



INSTITUTE OF HEALTH SCIENCE
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TIME TO STABILIZATION AND ITS PREDICTORS AMONG 6 TO 59
MONTHS CHILDREN ADMITTED WITH SEVERE ACUTE
MALNUTRITION TO SELECTED TERTIARY HOSPITALS IN WESTERN
OROMIA, ETHIOPIA: RETROSPECTIVE COHORT STUDY.

BY: DIRIBA BEKELE

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Final thesis approval sheet

The thesis entitled, “time to stabilization and its predictors among 6 to 59 months children admitted with severe acute malnutrition to selected hospitals in Western Oromia” was carried out by Diriba Bekele under supervision of Mr. Tesfaye Abera and Mr. Dawit Tesfaye. This title has been approved by the concerned bodies of Wollega University for the partial fulfillment of the requirements for master’s degree in Pediatrics and Child Health Nursing program.

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LIST OF ABBREVIATIONS AND ACRONYMS

CMAM: Community Based Management of Acute Malnutrition

HAI: Hospital Acquired Infection

JUMC: Jimma University Medical Center

LoS: Length of Stay

MKCSH: Metu Karl Comprehensive Specialized Hospital

NCSH: Nekemte Comprehensive Specialized Hospital

OTP: Out-Patient Treatment Program

RUTF: Ready To Use Therapeutic Feeding

REC: Research Ethical Committee

SAM: Severe Acute Malnutrition

SC: Stabilization Center

SDG: Sustainable Development Goal

TFC: Therapeutic Feeding Center

WHO: World Health Organization

WUCSH: Wollega University Comprehensive Specialized Hospitals

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ABSTRACT

Background: Due to their fragile physiologic functions, over 65 percent of deaths from complicated severe acute malnutrition occur in the first week of treatment, primarily due to medical complications. To reduce this, early stabilization is crucial, and there is limited evidence regarding stabilization time in Ethiopia.

Objective: To assess time to stabilization and its predictors among 6 to 59 months old children admitted with severe acute malnutrition to selected hospitals in Western Oromia from January 2020 to December 2024.

Method: A retrospective cohort study was conducted from January 20 to february 29, 2025 on 543 sampled children selected by a simple random sampling from severely malnourished children admitted to three selected hospitals in Western Oromia between January 2020 and December 2024. After collecting data using kobotoolbox, it was exported to STATA version 17 for analysis. Kaplan Meier curve and log-rank test were used to estimate the stabilization rate and presence of statistically significant difference in survival and hazard rate between a categories of explanatory variables. Proportional hazard assumption was checked using schoenfeld residual test and log-log survival curve. After performing model comparison, Weibull model was selected and variable with $p < 0.25$ on bi-variate regression was selected for multivariable weibull regression. Estimating adjusted hazard ratio with their respective 95% confidence interval, P-value of less than 0.05 was used to declare statistically significant association with stabilizing time.

Result: Over 5600 child-days of observation, the median time to stabilize from severe acute malnutrition was 11 days, with 86.39% rate of stabilization and 86.6/1000 incidence of stabilization (95% CI: (74.45 - 89.44)). Immunization status (AHR: 0.66, 95 CI (0.54-0.8)), pneumonia (AHR: 2.17, 95 CI (1.74-2.70)), hospital acquired infections (AHR: 1.34 95CI (1.09-1.65)) and vitamin A supplementation (AHR: 0.61, 95CI (0.49-0.77)) were predictors of stabilization time.

Conclusion: This study found prolonged time to stabilization of 11 days compared to recommendation of Ethiopian national management protocol of severe acute malnutrition. To achieve quicker stabilization, health professionals, hospital managers, and all stakeholders must collaboratively address and reduce the burdens stemming from identified predictors.

Key words: Children, Ethiopia, predictors, stabilization, severe acute malnutrition

1. INTRODUCTION

1.2. Background

In 2024, the total number of under five children reached around 647 million globally (1, 2). Even though they share significant proportion of world population, they often lack both quantitative and qualitative aspects of dietary intake during certain critical sensitive periods of their life (3). Early life nutrition, especially from conception to 2 years has a long term growth and developmental outcome in addition to high risk of chronic disease later in adulthood (4). For instance, prolonged breast feeding and compliance with exclusive breast feeding are shown to be associated with decreased body mass index (BMI) and resultant cardiovascular disease later in life (5, 6). Timely initiation of complementary feeding, age at weaning, getting enough proportion of dietary protein and other essential micronutrients affects neurodevelopmental and overall health outcomes of children during adulthood (3). WHO recommends the core indicators of Infant and Young Child Feeding (IYCF) practice including early initiation of breast feeding, exclusive breast feeding up to 6 months, continuation of breast feeding until two years of age, introduction complementary feeding at 6 months, Minimum Meal Frequency (MMF), Minimum Dietary Diversity (MDD) and minimum acceptable diet for children as an indicators to assess their nutritional status (7). However, IYCF practice quietly vary and is almost low in Ethiopia (8).

Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients (9). It can be broadly classified as under nutrition (stunting, wasting and underweight), over nutrition (obesity and diet related non communicable disease) and micronutrient deficiencies (10). It is resultant of interplay between these three major causes; basic causes (like drought and political instability), underlying causes (like insufficient household food security) and immediate causes like infections (11). In addition, poor compliance with IYCF practices make children vulnerable to malnutrition; especially stunting and micronutrient deficiencies (7).

Acute malnutrition is a form of undernutrition caused by a decrease in food consumption and/or illness resulting in bilateral pitting edema and/or sudden weight loss (10). While severe acute malnutrition (SAM) is diagnosed when children exhibit bilateral pitting edema or severe wasting ($WFH < -3$ z-score) (10). SAM can be classified as complicated or uncomplicated, based on presence or absence of medical complications and result of appetite tests (12). Children with SAM who have medical complication/s and/or failed appetite test should be diagnosed as complicated SAM and admitted to stabilization center (SC), while others are admitted to outpatient program

(OTP) (10). If a child fails the appetite test, it reflects a severe disturbance of metabolism and infections and they are in danger of death from hypoglycemia, hypothermia, fluid overload, and undetected infections (10, 13). Therefore, treatment in stabilization phase is designed to suit this condition using specialized formula called F-75 and F-100 (10). F-75 is specially made to meet the child's needs without overwhelming the body's systems in the initial stage of treatment until child is stabilized (14). After being stabilized, the children should be transitioned from F-75 to F-100 or RUTF over 2-3 days, as tolerated and enter rehabilitation phase (14). During rehabilitation, children can freely feed on F-100 or RUTF and rapid weight gain is expected (10). It is expected that children should be stabilized and transferred to OTP once medical complications are resolved, appetite regained, and bilateral edema is reduced. Moreover, delay in stabilization is related to significant inpatient death and majority of death from SAM occur during this initial phase of management (15). Prompt and effective stabilization shortens periods of intense physiological stress, which in turn lowers the chances of long-term cognitive deficits, emotional problems, stunted growth, and diminished academic achievement or work capacity later in life. Given the high number of complications and comorbidities, treatment during this phase demands considerable caution to avoid poor outcomes. However, in Ethiopia little is known about predictors of stabilization time, and existing literatures are inconsistent and conducted on single hospital. Therefore, a thorough understanding of the factors that affects duration of stabilization time is essential for enhancing treatment outcomes and overall recovery of children admitted with severe acute malnutrition.

1.2. Statement of the problem

In 2024, global prevalence of wasting and stunting was 6.6 and 23.2 percent respectively (16). More than three quarters of all children with severe wasting live in Asia and another 22 per cent live in Africa (17). Even though stunting has been declining steadily over the last decade (1990 – 2023), 148.1 million (22.3%) of children under age 5 were affected in 2024 (18). Nearly all children with stunting lived in Asia and Africa; 52 and 43 percent of the global share respectively (17). In African countries, child malnutrition is still posing a significant influence on child health and survival and moreover, child under-nutrition persists to be a burden in the poorest nations, with rates up to 10 times greater than in the richest (19). Studies revealed that sub-Saharan Africa are most affected area by malnutrition, with wasting prevalence in west Africa of 18, 15.5 and 12.5% in Niger, Burkina Faso and Mali respectively while 11.1% are in Ethiopia (20). According to EDHS 2019, 37% of under-five children are stunted (12% severe stunting), 7% are wasted (1% severely wasted) and 21% are suffering from underweight (21).

The first 1 to 2 weeks of inpatient stay is the most critical to the survival of children with complicated SAM. Of 40.5 % of the deaths from SAM, 30.6% died within 48 hours of admission, and 65.3% died within 1 week of admission (22). One study also reported the majority of deaths from SAM happen in the first 2 weeks of admission (23). Even in setting that follows WHO standard treatment guideline, inpatient mortality remains high, ranging from 10 to 30% of all treated cases (24). As a general, prolonged inpatient stay exacerbates a patient's emotional reaction, psychological well-being, and interferes with patients' abilities to cope and adjust (25). Specifically, prolonged hospitalization in children with SAM is associated with increased mortality risk (26), nosocomial infections (27), developmental delays, psychosocial problems (28), and a higher likelihood of ongoing malnutrition at the time of discharge (29). Furthermore, the combination of infection and under-nutrition can result in a potentially fatal cycle of recurrent infections, declining nutritional status, and frequent disease, leading to prolonged inpatient stay (30), longer stabilization time and hence poor treatment outcomes during stabilization phase. It was confirmed that children staying in hospital for 8-14 days have shown more recovery rate than those who stayed more or less than indicated range (31) showing that children shouldn't be hospitalized for more or less than recommended inpatient stay (26). This high burden of the problem and its devastating consequences highlight the urgent need for effective strategies in its management, specially addressing a critical aspect of SAM management, which is the duration it takes for a child to stabilize.

