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DEPARTMENT OF BIOSTATISTICS

PREDICTORS OF TIME TO RECOVERY FROM MODERATE ACUTE MALNUTRITION AMONG 6-59 MONTHS OLD CHILDREN IN INTERNALLY DISPLACED PERSONS SITES, NORTHWEST TIGRAY, ETHIOPIA, 2024, A RETROSPECTIVE FOLLOW UP

PRINCIPAL INVESTIGATOR: EFREM SHUSHAY BERHE (BSC. PUBLIC HEALTH)

NOVEMBER, 2024

MEKELLE, ETHIOPIA

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A THESIS SUBMITTED TO DEPARTMENT OF BIOSTATISTICS, SCHOOL OF PUBLIC HEALTH, COLLEGE OF HEALTH SCIENCES, MEKELLE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER OF SCIENCE IN BIOSTATISTICS AND HEALTH INFORMATICS

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We, the undersigned, members of the Board of Examiners of the final open defense by "Efrem Shushay" have read and evaluated his thesis "predictors of time to recovery from moderate acute malnutrition among 6-59 months old children in internally displaced persons sites, Northwest Tigray, Ethiopia, 2024, a retrospective follow up" and evaluated the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the MSc. Degree in biostatistics and health informatics.

Name of Chairperson: _____Signature: _____Date: _____

Name of Major Advisor: _____Signature: _____Date: _____

Name of Internal Examiner: _____Signature:_____ Date: _____

Name of External Examiner: _____Signature:_____ Date: _____

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the candidate's Department through the office of the Department Graduate Program Coordinator. Thesis Approved by

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Certification of the Final Thesis

I hereby certify that all the corrections and recommendations suggested by the Board of Examiners are incorporated into the final thesis entitled "predictors of time to recovery from moderate acute malnutrition among 6-59 months old children in internally displaced persons sites, Northwest Tigray, Ethiopia, 2024, a retrospective follow up" by Efrem Shushay.

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This is to certify that this research entitled predictors of time to recovery from moderate acute malnutrition among 6-59 months old children in internally displaced persons sites, Northwest Tigray, Ethiopia, 2024, a retrospective follow up is submitted in partial fulfillment of the requirements for the degree of Master of Science (MSc) in "Biostatistics and health informatics" to the graduate program of the college of health sciences, Mekelle University and has been carried out by: Efrem Shushay Berhe ID No: chs/pr/169498/12 under my examination. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit his research thesis to the department.

Mock thesis Examiners:

1. Name: _____sig: _____date:_____
2. Name: _____sig: _____date:_____

I hereby declare that this MSc research thesis is my original work and had not been presented for a degree in any other university and all sources of material used for this thesis proposal have been duly acknowledged.

Name: Efrem Shushay Berhe Signature: _____Date: _____

This MSc research thesis had been submitted for examination with my approval as thesis advisors.

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Table of contents

Contents

List of Figures

List of tables

List of abbreviations and acronyms

AHR	Adjusted Hazard Ratio
ARMSTD	Adjusted Restricted Mean Survival Time Difference
CI	Confidence Interval
EDHS	Ethiopian Demographic and Health Survey
IDPs	Internally Displaced Persons
IEC	Information Education and Counselling
IMC	International Medical Corps
IOM	International Organization of Migration
MAM	Moderate Acute Malnutrition
MUAC	Mid Upper Arm Circumference
OTP	Outpatient Therapeutic Program
PLW	Pregnant and Lactating Women
RMST	Restricted Mean Survival Time
RMSTD	Restricted Mean Survival Time Difference
RMTL	Restricted Mean Time Lost
RUSF	Ready to Use Supplementary Food
SAM	Severe Acute Malnutrition
SC	Stabilization Center
TSFP	Targeted Supplementary Feeding Program
WFH	Weight for Height
WFP	World Food Programme
WHO	World Health Organization

Abstract

Background: Moderate acute malnutrition is one of the acute malnutrition categories diagnosed with an anthropometric measurement of weight for height [-3, -2) Z-score standard deviation or/and mid upper arm circumference (12.5-11.5] cm and the child should be with-out nutritional edema. Despite the existence of targeted supplementary feeding programs, the prevalence of moderate acute malnutrition was seriously high (15.1%) and the studies conducted previously used an out dated criteria to assess their recovery status from moderate acute malnutrition.

Objective: The aim of this study was to determine the recovery time and its predictors among 6-59 Months old children with moderate acute malnutrition enrolled to targeted supplementary feeding program in internally displaced persons sites of Northwest Tigray, Ethiopia, 2024.

Methods: An institutional based retrospective cohort study was conducted among 452 children with moderate acute malnutrition selected using lottery method of simple random sampling with proportional allocation of the study participants to the selected fourteen sites. Data was collected using kobo tool box and imported to Stata version 17. Variables with p-value <0.25 at the restricted mean survival time uni-variable analysis, with 95% confidence interval were considered as important variables. The recovery status of the children was measured using mid upper arm circumference with measurement of >= 12.5 cm for two consecutive visits.

Result: About 244 (53.08%) were female and 265(58.6%) with an age category of 24-59 months old. The overall restricted mean survival time was 15.16 weeks and recovery rate 68.36% with a truncation time of 16 weeks. Admission mid upper arm circumference category with restricted mean survival time difference of 5.47 (95% CI 3.53:8.48), ready to use supplementary food sharing status 2.07 (95% CI 1.39:3.08), and follow up status 0.57 (95% CI 0.42:0.76) were Significant predictors of time to recovery from moderate acute under nutrition.

Conclusion: The study found an overall restricted mean survival time of 15.16 weeks and a recovery rate was below the minimum acceptable international standard.

Recommendation: Strategies that enhance early detection should be implemented to get the child with moderate acute malnutrition at early stage. Tracking lost to follow-ups are critical, alongside counseling caregivers to treat food as medicine.

Key words: Restricted mean survival analysis**,** moderate acute malnutrition, recovery time, predictors, internally displaced persons, Tigray, Ethiopia

1. INTRODUCTION

1.1. Background

Malnutrition is a broad term that represents both under nutrition and over nutrition. Under nutrition technically refers to any nutritional imbalance which is broadly classified into acute and chronic under nutrition. Acute malnutrition is a condition with nutritional imbalance diagnosed by an anthropometric measurement of weight for height WFH <-2 SD or Mid Upper Arm Circumference (MUAC) < 12.5 cm and/or nutritional bilateral edema(1). Acute malnutrition is often classified in to moderate acute malnutrition and severe acute under nutrition. Moderate acute malnutrition is a type of acute malnutrition that can be diagnosed with an anthropometric measurement of WFH [-3, -2) Z-score standard deviation (SD) or MUAC< 12.5 cm and with-out nutritional edema (2–4). There are risk factors for acute malnutrition that are classified in to three broad categories which are immediate causes (inadequate dietary intake and infection), intermediate causes (inappropriate feeding, fetal growth restriction, inadequate sanitation, lack of parental education, family size, incomplete vaccination and etc…) and the basic causes (poverty, economic, political, and environmental instability and emergency situations) (1).

Treatment of moderate acute malnutrition is often context based and involves two options: Improving the adequacy of home diet through nutrition Information, Education and Counselling (IEC); or Enrolling the MAM cases to targeted supplementary feeding program with an energy dense supplement food (3,5). Currently, targeted supplementary feeding program is the most common intervention for the management of MAM cases (5).The international reference standard for moderate acute malnutrition states that the cure rate of TSFP should be >=75% (6).

An internally displaced person is any person displaced from his/her permanent residence being forced due to human made crises or natural crises within the territory of the country. They are exposed to different challenges including shortage of food, shelter, access to health facilities, violence and etc. Among the Internally Displaced Persons (IDPs), children and pregnant and lactating mothers are highly vulnerable groups to most of the challenges, including infections, under nutrition, lack of pure drinking water, food and violence (7).

1.2. Statement of the problem

Malnutrition is one of the major worldwide health problem among children, which accounts for one third of the total under five children mortality. The global prevalence of wasting among children less than five years old in 2022 was 6.8% which is 45 million with around 70% of them are moderately wasting and 31.4 Million(4.75 %) children are affected by moderate acute malnutrition(MAM) globally with more than one quarter are lived in Africa (9). The world remains off track to achieve the 2030 target of reducing to 3% prevalence of wasting among children below five years old with the highest prevalence in Asia (9.3 %) followed by Africa (5.8%) (10)

In 2020, there were 45.4 million wasted children worldwide, with more than half all wasted children live in southern Asia and as a whole Asia is a home for more than three quarters of all children affected by severe wasting followed by Sub-Saharan Africa (11). According to a retrospective study conducted in India among 2869 children 6-18 months old, the case fatality rate of moderate acute malnutrition was 1.2% (12).The global acute malnutrition(GAM) rates among under five children in Ethiopia in 2024, is beyond the emergency threshold (>15%), with the worst outcomes in Tigray, Afar, Amhara, and parts of Oromia (13).

