

Beyond Recovery: Repeated Episodes of Severe Acute Malnutrition Among South Sudanese Refugee Children Aged 6–59 Months in Gambella, Ethiopia: A Camp-Based Cross-Sectional Study

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ABSTRACT

Background: Severe acute malnutrition affects approximately 16.9 million under-five children globally, with outcomes worsening when recovery is not sustained after intervention, leading to repeated episodes of malnutrition. In Africa, relapse rates as high as 37% have been reported following successful discharge from outpatient therapeutic programs. In Ethiopia's Gambella region, a major host for refugees, the prevalence of wasting reaches 14%, with 10% of repeated episodes of severe acute malnutrition occurring within the host community. However, the epidemiological burden of recurrent severe acute malnutrition and the factors associated among children residing in refugee camp settings remain insufficiently characterized in the existing literatures. Thus, this study assessed the magnitude and associated factors of repeated episodes of severe acute malnutrition among South Sudanese refugee children aged 6-59 months, discharged from the outpatient therapeutic program in Gambella region refugee camps, Ethiopia.

Method: A camp-based cross-sectional study was conducted among 242 children aged 6-59 months who had discharged from outpatient therapeutic programs between January 1, 2023, and January 1, 2024, along with their caregivers, in refugee camps in the Gambella region of western Ethiopia. Data were collected through document review, interviewer-administered questionnaires, and anthropometric measurements using pre-tested structured tools. Data entry was carried out using EpiData Version 3.5.1, and analysis was performed using STATA Version 17. Both bivariable and multivariable logistic regression analyses were conducted to identify factors associated with repeated episodes of severe acute malnutrition.

Result: Out of 242 study participants, with a response rate of 96.8%, 12.8% (95% CI: 8.6%–17%) experienced repeated episodes of severe acute malnutrition within one year of discharge. Having multiple children in the household (AOR = 2.90; 95% CI: 1.15–7.30), severe food insecurity (AOR = 3.20; 95% CI: 1.20–8.50), non-participation in mother-to-mother support groups (AOR = 7.50; 95% CI: 3.10–18.00), lack of nutrition counselling at discharge (AOR = 3.20; 95% CI: 1.40–7.50), and a history of edematous malnutrition (AOR = 2.10; 95% CI: 1.00–4.50) were significantly associated with repeated severe acute malnutrition.

Conclusion: The study findings revealed that the magnitude of repeated severe acute malnutrition in refugee context exceeded that reported in host-community settings. More than one in ten children, discharged from outpatient therapeutic programs, experienced repeated episodes of severe malnutrition within a year. factors associated include severe food insecurity, multiple under-five children in household, non-participation in mother-to-mother support groups, lack of nutrition counseling at discharge, and history of edema. Therefore, targeted post-discharge health and nutrition support is recommended.

Key words: Malnutrition, repeated episode, relapse, Severe acute malnutrition and Refugee

1. Background

Nutrition is an important factor for good health and child growth. Hence, failure to maintain proper nutritional habits will result in malnutrition, in which health and growth is hampered. Malnutrition is a category of condition that includes undernutrition and over nutrition [1]. Undernutrition is a lack of nutrients, which can result in stunted growth, wasting, and underweight, it is a form of malnutrition that remains among the critical public health problems in developing countries [2]. For malnutrition, under five children are classified as the most vulnerable groups of the community [3]. As the health status of a child is a major concern, the nutrition status of children under five years is an important outcome of measure for child health [3].

Severe acute malnutrition (SAM) is the most life threatening form of malnutrition. defined by the presence of bilateral pitting oedema or severe wasting ($\text{MUAC} < 11.5 \text{ cm}$ or a $\text{WFH} < -3 \text{ z-score}$ [WHO standards]) in 6-59-month children, SAM can also be used as a population-based indicator defined by existence of bilateral pitting oedema or wasting. As a child with SAM is approximately nine times more likely to die than a well-nourished child, immediate results of SAM are life threatening [2].

Geographically, the highest rate of child malnutrition is found in the sub-Saharan Africa countries, as Ethiopia is categorized amid east African countries which are prone to recurrent droughts that impact food security and water availability, the country has experienced a serious burden of malnutrition [2]. According to 2019 mini-Demographic and Health survey (EDHS), 7% of children under five years are wasted and 1% of these are severely wasted. Hence, the need for appropriate management and intervention approach is undoubtedly necessary[1].

For the management of acute malnutrition, the community-based management of acute malnutrition (CMAM) approach has been applied throughout the country. The approach aims to reach maximum number of children with malnutrition and to ensure access by providing treatment at decentralized sites instead of centrally located limited facilities [4]. Now used in more than 60 countries worldwide, the program provides children the lifesaving treatment they need and has been reported to be effective in terms of access and achieving key indicators mainly high recovery, low defaulter and low death rates [5]. even more, the recovery rate is above the national Sphere standard of $>75\%$ in most surveys published by implementing partners [6]. However, evidence shows that children eventually experience poor health and nutrition status after they are discharged from CMAM program, including relapse and another episode of SAM [5].

Basically, relapse is when a child's health and nutritional state deteriorates back to severe acute malnutrition within a certain period of time, after being recovered and discharged from SAM treatment[1]. The definition differed between studies and program reports, the national and CMAM guideline defines relapse as children Cured within the past 3 months and currently meets the admission criteria for treatment, thus children who were discharged cured over the past 3 months can simply be taken as a repeated another episode of SAM [4]. Ideally, to maximize long term outcomes of the recovery, the national guideline recommends recovered children should be under one or two months follow up through home visit and appointments [4, 7]. Yet, recent studies indicate that a static large portion of children maintain a high degree of vulnerability for repeated SAM or a relapse after recovery [8].

Although there are certain internationally agreed standards for nutrition program effectiveness and coverage of interventions. The existing guidelines typically evaluate short-term outcomes via the success of the nutrition intervention through monitoring routine program indicators (sphere standards), focusing on recovery, death, and defaulter during and shortly after treatment. yet, leaving no standards for post-discharge relapse (repeated cases), readmission, and mortality [5]. consequently, it is becoming clear that the risk of long-term effects like relapse, illness and mortality after programmatic recovery from SAM treatment remain elevated [9].

1.1 Statement of the Problem

Severe acute malnutrition (SAM) is a major global health problem affecting nearly 16.9 million children under five years of age. Rolling in, prevalence of wasting is high in Asia and Africa, with more than two-third of wasted children existed in Asia and more than one quarter in Africa [2]. Moreover, globally an estimated 1 million children die each year due to severe wasting, the situation is even worse when there is failure to sustain the recovery of malnutrition after successful intervention [2, 10]. A recent systematic review showed that the proportion of children relapsing to SAM after successful discharge from nutritional programs reaches up to 37% [9].

Studies have consistently documented an elevated prevalence of post-discharge morbidities and children remains at an increased risk of illness despite the weight gain sufficient for successful discharge [11, 12, 21]. This has been noted as 9 % in Bangladesh, 10 % in Sudan, and in Ethiopia 72.1% (34.6% SAM & 37.5% MAM) relapse proportions [8]. As compared to the effort and resources putted in place to intervene

malnutrition, recording a higher prevalence and failing to early identify and manage repeated episodes has hugely contributes for the sluggish improvement of national and global burden of SAM. Worldwide over the past 20 years, estimated reduction only in 11%, particularly when compared with progress made in reducing other indicators, such as stunting [5]. Likewise, in Ethiopia, it is indicated on 2019 mini DHS report on trends of wasting showing poor improvement on the prevalence in the past decade, i.e. 12% in 2005, 10% in 2011, 10% in 2016 and 7 % in 2019 [13].

Repeated episodes malnutrition heightens the risk of death and long-term development problems, it also contributes to persistently high rates of malnutrition across the world [21]. This undermines CMAM program effectiveness and cost-effectiveness, by deploying limited resources of the country to treat the same child multiple times [2]. Hence, long-term interventions were seemingly failed to succeed in a few occasions of resource shortage, as it related with failing to drain the malnutrition pool or caseload following long-term interventions [14]. Recently in Ethiopia, it has been revealed at times of resource scarcity, shifting due to crises and national disasters.

As the shortcomings to act on relapse cases needs the existence of monitoring standards, absence of such useful standards reflects, among many issues mostly subjected to political will, budget, and awareness on post-discharge care and most importantly the evidence that could be used to formulate such standards [8]. Accordingly, most programs do slight work on post-discharge follow-up despite reporting number of readmissions who have been discharged after an intervention [37].

Up on its psychological distress towards family members often resulted from their feelings of helplessness and frustration due to its repeated occurrence nature on children [15]. Even when it comes to Ethiopia, malnutrition contributes to more than 50% of all infant and child deaths. having the issue as a public health problem for quite long period [1], unfair to notice very limited number of studies (one case control study on acute malnutrition and one cohort study on severe acute malnutrition) conducted specifically on the repeated episodes of SAM cases [8], and none was focused on camp living setup nutrition interventions.

A wide range of factors associated with repeated episodes of malnutrition. Studies consistently shown that lower anthropometric measures at admission and discharge from nutritional programs can be the primary factors for relapse [9, 28]. Some studies have also identified measures of socioeconomic status, hygiene, sanitation, seasonality, age, sex, vaccination status and diet as an associated factor [8, 16, 17]. Although, proper discharge procedure, post discharge follow-up and mother to mother support groups were seemingly

associated with relapse, studies were not addressed the issues among the factors associated with repeated malnutrition. Moreover, considering the context, parallelly assessing untouched factors will remain as an area of improvement for researchers. Thus, most will be assessed in this study.

Gambella, the largest refugee hosting region in Ethiopia, is also the region with high prevalence of wasting, which was 14% with a mortality rate of 88 per 1000 live births [18]. As the situation in host community is critical, it is even more stimulating to explore the certain issue in a camp living context of targets, Where the Food security of refugees primarily depends on the monthly cyclical food ration assistance provided. Although there are varies surveys conducted in the camps, to the best of our knowledge, assessments in repeated SAM cases were not studied so far [19]. So that, this study aimed to assess the magnitude and associated factors of repeated SAM cases in refugee camps at Gambella region, western Ethiopia.