Stabilization time is understood to be affected by admission characteristics such as appetite tests, anthropometric measurements, types of malnutrition, anemia, and diarrhea (22, 32-35). Furthermore, acquiring nosocomial infections, medical complications, and type of therapeutic feeding used are other factors that are associated with stabilization time in children with severe acute malnutrition (15, 36). Additionally, having comorbid illnesses like HIV/AIDS, tuberculosis and pneumonia were identified as predictors of stabilization time (22, 34, 37). Moreover, recent studies indicated that stabilization time is prolonged in presence of a nasogastric tube, administration of intravenous infusions and blood transfusions, development of hospital-acquired infections, diagnosis of anemia, and failure of an appetite test (15, 34).

Because of high mortality and morbidity related to prolonged inpatient stay, malnourished children with medical complications and/or failed appetite test who are admitted for inpatient treatment should ideally be stabilized within 7 to 10 days before being discharged to outpatient therapy (OTP) (10, 34). However, earlier studies have indicated that the stabilization period vary, ranging from 7 to 13 days before discharge to OTP (34, 38), with a low stabilization rate among those who stayed in the hospital for an extended period (34). According to study in north Ethiopia, only 13.1% of children with complicated SAM were stabilized within expected time frame (39). When stabilization achieved, children enter phase 2 and feed F-100 and RUTF which is designed for patients to rapidly gain weight and replace wasted muscle. As the time to enter this phase increase, their chance to take this advantage and recover early will decrease and take them more time to recover (40). In addition, early stabilization helps to reduce overall burden on health care resources, including time, medical supplies and bed occupancy (41). Early stabilization functions as a critical gateway to the entire, more efficient, cost effective and scalable outpatient treatment model or CMAM. Moreover, stabilization time serves as a key indicator that reflect the effectiveness of treatment protocol being implemented and the overall quality of care provided for the clients (42). Therefore, understanding stabilization time and its predictors may help to work toward reduction of hospitalization time and as a result improve outcome of complicated SAM (43).

Various strategies have been devised to reduce inpatient stay, including approaches that address various facets of patient management, such as clinical care initiatives like enhanced recovery programs and early mobility protocols, as well as those that concentrate on staffing models and the logistics of care coordination (44). Agency for Healthcare Research and Quality (AHRQ) identified a need to implement broad system-level interventions to reduce LOS among patients

with high risk of prolonged LOS (45). Various strategies like discharge planning, medication management, clinical pathways, multi-disciplinary care, case management, hospitalist service, and tele-health were set to be followed by hospitals to accelerate recovery time and reduce length of inpatient stay (44). In 2007, multilateral UN agencies endorsed the approach that seeks to fulfill the shortcomings inherent in traditional management of SAM which relied predominantly on inpatient treatment centers, necessitating prolonged hospital stays that often separate children from their families and communities (14). This led to the implementation of community based management of malnutrition (CMAM) which tries to reduce inpatient stay while giving safe outpatient service for children (41). In addition, interdisciplinary bedside rounds (IBRs), where the patient's case is discussed at the bedside is, believed to be one of the strategies to reduce prolonged hospitalization through patient centered care (46). However, for children with complicated SAM, stabilization of life threatening complications should come before any attempts to shorten hospitalization and cannot be achieved solely without timely stabilization (34) and strict compliance with management protocols specially during early phase of the inpatient treatment (22).

While factors affecting overall recovery have been extensively studied, research specifically addressing predictors of initial stabilization time is relatively scarce, and findings from existing studies have been inconsistent. In addition to factors reported by previous literatures, further study is needed to determine relative contribution of different factors on stabilization time like IYCF practices (breast feeding status and complementary feeding), immunization status, and type of formula feeding given. In addition, a critical gap remains due to inconsistency of findings and heterogeneity among study settings, where one study setting reported improvement in stabilization due to involvement of various international and domestic NGOs. Furthermore, previous studies conducted on similar topic relied on small sample size (n=184&282) and conducted on single setting, raising the issues of generalizability (15, 34). Therefore, to come up with more consistent and representative findings, further research is warranted within a more homogenous setting, employing more sample size and recruiting from them multiple setting.

1.3. Significance of the study

Understanding the timeline for stabilization and its predictors is a critical step toward improving the overall treatment outcomes of complicated SAM.

Healthcare professionals equipped with insights into the stabilization time could implement more effective treatment strategies, ensuring that children are stabilized and transitioned to outpatient care as swiftly as possible. Moreover, focusing on stabilization time, health care provider could work to tackle the alarming rates of early inpatient mortality associated with it.

The findings of this study could be a significant step toward achieving SDG 3.2, which aims to reduce under-five mortality to 25 deaths per 1,000 live births by 2030.

Additionally, the findings of this study could serve as valuable input for the East Wollega Zonal Health Bureau and the Oromia Health Bureau to craft policies aimed at reducing under-five mortality and addressing areas needing improvement, such as logistics and supply management for hospitals in the region.

Furthermore, non-governmental organizations working toward reduction of death from SAM could be used as an input to prevent further causes of death in this age group.

Finally, this study's findings will enrich the existing literature by pinpointing the factors that predict outcomes in the initial phase of SAM treatment by identifying several factors associated with it.

2. LITERATURE REVIEW

2.1. Time to Stabilization among children admitted with severe acute malnutrition

The reported median time for children with complicated Severe Acute Malnutrition (SAM) to stabilize and transfer to a transition phase or discharge from a stabilization center ranges from 3 to 13 days. As reported by a randomized controlled trial (RCT) conducted on children in Kenya and Malawi, the median time for children to stabilize and transfer to the transition phase was 3 days (47). Another RCT carried out in Malawi indicated that the length of stay after transition phase to be 7 days (38). According to a study done in Zambia, the median length of stay (LOS) in stabilization center was 9 days (IQR, 5-14 days) (22). A Prospective cohort study conducted on children admitted to inpatient therapeutic feeding center in northern Ethiopia showed that the median time to stabilize from complicated SAM was 8 days with 96.2% stabilizing rate (15). Similarly, another prospective study done in southern Ethiopia found 71.4% recovery rate with the median stabilization time to be 8 days (36). However, retrospective study done in Northern Ethiopia revealed relatively long stabilizing time which is 13 days with the rate of discharge to OTP after stabilization of 85.8% (34). According to a research done in northern Ethiopia, 32.2% of children admitted with complicated SAM failed to enter phase 2 on day 10, and from those admitted with edema, 16.3% of them are still with edema on day 10 which shows presence of poor progress toward stabilization (48). However, both WHO and Ethiopian national management protocol recommends children to be stabilized from medical complications in 7-10 days (10, 32).

2.2. Predictors of time to stabilization children admitted with SAM

2.2.1. Sociodemographic Characteristics

Studies conducted in African countries including Ethiopia reported a significant association between sex of children and time to stabilization, (43, 49-51). According to study in Southern Ethiopia, compared to children above 24 months, children below 24 months have shown to have prolonged stabilization time (36). Similarly, evidence from double-blinded, RCT (52) and primary study (53) showed that a better recovery rate is associated with an increased age of the children. The place of residence is also associated with stabilization time, and related mortality (54, 55). Another retrospective cohort study done in North Ethiopia concluded that children from non-educated parents, have less than 2 years birth interval, and family with large number of under-five children in house were shown to have delayed recovery time (56).

2.2.2. Anthropometric Measurements

As stated by various studies, the type of SAM children admitted with has a great implication on time to stabilization and outcome. For instance, study done in Southern Ethiopia, Bangladesh, and Zambia reported that wasted children have worst recovery time than oedematous one (49, 57-59). On the other hand, according to various studies done in Ethiopia, oedematous children are less likely to recover faster compared to those who are wasted (33, 39, 50, 51, 60). In addition, study concluded that grade of edema the children admitted with is significant predictor of time stabilization (39). One systematic review and meta analysis conducted on sub-saharan Africa reported higher recovery rate among children admitted based MUAC threshold of 11.5cm than 11cm and increased age of children (61). In addition, study in southern Ethiopia indicated that admission MUAC and WFH had significant association with time to recovery (58). In addition, the admission weight of children is also significant predictor of time to stabilization (58) and admission weight of greater than 7 kg is found to significant predictor of early stabilization and recovery (62).

2.2.3. General Status of Children

As indicated by studies, admission status of children (new/readmission) is an important predictors of time to stabilization and its rate (55, 63, 64). On the other hand, exclusively breast fed children have shown to have shorter recovery time than children who didn't have exclusive breast feeding (39, 65). Studies conducted in North and South West Oromia showed that children who are not fully vaccinated have prolonged time to recover than their counterparts (35, 50). On the other hand, being admitted with both edema and wasting, edema alone or wasting alone is found to be predict stabilization time and discharge outcome of the children (31).

2.2.4. Medical Complications and Co-Morbidities

Almost all studies conducted on time to recovery and stabilization claimed that presence of medical complications have negative implication on nutritional recovery of the children with SAM. According to retrospective study conducted in Zambia, children with co-morbidities are 84% less likely to recover than those without it; HIV/AIDS and tuberculosis having significant association with nutritional recovery (49, 50). As reported by study conducted in Zambia, the mean length of stay to recover is 9.6 days with diarrhea, and 11.8 days in children without diarrhea and it is major cause of death during stabilization phase (22). The evidence obtained from retrospective study conducted in public hospitals in North Ethiopia from 2016 to 2019 concluded that those children admitted to stabilization center with palmar pallor have prolonged stabilization time than other without palmar pallor at admission (66). Similarly, results from study in Addis

Ababa, North and West Oromia concluded that presence of anemia as a medical complication delay recovery from severe acute malnutrition compared to those without anemia (51, 60, 67). Retrospective cohort study in North West Oromia indicated that SAM children with pneumonia, kwashi dermatosis and hospital acquired infections have long period of stabilization than others without the conditions (34).