According to mini Ethiopian demographic and health survey (EDHS) 2019 conducted in nation-wide Ethiopia, 2019 the prevalence of moderate acute malnutrition was 7% and 8.4% at the country level Ethiopia and Tigray region respectively (14). A cross sectional study conducted in 2022 in the conflict affected urban communities and IDPs sites of Tigray, among 368 children 6-23 months old, the overall proxy GAM rate was 44.3%, with 34.5% being moderate acute malnutrition (15).

The prevalence of MAM in Tigray increased after the crisis which were 21.8% , with the highest prevalence in southeastern Tigray. The prevalence MAM in the Northwester Tigray was 15.1%(16)**.**

Child under nutrition has a short term and long term consequences that include physical and mental development impairment and reduce academic performance throughout their lives. Under five under nutrition is an indicator of one's countries health status as well as economic conditions. Acutely malnourished children have increased risk of mortality, impaired physical and cognitive development, and infections compared to adequately nourished children which can be preventable by economic growth and under nutrition is directly/ indirectly attributed for 60% of the 10.9

million under five years old children deaths and two third of these are often associated with inappropriate feeding practices (1).

A study conducted in West Arsi zone, Ethiopia, 2018 shows that follow up status, household food security status, admission MUAC, transport access to health facility, and type of food treatment were predictors of time to recovery from MAM enrolled to TSFP with a median time recovery of 15 weeks (17). Similar study conducted in Darolabu district, Easter Ethiopia revealed that child age, admission type, MUAC category, deworming status, type of treatment foods, food security status, and time taken to receive services from the health post were significant predictors of time to recovery from MAM enrolled to TSFP with a median recovery time of 16 weeks (18). Another study conducted in Kirehe district health centers, Rwanda shows that child sex and micronutrients and deworming receiving status were significant predictors of recovery from MAM enrolled to TSFP (19).

Despite the ongoing implementation of a targeted supplementary feeding program, the prevalence of moderate acute malnutrition among internally displaced persons in Northwest Tigray remains alarmingly high at 15.1%. Even though there are limited previous studies conducted in Ethiopia, predominantly focused on comparing the recovery status of children treated with different food supplements in community settings, with limited outdated studies specifically addressing the situation in Tigray and the significant predictors are not consistent in the research done. In light of this, this study aimed to evaluate the duration of recovery and identify factors that contribute to recovery among children aged 6-59 months with moderate acute malnutrition who are enrolled in the targeted supplementary feeding program in IDP camps. Notably, all children in this study are treated with a Ready-to-Use Supplementary Food (RUSF) as their treatment.

1.3. Significance of the study

Acute malnutrition remains a significant public health concern all over the developing countries, particularly among under five children in humanitarian settings. To address the nutritional needs of children with MAM, the Targeted Supplementary Feeding Program (TSFP) has been implemented in IDPs Northwest Tigray under humanitarian settings. The TSFP aims to provide specialized nutritional support to children at risk of under nutrition and to enhance recovery of the children from MAM. However, despite the existence of such programs, there is limited understanding of the factors influencing the time to recovery among enrolled children and the effectiveness of the TSFP in achieving its intended outcomes.

Therefore, this research study seeks to investigate the time to recovery and its predictors among 6-59 months old children with MAM enrolled in the TSFP in IDP sites of Northwest Tigray, Ethiopia, in 2024. By examining the factors that influence the time to recovery and its predictors, this study aimed to contribute to the existing knowledge on the effectiveness of the program, to be an input to the caregivers and health professions knowledge about factors affecting the time to recovery and take as a reference for research.

2. LITERATURE REVIEW

2.1. Overview of moderate acute malnutrition

In a study conducted in rural areas of Malawi, to examine the effects of different treatments on the nutrition of 1967 children aged 6-59 months old. The children were randomly assigned to receive CSB+ plus, soy RUSF or soy/whey RUSF, and they were followed for a period of 12 months. The study found that the median duration of feeding was two weeks, with a maximum of 12 weeks feeding duration. During the 12-month follow up period, 63% of the children remained well nourished, 17% experienced a relapse to MAM, 10% developed SAM, 4% died, and 7% were lost to follow up (20).

A prospective cohort study conducted in the Centre region of Cameroon, 833 moderately wasted children aged 6-59 months from urban and rural areas were enrolled, after a 56-day follow-up period, 85% of children in the RUSF group (with a 95% confidence interval [CI] of 73% to 97%) and 73% in the CSB+ group (with a 95% CI of 59% to 87%) achieved recovery from moderate acute malnutrition(MAM) (21).

2.2. Literature on overall recovery rate and time to recovery from MAM

A prospective follow up study conducted in 16 health centers of Kirehe District of Rwanda among 200 children from 6 to 59 months followed for a period of three months, 77.5% of these have recovered from MAM within three months follow up period (19).

Retrospective follow up study design conducted among children aged 6–59 months treated in targeted supplementary feeding program among a total of 402 children selected from eight health posts by systematic random sampling, the overall average timely recovery was 15 weeks (17). Similarly, a retrospective follow up study conducted in Harare on 540 children with moderate acute malnutrition in 2021 the overall recovery rate was 73% (95% CI 69.4–76.4%) with the median time to recovery of 16 weeks (18).

Another Prospective cohort Study conducted among 884 children aged 6–59 months living with MAM in a rural area of Jimma Zone in South-western Ethiopia among children not eligible for a supplementary feeding program. Out of these 54.2% of the children recovered (22). Another prospective follow up study conducted among 325 MAM children followed for seven months in Mana and Dedo woredas of Jimma Zone in South-western Ethiopia, 64.0% (208/325) of the children were recovered (23). A retrospective study conducted in Oromia, Southern Ethiopia,

2023, among 440 children admitted to a hospital in Oromia for acute malnutrition between January 2015 and December 2016. The study shows that children with severe acute malnutrition at admission had a shorter survival time overall (with 49 days vs. 101 days; log-rank p = 0.042) (24).

2.3. Literature on predictors of time to recovery

Studies shows that admission MUAC was a significant predictor of time to recovery from moderate acute under nutrition. A Retrospective follow up study design conducted among children aged 6–59 months treated in targeted supplementary feeding program among a total of 402 children selected from eight health posts (HP) out of 39 HP using systematic random sampling which compares children with MAM who are treated with RUSF and corn soybean blend and used the recovery criteria was "Recovered = Children reach the target weight gain of 13% from admission weight and MUAC ≥ 12.5 cm or > -2 z-score period of two consecutive distributions" , revealed that children with admission MUAC of 11.5 cm were 82% (AHR 1.18; 95% CI 1.13-1.12) less likely to recover from MAM than children with admission MUAC [12.0-12.4 cm](15). Similarly a retrospective follow up study conducted in Harare among 540 children with MAM in 2021 shows that children with admission MUAC of [12.0-12.4 cm] are 1.27 times more likely to recover than children with admission MUAC category of [11.5-11.9 cm] (AHR = 1.27, 95% CI: 1.34–2.61) (18). Another prospective follow up study conducted among 325 MAM children followed for seven months in Mana and Dedo woredas of Jimma Zone, South-western Ethiopia also revealed that admission MUAC was a significant predictor (18).

Children with intermittent follow up status of who had missed one or more visits were less likely to recover from MAM. A Retrospective follow up study design conducted among children aged 6–59 months treated in targeted supplementary feeding program among a total of 402 children selected from eight health posts using systematic random sampling, shows that children with regular follow up status were 1.48 times more likely to recover (AHR 1.48; 95% CI 1.09-2.00) (15).

Children's from sever food in-secured family had lower chance to recover than moderate food in-secured house hold (AHR 0.49; 95% CI 0.31–0.52) (17). Additionally, an institutional based retrospective follow up study conducted in Deralobu district Eastern Ethiopia among 540 children with MAM in 2021, which used a MUAC measurement of >= 11.9 cm for two consecutive to assess the recovery status of the children, shows that children from food secured households were 1.8 (AHR = 1.8, 95% CI: 1.38–2.39) more likely to recover from MAM (16).

The recovery rate from MAM admitted to TSFP were higher among children with admission age category of 24-59 months old. An institutional based retrospective follow up study conducted in Deralobu district Eastern Ethiopia among 540 children with MAM in 2021 shows that children with the age category of 24-59 months old are 1.36 (95% CI: 1.01–1.54) more likely to recover from MAM (16).

Deworming status of the child was another significant predictor of recovery from MAM admitted to TSFP. An institutional based retrospective follow up study conducted in Deralobu district Eastern Ethiopia among 540 children with MAM in 2021 shows that children who had receive deworming tablet were 1.87 times (95% CI: 1.34–2.61) more likely to recover from MAM (16).

2.4. Conceptual frame work

This conceptual framework is adapted from different literatures (17–19,21–23,25–27) after extensive review based on the objective of the study. According to the reviewed literatures the predictors are categorized as socio-demographic characteristics, health services characteristics and HH factors.