1.2 Objectives

1.2.1 General Objective of the study

- To assess the magnitude and associated factors of repeated episodes of severe acute malnutrition among South Sudanese refugee children aged 6-59 months, discharged from the outpatient therapeutic program (OTP) between January 1, 2023, and January 1, 2024, in Gambella region refugee camps, Western Ethiopia, from March 1st to 30th, 2024.

1.2.2 Specific Objectives

- To assess the magnitude of repeated episodes of severe acute malnutrition among south Sudanese refugee children aged 6-59 months, discharged after cured from OTP between Jan 1, 2023, and Jan 1, 2024.
- To determine the factors associated with repeated episodes of severe acute malnutrition among south Sudanese refugee children aged 6-59 months at Gambella region refugee camp

1.3 Conceptual framework

The conceptual framework illustrating the potential factors associated with repeated episodes of severe acute malnutrition after recovery from outpatient therapeutic program treatment is presented in **Fig. 1**.

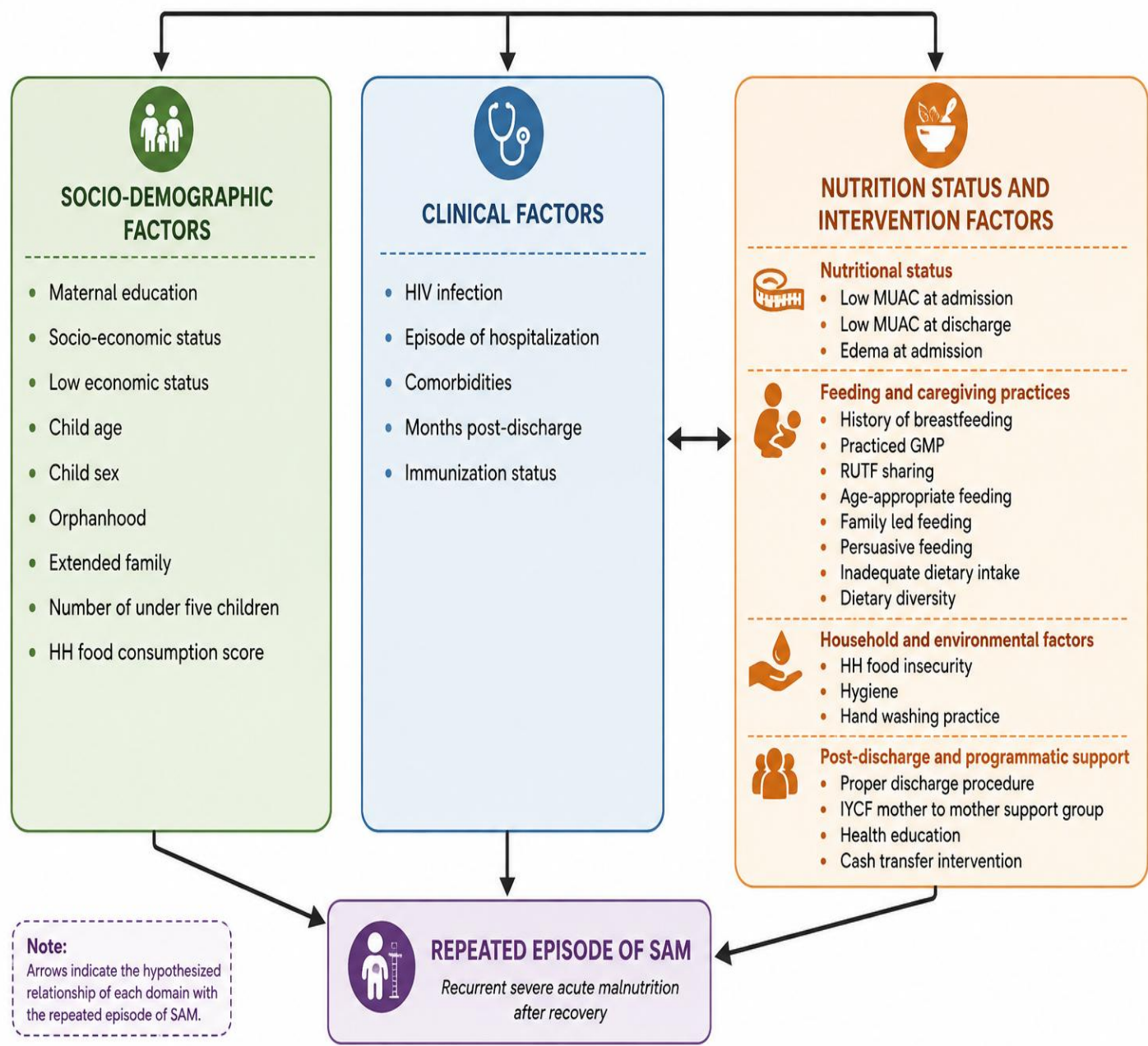


Figure 1. A conceptual framework for Magnitude and associated factors of repeated episode of SAM after recovery from OTP. (Source: formed from reviewed literatures).

2 METHODS

2.1 Study area and period

A camp-based cross-sectional study was conducted from March 1st to 30th, 2024, at randomly selected nutrition sites in all of the refugee camps in the Gambella region, located 777 km away from Addis Ababa, the capital city of Ethiopia. Gambella is one of the eleven regions of Ethiopia, formerly known as region 12, and its capital city is Gambella town. It is located in the western region of Ethiopia, bordering South Sudan on the west, south, and north. Its area is 25,802.01 square kilometers. The most prominent nationalities of the region include Anyuak, Nuer, Mezhenger, Komo, and Opo. However, there are also other ethnic groups, including settlers from other areas of the country.

Most of the South Sudanese refugee population in Ethiopia is housed in the Gambella Region; the region has a long history of sheltering refugees since 1993. As of September 30, 2022, the region was hosting 373,925 refugees in 7 camps (including one settlement, Akula). As a result of the conflict that broke out in December 2013, an enormous influx of South Sudanese refugees took place between 2014 and 2017. The new entrants came to the region through Pagak (94%), Akobo (4%), and Road (2%) entry routes. Refugees are hosted in seven refugee camps: the newest and largest camp, Nguenyiel (opened on October 24, 2016), Tierkidi (opened February 26, 2014), Kule (opened May 17, 2014), Jewi (opened March 16, 2015; note caseload was previously in Leitchuor), Pinyudo 1 was established in 1993, and the additional population arrived in 2012–2014. Pinyudo 2 (opened on August 20, 2015) and Okugo (opened on May 7, 2013) The UNHCR sub-office in Gambella provides regulation for the refugee operation in the region, with a field office in Pinyudo and a field unit in Okugo. 88% of the refugees in Gambella are women and children, with 65% under the age of 18; 20% are youth (15–24 years); approximately 17% are children under 5 years; and about 4% are pregnant and breastfeeding women.

The nutrition program in Gambella is implemented in seven camps and one welcome facility, including 17 decentralized nutrition facilities. Nutrition-specific and nutrition-sensitive partners currently include GOAL, AAH, CWW, and IMC for mainly nutrition-specific interventions, and DCA and HAI for nutrition-sensitive programs. All the nutrition-specific partners have mainstreamed some nutrition-sensitive initiatives in program design, albeit on a small scale. The core program targets are children under five years, pregnant and breastfeeding women, and other social medical issues at the individual level. Nutrition programs are in line with the UNHCR worldwide strategy on public health and the UNHCR Ethiopia country multiyear multiparter and solutions strategic plan.

Administration is coordinated by UNHCR and RRS in partnership with WFP, the source of food aid and supplementary feeding, and UNICEF, who provide technical support as well as therapeutic feeding

supplies. Nutrition and food security programming over the years has contributed to an improvement in the nutrition status, from an emergency-level prevalence of global acute malnutrition (GAM) to an acceptable level, whereas the prevalence remains over the UNHCR <10% target. This is mainly due to the dependence of the people on the general food ration, with limited access to a diversified diet, which has been made more difficult by the smaller ration in an environment where livelihood interventions do not have high coverage. The geographic distribution of the refugee camps included in the study area is shown on **Fig. 2**.

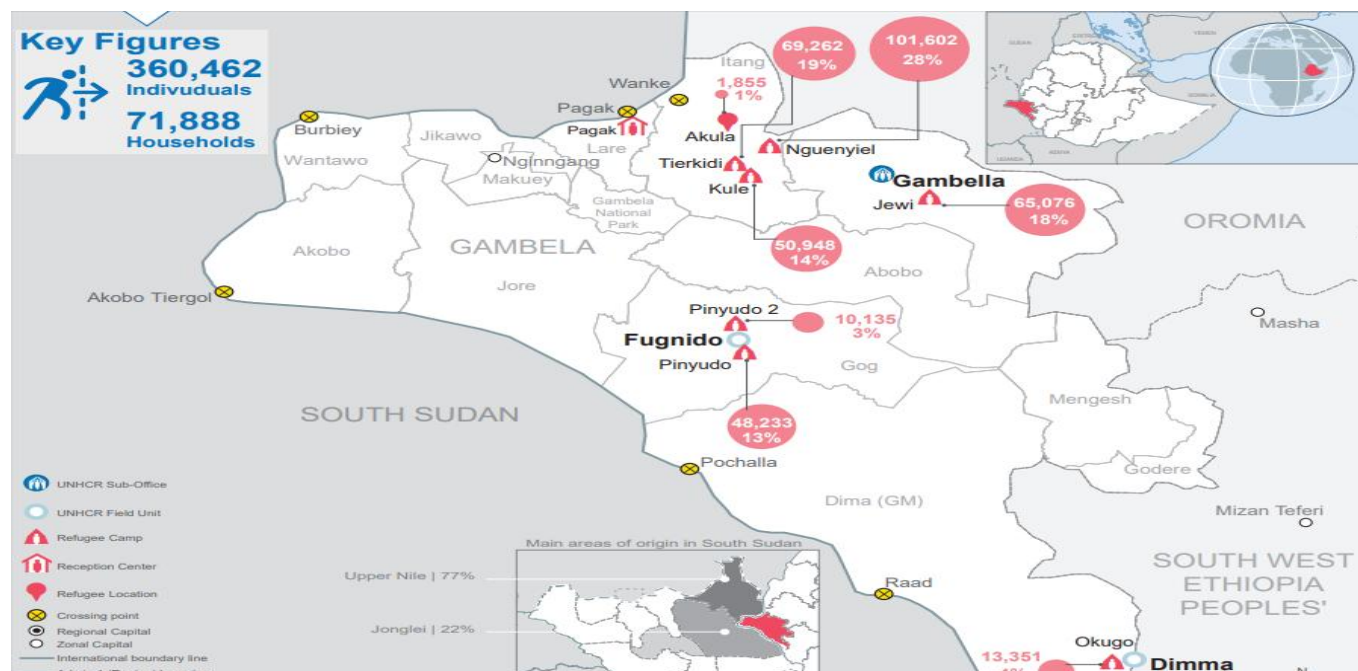


Figure 2. Map of refugee camps in Gambella Ethiopia, (source: UNHCR, standardized nutrition survey report. 2023).