Another prospective study conducted in Kenya indicated that malnourished children who have a diarrhea had a higher risk of death and those who are survived had longer stabilization time than those who did not have diarrhoea during their hospital stay (68). As an evidence from studies conducted in North Ethiopia, probability of recovery is reduced by 58.5% and 84% among children admitted with co-morbidity/ties (50, 66). It is reported by study conducted in South West Oromia that, presence of TB, malaria and shock delay recovery from SAM (37). Additionally, study done in Northern and Southern Ethiopia concluded that pneumonia prolong time to stabilize from SAM complication compared to those without the condition (39). As indicated by result of systematic review and meta analysis conducted in Sub-Saharan Africa, recovery of children with HIV/AIDS is decreased by 81% compared to those not having the condition (61). It is revealed that severely malnourished children with malaria had a 65.9% delayed recovery (37) and shortened time to death (69) than their non malarious counterparts. The finding of study conducted in South West Oromia shows that children who developed shock had 82% longer nutritional recovery time than those who did not develop shock (37). Prospective cohort study conducted in Tigray also concluded failed appetite test is independent predictor of stabilizing time (15). Meta analysis and systematic review of 8 African countries also associate failed appetite test on admission to late recovery and poor outcome (70). In addition, children admitted without dehydration have a shorter recovery time than children who have dehydration on the admission day (36).

2.2.5. Routine Medications and Treatments.

A double blinded randomized clinical trial conducted in Niger and Malawi indicates that nutritional recovery time was shorter for SAM children treated with Amoxicillin than placebo (71, 72). According to study carried out in Uganda, SAM children who are dewormed with Albendazole/mebendazole are more likely to recover faster than others (73). It is found that antibiotics like ceftriaxone and cloxacillin delay recovery from SAM (39). Finding of one systematic review concluded that introduction of a standardized antibiotic regimen composed of ampicillin and gentamicin, reduced the case fatality rate from 20% to 6% (74). On the other hand, children who are on NG tube for feeding were shown to recover less likely than others (40). Similarly, prospective cohort study done in Tigray also indicated that children who were able to

take therapeutic milk orally had better chance of stabilizing unlike those who were fed with NG tube (15). Children who received folic acid supplements at the time of admission recovered faster than those who did not (53, 75). While administration of special medication like IV fluids, IV antibiotics and blood transfusions is shown to decrease probability of recovery (15, 67, 76). Various study conducted in Ethiopia indicated that provision of vitamin A to SAM children enhance recovery and improve the outcomes of the treatment. Study done in Addis Ababa reported that children who were given vitamin A were more likely to recover than others (67). Further more studies carried out in northern Ethiopia and north West Oromia found that being given vitamin A shorten recovery time and improve treatment outcomes (39, 51).

2.2.6. Feeding type given

Several studies have been conducted to compare effectiveness of RUTF and F-100 for treatment of severe acute malnutrition (36, 42). Systematic review carried out in India concluded the overall recovery rate with the use of RUTF of more than 85% with a mortality of less than 1% (42). A prospective cohort study conducted on effectiveness of RUTF and F-100 in Southern Ethiopia also found that the median recovery time for children taking RUTF was shorter (7 days) compared to children given F-100 (10 days) (36). Similarly, a prospective cohort study done in Northern Ethiopia declared that children who feed on plumpy nut are 50.8% more likely to recover soon than others not taking plumpy nut (77). Study also revealed that children who had appropriate complementary feeding at age were more likely to recover from SAM compared with children who did not have it (75). Additionally, children who didn't have history of bottle feeding showed more chance of recovery than those without bottle feeding history (67).

2.3. Conceptual Framework

This is conceptual framework of time to stabilization and its predictors among 6 to 59 months children admitted with severe acute malnutrition. The predictors variables are arranged as sociodemographic characteristics, treatments and routine medications, general status of children, anthropometric measurements, comorbidities and medical complications, and types of malnutrition which are adapted from different literatures (15, 34, 36, 37, 39, 48, 50).

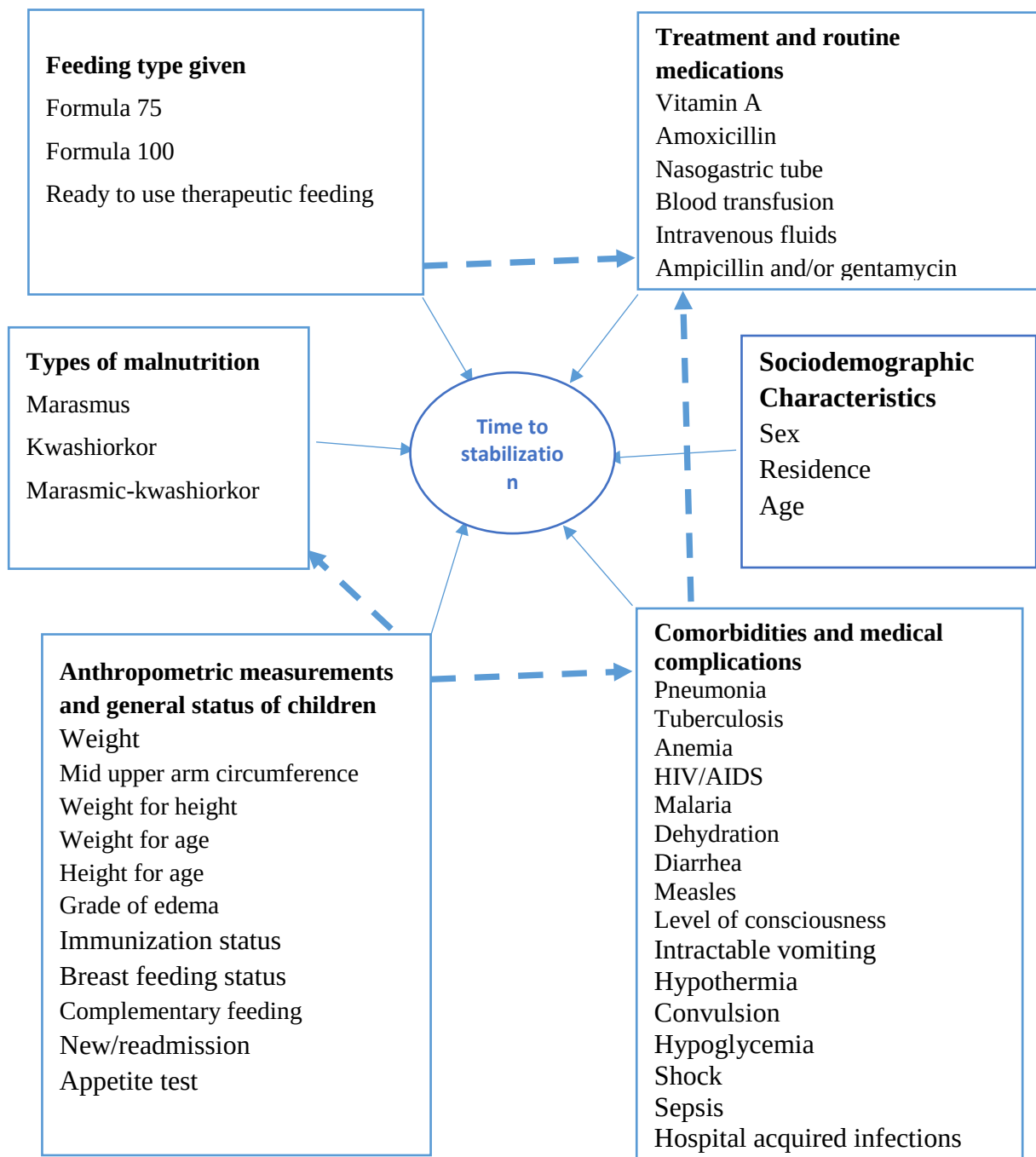


Figure 1: Conceptual framework for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of selected hospitals.

3. OBJECTIVES

3.1 General Objective

- To assess time to stabilization and its predictors among 6 to 59 months old children admitted with severe acute malnutrition to selected hospitals in Western Oromia, 2025.

3.2 Specific Objectives

- To determine time to stabilization among 6 to 59 months old children admitted with severe acute malnutrition to selected hospitals in Western Oromia, 2025
- To identify predictors of time to stabilization among under 6 to 59 months old admitted with severe acute malnutrition to selected hospitals in Western Oromia, 2025.

4. METHOD AND MATERIALS

4.1. Study setting and Period

This study was conducted at three selected tertiary hospitals in West Oromia; Wollega University comprehensive specialized hospital (WUCSH), Metu Karl comprehensive specialized hospital (MKCSH) and Jimma University medical center (JUMC).

WURH was established as a teaching and referral hospital and providing clinical services in June 2017. Recently it is recognized as a comprehensive specialized hospital and added more services including CT scan. In terms of child health service, the hospital has one pediatric emergency and ward. The hospital's pediatric ward is arranged as chronic disease, surgical, critical 1 and 2, and SAM unit. The SAM unit is organized into milk preparation room, appetite test area, breast feeding corner, psychomotor stimulation room, stabilization phase, and transition phase. (From WURH health information management systems, 2017). JUMC is the only medical center in the western Oromia. The hospital covers the large catchment areas providing advanced health service for more than 250,000 outpatient cases, 19,000 inpatient cases 15,000 emergency cases and 7,000 delivery cases per year. In terms of child health, in addition to routine services, like wards and OPD, it provides more advanced psychomotor stimulation by a trained nurse at decorated play stimulation room with different toys and playing aids based on the age of the child for at least for 30–45 min/ day.