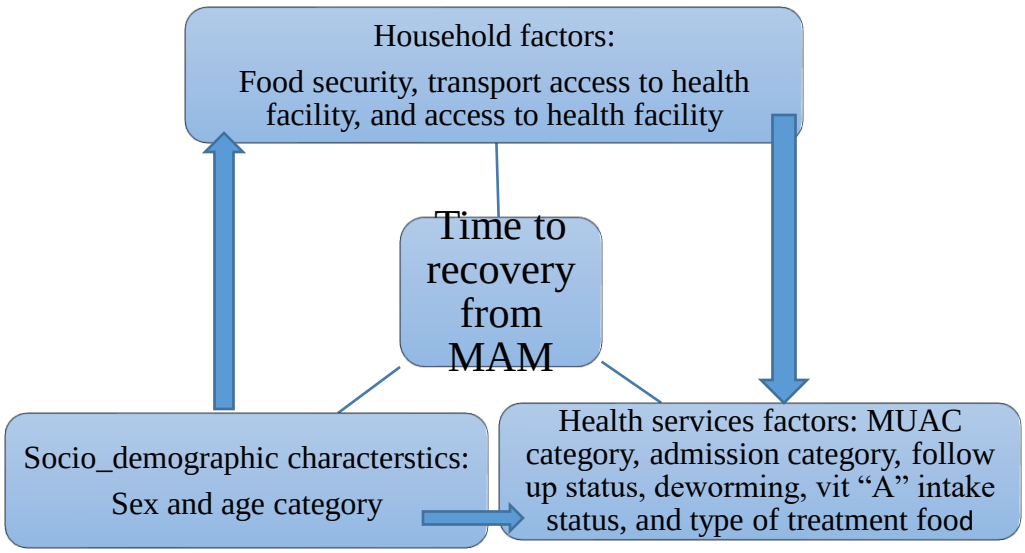


Figure 1: Conceptual frame adapted on time to recovery and its predictors among 6-59 months old children enrolled to TSFP in IDPs sites of Northwest Tigray, Ethiopia, 2024 **(17–19,21–23,25–27)**

3. OBJECTIVES

3.1. General objective

- To assess predictors of time to recovery from moderate acute malnutrition among 6-59 months old children enrolled to targeted supplementary feeding program in internally displaced persons sites, northwest Tigray, Ethiopia, 2024.

3.2. Specific objectives

- To determine recovery time from moderate acute malnutrition among 6-59 months old children enrolled to targeted supplementary feeding program in internally displaced persons sites
- To identify the predictors of time to recovery from moderate acute malnutrition among 6-59 months old children enrolled to targeted supplementary feeding program in internally displaced persons sites

4. MATERIALS AND METHODS

4.1. Study area and period

The study was conducted among children with MAM admitted to TSFP sites of internally displaced persons site which are found in Northern-west Tigray. Northwest Tigray is one of the seven zones of Tigray region, Ethiopia with its capital city of Shire, which is bordered by central zone of Tigray on the East, Amhara region by south, by western zone of Tigray by west and Eritrea by North and it has a total of eleven woredas or district. Almost all of the internally displaced persons live in the Northwest Tigray are people displaced from the western and Northwest Tigray due to civil war started on Nov-2020.

According to a census conducted by IOM, there are total of 73,562 households, 315,637 individuals and 48,137 under five children, internally displaced from Western and Northwest Tigray who live in the host community and IDPs sites. Around 20,476 households, 85,782 individuals and 9,916 under five children live in the IDPs sites of Northwest Tigray. There are 28 IDPs sites selected for TSFP distributions which are 14 in Shire, 10 in Sheraro, 2 in Enda-baguna, one in Mayhanse and one in Htsats (28). According to international organization of migration (IOM) in 2022, there were above 4.5 million IDPs in Ethiopia, with most of these are in Tigray which are around 1.8 million that was assessed using emergency site assessment only (8). The study period was from November/2023 to June /2024.

4.2. Study design

An institutional based retrospective follow up study design was conducted

4.3. Populations

4.3.1. Source population

The source population are all 6-59 months old children with moderate acute malnutrition enrolled to Targeted Supplementary Feeding Program (TSFP) in all internally displaced persons sites of Northwest Tigray, Ethiopia.

4.3.2. Study Population

The study population are all 6-59 months old children with moderate acute malnutrition enrolled to Targeted Supplementary Feeding Program (TSFP) in November-01/2023 to December-05/2023 in the fourteen selected IDPs sites of Northwest Tigray, Ethiopia.

4.4. Eligibility (Inclusion and exclusion) criteria

4.4.1. Inclusion Criteria

Children aged between 6 and 59 months diagnosed with moderate acute malnutrition based on MUAC ≥11.5 cm < 12.5 cm enrolled to TSFP on November 01 up to December-05/2023 and with available records of their enrollment date, age, admission status and subsequent follow up data.

4.4.2. Exclusion Criteria:

Children aged 6- 59 months admitted to the program with known chronic/ congenital illness.

4.5. Sample Size Determination and Sampling method

4.5.1. Sample Size Determination

Sample size was determined using Stata version 17 (29) through cox proportional hazard model with the assumptions of 95% CI, 80% power, probability of recovery 0.82 and by taking hazard ratio of MUAC at admission and HHs food security status of 1.37 and 2.03 respectively (18). Finally adding 10% non-response rate in account of refusal to participate or incomplete information. The total sample size needed for the study was 452 individuals with expected number of events 333 events.

Table 1: Sample size calculated on study of predictors of time to recovery among 6-59 months old children with moderate acute malnutrition enrolled to TSFP in IDPs sites of Northwest Tigray, Ethiopia, 2024

s/no	Predictors	HR	Probability of recovery	Expected no of event	Total sample size after 10% added	Reference
1	MUAC at admission	1.37	0.818	333	452	(18)
2	HH food security status	2.03	0.818	63	86	

$$\mathbf{d} = \frac{(z1-\alpha/2+z1-\beta)2}{px(1-px)[\log(\varphi)]2} \qquad 1 \quad (30) \qquad 2$$

$$\mathbf{n} = \frac{2d}{2-\exp(-t\lambda 0)-\exp^{(-t\lambda 1)}}$$

d- Number of recovered children from MAM

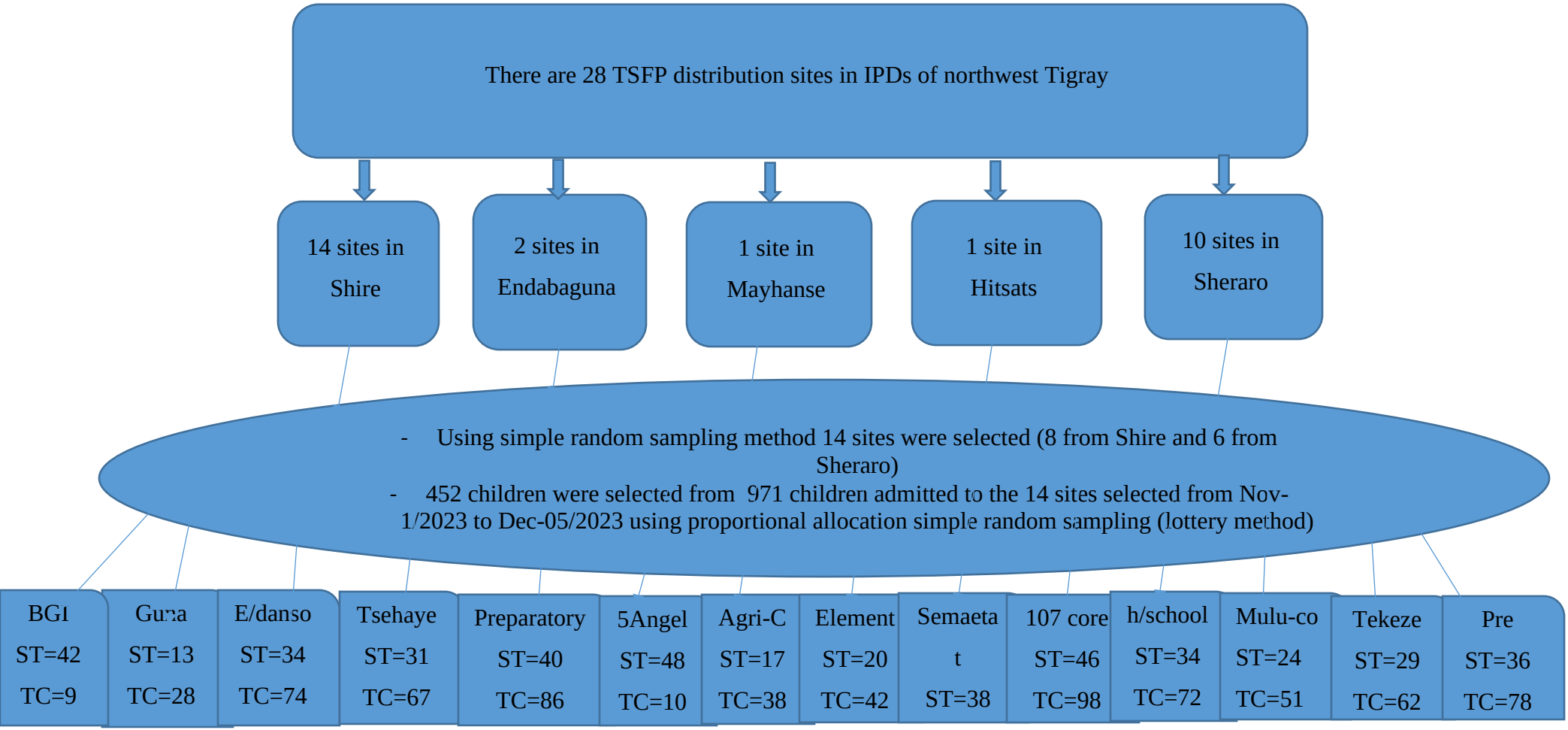
Px= percentage of participants by MUAC category