2.2 Study design

Camp based cross-sectional study design was employed to identify magnitude of repeated cases of SAM and its associated factors in camp-based treatment facilities at Gambella refugee camps.

2.3 Source population

All children aged 6–59 months discharged after recovery from outpatient therapeutic program (OTP) and their mothers or caregivers in Gambella region refugee camps.

2.4 Study population

All children aged 6–59 months discharged after recovery from outpatient therapeutic program (OTP) between January 1, 2023, and January 1, 2024, and their mothers or caregivers in Gambella region refugee camps.

2.5 Sample size determination

2.5.1 Sample size determination for objective one (Magnitude of post discharge SAM)

The sample size was calculated using single population proportion formula based on the following assumption SAM relapse (WHZ<-3) of 18.1% from the previous study done in Nigeria [24], a margin of error of 5% and 95% confidence interval. The calculated sample size becomes (227) and by considering a non-response rate of 10% the final sample size becomes (250).

$$n = \frac{(Z_{\alpha/2})^2 * (P) * (1-P)}{d^2}$$

$$n = \frac{(1.96)^2 * 0.181 * (1-0.181)}{(0.05)^2} = 227$$

Where n is the required sample size

z = the standard score corresponding 95% confidence level (1.96).

p = proportion of SAM among children discharged from SAM management from a study done in Nigeria.

q = complement probability (1-p).

d = the permissible Margin of error (the required precision) = 5%

2.5.2 Sample size determination for objective two (factors associated with SAM relapse)

To estimate the required sample size for objective two, epi-info version 7.2.0.1 software were used, considering the percent outcome in exposed (p1) and percent outcome in unexposed (p2) from previous studies with a 1:1 ratio of unexposed to exposed, a 95% confidence interval, and a power of 80%. Variables considered for sample size calculation are age [31], breastfeeding status [12], and an episode of hospitalization [17].

Table 1: Sample size determination for factors associated with SAM relapse post discharge from OTP

Variable	Power (%)	CI (%)	AOR	Ratio	Outcome among non-exposed (%)	Sample size (N)	Final sample size with non-response rate 10%
Breastfeeding status (39)	80	95	4	1:1	50.8	92	102
Episode of hospitalization (33)	80	95	3.9	1:1	13.2	118	130
Age <12 Month (34)	80	95	2.49	1:1	31	178	196
HIV status (34)	80	95	4.03	1:1	17	96	106

The sample size calculated for the first specific objective using the single population proportion formula considering a 10% non-response rate was 250, which was the largest sample size calculated value compared to the sample size calculated for objective two. Therefore, the sample size selected for the study was 250.

2.6 Sampling procedure and technique

Simple random sampling was utilized to select study participants. Initially, OTP cards and registration books were reviewed to compile a comprehensive list of all children discharged as cured within the specified period for potential inclusion in the study. The total sample size was then proportionally assigned among the nutrition facilities in the refugee camps based on their respective discharge caseloads from the previous year. Using this compiled list as the sampling frame, names were selected through simple random sampling a computerized lottery method. After the selection process was completed, comprehensive information about the selected children, including specific household addresses, was recorded from the OTP registration book for data collection in the refugee camps. In cases where selected participants declined to enroll, passed away before data collection, or had incomplete information in the registration book, replacements were chosen using the same computerized lottery method from the list of the names in the OTP registration books.

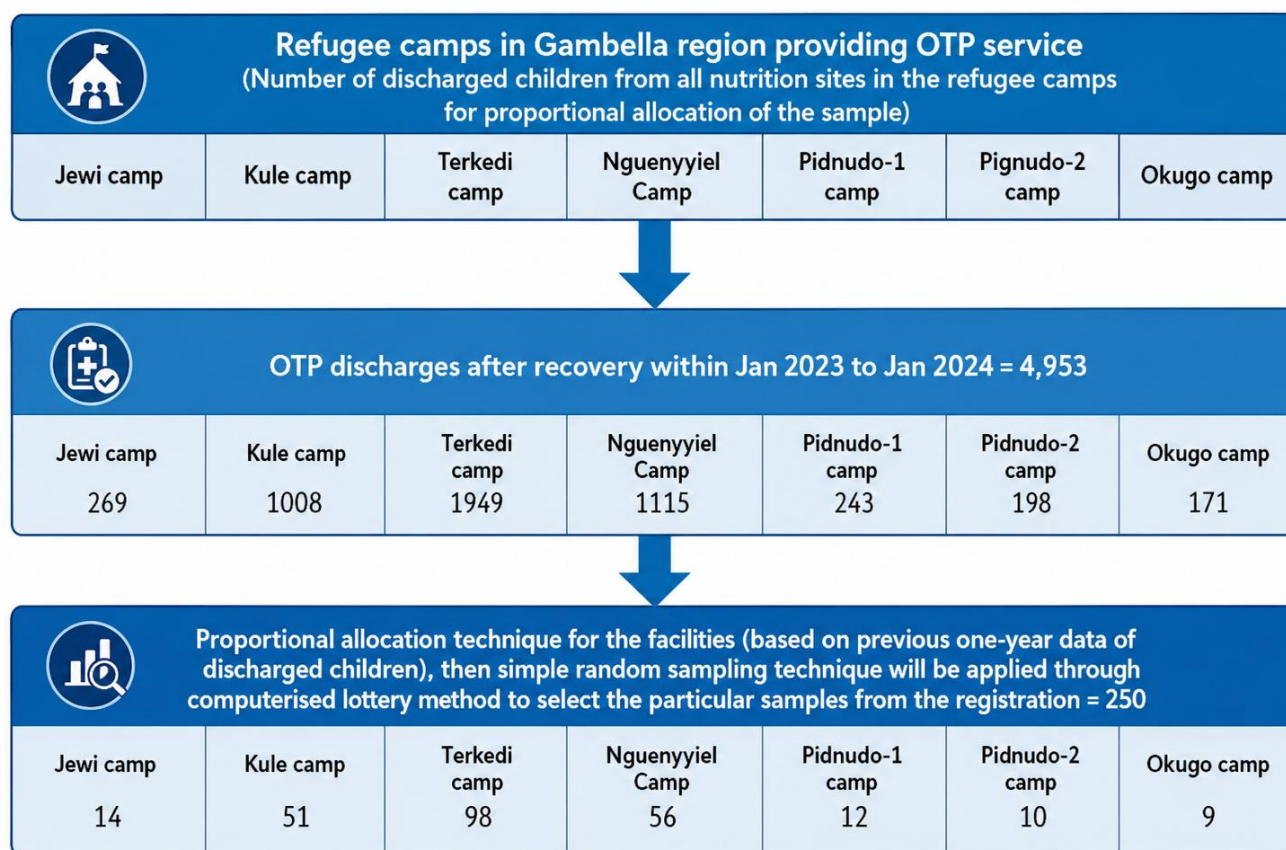


Figure 3: Schematic representation of sampling procedure on assessment of SAM relapse in children (6-59 months) and its associated factors in refugee camps, Gambella region, Western Ethiopia.

2.7 Data collection method

2.7.1 Data Collection Tools/Instruments

Data were collected using a structured interviewer-administered questionnaire and a checklist developed from OTP registration logbooks and treatment records, consistent with the Ethiopian Health Management Information System (HMIS) and DHIS2 reporting requirements [1]. The checklist was used to extract information on the child's sex, age, weight, height, MUAC, admission and discharge dates, residential address, and nutritional status at admission and discharge.

The questionnaire comprised three sections addressing socio-demographic, clinical, and nutritional characteristics. Primary data were obtained through face-to-face interviews with mothers or caregivers using the structured questionnaire. Data collection was conducted from March 1 to 30, 2024.

2.7.2 Data Collectors

Ten data collectors were recruited from nutrition workers currently working in OTP centres. All were diploma nurses, had previous experience in data collection, had received training on the CMAM

protocol, and were able to communicate in the local language. Three supervisors were assigned to oversee field-level data collection, while the principal investigator provided overall supervision.

Before the commencement of data collection, the data collectors and supervisors participated in a two-day training. The training covered the study objectives, contents of the questionnaire, data collection procedures, and anthropometric measurement techniques. It was delivered through presentations, discussions, practical demonstrations, question-and-answer sessions, and fieldwork planning.

2.7.3 Data Collection Procedure

The process of data collection was started by reviewing the OTP registration and preparing a checklist using the OTP multi-chart and registration logbook that had been used in the country [22]. From the registration book, important variables like sex, age, weight, height, MUAC, date of admission, date of discharge, and address (specific site in camp) of the caregivers were captured and documented on hardcopy forms. Then, based on the address in the registration, children discharged as recovered or cured were identified. Additionally, the severity of malnutrition on admission and discharge from the OTP program was captured from the same OTP registration book.

During the data collection, procedurally the first step was data collectors explaining the purpose of the study and obtaining informed consent from the caregivers. Then after, caregivers were interviewed using a structured questionnaire, which took about 20–30 minutes, and were asked to bring children for anthropometric measurement, in which measurements were taken.

A total of 10 data collectors who could speak the local language and were currently working in OTP centers, trained on the CMAM protocol, and had previous experience in data collection were recruited (diploma nurses) and trained for 2 days, along with 3 supervisors (health officers). The training was a preparatory phase for the data collection comprising sessions for presentation, discussion, demonstration, Q&A, and planning.