Metu Karl comprehensive specialized hospital is the only tertiary hospital in Ilu abba bora zone, which provide comprehensive service for more than 2 million people from the zone and other regions like Gambela. The hospital provides both inpatient and outpatient child health service. The malnutrition unit of the hospital is designed with special psychomotor stimulation unit in addition to ward and emergency unit.

The study was conducted from January 20 to February 29, 2025 among 6 to 59 months children admitted with SAM from January 2020 to December 2024.

4.2. Study Design

Hospital-based retrospective cohort study was conducted among 6 to 59 months old children admitted to Wollega University comprehensive specialized hospital, Metu Karl comprehensive specialized hospital and Jimma university medical center with SAM from January 2020 to December 2024.

4.3. Population

4.3.1. Source Population

The source population was all children aged 6 to 59 months who were admitted to therapeutic feeding center (TFC) of tertiary hospitals in western Oromia with SAM from January 2020 to December 2024.

4.3.2. Study Population

All randomly selected eligible charts of 6 to 59 months old children admitted to TFC of Wollega University comprehensive specialized hospital, Metu Kerl comprehensive specialized hospital and Jimma university medical center with SAM from January 2020 to December 2024.

Study unit: Each individual's chart of child (6-59 months) admitted to TFC of Wollega University comprehensive specialized hospital, Metu Kerl comprehensive specialized hospital and Jimma university medical center with SAM from January 2020 to December 2024.

4.3.2.1. Eligibility Criteria

Inclusion criteria

All medical records of children aged 6 to 59 months with SAM admitted to the TFC of the selected hospitals during the study period was included.

Exlcusion criteria

Any children **transferred in** from another facility or program for further treatment or logistic reason, MRN with unspecified age on logbook, charts whose admission, discharge date and outcome not registered, children having down syndrome, cleft palate or any anatomic problems which interfere with feeding were exluded.

4.4. Sample Size Determination, Sampling Technique and Procedure

4.4.1. Sample Size Determination

- The required sample size was calculated using STATA version 17, considering significant predictors from previous studies, a 10% withdrawal probability, and a 95% confidence interval (Table 1).

Table 1: sample size calculation for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of selected hospitals.

Assumption	Predictors	Adjusted hazard ratio/AHR	Sample size	Reference
• A confidence level of 95% • Power of 80% • P = 0.96				
	Anemia	1.7	297	(34)
	Pneumonia	1.6	378	(34)
	NG tube feeding	1.48	543	(15)
	IV fluid	2.01	172	(15)

The final sample size was **543** children with SAM (10% for incomplete data was included during sample size calculation).

4.4.2. Sampling Technique and Procedure

There are six tertiary hospitals in Western Oromia (Nekemte comprehensive specialized hospital, Wollega university comprehensive specialized hospital, Dembidolo University teaching hospital, Ambo university referral hospital, Jimma university medical center, and Metu Kerl comprehensive specialized hospital). From this sampling frame, three hospitals; Wollega University Comprehensive Specialized Hospital (WUCSH), Metu Kerl Comprehensive Specialized Hospital (MKCSH), and Jimma University Medical Center (JUMC) were selected using simple random sampling. The total number of children admitted for Severe Acute Malnutrition to each of these three hospitals between January 2020 and December 2024 was retrieved from their respective SAM registration logbooks. The total number of children admitted were 980 for WUCSH, 1010 for MKCSH, and 1310 for JUMC. The samples were proportionally allocated to the three hospitals based on the number of children admitted to their TFC during the study period using formula, $n_i = \frac{n}{N} \times N_i$, where N=total number of children admitted to three hospitals (3300), N_i = sample size (543), n=total number of SAM children in each hospital. Accordingly, 161, 166 and 216 children were selected from WUCSH, MKCSH and JUMC respectively. Subsequently, a total sample of 543 children were selected using simple random sampling. This selection was made from a comprehensive sampling frame compiled from the medical record numbers (MRNs) of all SAM children admitted to the therapeutic feeding centers of the three selected hospitals between January 2020 and December 2024.

SPSS version 26 software was utilized to generate random numbers from the prepared sampling frame. Based on proportional allocation, 161, 166, and 216 children were randomly selected for WUCSH, MKCSH, and JUMC, respectively. The generated random numbers were then printed to facilitate the retrieval of corresponding children's medical records from the record center for data extraction. However, 14 of the selected records were incomplete or lost. Consequently, data extraction was performed for 156, 162, and 211 records (a total of 529) from WUCSH, MKCSH, and JUMC, respectively.

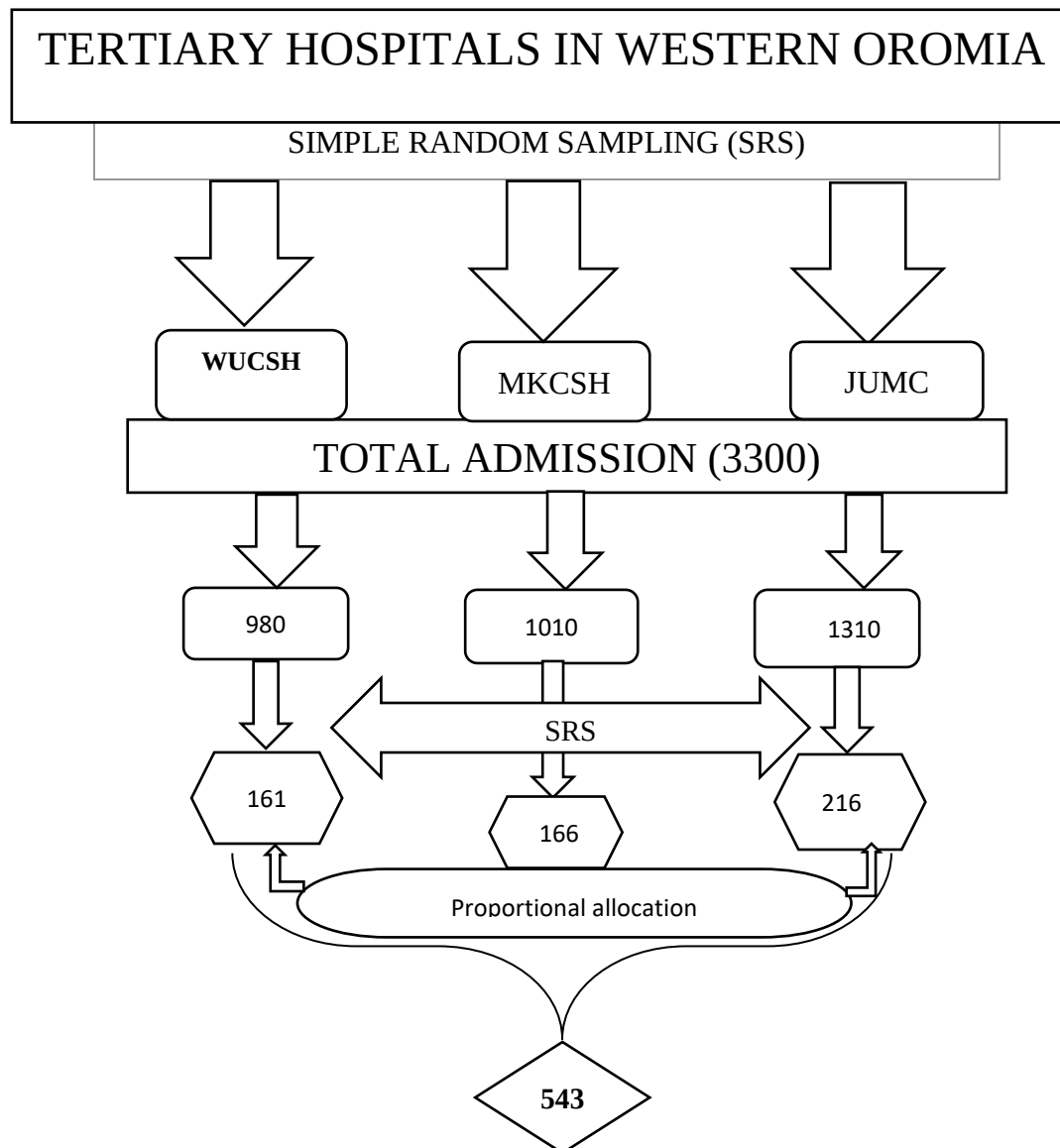


Figure 2: Schematic presentation of sample size allocation for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of selected hospitals.

4.5. Data Collection Technique and Procedure

The structured tool English version questionnaire which was adapted from the same study conducted in northern Ethiopia and then modified after reviewing other literature was used for

data collection (15, 34). Content validity of adapted tool was evaluated by subject matter experts (SME) and they reviewed each item in the tool, assessing its relevance and representativeness in relation to the construct. Pretest was conducted on 5% of sample size. Following the pretest findings, the questionnaire was revised by removing variables such as daily weight gain, entering phase 2 on day 10, deworming, folic acid, and questionnaire was subsequently rearranged to reflect these changes. Two bachelor's degree nurses were recruited to each hospital to collect data based on evaluation of their previous experience in data collection. After thorough discussion with the principal investigator regarding the data collection tool, one MSc-qualified person assigned as supervisor to train and oversee data collectors, handled any issues that arose, and acted as a liaison between the principal investigator and the data collectors. Prior to that, training was given for assigned supervisor on kobo toolbox usage and data extraction techniques. During data collection, the collected data were checked by trained supervisor and then by PI for completeness, consistency, accuracy of data entries, and reviewed for logical errors and outliers.