Φ=hazard ratio

n= sample size needed

4.5.2. Sampling procedure and methods

Fourteen sites were selected using simple random sampling from a total of 28 IDPs sites. Then after, using proportional allocation of samples 452 children were selected from the total of 971 children admitted to TSFP from Nov-01/2023 to Dec-05/2023 in the fourteen selected IDPs sites using simple random sampling. The sampling frame was TSFP registration unique number of all children that were gotten from IMC staffs**.**



Key: ST: sample taken, TC: total MAM cases; The first Eight sites are from Shire and the last Six sites are from Sheraro

Figure 2: Sampling process of selecting participants on time to recovery and its determinants among 6-59 months old children enrolled to TSFP in IDPs sites of Northwest Tigray, Ethiopia, 2024

4.6. Study variables

4.6.1. Dependent variable

Time to recovery: the time from an admission until the child is discharged as cured (Children reach MUAC ≥ 12.5 cm for two consecutive visits and clinically well and alert)

4.6.2. Independent variables

Socio-demographic characteristics

Sex, age, employment status of the caregiver, and educational status

Health services characteristics

MUAC, admission type, follow up status, vit "A" intake status, history of cough, fever, and diarrhea

Household factors

Food security, source of drinking water, toilet facility, functional hand washing availability, and access to health facility

4.7. Terminologies and Operational Definition

Moderate acute malnutrition defined as a child with MUAC 11.5 to 12.4 cm

Recovered: Children reach MUAC ≥ 12.5 cm for two consecutive visits

Intermittent follow up: Lost the TSFP program at least once during treatment period.

Food security: is a situation where exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Humanitarian water source: the water source distributed by the trucks of the humanitarian organizations.

4.8. Data collection tools

The data collection have been carried out retrospectively from the targeted supplementary feeding program registration book and from the care givers (mothers) of the enrolled children using interviewer administered kobo tool box prepared structured questionnaires. The kobo tool box was developed by creating a personal account on kobo tool box and importing the questions prepared to the kobo tool box. After creating the questionnaire on kobo tool box, it was deployed on the system to collect the data. The food security level of the household was assessed using Nine questions with their respective frequency of experienced the respective question. The data

collectors were BSc. nurses and collected the data through record review and information from the caregiver using a single questionnaire that contains the data collected from the registration and primary care giver. The Data collected from the TSFP registration are age, sex, MUAC, admission type, outcome status, time length of follow up, and follow up status. Other data have been collected directly from the caregiver using interviewer administered questionnaire.

4.9. Data quality control

A pre-test was done in Mekelle IDPs and a one day training was given for the data collectors and supervisors about the objective of the study and how to collect the data. Form validation in kobo tool box (checking for required fields, data type validations and range checks to catch invalid entries was configured and also appropriate skip logic was implemented. After listing the variables to be collected, the questions were organized in a way that can be collected from the TSFP registration and the care giver by reviewing the TSFP registration first. By taking samples from each data collectors regular review of the collected data was implemented by the supervisors. Daily analysis of the collected data have been carried out to identify missing values and immediately fill the missing value.

4.10. Data processing and analysis

The Collected data using kobo tool box was exported to Excel for data cleaning. Missing data was analyzed using mean imputation for continuous variables and mode imputation for categorical variables. The cleaned data have been imported to stata version 17 (29) and R software version 4.4.0 (32) and transformed into a format suitable for survival time analysis, which focuses on studying the time to an event (recovery). During the data analysis the following activities were carried out,

4.10.1. Descriptive statistics

Descriptive statistics have been done on the data set to recognize the restricted mean survival time of patients with MAM enrolled to TSFP with the independent variables using graphs, tables, frequencies, percentages, and Kaplan Meier curves.

4.10.2. Proportionality assumptions of cox proportional hazard model

In Cox proportional hazard model, the proportionality assumption states that the relationship between a predictor and the hazard of time to recovery remains constant over time. The proportionality assumptions of Cox proportional hazard model were checked using visual plots of the Schoenfeld's residuals, but the graph crosses at some point that indicates as violation of the

proportionality assumption of the Cox proportional hazard. The proportionality also checked using goodness of fit tests, the p-value was significant that indicates violation of the proportionality assumptions of Cox. Due to the violation of the proportional assumptions of Cox and overlapping of the median survival time and end of the study period, which was four months (the maximum length of stay a child with MAM stays in TSFP), it is advisable to use the restricted mean survival time analysis method. Choosing the right truncation time is the most critical point when we use RMST analysis, so choose the minimum time with the largest observed event time with in each group, which is 16 weeks in this case.

Restricted mean survival time (RMST) is suggested as a novel alternative measure in survival analyses and may be useful when proportional hazards assumption cannot be made or when event rate is low. The time point should be explicitly chosen to obtain an RMST to reflect the clinically relevant time horizon. The advantage of RMST over extended Cox regression are it provides a more intuitive and clinically meaningful interpretation of treatment effects and it allows to focuses on a specific, clinically relevant time interval, rather than the entire survival distribution. Restricted mean time is more useful than median time in case of skewed distribution with censored data.

RMST is defined as the area under the survival curve until the time "τ". So the value is not discrete value instead it is an integral value (area value).so the formula will be used an integration:

$$\mathrm{RMST}_\tau = \mu_\tau = \int_0^\tau s(t)\,dt$$

$$=\sum_{ti\le\tau}(t_i - t_{i-1})s_{i-1}$$

s_{i-1} = the survival probability between t_i and t_{i-1}

t_i = the time point in which the event or cencered happend

t_{i-1}=the initial time in the in the RMST

S(t)= the survival probability up to time t which is unrestricted

τ = the trunction time (33,34)

4.10.3. Uni-variable RMST analysis

To determine the significance of categorical and continuous predictors on the time to recovery status of the children from MAM due to admission to TSFP using RMST difference, Uni-variable RMST difference had been used to compare the restricted mean survival time difference between different groups. If the p-value is below 0.25, the predictor is considered important. Important predictors had been included in the final Cox model to estimate the coefficients of RMST

difference and assess their independent effect on the risk of recovery, while considering other variables (35).

4.10.4. Multi-variable analysis and model building

By taking all important variables (variables with p- value of <0.25) in the Uni-variable RMST analysis, multi-variable RMST difference analysis was done with a 95% confidence interval. Predicators with a p value of <0.05 was considered significant variables.

Model Building for the outcome variable (time to recovery)

The model to predict, time to recovery among children with acute malnutrition in IDP sites of Northern-west Tigray, Ethiopia, was constructed using predictors that were important with a P-value of <0.25 in both the categorical and continuous uni-variable analysis. Finally, the model building process was using a stepwise variable selection and selected the best fit model by concordance (C-index).

Concordance (C-index) is a measure of the predictive performance of a model in the context of survival analysis and RMST. Its value ranges from 0.5 to 1.0 and the model with higher concordance value is generally considered to be the better performing model.

4.10.5. RMST difference interpretation

After identifying the significant predictors for the RMST difference of recovery from moderate acute malnutrition among children enrolled to TSFP in IDP sites of northern-west Tigray, Ethiopia, the RMST model have been developed by including only predictors that have a statistically significant relationship with the outcome.

The interpretation of the RMST difference in the final model have been interpreted as follow, if the predictor is continuous for a unit increase in value of the predictor the RMST difference of recovery increased or decreased by the amount of the RMST difference value unit (unit of follow up, weeks/months/years). If the predictor is categorical variable for any change in the categorical variable the RMST difference of recovery increased or decreased by the amount of the RMST difference value.