To determine the age of children during the data collection, mothers were asked to recall the date of birth, and all mothers were asked to bring birth certificates and immunization cards to cross-check and capture the date of birth. Then the age of the children was calculated by subtracting their date of birth from the interview date and recorded in months. The age of the caregivers was measured in years. Questionnaires related to maternal age, maternal education, marital status, number of people living in the household, number of children under 5 in the household, and occupational status of the caregivers were adopted from EDHS [38].

While getting information related to child feeding practices, standard indicators for assessing infant and child feeding practices were asked of the caregivers [2]. These questions were related to the initiation of breastfeeding, colostrum, exclusive breastfeeding, and complementary feeding. Initiation of breastfeeding was categorized into three categories: Immediately (within 1 hour of birth), <24 hours, and >one day. Questions related to colostrum were categorized into two categories: a child who received colostrum within three days of birth (yes) or a child who did not receive colostrum within three days of birth (no). Questions related to exclusive breastfeeding were categorized into four categories: a child received breast milk only; a child received breast milk and water; breast milk and infant formula.

To get information on age-appropriate complementary feeding introduced, the question was categorized into three categories: supplementary feeding introduced at <6 months, at 6 months, and >6 months. For children under 2 years of age, questions on the continuity of breastfeeding were also asked. It was categorized into two groups: children currently breastfeeding (yes) and children not currently breastfeeding (no). Furthermore, based on the literature reviewed, questions were asked about whether the caregivers had obtained any education on IYCF practice, participated in a mother-to-mother support group, received discharge rations, and received education. It was categorized into two categories: had education on IYCF practice (yes) and had not gotten any education on IYCF practice (no).

Regarding the HIV status of the child, the study captured the test result recorded in OTP registration and cross-checked with the caregivers. Concerning child-level illness, the caregiver was asked to know whether the child was ill the previous month before the survey. Then, for children who were ill, symptoms of the illness and an episode of hospitalization were asked. Regarding immunization status, FMOH's guideline was used, and based on the schedule in the guideline, children's status was evaluated [1]. First, the caregivers were asked whether the child had received any vaccinations previously (yes or no). Then, for children who were vaccinated, the study assessed whether they were fully vaccinated for their age by reviewing immunization cards.

Anthropometric measurements

Anthropometric measurements were obtained following standard procedures [22]. Children aged two years or older were measured in a standing position using a portable height board, with appropriate positioning of the child during measurement. For children younger than two years, those with a height below 85 cm, or those unable to cooperate with the standing measurement, recumbent length was measured using a measuring board positioned on the ground. Height or length was recorded to the nearest 0.1 cm [1].

Body weight was assessed using a digital weighing scale. Children aged two years or older were weighed independently. For children younger than two years, the child was weighed together with the mother, after which the mother's weight was measured separately. The child's weight was obtained by subtracting the mother's weight from the combined measurement and was recorded to the nearest 0.01 kg [1].

Each child's weight and height/length were measured twice. The two readings were compared during data collection, and measurements were repeated when the difference exceeded the predefined allowable limit. The mean of the two acceptable measurements was used in the analysis. The maximum allowable difference between duplicate measurements was 0.5 kg for weight and 1.0 cm for height/length [1].

Bilateral pitting oedema was assessed by applying thumb pressure to the upper surface of both feet for three seconds and checking for the presence of a persistent pitting edema [1]

2.8 Operational definitions

Repeated Episode of SAM: A child aged 6–59 months who had previously been discharged as recovered from OTP treatment for SAM and was found to meet the SAM admission criteria at the time of the post-discharge assessment conducted during the study period. A repeated episode was identified through anthropometric assessment, based on weight-for-height z-score (WHZ) < -3 and/or mid-upper arm circumference (MUAC) < 11.5 cm and/or the presence of bilateral pitting oedema [4]. Thus, children who had recovered from their previous OTP episode but were identified as having SAM again during the study assessment were classified as having a repeated episode of SAM.

Hand washing practice will be categorized as having **good hand washing practice** if they reported washing hands at 3 or more of the recommended critical times/points (before eating, before preparing food, after defecation, and after cleaning child's bottom) [3].

Household food insecurity status was determined using the 9 items Household Food Insecurity Access Scale (HFIA) question. and prior to assigning the food insecurity category (access), each frequency of occurrence responses was coded as 0 for all cases where the answer to the corresponding occurrence question was “no” and then the four food security categories were computed and created sequentially as recommended by FANTA [39, 40]. Finally, the HFIA category 1 was considered as food secure and the remaining as food insecure.

Immunization status is categorized as **full (complete) immunization:** A child is defined as fully vaccinated for his/her age, when a child receives all the recommended vaccines, including at birth (polio 0 and BCG), at six weeks (pentavalent, OPV1, PCV1, Rota1), at 10 weeks (pentavalent2, OPV2, PCV2,

Rota2), at 14 weeks (pentavalent3, OPV3, PCV3), at 9-month measles and recent vitamin A supplementation (within 6 months) [41].

Immunization status is categorized as **Partial (incomplete) immunization:** A child is defined as incompletely vaccinated for his/her age; when a child missed at least one of the recommended vaccines at that age [41].

Economic status of the household is measured through the household monthly average income and follows the four categorizations of status based on world bank atlas method. **Income:** The monthly average income of the household was classified using the World Bank Atlas method [42]. And was categorized in to four: low-income (≤ 2424 ETB), low-middle- income (2426-9475 ETB), upper-middle-income (9477-29362 ETB) and high-income (≥ 29364 ETB).

2.9 Data Quality Control

Data quality was addressed during the preparation, training, pre-testing, fieldwork, and data-processing stages. The data collection instruments were developed based on relevant literature and the information routinely documented in OTP records. Data collectors and supervisors received two days of training covering the study objectives, questionnaire administration, and anthropometric measurement procedures. Appropriate COVID-19 prevention measures were also followed in accordance with the refugee surveying standard operating procedure (SOP).

Prior to the main survey, the data collection instruments were pre-tested among 5% of the calculated sample size at a selected nutrition centre outside the study area. Necessary modifications and corrections were made based on the findings of the pre-test before commencement of the actual data collection.

Throughout the data collection period, the principal investigator and supervisors conducted daily field-level monitoring. Completed data collection forms were reviewed for completeness and appropriateness, and necessary feedback was provided to the data collectors. The collected data were subsequently coded, edited, and cleaned before entry and statistical analysis. The accuracy of the weighing scale was checked using 3-kg iron bars to minimize measurement error.

2.10 Data processing and analysis

Following data collection, the questionnaires were edited, coded, and entered into EpiData version 3.5.1. The resulting dataset was exported to Stata version 17 for analysis. The dataset was examined for missing values and inconsistencies, which were addressed before statistical analysis. Predictor variables were categorized as dichotomous or polychotomous variables where appropriate, while the outcome was

coded as repeated SAM (1) and non-repeated SAM (2). WHO Anthro version 3.2.2 was used to generate the relevant anthropometric indices.

Descriptive analysis was conducted using frequencies and summary statistics. For categorical variables, associations with repeated SAM were assessed using the chi-square test or Fisher's exact test, as appropriate. A paired Wilcoxon signed-rank test was applied to assess differences between MUAC measured at OTP discharge and MUAC measured during the post-discharge assessment.

Factors associated with repeated SAM were examined using binary logistic regression. Univariable analyses were conducted initially, and variables with $p \leq 0.25$ were considered for inclusion in the multivariable logistic regression model. A backward stepwise approach was then used to obtain the final multivariable model. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were reported to describe the strength and precision of associations. Statistical significance was declared at $p < 0.05$.

3 RESULTS

3.1 Socio demographic characteristics of the respondents

This study, which initially aimed to involve 250 children, successfully collected data from 242 participants, resulting in a response rate of 96.8%. Of the remaining 8 children, 5 (2%) had left the camp, while 3 (1.2%) provided untraceable addresses. Regarding the participant children, 126 children (52.1%) were between the ages of 6 and 24 months, with 85 (35.1%) being male. Among the caregivers, 239 (98.7%) were female, with ages ranging from 16 to 61 years, and a mean age of 31 years ($SD \pm 6.4$). In terms of education, 27 caregivers (11.2%) had no formal schooling and were unable to read or write while 112 (46.3%) participants completed elementary school. A significant proportion of respondents, 232 (95.9%), reported earning a monthly income of less than 2,500 ETB, with a mean income of 2,000 ETB ($SD \pm 500$). Additionally, 135 respondents (55.8%) had a family size of more than five members. Furthermore, 129 respondents (53.3%) had two or more children under the age of five in the household, and 116 (47.9%) of the caregivers shared meals with their families.

Table 2: Socio-demographic and economic characteristics of study participants Gambella refugee camps, western Ethiopia 2024 (n=242).

Characteristics	Category	Frequency	Percentage (%)
Age of the child	6 – 24 months	126	52.1
	24-59 month	116	47.9
Child sex	Male	85	35.1
	Female	157	64.9
Age of care giver in year	15-30	211	87.2
	30-45	29	12.0
	>45	2	0.8
Marital status of care giver	Single	3	1.2
	Married	225	93.0
	Divorced/Separated	5	2.1
	Widowed	9	3.7
Religion	Christian	238	98.3
	other	4	1.7
Educational level	Never attended	27	11.2
	Elementary	112	46.3
	5-10 grade	103	42.5
Monthly income	<2500 ETB	232	95.9
	2500-10,000 ETB	10	4.1
Family size	(1-4)	107	44.2
	(5-13)	135	55.8
	1	113	46.7

Number of U5 children in the HH	≥ 2	129	53.3
Eat with family or not	Alone	126	52.1
	With family	116	47.9

3.2 Household and Environmental Condition

Regarding household and environmental characteristics, 135 (55.8%) respondents reported that piped water was the primary source of drinking water for their households. 56 (64.5%) adult women and 49 (20.2%) female children were primarily responsible for fetching water. In the past two weeks, 240 (99.2%) participants experienced at least one full day of water unavailability. Furthermore, 124 (51.2%) participants reported taking measures to ensure the safety of their drinking water. Among those who treated their water, 54 (22.3%) participants treat water through boiling. Among the respondents, the majority utilized pit latrines for sanitation, with 203 participants (83.9%) reporting this practice. Regarding household fuel sources, 115 participants (47.5%) used straw, shrubs, or grass. Cooking practices varied, with 157 participants (64.9%) indicating that they cooked indoors.