4.6 Study Variables

The outcome variable for this study was stabilization, dichotomized into event (stabilized=1) and censored =0, if children not stabilized at the end of the follow up, defaulted, referred, transferred out and died.

Dependent variable: Time to stabilization

Independent variables

Sociodemographic and admission characteristics

Sociodemographic: age, sex and residence

Admission characteristics: immunization status, breast feeding status, new/re-admission

Comorbidities and medical complications

Pneumonia, malaria, tuberculosis, anemia, HIV/AIDS, level of consciousness, diarrhea, measles, dehydration, intractable vomiting, hypothermia, convulsion, shock, hypoglycemia, sepsis, Hospital acquired infections

Feeding type given

F-75, F-100, RUTF, and complementary feeding

Treatments and routine medications

Vitamin A, amoxicillin, NG tube, blood transfusion, IV fluids, ampicillin and/or gentamycin

Type of malnutrition

Kwashiorkor, marasmus and marasmic kwashiorkor

Anthropometric measurements: Weight, weight for age, weight for height/length

4.7. Operational and term Definition

Stabilized: means free from any medical complication, regained appetite and referred to continue treatment in outpatient therapeutic program (OTP) (10). The child is considered **stabilized** and ready for OTP treatment once they've completely transitioned from F-75 and are independently feeding on RUTF or F-100. Additionally, all medical complications must be resolved, and edema should be reduced to grade I or II, if present.

Time to stabilization: was determined by calculating the difference (in days) from the start of treatment for SAM (F-75 initiation) until the child is discharged to OTP (15).

Event: stabilization from medical complications, and regain appetite (until the child takes the full requirement of RUTF) (10)

Died: when children dies while receiving treatments in SC.

Defaulted: those who are absent from the ward for two consecutive days.

Transfer out: referred to another facility for further treatment or moved out to receive care in another SC.

Co-morbidity: is presence of one or more additional health conditions coexisting with a SAM.

Medical complications: any serious health issue that arises as a result of malnutrition.

Censored: are those children who didn't develop an event or not stabilized at the end of follow up period, referred, died, defaulted, or transferred out (10).

Special medication: is the term used to describe use of treatments like Resomal fluid, blood transfusion, IV fluid and NG tube as per the national guideline (10).

Follow up time: the period (in days) from initiation of SAM treatment to the day they developed event of interest or censored; referred, died, transferred out or defaulted, whichever happened first (followed for maximum of 28 days) (60).

Incomplete cards: the cards with no pertinent informations like feeding type given, and their initiation and discontinuation date.

New admission: new case who meets the admission criteria for SC (10).

Re-admission: re-admitted for treatment in SC due to relapse or a returned defaulter who meets the admission criteria (10).

Relapse: cured within the past 3 months and now meets the admission criteria for SC (10).

Returned defaulter: Defaulted within the past 3 weeks and has returned to continue treatment in SC (10).

4.8. Data Processing and Analysis

The data was collected using KoboCollect version 2024.2.4 software. After exporting to the STATA, data was cleaned and coded using simple frequency and cross tabulation. Then, the exported data was analysed using STATA version 17. Descriptive statistics of time to stabilization was displayed in mean, median, and percentage. The outcome of each study subjects was dichotomized into stabilized and censored. Kaplan meir curve was used for comparison of survivor function & estimate time to stabilization at a given time. Then, logrank test was used to show whether there is statistically significant difference in stabilizing rate between groups of predictors where its P- value is <0.05 .

To check the assumption of proportional hazards, schoenfeld residual test was calculated for every variable where a p-value greater than 0.05 satisfy assumption, along with a log-log survival curve analysis where the parallelism of the $\log(-\log(\text{survival time}))$ curve was examined to ensure it meets the proportional hazards assumption. After performing model comparison among models of survival analysis, Weibull regression model was selected having the lowest Akaike Information Criteria (AIC) value. Frailty model was incorporated to account for unobserved heterogeneity. Then, the overall goodness of the selected was checked by cox snell residuals test. Furthermore, to check for multicollinearity among variables, we calculated the variance inflation factor (VIF), and all variable had VIF value of less than 10, with mean value of 1.50 and tolerance of 0.70.

Only variables that satisfy the proportional hazard assumption was used for bivariate analysis. Variables that yield a p-value of less than 0.25 during this initial regression was considered for inclusion in the multivariable analysis. Adjusted hazard ratios (AHRs) along with their corresponding 95% confidence intervals (CIs) was calculated. A p-value of less than 0.05 was used to identify statistically significant associations with stabilizing time. Missing values were identified for four variables (Exclusive breast feeding, appetite test, MUAC, and immunization status), and the it ranges from 1.13 to 1.89%. Since the missing data pattern was random, the values were imputed using multiple imputation and then analyzed alongside the other variables. Finally, the findings of this study was presented through a combination of tables, graphs, charts, and descriptive statements.

4.9. Data Quality Management

Firstly, content validity of adapted tool was evaluated by experts in the area. Before data collection begins, prepared tool was approved by advisors and training was given for data

collectors and supervisors regarding the variables under investigation. Data collectors were closely followed throughout collection period. Further more, the pretest was done 2 weeks before actual data collection at Nekemte comprehensive specialized hospital (NCSH) on 5 % of sample size to check for feasibility, clarity of language used, and flow of idea of the questionnaire. Then, children's card was checked for eligibility and completeness and consistency of data was checked for eligible cards based on tool provided. Furtherly, data collecting format was cross matched with available information on the card and rearrangements was made as necessary. Most importantly, the collected data was checked for completeness and accuracy on daily basis.

4.10. Ethical Consideration

After getting ethical clearance with Reference number of IHS REC/007/060/2025 from Wollega University research ethical committee (REC), the permission letter was given to governing body of the selected hospitals to get patient cards. Since it is secondary data, getting participant consent is not possible. However, all concerned bodies was informed the importance of the research and permission was obtained from hospital management to get access to the cards. Then, the objective of this study was explained for head of SAM unit and staffs. To maintain the confidentiality of the data, first PI was discussed with data collectors on importance of keeping patient data confidential from unauthorized body. Before data collection begin, data collectors must agree not allow any personally identifiable information accessible to anyone outside of the research team. Then, they was instructed and supervised to code the patient cards anonymously so that unauthorized body have no access to participants informations during and after the study.

4.11. Dissemination Plan

The results of the study will be presented and disseminated to Wollega University, institute of health science department of pediatrics and neonatal nursing. The pertinent findings of the study will be given to selected hospitals, regional and zonal health bureau, and NGOs for actions. Furthermore, the study will be published in an international reputable journal.

5. RESULTS

5.1. Sociodemographic characteristics of the participants

While 543 medical records were initially selected for this study, 14 were excluded due to incomplete baseline data or lost cards. This resulted in a final dataset with a 97.42% completeness rate. Therefore, data was collected from 529 participants who exhibit complete information. The study participants had a median age of 24 months (IQR: 14-38) and a median admission weight of 8 kg (IQR: 6-10.2). Regarding age distribution, 274 (51.81%) were aged 6 to 24 months, while 255 (48.20%) were aged 25 to 59 months. Among these children, 294 (55.5%) were females, and over 85% of the total participants resided in rural areas. The data revealed that 455 (86%) of the children were newly admitted, while the remaining admissions were attributed to relapse (8.1%) and default (5.9%) (Table 2).

Table 2: Sociodemographic characteristics and baseline information of the participants of children admitted to TFC of selected hospitals from January 2020 to December 2024, West Oromia

Variables	Category	Frequency (%)	Status	
			Event N (%)	Censored N (%)
Sex	Male	235 (44.42)	202 (85.96)	33 (14.04)
	Female	294 (55.58)	255 (86.73)	39 (13.27)
Age	6-24 months	274 (51.81)	241 (87.96)	33 (12.04)
	25-59 months	255 (48.20)	216 (84.71)	39 (15.29)
Residence	Urban	79 (14.93)	70 (88.61)	9 (11.39)
	Rural	450 (85.07)	387 (86.00)	63 (14.00)
Admission type	New admission	455 (86.01)	391 (85.93)	64 (14.07)
	Re-admission after relapse	43 (8.13)	39 (88.64)	5 (11.36)
	Re-admission after default	31 (5.86)	27 (90.00)	3 (10.00)

5.2. Clinical conditions at admission and comorbidities

Out of the study participants, nearly one third 129 (24.39%) underwent an appetite test on admission, while the remaining were based on medical complications criteria. Only 192 children (36.29%) were fully immunized and/up to date for their age. Regarding infant feeding practices, 241 respondents (54.44%) reported practicing exclusive breastfeeding for the first six months, while only 243 (45.94%) reported appropriate complementary feeding. In this study, diarrhea was the most prevalent medical complication, occurring in 339 participants (64.08%). Among those

with diarrhea, more than three fourth (77.87%) of the children experienced acute episode, and 108 individuals (20.42%) presented with dehydration. Upon admission, over 34.97% participants presented with pneumonia and 44.23% had anemia. Moreover, more than one third (35.73%) of the study participants got hospital acquired infections, and 21.55 % were diagnosed with tuberculosis on/and after admission.