4.11. Ethical clearance

The study was carried out after gaining ethical approval from the institutional review board (IRB) of Mekelle University, College of health science. After approval by IRB, an official letter of co-operation have been written to regional health bureau. Then after an official letter from regional health bureau was written to each selected implementing partner and the administrative of the

IDPs. Lastly, data was collected after receiving permission from the concerning bodies and caregiver's by requesting an informed consent. Data coding was used to keep throughout the study to ensure anonymity and confidentiality.

4.12. Results dissemination and utilization

The result of this finding will be disseminated to Mekelle University College of health science, regional health bureau and implementing partners.

5. RESULT

5.1. Descriptive analysis

5.1.1 Socio-demographic characteristics of the participants

The study had been conducted among 452 children 6-59 months old with moderate acute malnutrition admitted to targeted supplementary feeding program in internally displaced persons sites of Northwest Tigray, with majority of the study participants are female 244 (53.08%) and 265 (58.60 %) of the study participant were under the age category of 24-59 months old. The mean age of the study participants was 25.21 months and with a standard deviation of 11.96 months.

Table 2:Socio-demographic characteristics of 6-59 months old children admitted to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024 (n=452)

Variable	Category	Total	
		Frequency	Percentage
Sex of Child	Male	208	46.02
	Female	244	53.08
Age Category	6-23 Months	187	41.37
	24-59 Months	265	58.63
Educational Status	Can't Read And Write	157	34.73
	Primary	126	27.87
	Secondary	103	22.79
	College And Above	66	14.60
Employment Status	Employed	44	9.73
	Unemployed	408	90.27
Number Of Household Members	Less/Equal To Five	300	66.37
	Greater Than Five	152	33.63

5.1.2. Child health and nutrition care related characteristics

More than Two third of the study participants have a MUAC measurement between 12.0-12.4 cm at the time of admission with around 61.06 % are admitted under the admission type of new and 66.37 % of the study participant had a continuous follow up status. The mean admission MUAC of the study participants was 12.0 cm and with a standard deviation of 0.25cm.

Table 3: health and nutrition characteristics of 6-59 months old children admitted to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024 (n=452)

Variable	Category	Total	
		Frequency	Percentage
MUAC Category	11.5-11.9cm	140	30.97
	12.0-12.4 Cm	312	69.03
Admission type	New	276	61.06
	Readmission	176	38.94
Follow Up Status	Continuous	300	66.37
	Intermittent	152	33.63
Fever	Yes	235	51.99
	No	217	48.01
Cough	Yes	202	44.70
	No	250	55.30
Diarrhea	Yes	175	38.70
	No	277	61.30
Vit “A”	Vaccinated	410	90.70
	Unvaccinated	42	9.30
Deworming	Yes	180	39.80
	No	272	60.20
Measles Vaccination	Yes	436	96.50
	No	16	3.50
Breast Feeding	Yes	210	46.50
	No	242	53.50
RUSF Sharing	Yes	139	30.75
	No	313	69.25

5.1.3. House hold characteristics of the sampled population

The availability of functional hand washing on the study subject were 44 (9.73 %). Around two third of the study participant 311 (68.8 %) used humanitarian distributed water as a source of drinking water.

Table 4:Household characteristics of 6-59 months old children admitted to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024 (n=452)

Variable	Category	Total	
		Frequency	Percentage
Functional Hand Washing	Yes	44	9.70
	No	408	90.30
Toilet Facility	No Facility	1	0.22
	Pit Latrine	121	26.80
	VIP Latrine	36	7.95
	Shared/ Public Latrine	294	64.83
Source Of Drinking Water	Piped To Yard	118	26.10
	Public	21	4.65
	Hand Pump	2	0.44
	Humanitarian	311	68.80
Access To Health Facility	Yes	439	97.12
	No	13	2.88
Food Security	Mild In-secured	22	4.87
	Moderate In-secured	238	52.65
	Severe In-secured	192	42.48

5.1.4. RMST curve and Kaplan Meier graph among the groups

The truncation time was selected based on the clinical significant of time frame that is 16 weeks which is the recommended follow up time a child with MAM can stay in TSFP by taking RUSF biweekly and routine drugs including immunizations. As shown in the fig.3, most of the children recovered from MAM during the time of 12 weeks to 14 weeks follow up with the median survival time of 14 weeks The predictor used to classify into two arms was MUAC category which is 11.5-11.9 cm and 12.0-12.4 cm. As shown from fig.3, the survival time of children who have continuous follow up status have shorter survival time (i.e indicates that they recover earlier than children with intermittent follow up status), similarly the survival time of children who had not RUSF sharing is shorter than their counterparts.

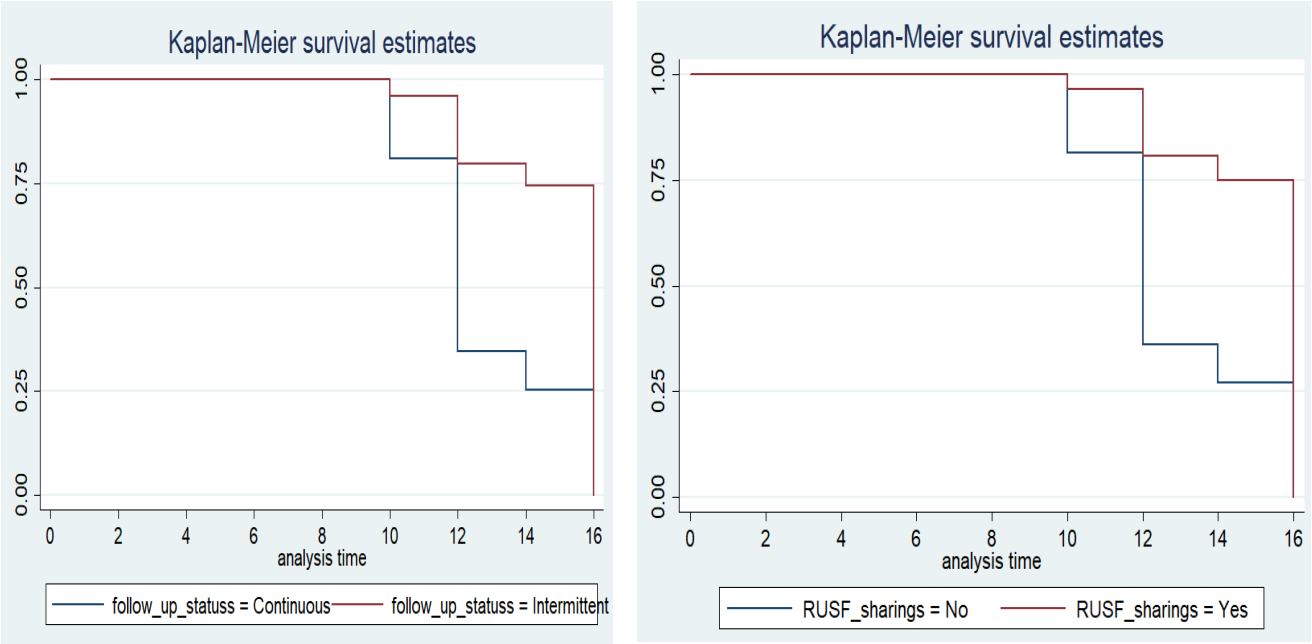


Figure 3: Kaplan Meier curve compares survival time between follow up status groups and RUSF sharing status among children 6-59 months old enrolled to TSFP IDPs sites of Northwest Tigray, Ethiopia, 2024

As you see, fig 4 shows the restricted mean survival time and restricted mean time lost using a curve for the two groups of MUAC category with group 0 (arm=0) 11.5 cm up to 11.9 cm and group 2 (arm=1) 12.0 cm up to 12.4 cm. The restricted mean survival time for arm=1 was 14.85 weeks which is lower than arm=0 (15.84 weeks) and this reflects that arm=1 recovers earlier than arm=0

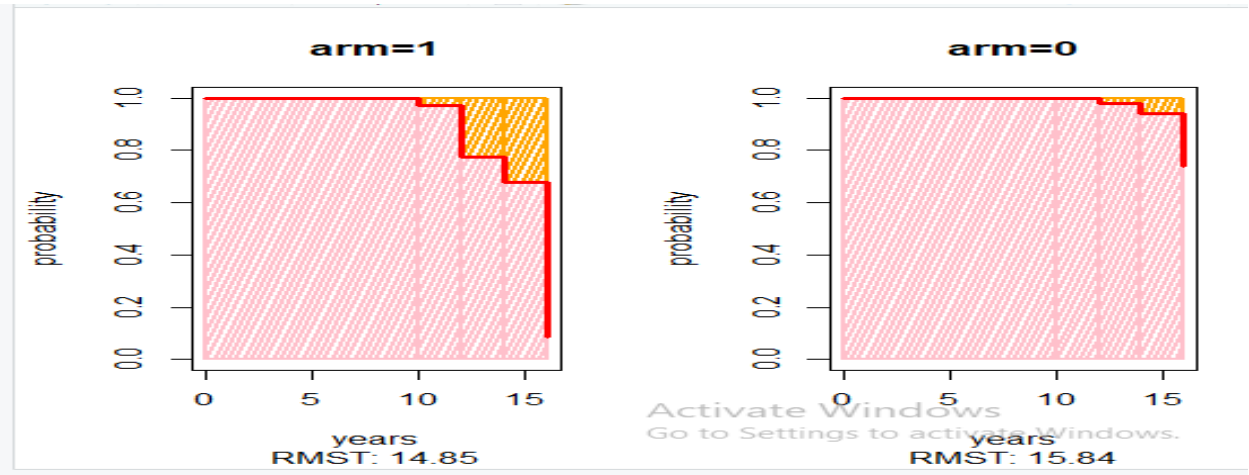


Figure 4: Shows RMST and RMLT curve area of the arm group with a truncation time of 16 weeks among children 6-59 months old enrolled to TSFP IDPs sites of Northwest Tigray, Ethiopia, 2024

5.1.5. Recovery time (Restricted mean survival time)

The overall restricted mean survival time was 15.16 weeks (95%CI, 14.85: 15.84) and the overall recovery rate was 68.36%, with in the follow up period which was four months with a bi-weekly follow up period. The overall incidence rate was 0.050 recovery per person time.