Table 3: Household and environmental characteristics of study participants Gambella refugee camps, western Ethiopia 2024 (n=242).

Characteristics	Category	Frequency	Percentage (%)
What is the main source of drinking water formembers of your household?	Piped water	135	55.8
	Dug well	107	44.2
Who usually goes to this source to fetch thewater for your household?	1. Adult woman	156	64.5
	2. Female child	49	20.2
	3. Male child	23	9.5
	4. Adult man	14	5.8
Do you do anything to the water to make it safer to drink?	1. Yes	124	51.2
	2. No	73	30.2
	3. Don't know	45	18.6
What do you usually do to make the watersafer to drink? Anything else?	Boil	54	22.3
	Add bleach/chlorine	153	63.2
	Strain through a cloth	21	8.7
	Let it stand and settle	14	5.8
	Pit latrine HHS	203	83.9
	open field / brush	39	16.1
What type of fuel does your householdmainly use for cooking?	1.Charcoal	31	12.8
	2. Animal dung	11	4.5
	3. Wood	85	35.1
	4.Straw/shrubs/grass	115	47.5

Is the cooking usually done in the house, in a separate building, or outdoors?	In the house	157	64.9
	Outdoors	65	26.9
	In a separate building	20	8.3
Do you have a separate room which is used as a kitchen?	1. Yes	21	8.7
	2. No	221	91.3

3.3 Household food security characteristics of the participants

Based on the study findings, of the 242 participants, 218 (91%; 95% CI) were classified as food insecure according to their responses to the food security scale. Among these households, 35 (16%) experienced severe food insecurity, 77 (35.3%) moderate food insecurity, and 106 (48.6%) mild food insecurity.

Table 4: Household food insecurity access scale among study participants Gambella refugee camps, western Ethiopia 2024 (n=242).

Variables			Frequency	Percent
In the past 4 weeks, did you worry that your household would not have enough food?	Yes	1 = Rarely (once or twice)	162	72.6
		2 = Sometimes (3-10 times)	25	11.2
		3 = Often (> 10 times)	9	4.0
	No		24	10.9
In the past 4 weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	Yes	1 = Rarely (once or twice)	135	60.5
		2 = Sometimes (3-10 times)	24	10.8
		3 = Often (> 10 times)	8	3.6
	No		53	24
In the past 4 weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	Yes	1 = Rarely (once or twice)	133	59.6
		2 = Sometimes (3-10 times)	12	5.4
		3 = Often (> 10 times)	12	5.4
	No		63	28.6
In the past 4 weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	Yes	1 = Rarely (once or twice)	101	45.3
		2 = Sometimes (3-10 times)	31	13.9
		3 = Often (> 10 times)	3	1.3
	No		85	38.6
In the past 4 weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	Yes	1 = Rarely (once or twice)	112	50.2
		2 = Sometimes (3-10 times)	11	4.9
		3 = Often (> 10 times)	6	2.7
	No		91	41.4
In the past 4 weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	Yes	1 = Rarely (once or twice)	73	32.7
		2 = Sometimes (3-10 times)	16	7.2
		3 = Often (> 10 times)	10	4.5
	No		121	55
In the past 4 weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	Yes	1 = Rarely (once or twice)	69	30.9
		2 = Sometimes (3-10 times)	19	8.5
		3 = Often (> 10 times)	8	3.6
	No		124	56.4
In the past 4 weeks, did you or any household member go to sleep at	Yes	1 = Rarely (once or twice)	65	29.1
		2 = Sometimes (3-10 times)	12	5.4

night hungry because there was not enough food?		3 = Often (> 10 times)	6	2.7
	No		137	62.3
In the past 4 weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	Yes	1 = Rarely (once or twice)	39	17.5
		ometimes (3-10 times)		
		ften (> 10 times)		

3.4 Child nutritional characteristics and feeding practice of the respondents

Regarding the nutritional experiences and feeding practices of the participants, a significant majority of mothers, 208 (86.0%), initiated breastfeeding within one hour of birth, and the same number (208, 86.0%) provided colostrum to their newborns. Pre-lacteal feeding was uncommon, practiced by only 11 participants (4.5%) In terms of treatment history, 227 children (93.8%) had been admitted to the Outpatient Therapeutic Program (OTP) only once, while 17 (7.0%) reported sharing the therapeutic food (Plumpy Nut) at home. At the time of the study, 110 children (45.5%) were still being breastfed, although 167 mothers (69.0%) breastfed fewer than eight times per day. The majority of children, 156 (64.5%), were introduced to liquid or solid foods at six months. Only 57 mothers (23.6%) prepared food separately for their children, and 98 (40.5%) had received training on child food preparation. Similarly, 98 participants (40.5%) had participated in mother-to-mother support groups, with the same number (98, 40.5%) completing and graduating from the program.

In terms of hygiene practices, 209 mothers (86.4%) reported frequent handwashing and handwashing during food preparation, while 221 (91.3%) disposed of child feces properly. Deworming tablets and Vitamin A supplements were administered to 165 children (68.2%), though only 15 children (6.2%) had their growth monitored in the Growth Monitoring Program (GMP). Nutrition counseling at discharge was provided to 68 participants (28.1%), and 171 (70.7%) received a one-week ration of Ready-to-Use Therapeutic Food (RUTF) at discharge.

Table 5: nutritional characteristics and feeding practice of children among study participants Gambella refugee camps, western Ethiopia 2024 (n=242).

Variable	Response	Frequency	Percentage
Breast feeding initiated within 1 hr of birth	Yes	208	86.0
	No	34	14.0
Colostrum given during birth	Yes	208	86.0
	No	34	14.0
Pre-lacteal feeding practiced	Yes	11	4.5
	No	231	95.5
Number of times child admitted to OTP previously before January 2023	Once	227	93.8
	Two and more	15	6.2

Plumpy nut shared at home	Yes	17	7.0
	No	225	93.0
Currently on breast feeding	Yes	110	45.5
	No	132	54.5
Frequency of breast-feeding p/day	8-12	75	31.0
	Less than 8	167	69.0
Age first introduced to liquid or food	< 6 months	37	15.3
	At 6 months	156	64.5
	After 6 months	49	20.2
Food prepared separately for children	Yes	57	23.6
	No	185	76.4
Mothers trained on child food preparation	Yes	98	40.5
	No	144	59.5
Ever been on mother-to-mother support group	Yes	98	40.5
	No	144	59.5
Completed and graduated for M2MSG	Yes	98	40.5
	No	144	59.5
Often wash hands while preparing food	Yes	209	86.4
	No	133	55.0
Child feces disposal	Yes	221	91.3
	No	21	8.7
Deworming tablet given	Yes	165	68.2
	No	77	31.8
Vitamin A supplementation given	Yes	165	68.2
	No	77	31.8
Child growth followed in GMP	Yes	15	6.2
	No	227	93.8
Received nutrition counselling at discharge	Yes	68	28.1
	No	174	71.9
Received one week of RUTF ration at discharge	Yes	171	70.7
	No	71	29.3

3.4.1 Household dietary diversity score

Based on the 24-hour recall method, the household dietary diversity score among 242 participants reveals a high reliance on cereals, with all households (100%) consuming cereals such as rice, maize, wheat, and millet. Roots and tubers are consumed by 210 households (86.8%), while 32 households (13.2%) do not. Vegetable consumption is minimal, with only 16 households (6.6%) including items like spinach, tomatoes, and carrots, while 226 households (93.4%) omit them from their meals.

As compared to others, Fruit consumption is low, with just 2 households (0.8%) reporting intake, and 240 households (99.2%) not consuming fruits. Similarly, 51 households (21.1%) include meat, fish, or eggs in their diet, while 191 households (78.9%) do not. Dairy products are consumed by 23 households (9.5%), leaving 219 households (90.5%) without dairy. A majority, 187 households (77.3%), consume legumes or nuts, while 55 households (22.7%) do not. Oils and fats are used by 211 households (87.2%), and 201

households (83.1%) incorporate sugars and honey. The data points to a significant dependence on cereals, roots, tubers, legumes, oils, and fats, with a marked deficiency in the intake of vegetables, fruits, meat, fish, eggs, and dairy among households in the refugee camps.

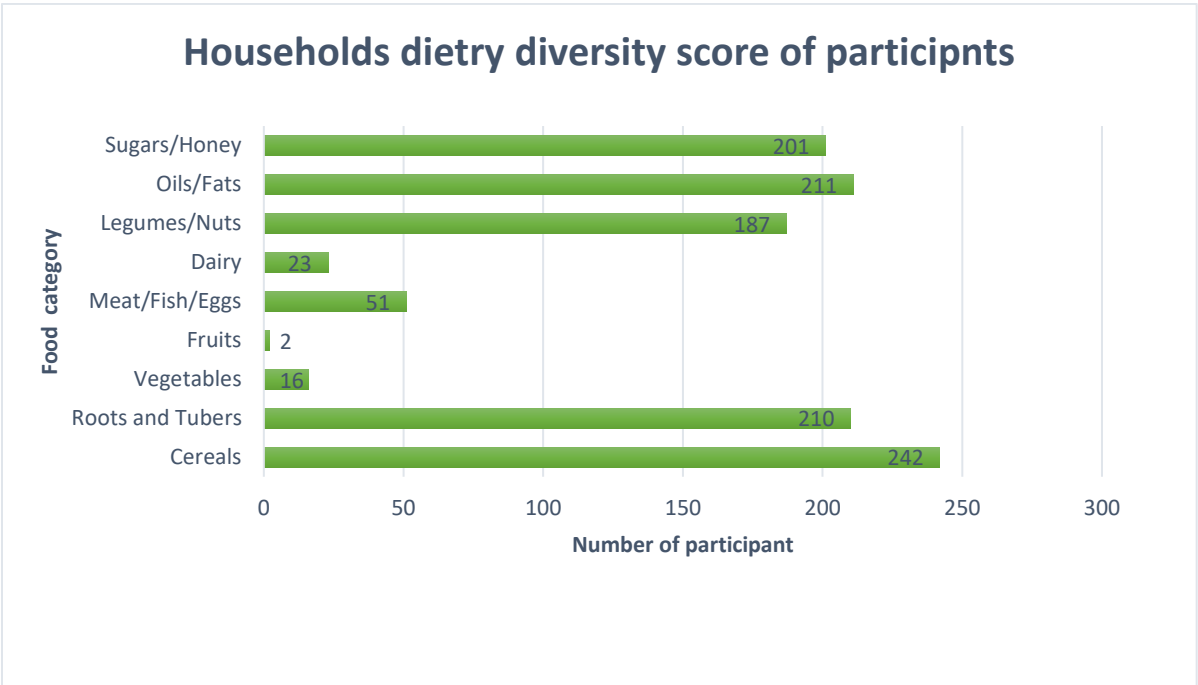


Figure 4: The Households dietary diversity score of participants Gambella refugee camps, western Ethiopia 2024 (n=242).