The most frequently observed comorbidities among the children were diarrhea (64.08%), anemia (44.23%), and pneumonia (34.97%). Additionally, acute gastroenteritis (16.26%) and malaria (12.85%) were noted as other complications. Upon admission, the vast majority of participants (91.5%) were alert, while a smaller proportion (5.10%) presented with lethargy. (Table 3)

Table 3: Clinical conditions at admission of children admitted to TFC selected hospitals from January 2020 to December 2024, West Oromia

Variables	Category	Frequency (%)	Status	
			Event N (%)	Censored N (%)
Feeding status	Exclusive BF	241 (54.44)	203 (84.23)	38 (15.77)
	Mixed feeding	288 (45.56)	254 (88.19)	34 (11.81)
Appropriate CF	Yes	243 (45.94)	206 (11.81)	37 (15.23)
	No	286 (54.06)	251 (87.76)	35 (12.24)
Appetite test done	Yes	129 (24.39)	110 (85.27)	19 (14.73)
	No	400 (75.61)	347 (86.75)	53 (13.25)
Appetite result	Passed	28 (21.70)	28 (100)	0
	Failed	101 (78.30)	82 (81.18)	19 (18.81)
Fully immunized	Yes	192 (36.29)	168 (87.50)	24 (12.50)
	No	337 (63.71)	289 (85.76)	48 (14.24)
Severe pneumonia	Yes	185 (34.97)	160 (86.49)	25 (13.51)
	No	344 (65.03)	297 (86.34)	47 (13.66)
Diarrhea	Yes	339 (64.08)	284 (83.78)	55 (16.22)
	No	190 (35.92)	173 (91.05)	17 (8.95)
Duration of diarrhea	< 14 days	264 (77.87)	218 (82.58)	46 (17.42)
	≥ 14 days	75 (22.13)	66 (88.00)	9 (12.00)
Intractable vomiting	Yes	146 (27.60)	121 (82.88)	25 (17.12)
	No	383 (72.40)	336 (87.73)	47 (12.27)
Fever >38.5 °C	Yes	162 (30.62)	145 (89.51)	17 (10.49)
	No	367 (69.38)	312 (85.01)	55 (14.99)
Hypoglycemia	Yes	136 (25.71)	98 (72.06)	38 (27.94)
	No	393 (74.29)	359 (91.35)	34 (8.65)

Variables	Category	Frequency (%)	Status	
			Event N (%)	Censored N (%)
Mental status	Alert	484 (91.49)	428 (88.43)	56 (11.57)
	Lethargic	27 (5.10)	15 (55.56)	12 (44.44)
	Unconscious	18 (3.40)	14 (77.78)	4 (22.22)
Palmar pallor/Anemia	Yes	234 (44.23)	210 (89.74)	24 (10.26)
	No	295 (55.77)	247 (83.73)	48 (16.27)
Convulsion	Yes	24 (4.54)	21 (87.50)	3 (12.50)
	No	505 (95.46)	436 (86.34)	69 (13.66)
Dehydration	Yes	108 (20.42)	98 (89.91)	11 (10.09)
	No	421 (79.58)	359 (85.48)	61 (14.52)
Level of DHN	Some	60 (55.04)	56 (93.33)	4 (6.67)
	Moderate	30 (27.52)	28 (93.33)	2 (6.67)
	Severe	19 (17.43)	13 (68.42)	6 (31.58)
HIV/AIDS	Yes	7 (1.32)	6 (85.71)	1 (14.29)
	No	522 (98.68)	451 (86.40)	71 (13.60)
Tuberculosis	Yes	114 (21.55)	98 (85.96)	16 (14.04)
	No	415 (78.45)	359 (86.51)	56 (13.49)
Measles	Yes	101 (19.09)	91 (90.10)	10 (9.90)
	No	428 (80.91)	366 (85.51)	62 (14.49)
Shock	Yes	26 (4.91)	18 (69.23)	8 (30.77)
	No	503 (95.09)	439 (87.28)	64 (12.72)
Sepsis	Yes	63 (11.91)	45 (71.43)	18 (28.57)
	No	466 (88.09)	412 (88.41)	54 (11.59)
Hospital acquired infections (HAI)	Yes	189 (35.73)	159 (84.13)	30 (15.87)
	No	340 (64.27)	298 (87.65)	42 (12.35)

CF: complementary feeding, BF: breast feeding, DHN: dehydration, N: number

5.3. Admission Anthropometric measurement of the patients

Following admission, 290 (54.82%) of the study participants had edematous severe acute malnutrition (SAM); of these, 198 (68.27%) exhibit grade III bilateral pitting edema. More than 56% of the participants were classified as severely wasted based on weight-for-height (WFH) and MUAC measurement criteria.

Out of the study participants, 335 individuals (63.33%) were severely underweight and 220 (41.59%) exhibited severe stunting. Nearly half (48.39%) of the study participants were admitted with diagnosis of marasmus, while 169 (31.95%) had kwashiorkor and 104 (19.66%) presented with Marasmic-kwashiorkor. (Table 4)

Table 4: admission anthropometric measurements of children admitted to TFC of selected hospitals from January 2020 to December 2024, West Oromia

Variables	Category	Frequency (%)	Status	
			Event N (%)	Censored N (%)
Edema	Yes	290 (54.82)	249 (85.86)	41 (14.14)
	No	239 (45.18)	208 (87.03)	31 (12.97)
Grade of edema	Grade I	27 (9.31)	20 (74.07)	7 (25.93)
	Grade II	64 (22.06)	60 (93.75)	4 (6.25)
	Grade III	198 (68.27)	167 (84.34)	31 (15.66)
WFH	Normal	118 (22.30)	99 (83.89)	19 (16.11)
	Moderate	113 (21.36)	108 (95.57)	5 (4.43)
	Severe	298 (56.33)	250 (83.89)	48 (16.11)
WFA	Normal	50 (9.45)	47 (94.00)	3 (6.00)
	Moderate	144 (27.22)	129 (89.58)	15 (10.42)
	Severe	335 (63.33)	281 (83.88)	54 (16.12)
HFA	Normal	113 (21.36)	105 (92.92)	8 (7.08)
	Moderate	196 (37.05)	164 (83.67)	32 (16.33)
	Severe	220 (41.59)	188 (85.45)	32 (14.55)
MUAC	Normal	155 (29.30)	128 (82.58)	23 (17.42)
	Moderate	74 (13.99)	61 (82.43)	13 (17.57)
	Severe	300 (56.71)	268 (89.33)	32 (10.67)
Diagnosis	Kwashiorkor	169 (31.95)	141 (83.43)	28 (16.57)
	Marasmus	256 (48.39)	225 (87.89)	31 (12.11)
	Marasmic-kwash	104 (19.66)	91 (87.50)	13 (12.50)

WFH: weight for height, HFA: height for age, MUAC: mid upper arm circumference, WFA: weight for age, N: number

5.4. Treatment, routine medications and feeding

The management protocol in these hospitals followed national management guideline of SAM and Ampicillin and/gentamycin were most commonly (85.09%) administered intravenous antibiotics. Nearly two-thirds (65.78%) of the participants received amoxicillin, and over 35% were supplemented with vitamin A. During the stabilization phase of treatment, more than one-fifth (21.74%) of participants received nasogastric tube feeding. Regarding feeding given, all participants (100%) received F-75 formula before transitioning to RUTF or F-100. Approximately three-fourths of the participants (72.40%) received both F-75 and RUTF, while the remaining participants were given F-75 followed by F-100. (Table 5)

Table 5: Treatment, routine medications and feeding of children admitted to TFC of selected hospitals from January 2020 to December 2024, West Oromia

Variables	Category	Frequency (%)	Status	
			Event N (%)	Censored N (%)
Transfused	Yes	121 (22.87)	100 (82.64)	21 (17.36)
	No	408 (77.13)	357 (87.50)	51 (12.50)
Infused	Yes	57 (10.78)	43 (75.44)	14 (24.56)
	No	472 (89.22)	414 (87.71)	58 (12.29)
NG tube	Yes	115 (21.74)	84 (73.04)	31 (26.96)
	No	414 (78.26)	373 (90.10)	41 (9.90)
Vitamin A	Yes	186 (35.16)	159 (85.48)	27 (14.52)
	No	233 (44.05)	206 (88.41)	27 (11.59)
	Not indicated	110 (21.36)	92 (83.64)	18 (16.36)
Ampicillin and/gentamycin	Yes	451 (85.09)	384 (85.33)	66 (14.67)
	No	79 (14.91)	73 (92.41)	6 (7.59)
Amoxicillin	Yes	348 (65.78)	309 (88.79)	39 (11.21)
	No	181 (34.22)	148 (81.77)	33 (18.23)
Feeding given	F-75 and F-100	146 (27.60)	118 (80.82)	28 (19.18)
	F-75 and RUTF	383 (72.40)	339 (88.51)	44 (11.49)

NG tube: nasogastric tube, RUTF: ready to use therapeutic food, F-75: formula 75, F-100: Formula 100

5.5. Treatment outcome of the children with severe acute malnutrition

In the study, 457 participants 86.39% (CI: 0.83-0.89) experienced the event of interest (stabilization) and 72 participants (13.61%) were censored because of referral, death, default, and transfer (Figure 3). From the study finding, the overall incidence rate of stabilization was 81.6/1000 children days of observation (95% CI: 74.45 – 89.44).