5.2. Predictors of time to recover from MAM

5.2.1. Uni-variable analysis of predictors of time to recovery

Uni-variable RMST difference with a truncation time of 16 weeks done using R software version 4.4.0 for all variables of the study. Variables that was selected as important variables (with p value of <0.25) were MUAC category, follow up status, RUSF sharing, fever history, cough history, diarrhea history, deworming status, source of drinking water, access to health facility, and educational status of the primary care giver, employment status of the care giver (see Table5)

5.2.2. Multivariable Restricted Mean survival time analysis

In the multivariable analysis variables that are statistically significant at 95% confidence interval with P-value < 0.05 are child MUAC category, follow up status, and source of drinking water using RMST difference method of summarization. The result summarized as follow in the table-6

Table 5: Multi-variable analysis of time to recovery and its Predictors among 6-59 months old children with moderate acute malnutrition enrolled to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024.

Parameter	Adjusted RMSTD (95% C.I)	P-value
MUAC category	-1.076(-1.608 :-0.544)	0.001
Follow up status	1.487(1.018 :1.956	0.001

Parameter	Adjusted RMSTD (95% C.I)	P-value
Fever history	0.511(-0.067 :1.088)	0.083
Cough history	0.384(-0.253 :1.021)	0.237
Diarrhea history	0.212(-0.279 :0.703)	0.396
RUSF sharing	-0.493(-1.110 : 0.125)	0.118
Educational status of primary caregiver	-0.009(-0.220 : 0.201)	0.932
Employment status	-0.501(-1.235 : 0.234)	0.182
Source of drinking water	-0.491(-0.960 : -0.021)	0.040
Access to Health facility	0.918(-0.129 : 1.965)	0.086

5.2.3. Final model building

In the final model variables that are statistically significant predictors of time to recovery from MAM were follow-up status, RUSF sharing and MUAC category. Children with an admission MUAC category of [12.0 – 12.4] cm recovered from MAM with 5.47 weeks earlier than children with admission MUAC category of [11.5 – 11.9] cm. Similarly, children who had not history of RUSF sharing recovered 2.07 weeks earlier than counterparts, and children with a continuous follow up status recovered 0.57 weeks earlier than their counterparts.

Table 6: Final model predictors of time to recovery among 6-59 months old children with moderate acute malnutrition enrolled to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024.

Parameter	Category	RMSTD (CI 95%Ci)	P-Value
RUSF Sharing	Yes	2.070(1.391 : 3.081)	0.001
	No	1	
MUAC Category	11.5-11.9 cm	5.475 (3.530 : 8.484)	0.001
	12.0-12.4 cm	1	
Follow-Up Status	Intermittent	0.573(0.428 :0.767)	0.001
	Continuous	1	

6. DISCUSSION

This study assessed the predictors of time to recovery among 452 children 6-59 months old with moderate acute malnutrition admitted to targeted supplementary feeding program in the IDP sites of Northwest Tigray, Ethiopia in 2023/2024, based on variables categorized under socio-demographic characteristics, child health and nutrition related variables. The overall recovery rate was 68.36% and the overall restricted mean survival time was 15.16 weeks with MUAC category, follow up status and RUSF sharing were the significant predictors of time to recovery from MAM enrolled to TSFP.

The overall recovery rate of this study is 68.36%, which is lower than the recommended by the international reference standard for moderate acute malnutrition(>=75%) (6). Similarly it is lower than the recovery rate in a prospective study conducted in Kirehe district of Rwanda among 200 children from 6 to 59 months followed for a period of three months (77.5%) (19) and a retrospective study conducted in Harare on 540 children with moderate acute malnutrition in 2021 the overall recovery rate was 73% (95% CI 69.4–76.4%) (18). This could be justified by being an IDP can lead them to household resource scarcity, disruption of social safety nets, work overload of the care givers and living greater than one family in a house

The overall restricted mean survival time was 15.16 weeks, which is almost similar to the median time revealed by a research conducted in Shalla district, West Arsi zone, Ethiopia (17) and a retrospective follow up study conducted in Harare on 540 children with the median time to recovery of 16 weeks (18).

In this study, MUAC category was significant predictor of time to recover from moderate acute malnutrition admitted to TSFP, with RMST difference of 5.47 with 95% CI and p-value of 0.000 (CI: 3.53 : 8.48). Children with a MUAC category of [11.5, 11.9] cm took 5.47 weeks more to recover from MAM than children with a MUAC category of [12.0-12.4] cm. Another studies also revealed that MUAC category was a significant predictor of time to recovery from MAM admitted to TSFP, a retrospective follow up study design conducted among children aged 6–59 months treated in targeted supplementary feeding program among a total of 402 children selected from eight health posts using systematic random sampling, revealed that children with admission MUAC of 11.5 cm were 18%(AHR 1.18; 95% CI 1.13-1.12) higher risk to recover from MAM than counterparts (15). Similarly a retrospective follow up study conducted in Harare among 540

children with MAM in 2021 shows that children with admission MUAC of [12.0-12.4 cm] are 1.27 times more likely to recover than children with admission MUAC category of [11.5-11.9 cm] (AHR = 1.27, 95% CI: 1.34–2.61) (18). Another prospective follow up study conducted among 325 MAM children followed for seven months in Mana and Dedo woredas of Jimma Zone, South-western Ethiopia also revealed that admission MUAC was a significant predictor (18). This could be due to those who are above 12.0 cm MUAC are less likely to develop malnutrition related complications, better initial nutritional reserve, higher muscle mass and fat stores, and can utilize RUSF more efficiently.

Additionally, RUSF sharing was a significant predictor of time to recovery with RMST difference of 2.07 (CI: 1.39: 3.08) with 95% confidence interval and 0.0003 p-value. Children who had experience of RUSF sharing during the treatment period delayed 2.07 weeks more than children without RUSF sharing. There is no any literature that revealed the significance of RUSF sharing in the time to recovery from MAM admitted to TSFP. This could be justified by being an IDP can lead them to household resource scarcity, disruption of social safety nets, work overload of the care givers and living greater than one family in a house. This could be justified by being an IDP can lead them to household resource scarcity, disruption of social safety nets, work overload of the care givers and living greater than one family in a house. This could be as RUSF is the first line treatment for MAM in children, having RUSF sharing means there is non-adherence to the medication of RUSF and those who has RUSF sharing history are not getting adequate nutritional intake which exposes them to malnutrition related complications.

Follow up status of the child was another significant predictor of time to recovery from moderate acute malnutrition with RMST difference of 0.57 (CI: 0.42: 0.76) p-value 0.000. The recovery time from MAM admitted to TSFP among children with a continuous follow up status was 0.57 weeks shorter than children with intermittent follow up status. Similarly, a retrospective follow up study design conducted among children aged 6–59 months treated in targeted supplementary feeding program among a total of 402 children selected from eight health posts using systematic random sampling, shows that children with regular follow up status were 1.48 times more likely to recover (AHR 1.48; 95% CI 1.09-2.00) (15). Having an intermittent follow up status means the child is not taking the amount of RUSF he/she should take to recover with in the recommended time period of MAM treatment and additionally it may increase the vulnerability of the child to nutrient deficiencies and malnutrition related complications.

7. STRENGTH AND LIMITATION OF THE STUDY

7.1. Strength of the study

- Data was collected from the TSFP registration and directly from the care giver
- This study used a restricted mean survival time by using the clinically accepted truncation time which is 16 weeks

7.2. Limitation of study

- This study used a retrospective follow up study design which can lead to recall bias
- The study participants was taken those admitted on Nov up to Dec/2023 and this may lead to seasonal variation
- The sample size was calculated based on Cox proportional hazard analysis

8. CONCLUSION AND RECOMMENDATION

8.1. Conclusion

In this study the overall restricted mean survival time was 15.16 weeks almost similar to the median time conducted in other areas at the community setting. The overall recovery rate was below the minimum accepted international recovery rate.