3.4.2 Food Consumption Score (FCS)

The findings from the Food Consumption Score (FCS) among the 242 study participants in the refugee camp indicate a critical nutritional situation. The assessment, based on participants' reports of their food consumption over the previous week, reveals that 218 individuals (90%) are experiencing poor food consumption levels, with an average FC of 20.3. Additionally, 15 participants (6%) fall into the borderline food consumption category, while only 9 participants (3.7%) are in the acceptable food consumption category, with an average score of 72.1.

All participants (100%) reported that their food supply comes exclusively from rations provided by the camp, highlighting their heavy dependence on food donations. This reliance on rations underscores a significant concern, as the provided food is insufficient to meet the participants' dietary needs adequately.

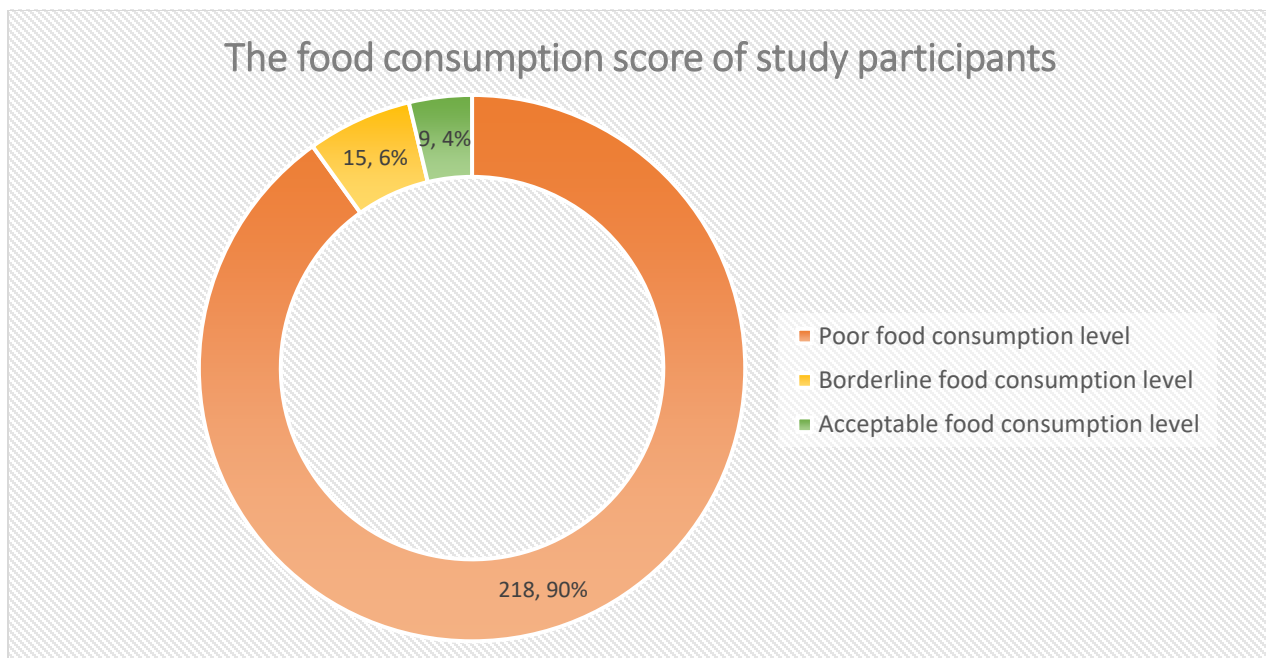


Figure 5: The Household food consumption score of participants Gambella refugee camps, western Ethiopia 2024 (n=242).

3.5 Clinical factors and previous Admission history

Among the 242 participants, a significant majority of the children, 203 out of 242 (83.9%), were reported to be fully immunized, whereas 39 children (16.1%) had not completed their immunization schedules. Regarding recent illnesses, 31 children (12.8%) had experienced a recent illness, while the vast majority, 211 children (87.2%), had not been ill recently. When examining the history of hospitalization, only 18 children (7.4%) had been hospitalized recently, with 224 children (92.5%) having no such history.

On HIV/AIDS status, only a small proportion of children, 4 out of 242 (1.7%), were reported to be HIV positive. The majority, 208 children (86.0%), were confirmed to be HIV negative. However, for 30 children (12.4%), the HIV status was unknown.

In terms of ongoing treatment for SAM, the vast majority children (96.7%), no longer undergoing treatment. Among those who had previously been treated for SAM, 83 children (34.3%) had experienced edematous SAM, and 159 children (65.7%) had suffered from non-edematous SAM. The duration since their first recovery from SAM was predominantly between 12 to 24 months, reported by 231 children (95.5%), with only (4.5%) children having recovered less than 12 months prior to the study.

Table 6: Immunization and Episode of hospitalization status of study participants, Gambella refugee camps, western Ethiopia 2024 (n=242).

Variable	Category	Frequency	Percentage
Child fully immunized	Yes	203	83.9
	No	39	16.1
Has the child had a recent illness	Yes	31	12.8
	No	211	87.2
Has a child a recent history of hospitalization	Yes	18	7.4
	No	224	92.5
HIV AIDS status	Positive	4	1.7
	Negative	208	86.0
	Unknown	30	12.4
Child currently on SAM treatment	Yes	8	3.3
	No	234	96.7
Admission Status of previous SAM	Edematous SAM	83	34.3
	Non-Edematous SAM	159	65.7
Duration after first recovery from SAM	< 6 MONTHS	51	21
	6-12MONTH	164	67.7
	>12 Months	27	11.1

3.6 The Magnitude of Repeated Episodes Severe Acute Malnutrition

Among the 242 children included in the study, 31 (12.8%; 95% CI: 8.6-17%) were identified WHZ < -3, indicating they experienced a repeated episode of severe acute malnutrition (SAM) (Figure 6).

Among the 31 children with a repeated episode of SAM, 11 (35.4%) had been discharged from OTP less than six months prior to data collection. Notably, all 31 children had only been admitted for SAM treatment once after January 2023. Among the 211 children who did not experience a repeated episode of SAM, 39 (16.1%) were identified as moderate acutely malnourished (MAM).

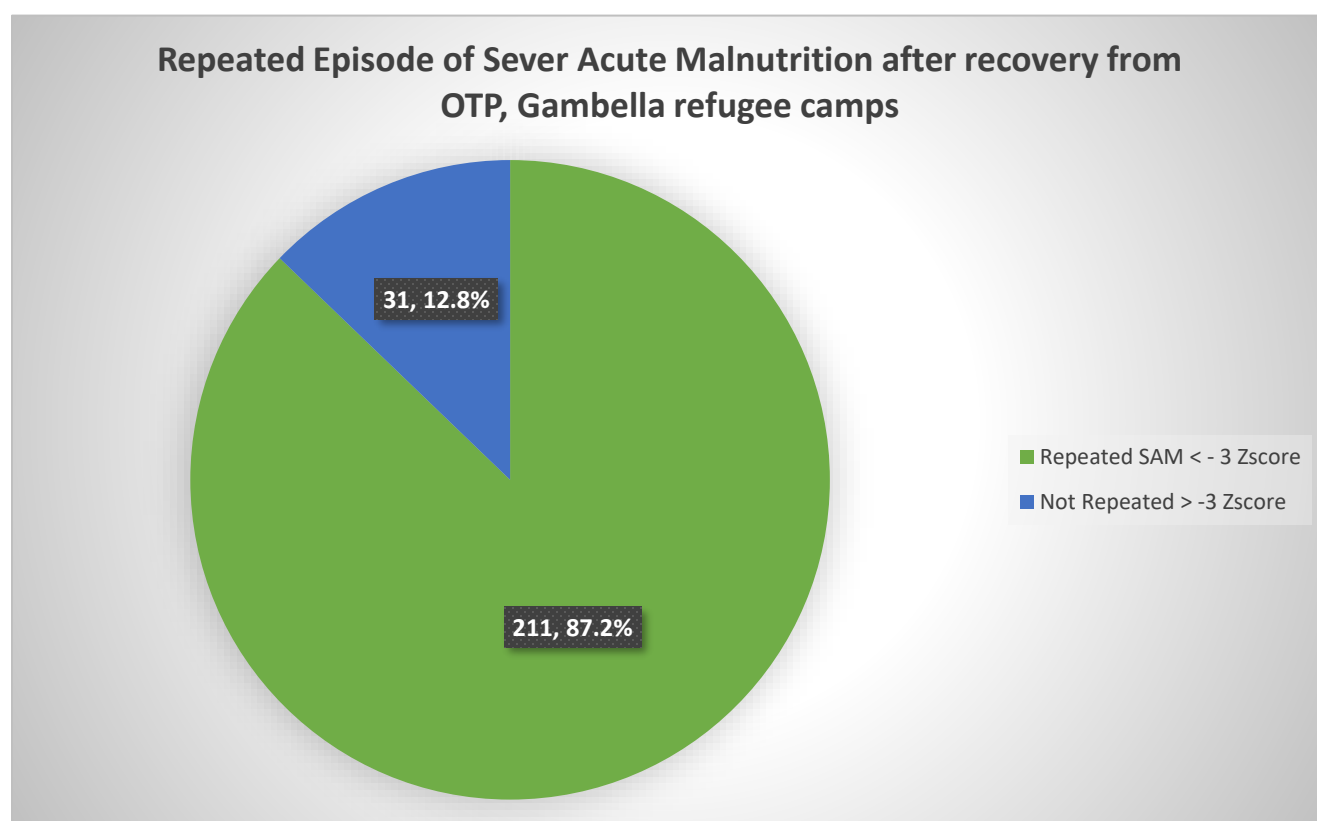


Figure 6: The magnitude of repeated episode of SAM among children (6-59 months) of age who have been discharged cured from OTP (from January 1, 2023 – January 1, 2024), in Gambella refugee camps, western Ethiopia (N=242)

3.6.1 Comparison of MUAC measurements at SAM recovery (discharge) with at the time of data collection

The results of the Wilcoxon signed-rank test demonstrate a significant decrease in MUAC measurements from discharge (Mdn = 12.5) to the time of data collection among the 242 children studied, indicating a statistically significant reduction (p-value = 5.866e-13). The Z-value (-7.2035) further supports this substantial change. The average difference in MUAC (-0.2702), showing that children's MUAC measurements decreased over time. With an effect size ($r = -0.7955$), the magnitude of this change is large and practically significant. Additionally, there were 82 non-zero difference pairs, and the skewness (-1.9345) suggests that many children experienced marked decreases in MUAC over the course of one-year post-discharge. MUAC was used Wilcoxon signed-rank test instead of weight-for-height z-scores (WHZ) because completed program outcomes were recorded based on MUAC values at discharge.

