied recovery patterns, influenced by the criteria applied. Discharging children using WHZ ≥ -2 showed the highest discharge rates, reflecting WHZ's responsiveness to short-term weight gain. However, this reliance risks premature discharge, as MUAC recovery, which takes longer to rebuild muscle and fat stores, often remains incomplete [32, 33].

Using MUAC ≥ 12.5 cm resulted in lower discharge rates, especially among dual-deficient children, highlighting the need for extended nutritional rehabilitation in OTPs. The combined WHZ or MUAC criterion provided flexibility but risked overlooking persistent MUAC deficits, while the stricter WHZ and MUAC criterion ensured comprehensive recovery but prolonged stays [34]. Dual-deficient children recovered more slowly in all scenarios, highlighting the need for tailored discharge criteria and continued follow-up for long-term recovery.

#### Study limitations and implications for broader context

This study has several limitations. Although based on a prospective cohort, the analysis was conducted retrospectively on a subset of 188 children with complete and valid records. Children with missing data, incomplete treatments, or flagged anthropometric values were excluded to ensure data integrity. While the final analyzed

sample was broadly representative of the original cohort in terms of nutritional severity, as shown in Supplementary Fig. 1 and Supplementary Table 1, the exclusion of cases may have introduced selection bias. In addition, no a priori sample size calculation was conducted for this subset, potentially limiting the statistical power. Lastly, although baseline information on comorbidities, vaccination status, breastfeeding practices, socio-economic status, and food security was collected, these factors were not analyzed for their influence on recovery outcomes. Future studies should explore how these factors interact with treatment outcomes, particularly among children with dual anthropometric deficits.

While this study was conducted in a conflict-affected setting with fragile health infrastructure, the findings regarding gaps in admission and discharge practices, particularly for children with dual anthropometric deficits, may also have relevance in non-conflict settings. In contexts with stronger healthcare systems, better adherence to protocols and closer monitoring could potentially mitigate some of the risks identified. However, the fundamental issue of a lack of specific guidance for children presenting with both WHZ and MUAC deficits remains globally relevant, regardless of healthcare system strength.

## Conclusion

This study highlights a high burden of dual anthropometric deficiencies among children admitted for complicated SAM, with significant gaps in recovery when using current discharge protocols. The findings suggest that reliance on WHZ-based criteria may lead to the premature discharge of children with persistent MUAC deficiencies. To ensure comprehensive recovery, SAM management protocols should be revised to better address dual deficits, especially in conflict-affected settings. Strengthening integrated monitoring systems across TFCs and OTPs and allocating sufficient resources for follow-up care are essential. Further research is needed to assess the long-term outcomes of children discharged under different anthropometric criteria.

### Abbreviations

| | |
|---|---|
| CI | Confidence Interval |
| MUAC | Mid-upper arm circumference |
| OTP | Out-Patient Therapeutic Program |
| SAM | Severe Acute Malnutrition |
| SD | Standard deviations |
| TFC | Therapeutic Feeding Center |
| WHO | World Health Organization |
| WHZ | Weight for height Z score |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13031-025-00666-0.

Supplementary Material

### Acknowledgements

We would like to thank staff working in the TFCs data collectors and study participants.

### Author contributions

MAA contributed to the conception, design study, methodology, and data analysis, and wrote the draft manuscript. KA contributed to the results interpretation and writing the draft manuscript. YAR reviewed the overall study, interpreted the results, and revised the final manuscript. All authors read and approved the final manuscript.

### Funding

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

### Data availability

All relevant data are presented in this paper, and more information can be provided upon reasonable request from the corresponding author.

## Declarations

### Competing interests

The authors declare no competing interests.

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Received: 22 February 2025 / Accepted: 21 April 2025
Published online: 24 April 2025

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