MUAC category with RMST difference of 5.47, RUSF sharing with RMST difference of 2.12 and Follow up status of the child with RMST difference of 0.57 were significant predictors of time to recovery from MAM admitted to TSFP.

8.2. Recommendations

1. Health ministry, regional health bureau, and NGOs

Especial trainings should be given for health workers on approaching MAM cases with low MUAC, sharing of RUSF, and follow up status. Strategies that enhance early detection should be implemented to get the child with MAM at early stage

2. Health workers

Tracking and special attention like conducting home visit should be given for children who are lost to follow up or absent child from the TSFP at the time of distribution, children who has history of RUSF sharing, and children with admission MUAC less than 12.0 cm. similarly, counseling caregivers to treat food as medicine.

3. Community and care giver

Moderate acute malnutrition is a diseases that is caused due to the imbalance of nutrients in the body, so the treatment food given for the child should be given as a medicine. Additionally, as other diseases need early diagnosis to increase the chance of recovery, the child should took to the screening sites every month and with no interruption of follow up if diagnosed with MAM

4. Researchers

This research has revealed the RUSF sharing status is one of the significant predictors of time to recovery from MAM, which was not significant predictor in previous studies. Therefore, the researcher recommend further studies attempt to replicate its significance.

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10. ANNEX

10.1. Annex- I: INFORMATION SHEET

Title of the project: Time to recovery and its Predictors among 6-59 months old children with moderate acute malnutrition enrolled to TSFP under humanitarian settings in IDPs of Northwest Tigray, Ethiopia, 2024, retrospective follow up study.

Name of the principal investigator: Efrem Shushay (BSc in public health)

Name of the organization: Mekelle University College of health science

Name of the sponsor: Mekelle University College of health science

Introduction: The aim of this form is to make the above concerned body clear about the purpose of the research, data collection procedure, and get permission to conduct the research.

Purpose of the research project: to assess Time to recovery and its Predictors among 6-59 months old children with moderate acute malnutrition enrolled to Targeted Supplementary Feeding Program (TSFP) in internally displaced persons Sites (IDPs) of Northwest Tigray, Ethiopia, 2024

Procedure: To achieve the above stated objective, information which is necessary for the study will be taken from TSFP registration records follow up forms and data from the care giver.

Risk and or discomfort: Since this will be conducted by taking appropriate information from TSFP registration and information from the care giver, it will not inflict any harm on the children and care giver. The name or any other identifying information will not be recorded on the check lists and all information from the chart will be kept strictly confidential and in safe place. The information retrieved will be used for study purpose only.

Benefits: The research has no direct benefit for those whose document /record reviewed in this research. But the indirect benefit of the research for the participants and other clients in the program is clear. This is enables the concerned bodies to have an information about the time to recovery and its predictors of children with MAM admitted to TSFP. Of all, the research work will have paramount input benefits for health care planners and managers, especially for those on moderate acute malnutrition prevention, treatment and support program planning and management.

Confidentiality: To assure confidentiality, information will be collected without the name of clients and names were not included in the data collection format. After entered to the computer the data

will be locked by password and will not be disclosed to any other person other than principal investigator.

Person to contact: This research project have been reviewed and approved by the institution review board of Mekelle University College of health science and comprehensive specialized referral hospital. If you have any question, you can contact any of the following individuals (investigator and advisors) and you may ask at any time you want.

Principal investigator: Efrem Shushay (BSc) Cell phone +125901275376, Email: Efremshushay97@gmail.com

Advisor

- Ms. Letekirstos Gebreezgiabher (MSC. in Biostatistics and Health informatics, Assistant professor in Biostatistics) Telephone number- 0914155042, email: letekirstos.gebreegziabher@mu.edu.et
- Mr. G/kiros G/Michael (MSc. Public Health, Assistant Professor) Telephone number- 0914564506, email: gebrekiros.meles@mu.edu.et

10.2. Annex -II: DATA EXTRACTION FORMAT

This format is adopted from related studies and self-developed from reviewing MAM treatment guideline, TSFP registration booklet, and TSFP ration cards. It is prepared for the collection of child related factors, mother's/caregiver's related factors and household related factors information that are important for the assessment of time to recovery and its Predictors among 6-59 months old children with moderate acute malnutrition enrolled to Targeted Supplementary Feeding Program (TSFP) in Internally displaced persons Sites (IDPs) of Northwest Tigray, Ethiopia, 2024. All the information will be retrieved from the TSFP registration book/ TSFP ration card and mother's / caregiver's by trained BSc nurse/public health working outside of the selected study sites without mentioning the name the clients.

Informed consent

You are being invited to participate in a research study to investigate time to recovery and its determinants among children 6-59 months old with moderate acute malnutrition enrolled to TSFP. This study aims to improve our understanding of factors that influence recovery time and determine the recovery rate per time. There is no direct or indirect risk associated with participating on this study and all the data collected from the participants will be treated confidentially. To complete these total questions will take around 20 minutes and participating on this study is entirely voluntary. Therefore, are you voluntary to participate on this study?

If yes, proceed to data collection.

Table 7: Data extraction tool used to determine time to recovery and its Predictors among 6-59 months old children with moderate acute malnutrition enrolled to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024.

S.no	Child related characteristics	Possible answer
101	Age of the child at admission(months)	
102	Sex of the child	Male Female
103	MUAC of the child at admission (cm)	
104	Category of admission	New Readmission
105	Follow up status	Continuous Intermittent
106	Outcome status	Recovered Censored
107	If recovered/censored, at how much weeks from admission does the child discharged	
108	Does the child experience fever in the past four months	Yes No
109	Does the child experience cough in the past four months	Yes No
110	Does the child experience diarrhea in the past four months	Yes No
111	Does the child receives Vit''A'' in the past six weeks	Yes No
112	Does the child receives deworming with in the past six months	Yes No
113	Does the child receives measles vaccination	Yes No
114	Does the child is under breast feeding	Yes No
204	Educational status of the primary care giver	Can't read and write Primary Secondary College/university
205	Employment status of the caregiver	un-employed Employed

206	Was there sharing of the ration RUSF given with any member of the household/others/ selling	Yes No
	Household	
301	Availability of functional hand-washing	Yes No
302	What kind of toilet facility do members of your HH usually use	No facility/bush/field Pit latrine VIP latrine Shared/public latrine Other
303	Source of drinking water	Piped to yard Public Hand pump humanitarian
304	Do you have Access to health facility	Yes No
305	In the past four weeks, did you worry that your HH would not have enough food	Yes No
306	In the past four weeks, were you or any HH member not able to eat the kinds of foods you preferred because of a lack of resources	Yes No
307	In the past four weeks, did you or any HH member have to eat a limited variety of foods due to a lack of resources	Yes No
315	In the past four weeks, did you or any HH 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 No
316	In the past four weeks, did you or any HH member have to eat a smaller meal than you felt you needed because there was not enough food	Yes No
317	In the past four weeks, did you or any HH member have to eat fewer meals in a day because there was not enough food	Yes No
318	In the past four weeks, was there ever no food to eat any kind in your HH because of lack of resources to get food	Yes No
319	In the past four weeks, did you or any HH member go to sleep at night hungry because of there was not enough food	Yes No
320	In the past four weeks, did you or any HH member go a whole day and night without eating anything because there was not enough food	Yes No

10.3. Annex -III: Uni-variable RMST analysis

Table 8: Uni-variable analysis of time to recovery and its Predictors among 6-59 months old children with moderate acute malnutrition enrolled to TSFP in IDPs of Northern-west Tigray, Ethiopia, 2024 (n=452)

Variable	Category	Recovered (n=309)	Censored (n=143)	Crude RMST difference	p-value
Sex of child	Male	142	66	1	0.723
	Female	167	77	0.115(-0.524 : 0.740)	
MUAC category	11.5-11.9cm	30	110	1	0.000
	12.0-12.4 cm	279	33	-3.193(-3.687: -2.699)	
Admission type	New	172	104	1	0.342
	Readmission	137	39	-0.222(-0.883: 0.561)	
Follow up status	Continuous	261	39	1	0.000
	Intermittent	48	104	2.18(1.593 : 2.767)	
Fever	Yes	108	127	1	0.000
	No	201	16	-1.658(-2.319 : -0.997)	
Cough	Yes	73	129	1	0.000
	No	236	14	-2.544(-3.167 : -1.922)	
Diarrhea	Yes	52	123	1	0.000
	No	257	20	-2.594(-3.171 : -2.017)	
Vit “A”	Vaccinated	285	125	1	0.627
	Unvaccinated	24	18	-0.277(-1.394 : 0.84)	
Age category	6-23 months	131	56	1	0.000
	24-59 months	178	87	-1.346(-1.968 : -0.724)	
Measle vaccination	Yes	301	135	1	0.743
	No	8	8	-0.204(-1.426 : 1.018)	
RUSF sharing	Yes	44	95	1	0.000
	No	265	48	-2.141(-2.729 : -1.554)	
Functional hand washing	Yes	35	9	1	0.253
	No	274	134	-0.787(-2.081 : 0.507)	
	Shared/ public	180	113	-0.44(-0.926 : 0.169)	0.421
Source of drinking water	Piped to yard	102	16	1	
	Public	16	5	-0.147(-0.512 : 0.218)	0.430