Table 7: Wilcoxon signed ranks tests result of MUAC on discharge and at the time of data collection for participant children (6-59months) in Gambella refugee camps, southwest Ethiopia.

Parameter	Value
P-value	5.866e-13
Surprisal (S-value)	40.6326
Effect Size (r)	-0.7955
Z	-7.2035
W, (W-, W+)	144, (3259, 144)
Number of pairs (N)	242
Non-zero difference pairs (n)	82
Ties Correction	73.125
S.E	216.1438
Average of differences ($\bar{x}_d$)	-0.2702
SD of differences (S_d)	0.5577
Normality p-value	0
Skewness	-1.9345

3.7 Factors Associated with repeated episode of SAM after Recovery

Variables were examined to identify factors associated with the repeated episodes of severe acute malnutrition using a bivariate logistic regression model. As per the result, a total of 13 variables with a p-value < 0.25 were identified and qualified for inclusion in the multivariable analysis. The factors eligible for multivariable analysis includes, having two or more children under five years in the household, being aged 6–24 months, sharing Plumpy Nut at home, experiencing severe food insecurity, having poor food consumption scores, absence of follow-up in growth monitoring programs (GMP), mothers being untrained in child food preparation, non-participation in mother-to-mother support groups, not receiving nutrition counseling at discharge, lack of a Ready-to-Use Therapeutic Food (RUTF) ration at discharge, Food not prepared separately for children, Admission Status of previous SAM and Child not fully immunized (Table 8).

Values included factors with P Value < 0.25 on bivariate analysis were having two or more children under five in the household (COR = 2.90; 95% CI: 1.30–6.50), being aged 6–24 months (COR = 2.60; 95% CI: 1.20–5.50), sharing Plumpy nut at home (COR = 12.00; 95% CI: 3.60–40.00). Severe food insecurity (COR = 3.60; 95% CI: 1.50–8.50), poor food consumption scores (COR = 5.50; 95% CI: 2.50–12.00), absence of follow-up in growth monitoring programs (GMP) (COR = 6.50; 95% CI: 2.30–18.50), mothers untrained in child food preparation (COR = 3.10; 95% CI: 1.40–7.00), non-participation in mother-to-mother support groups (COR = 7.00; 95% CI: 3.30–14.80), Not receiving nutrition counseling at discharge (COR = 3.00; 95% CI: 1.50–6.10) and lack of a Ready-to-Use Therapeutic Food (RUTF) ration at discharge (COR = 5.70; 95% CI: 2.70–12.00), incomplete immunization (COR = 25.00; 95% CI: 10.50–60.00), history of edematous SAM at admission (COR = 1.80; 95% CI: 0.85–3.80), Preparing food separately for children (COR = 1.80; 95% CI: 0.80–4.20) qualified and proceeded for multivariate analysis (Table 8).

Table 8: result of bivariate analysis study participants, Gambella refugee camps, western Ethiopia.

Variable	Response	Frequency	Percentage	COR (95%CI)	P-value
Number of U5 children in the HH	1(Ref)	113	46.7	1	-
	≥ 2	129	53.3	2.90 (1.30–6.50)	0.009
Age of the child	6 – 24 months(Ref)	126	52.1	1	-
	24-59 month	116	47.9	0.40 (0.15–0.98)	0.045
Plumpy nut shared at home	Yes	17	7.0	12.00 (3.60–40.00)	<0.001
	No (Ref)	225	93.0	1	-

HFIAS	Severe food insecurity	35	16	3.60 (1.50–8.50)	0.004
	Moderate food insecurity	77	35.3	0.85 (0.35–2.00)	0.17
	Mild food insecurity	106	48.6	1	-
Food Consumption Score	Poor food consumption level	218	90	5.50 (2.50–12.00)	<0.001
	Borderline food consumption level	15	6	2.20 (0.70–7.00)	0.17
	Acceptable food consumption level(Ref)	9	3.7	1	-
Child growth followed in GMP	Yes(Ref)	15	6.2	1	-
	No	227	93.8	0.15 (0.06–0.42)	<0.001
Mothers trained on child food preparation	Yes(Ref)	98	40.5	1	-
	No	144	59.5	3.10 (1.40–7.00)	0.006
Ever been on mother-to-mother support group	Yes(Ref)	98	40.5	1	-
	No	144	59.5	7.00 (3.30–14.80)	<0.001
Received nutrition counselling at discharge	Yes(Ref)	68	28.1	1	-
	No	174	71.9	3.00 (1.50–6.10)	0.002
Received one week of RUTF ration at discharge	Yes(Ref)	171	70.7	1	-
	No	71	29.3	5.70 (2.70–12.00)	<0.001
Food prepared separately for children	Yes(Ref)	57	23.6	1	-
	No	185	76.4	0.55 (0.25–1.20)	0.14
Admission Status of previous SAM	Edematous	83	34.3	1.80 (0.85–3.80)	0.12
	Non-Edematous(Ref)	159	65.7	1	-
Child fully immunized	Yes(Ref)	203	83.9	1	-
	No	39	16.1	25.00(10.50–60.00)	<0.001

The multivariate logistic regression analysis identified five key factors significantly associated with repeated episodes of severe acute malnutrition (SAM). Households with two or more under-five children had nearly three times the odds of experiencing repeated SAM compared to households with only one under-five child (AOR = 2.90; 95% CI: 1.15–7.30; $p = 0.024$). Severe food insecurity was linked to more than three times the odds of repeated SAM compared to mild food insecurity (AOR = 3.20; 95% CI: 1.20–8.50; $p = 0.020$). Mothers who did not participate in mother-to-mother support groups had 7.5

times odds of their children experiencing repeated SAM compared to those who participated in these groups (AOR = 7.50; 95% CI: 3.10–18.00; $p = 0.001$). Conversely, participation in mother-to-mother support groups reduces the odds of repeated SAM by 94% (AOR = 0.06; 95% CI: 0.02–0.18; $p = 0.002$). Not receiving nutrition counseling at discharge was associated with threefold the odds of repeated SAM compared to those who received counseling (AOR = 3.20; 95% CI: 1.40–7.50; $p = 0.019$). Additionally, a history of edematous SAM was associated with more than double the odds of repeated SAM compared to non-edematous SAM (AOR = 2.10; 95% CI: 1.00–4.50; $p = 0.046$) (Table 9).

To further assess model's appropriateness and multicollinearity, Hosmer-Lemeshow test and Variance Inflation Factor (VIF) were employed respectively. The goodness of fit for the model was assessed using the Hosmer-Lemeshow test, which yielded a $\chi^2 = 1.7$ ($n = 242$) with a p -value of 0.78, indicating an adequate model fit. Multicollinearity among the independent variables was evaluated through the calculation of Variance Inflation Factor (VIF) values, all of which were below 3, suggesting no significant multicollinearity.

Table 9: Result of multivariate analysis study participants, Gambella refugee camps, western Ethiopia.

Variable	Response	Frequency	Percentage	SAM repeated)	SAM (not repeated)	COR 95% CI)	AOR (95% CI)	P-value
Number of U5 children in the HH	1(Ref)	113	46.7	7	106	1	1	-
	≥ 2	129	53.3	21	108	2.90 (1.30–6.50)	2.90 (1.15–7.30)	0.024
HFAS	Severe food insecurity	35	16	17	18	3.60 (1.50–8.50)	3.20 (1.20–8.50)	0.02
	Moderate food insecurity	77	35.3	9	68	0.85 (0.35–2.00)	0.80 (0.30–2.10)	0.073
	Mild food insecurity(Ref)	106	48.6	5	101	1	1	-

Ever been on mother-to-mother support group	Yes(Ref)	98	40.5	3	95	1	1	-
	No	144	59.5	28	116	7.00 (3.30–14.80)	7.50 (3.10–18.00)	0.001
Received nutrition counselling at discharge	Yes(Ref)	68	28.1	6	62	1	1	-
	No	174	71.9	25	149	3.00 (1.50–6.10)	3.20 (1.40–7.50)	0.019
Admission Status of previous SAM	Edematous	83	34.3	17	66	1.80 (0.85–3.80)	2.10 (1.00–4.50)	0.046
	Non-Edematous	159	65.7	14	145	1	1	-

4 DISCUSSION

Among the 242 children assessed, the study found 12.8% (95% CI: 8.6-17%) of repeated episodes of severe acute malnutrition. Regarding the associated factors, severe household food insecurity, non-participation in mother-to-mother support groups, absence of nutrition counselling at discharge, and history of edematous SAM were significant factors associated with repeated episode of severe acute malnutrition.