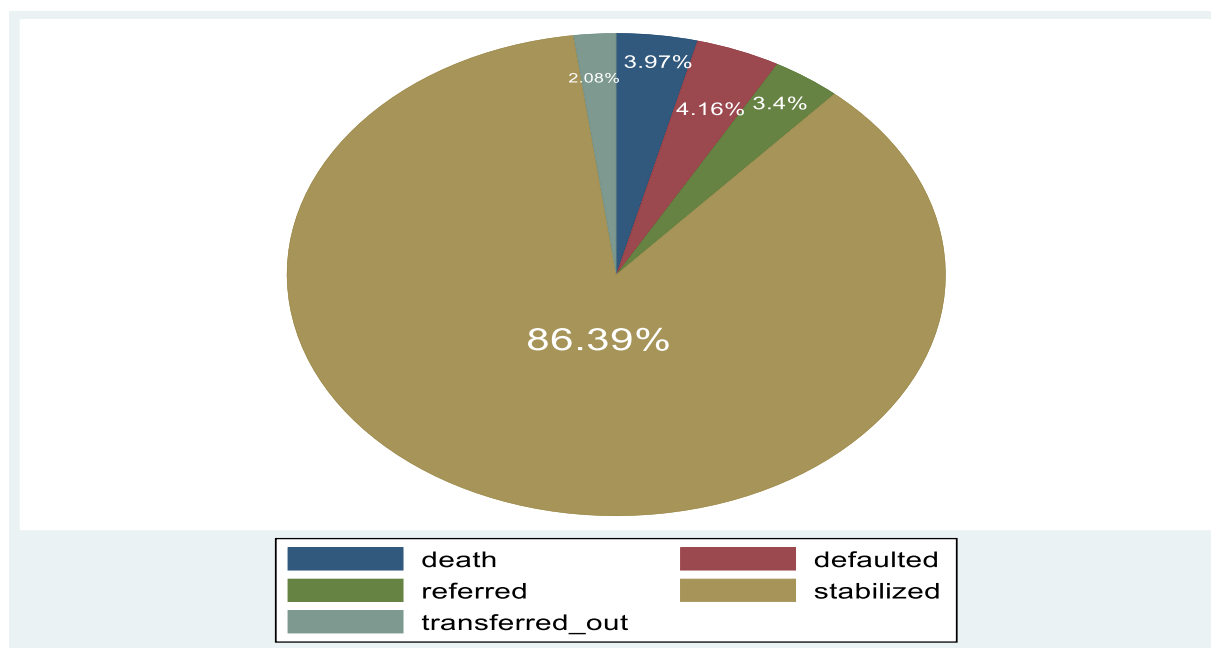


Figure 3: Treatment outcomes for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals.

5.6. Incidence rate and median time to stabilization of children admitted with severe acute malnutrition

A total of 5600 children-days were monitored for 529 children admitted with SAM, ranging from a minimum of 3 days to a maximum of 22 days. The overall median stabilization time for this study was 11 days (IQR: 8-14) (Figure 4). Majority (47.4%) of children were stabilized and discharged between 6 and 12 days of inpatient stay, while the lowest stabilization (4.3%) occurred between 18 and 22 days. An estimated cumulative survival probability at 6, 12, 18 and 24 days were 0.95, 0.44, 0.08, and 0.008 respectively (Table 6).

The incidence of stabilization was 83.3 per 1,000 at WUCSH, 75.4 per 1,000 at MKCSH, and 86.0 per 1,000 children-days of observation at JUMC. Furthermore, the median stabilization time was 11 days (IQR: 9-14) at WUCSH, 12 days (IQR: 9-15) at MKCSH, and 10 days (IQR: 8-13) at JUMC, respectively.

Table 6: Cumulative survival probability estimates for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals.

Interval	Number at risk	Stabilization	Censored	Survival	95% CI
0-6	529	26	23	0.95	0.92, 0.96
6-12	480	251	28	0.44	0.39, 0.48
12-18	201	157	16	0.08	0.05, 0.10
18-24	28	23	5	0.008	0.002, 0.023

Overall failure function

As shown by overall Kaplan Meir failure function, the stabilization probability of children with severe acute malnutrition increases over time, with 0.05% and 0.99 at the end of 6th and 22th day respectively.

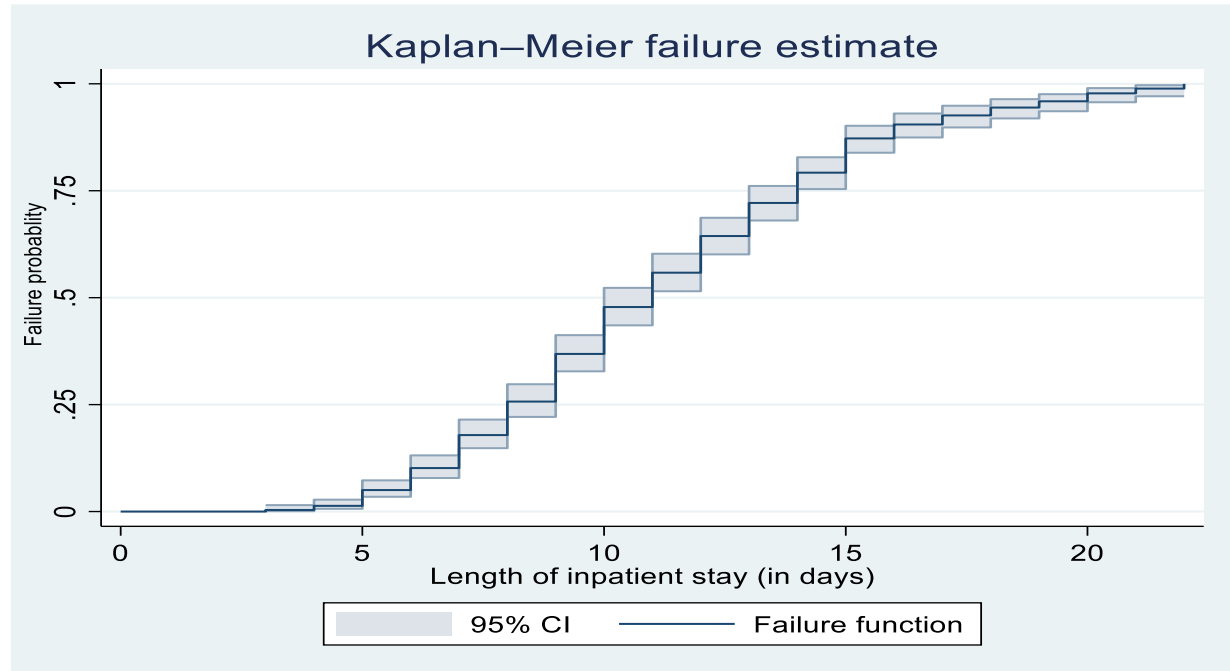


Figure 4: Overall failure estimates for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals.

5.7. Comparison of stabilization time among categories of covariates

To check existence of difference in stabilization time among various groups of covariates in this study, we used Kaplan Meir survival curve along with log rank test. Based on these, significant difference in stabilization time and rate were noted among categories of variables like immunization status, severe pneumonia, anemia, tuberculosis, HAIs, and vitamin A supplementation. A statistically significant difference was observed in stabilization time based on the presence of pneumonia at admission: children with pneumonia had a median stabilization time of 13 days, which was longer than the 10 days observed in those without pneumonia (Log rank, $P = 0.003$) (Figure 6). Additionally, children admitted with incomplete immunization for their age had a median stabilization time of 12 days, compared to 9 days for those who were fully immunized (Log rank, $P < 0.001$) (Figure 5). Furthermore, children who received vitamin A supplementation stabilized at a median time of 10 days, compared to 12 days for those who did not receive it (Log rank, $P < 0.001$) (Figure 7).

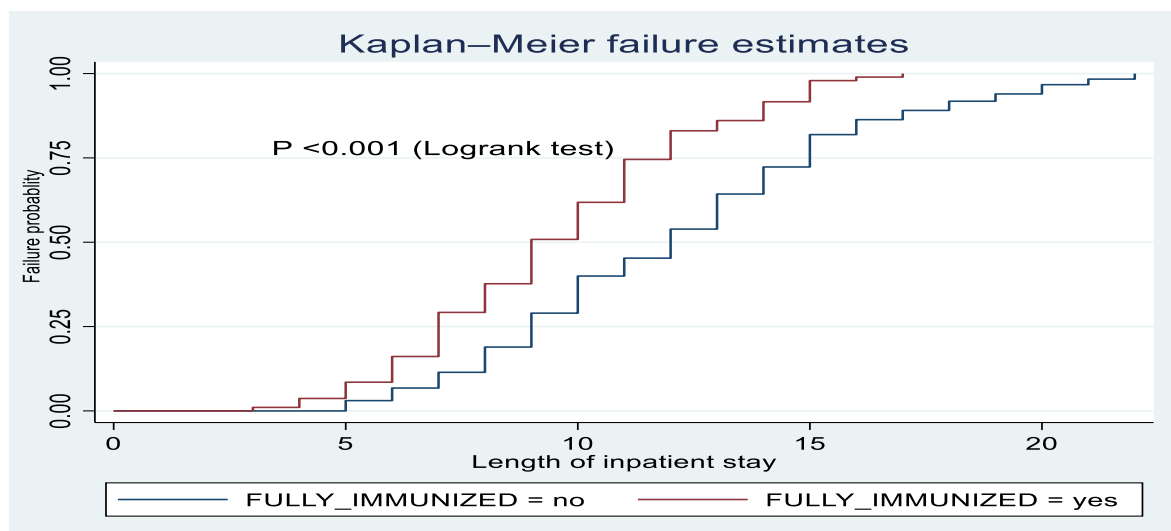


Figure 5: Log rank failure estimate for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals by immunization status.