Variable	Category	Recovered (n=309)	Censored (n=143)	Crude RMST difference	p-value
	Hand pump	1	1	-1.017(-1.723 : -0.311)	0.005
	Humanitarian	190	121	-1.895(-3.319 : -0.470)	0.009
Access to health facility	Yes	303	137	1	0.000
	No	6	6	-2.000(-2.327 : -1.673)	
Food security	Mild	20	2	1	
	Moderate	218	20	0.489(-1.341 : 2.319)	0.600
	Severe	71	121	0.836(-1.810: 1.628)	0.435
Educational status	Can't read/ write	79	78	1	
	primary	94	32	-0.668(-1.672 : 0.335)	0.192
	secondary	80	23	-0.577(-1.373 : 0.218)	0.155
	College/ above	56	10	-0.435(-1.302 : -0.432)	0.325
Employment status	employed	38	6	1	0.183
	unemployed	271	137	1.160(0.776 : 1.695)	
Number of HH members	<=5	223	77	1	0.729
	>5	86	66	-0.118(-0.786 : 0.550)	

10.4. Annex -IV: Data analysis soft wares output

Data analysis (Stata and R software) output samples
Cox proportionality assumption checking

```
estat phtest, rank detail
```

```
Test of proportional-hazards assumption

Time:  Rank(t)
```

	rho	chi2	df	Prob>chi2
admission_~o	-0.08822	3.58	1	0.0586
follow_up_~s	0.05143	1.42	1	0.2336
fever_his	-0.05848	1.54	1	0.2145
cough_his	0.07600	2.77	1	0.0962
diarrhea_his	-0.01375	0.08	1	0.7724
vit_A_vacc~n	-0.02438	0.27	1	0.6004
measle_vac~n	0.05603	1.47	1	0.2258
RUSF_shari~s	-0.01318	0.09	1	0.7633
primary_ca~x	0.01978	0.18	1	0.6702
primary_ca~l	0.00459	0.01	1	0.9215
pcg_employ~s	-0.02455	0.29	1	0.5919
source_dri~r	-0.00969	0.05	1	0.8305
access_HF	-0.02243	0.23	1	0.6341
HH_food_se~y	0.07289	2.55	1	0.1105
age_category	0.00110	0.00	1	0.9809
muac_categ~y	-0.20847	16.52	1	0.0000
global test		74.48	16	0.0000

Uni-variable RMST test sample

```
. strmst2 muac_category, tau(16) rmtl

Number of observations for analysis = 452

The truncation time: tau = 16 was specified.

Restricted Mean Survival Time (RMST) by arm
```

Group	Estimate	Std. Err.	[95% Conf.	Interval]
arm 2	12.564	0.227	12.119	13.009
arm 1	15.757	0.110	15.541	15.973

Restricted Mean Time Lost (RMTL) by arm

Group	Estimate	Std. Err.	[95% Conf.	Interval]
arm 2	3.436	0.227	2.991	3.881
arm 1	0.243	0.110	0.027	0.459

Between-group contrast (arm 2 versus arm 1)

Contrast	Estimate	[95% Conf.	Interval]	P>|z|
RMST (arm 2 - arm 1)	-3.193	-3.687	-2.699	0.000
RMST (arm 2 / arm 1)	0.797	0.768	0.828	0.000
RMTL (arm 2 / arm 1)	14.148	5.755	34.778	0.000

Multi-Variable RMST analysis

```
> rmst2(RRR$time, RRR$status, RRR$arm, tau = 16, covariates = x)

The truncation time: tau = 16  was specified.

Summary of between-group contrast (adjusted for the covariates)
                      Est. lower .95 upper .95 p
RMST (arm=1)-(arm=0) -1.076    -1.608    -0.544 0
RMST (arm=1)/(arm=0)  0.927     0.892     0.963 0
RMTL (arm=1)/(arm=0)  1.819     1.354     2.442 0


Model summary (difference of RMST)
                                coef se(coef)      z     p lower .95 upper .95
intercept                     12.174    1.555  7.827 0.000     9.125    15.222
arm                           -1.076    0.271 -3.963 0.000    -1.608    -0.544
follow_up_status1              1.487    0.239  6.215 0.000     1.018     1.956
fever_history1                 0.511    0.295  1.733 0.083    -0.067     1.088
cough_history1                 0.384    0.325  1.182 0.237    -0.253     1.021
diarrhea_history1              0.212    0.250  0.848 0.396    -0.279     0.703
rusf_sharing1                 -0.493    0.315 -1.564 0.118    -1.110     0.125
educational_status_caregiver1 -0.009    0.107 -0.085 0.932    -0.220     0.201
employment_status_caregiver1  -0.501    0.375 -1.336 0.182    -1.235     0.234
source_drinking_water1        -0.491    0.239 -2.049 0.040    -0.960    -0.021
access_hf                      0.918    0.534  1.718 0.086    -0.129     1.965
age_category                   0.275    0.452  0.608 0.543    -0.611     1.162
```

Variable selection using stepwise method

```
> library(My.stepwise)
> RRR$status1 <- ifelse(RRR$status==2,1,0)
> my.variable.list  <- c("childs_age_admission", "primary_caregiver_sex1", "educational_status_caregiver1", "employment
_status_caregiver1", "source_drinking_water1", "access_HF", "age_primarycaregiver", "follow_up_status1", "fever_history
1", "cough_history1", "diarrhea_history1", "deworming_status1", "breast_feeding_status1", "age_category")
> My.stepwise.coxph(Time = "time", Status = "status1", variable.list = my.variable.list, in.variable = c("admission_cat
egory1","childs_age_admission",  "food_security_level", "arm", "follow_up_status1", "rusf_sharing1", "muac_category"),
data = RRR)
# ------------------------------------------------------------------------------------------------
# Initial Model:
Call:
coxph(formula = as.formula(paste("Surv(", Time, ", ", Status,
    ") ~ ", paste(in.variable, collapse = "+"), sep = "")), data = data,
    method = "efron")

                        coef exp(coef)  se(coef)      z Pr(>|z|)
admission_category1  0.191264  1.210779  0.142071  1.346 0.178222
childs_age_admission -0.006919  0.993105  0.005334 -1.297 0.194616
food_security_level  -0.112696  0.893422  0.068176 -1.653 0.098326 .
arm                   1.700115  5.474578  0.223770  7.598 3.02e-14 ***
follow_up_status1    -0.556728  0.573081  0.148875 -3.740 0.000184 ***
rusf_sharing1         0.727858  2.070640  0.202856  3.588 0.000333 ***
muac_category               NA        NA  0.000000     NA       NA
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

                    exp(coef) exp(-coef) lower .95 upper .95
admission_category1    1.2108     0.8259    0.9165    1.5995
childs_age_admission   0.9931     1.0069    0.9828    1.0035
food_security_level    0.8934     1.1193    0.7817    1.0211
arm                    5.4746     0.1827    3.5308    8.4884
follow_up_status1      0.5731     1.7450    0.4280    0.7673
rusf_sharing1          2.0706     0.4829    1.3913    3.0816
muac_category              NA         NA        NA        NA

Concordance= 0.777  (se = 0.021 )
Likelihood ratio test= 191  on 6 df,   p=<2e-16
Wald test            = 127  on 6 df,   p=<2e-16
Score (logrank) test = 162.4  on 6 df,   p=<2e-16

--------------- Variance Inflating Factor (VIF) ---------------
Multicollinearity Problem: Variance Inflating Factor (VIF) is bigger than 10 (Continuous variable) or is bigger than 2.
5 (Categorical variable)
```

10.5. Anex-V: Declaration

Title of the project: Time to recovery and Predictors among 6-59 months old children with moderate acute malnutrition enrolled to Targeted Supplementary Feeding Program in Internally displaced persons Sites (IDPs) of Northwest Tigray, Ethiopia, 2024 This is to certify, that this project is my own work, based on my personal study and /or research. I have duly acknowledged all materials and sources used in its preparation, whether it could be books, articles, reports, lecturer notes and any other kind of document, electronic or personal communication. I also certify that this project has not previously been submitted for assessment in any academic capacity, and I have not copied in part or whole that means it is free from of any plagiarism.

I am confirming that I have identified and declared all possible conflicts that I may have.

Name of investigator: Efrem Shushay (BSc) signature: _____