The magnitude of repeated episodes of SAM found in this study aligns with results from other studies conducted in host communities in Southern Ethiopia, which reported a SAM relapse rate of 9.6% [5], as well as studies from Congo and Burkina Faso, which observed SAM relapse rates of 11.1% and 10.5%, respectively [29]. With magnitude of 12.8%, current repeated SAM among refugee children is slightly higher than the 10% observed in the host community in Gambella region [43]. However, the magnitude in the current study was lower than the 24% observed in the Nigerian study [16], which relied solely on mid-upper arm circumference for admission and discharge criteria. In contrast, the present study followed using both MUAC and weight-for-height z-scores [3, 4, 36]. Additionally, unlike the current study, the study in Nigeria was conducted during the rainy season, Hence the difference in the magnitude might be related with the difference in admission and discharge criteria as well as the seasonal variations.

On the other hand, the prevalence of repeated episodes of SAM observed in the current study was significantly higher than the rates reported in Malawi (1.9%) and Bangladesh (7%) [23, 40]. In Bangladesh, children were discharged based on weight-for-height measurements rather than MUAC, with only 7% requiring readmission [23, 40]. Additionally, in Malawi, an extra two-week ration was provided prior to discharge [40]. In contrast, the current study context employed both MUAC and WHZ for discharge criteria, and guidelines recommending a one-week post-discharge ration were not fully implemented due to supply shortages and non-compliance. This may account for the lower prevalence rates observed in Malawi and Bangladesh. Furthermore, a significant contextual difference exists: the studies conducted in Malawi and Bangladesh took place in host communities, while the current study was conducted in a refugee camp [23, 40].

Households with two or more under-five children had nearly three times likely to experience repeated severe acute malnutrition compared to households with only one child. This finding aligns with a study conducted in India, which indicated that children living in families with more than two under-five children were twice as likely to experience SAM relapse compared to those living in households with

two or fewer children [17]. This similarity underlines the difficulty to sustain adequate healthcare and nutritional support for multiple children in a single household.

Severe food insecurity was associated with more than a threefold increased likelihood of repeated SAM compared to mild food insecurity. This is consistent with a study conducted in northern Ethiopia, which reported 1.5-fold increased odds. Food insecurity is often linked to inadequate intake of diversified foods, with studies showing that low dietary diversity is associated with acute malnutrition. Additionally, food insecurity is influenced by low socioeconomic status, which reduces purchasing power and limits access to food.

Mothers who did not participate in mother-to-mother support groups had a 7.5 times higher likelihood of their children experiencing repeated SAM. Participation in these support groups reduces the odds of repeated SAM by 94%. This finding is supported by a study indicating that cases of severe acute malnutrition were less prevalent among children whose mothers attended mother support groups [35]. A comparative study conducted at the Laisamis Catholic Hospital in Kenya found that nutritional status was better among children whose mothers participated in support groups ($p = 0.001$) [35].

Lack of nutrition counselling at discharge was associated with a threefold increase in the odds of repeated SAM compared to those who received counselling. This finding is consistent with studies from Ethiopia and India, which found that children of mothers who had not received nutritional counselling on infant and young child feeding practices were more likely to relapse [44, 45]. This may be explained by the fact that knowledge about nutrition can be more impactful than formal maternal education in influencing a child's nutritional status [15, 31]. Furthermore, poor IYCF practices are often linked to a lack of nutrition knowledge rather than the affordability of food [6, 33].

A history of edematous SAM was associated with more than double the likelihood of repeated SAM compared to non-edematous. This finding aligns with an institution-based retrospective cohort study conducted in Hadiya Zone of Southern Ethiopia, which found that first admissions increased the incidence rate of SAM relapse by 2.21 times ($IRR = 2.21$; 95% CI: 1.30–3.73) [5]. This may be due to that edematous children lose significant amounts of lean body mass and have marginal protein reserves, requiring more time for recovery. Experimental studies on edema have shown that dietary treatment can improve edema before albumin concentrations increase. In edematous children, low plasma zinc concentrations were associated with nutritional edema and correlated with stunting, skin ulceration, and wasting [8].

4.1 Strength and limitation of study

The strength of this study lies in its new investigation of the topic repeated episodes of SAM within the study area of refugee contexts. As the first study to address this specific context, it explored unique and previously unexamined factors, offering valuable insights. Unlike other research on similar topics, this study specifically assessed factors related to initial nutritional treatment, providing a comprehensive understanding of how previous interventions influence repeated episodes of SAM. Additionally, a key strength of this study is its comprehensive sampling across all refugee camps in the region, ensuring broad representation and enhancing the generalizability of the findings to children in refugee camps

Moreover, the study considered household food security status, an often-overlooked factor in similar research, providing a more holistic view of the determinants of repeated SAM episodes.

Despite its strengths, the study has some limitations. Firstly, data related to the address information of participants and the history of first admission were taken from reviewing OTP registration books, which might be subject to missing data and measurement bias, as the records were prefilled by professionals during the first admission, making it hard to control at the time of review and data collection. Secondly, information collected from mothers could be subject to recall bias, influencing the accuracy of the data. Thirdly, micronutrient status was not assessed due to limited resources, which could have provided additional insights into the nutritional factors influencing SAM relapse. Furthermore, caution is advised when extrapolating the study findings to other regions or host communities, as contextual differences may limit the generalizability of the results.

5. CONCLUSION

a. Conclusion

The study assessed the magnitude and associated factors of repeated episodes of severe acute malnutrition among South Sudanese refugee children aged 6–59 months who were discharged from the Outpatient Therapeutic Programs in refugee camps in the Gambella region, Western Ethiopia. The findings revealed a magnitude of 12.8% for repeated SAM cases, indicating that the magnitude of repeated SAM in the refugee context is notably high, exceeding that observed in host communities. This suggests that over 1 in 10 children experienced repeated episodes of SAM after being discharged as cured. Such findings underline the significant magnitude of repeated SAM, and the ongoing nutritional challenges faced by children in refugee settings. These findings highlight the unique vulnerabilities of refugee children, who often face compounded risks due to the challenging living conditions in refugee camps, including limited access to food, healthcare, and social support systems. Understanding these factors might help in identifying a subset of children who are highly likely to relapse into SAM after successful recovery.

b. Recommendations

To address the high risk of repeated SAM in refugee camps, the study proposed the following recommendations:

For Cam-Based Health and Nutrition Intervention Implementation Partners:

- Enhance Family Planning and Support Services: targeted interventions that support family planning and tailored nutritional assistance in the camp setting.
- Strengthen Food Security Initiatives: Food security interventions should be scaled up, focusing on the most vulnerable households. This includes enhancing food aid distribution, supporting income-generating activities, and promoting sustainable food production methods suitable for the camp environment.
- Promote and Integrate Mother-to-Mother Support Groups: Increasing participation in IYCF mother-to-mother support groups, Efforts should include community mobilization, awareness campaigns, and integrating support groups into existing camp health and nutrition programs.
- Improve Access to Nutritional Counseling at treatment Discharge: Ensuring comprehensive nutritional counseling at discharge for all mothers should be a priority.
- Monitor High-Risk Children Post-Discharge: Children with a history of edematous SAM should receive targeted follow-up and additional nutritional support post-discharge.
- Advocate for the inclusion of indicators to on repeated SAM on sphere standards for a follow-up

- Strengthen Camp-Based Health Services: Improving the capacity of health services within refugee camps to address malnutrition through early identification, treatment, and preventive care.

For researchers:

- To conduct further studies on repeated episodes of severe acute malnutrition (SAM) among children aged 6–59 months by enhancing the study methodology to include biochemical parameters in the nutritional assessment and to report the findings to all stakeholders for informed act

6. List of ABBREVIATIONS

BF:	Breast Feeding
BMI:	Body Mass Index
BSc:	Bachelor of Science
BSF	Blanket supplementary feeding
CI:	Confidence Interval
CMAM:	Community based management of malnutrition
COR:	Crude Odds Ratio
DF:	Degree of Freedom
ETB:	Ethiopian Birr
FANTA:	Food and Nutrition Technical Assistance
FMOH:	Federal Ministry of Health
GMP:	Growth Monitoring and Promotion
HC:	Health Center
HHFS:	Household Food Security
HP:	Health Post
IRR:	Incidence of Relative Risk
IHRERC:	Institutional Health Research Ethics Review Committee
IYCF:	Infant and young child feeding
MUAC:	Mid-Upper Arm Circumference
NNP:	National Nutritional Program
NRR:	Non-Response Rate
OR:	Odds Ratio
OPD:	Outpatient Department
ORHB:	Oromia Regional Health Bureau

OTP:	Outpatient therapeutic Unit
P:	P-value
PI:	Principal Investigation
PR:	Prevalence Rate
RR:	Relative Risk.
RUTF:	Ready to use therapeutic feeding
SAM:	Sever acute Malnutrition
SPSS:	Statistical Package for Social Science
UNICEF:	United Nation Children Fund
WHO:	World Health Organization.
WHZ:	Weight for height Z-score

7. Declarations

7.1 Ethics approval and consent to participate

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of the College of Health and Medical Sciences, Haramaya University (reference number: IHRERC/062/2024). Informed consent to participate was obtained from the parents or legal guardians of all participating children before data collection. Parents or legal guardians were informed about the purpose and procedures of the study, their child's voluntary participation, and their right to withdraw at any time without any consequences. Confidentiality and privacy were maintained throughout the study through the use of coded study information.

7.2 Consent for publication: Not applicable.

7.3 Availability of data and materials: The datasets generated and/or analyzed during the current study are not publicly available due to restrictions related to participant privacy and ethical considerations. The data may be available from the corresponding author upon reasonable request and subject to permission from the relevant ethical review body and institutional authorities.

7.4 Competing interests: The authors declare no competing interests.

7.5 Funding: None

7.6 Authors' contributions: **Michael Birhanu Wondimu:** Conceptualization, study design, methodology, investigation, data collection and management, formal data analysis, interpretation of findings, and writing of the original manuscript. **Tedi Feleke:** Interpretation of findings and contribution to writing the Results section. **Alemayehu Aschalew:** Data collection, manuscript review, and critical revision of the manuscript. **Dr. Maleda Tefera:** Academic supervision, conceptual guidance, review of the research proposal and manuscript, and critical revision of the manuscript. All authors reviewed and approved the final manuscript.

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