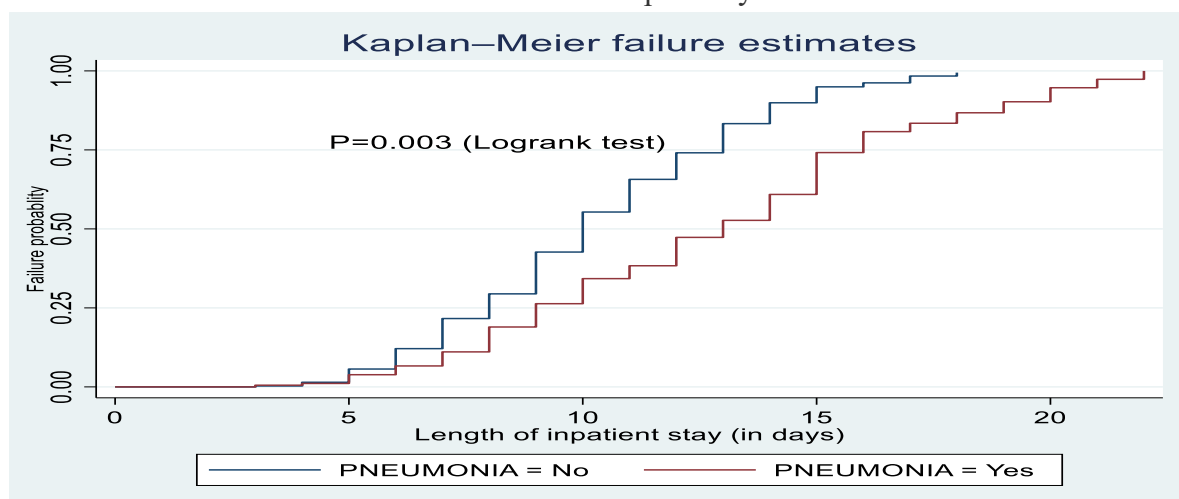


Figure 6: Log rank failure estimate for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals by pneumonia

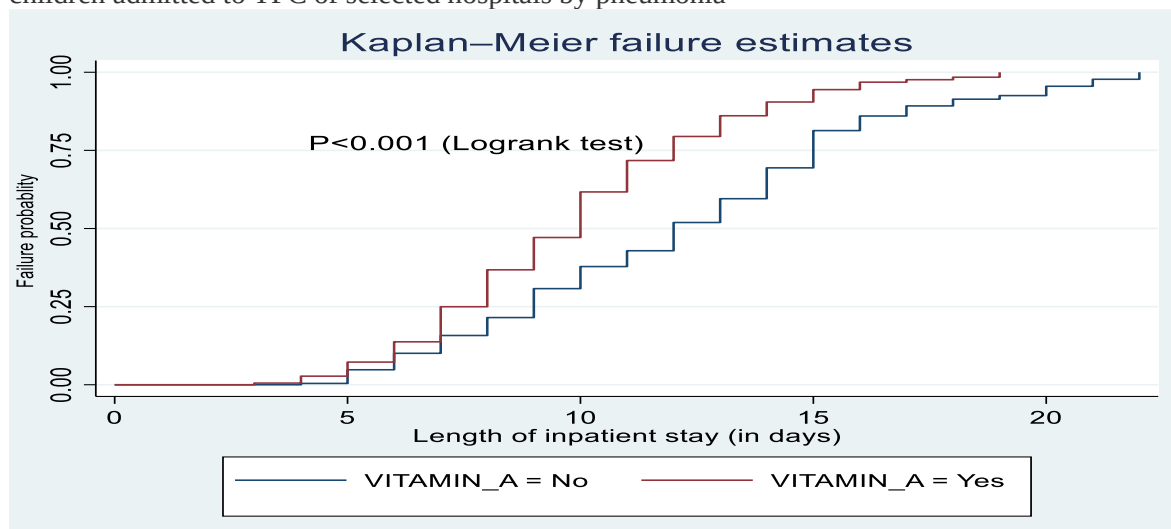


Figure 7: Log Rank failure estimate for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals by severe pneumonia.

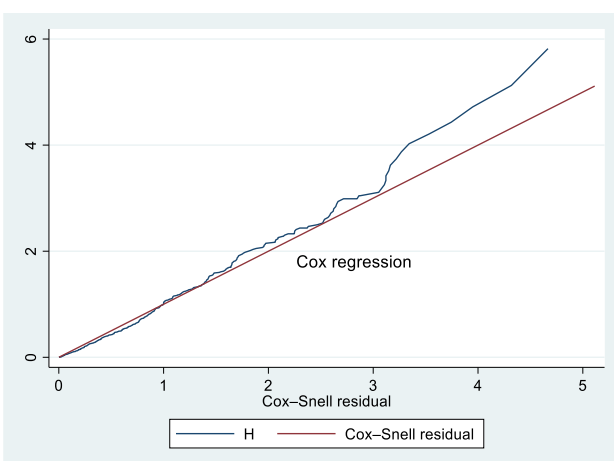
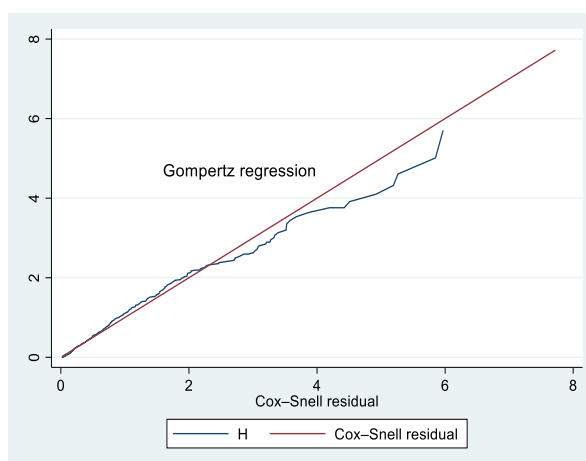
5.8. Model comparison

To identify the most parsimonious model for our data, all candidate variables were fitted into both parametric and non-parametric survival models (Weibull, exponential, Gompertz, and Cox regression) and compared them both statistically and graphically. Among these, the Weibull regression model was selected having the lowest (331.92) Akaike Information Criterion (AIC) value. (Table 6) (Figure 8). Then, the baseline hazard of stabilization time was estimated using Weibull model with shape parameter P of 3.89 ($P=3.89$, CI: 3.62-4.18), indicating over time increment of hazard rate. To account for unobserved heterogeneity within groups of individuals, frailty model which acts multiplicatively on the baseline hazard was integrated into a Weibull regression model, and revealed significant heterogeneity, as evidenced by theta (θ) parameter estimate of 17.71. This indicates presence of greater variability in baseline hazard across cluster of individuals after frailty model is fitted.

Table 6: Model comparison for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals.

Model	N	ll(null)	ll(model)	df	AIC	BIC
Weibull	529	-237.46	-144.96	21	331.92	421.61
exponential	529	-543.01	-531.27	20	1102.55	1187.97
gompertz	529	-284.85	-177.04	21	396.09	485.78
cox	529	-2447.64	-2378.93	19	4795.86	4877.01

ll (null): log likelihood of null model, ll (model): Log likelihood of fitted, AIC: Akaike information criteria, BIC: Bayesian information criteria, DF; degree of freedom



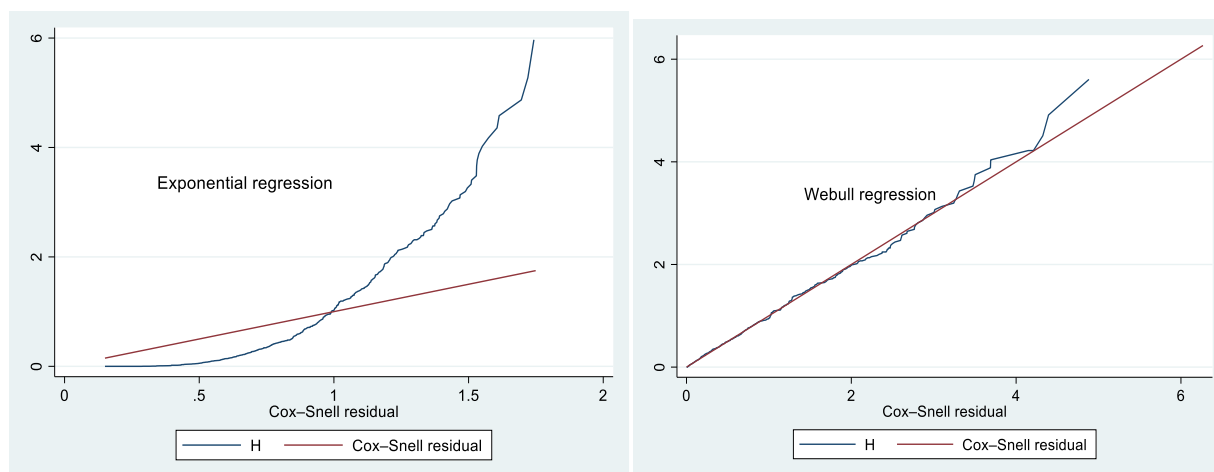


Figure 8: graphical model comparison among cox, Weibull, gompertz and exponential regression for time to stabilization and its predictors among 6 to 59 months children admitted to TFC selected hospitals.

5.9. Proportional hazard assumptions

Before fitting variables into the model, proportional hazard assumption was checked by Schoenfeld residual test, where every single's variables P-value was above 0.05, and overall global test for the variables was 0.347 indicating the fulfillment of the assumptions. (Table 6) Graphically, we tested proportional hazard assumptions for individual variables using log (-log) survival curve, and the curves were parallel which indicates fulfillment of the assumption.

5.9.1. Testing of model goodness of fitness

Using cox Snell residual test, the goodness of fit of the Weibull regression model was assessed. By using the Kaplan-Meier estimated failure function as the basis, Cox-Snell residuals were computed to check the overall model adequacy of fitted model. The 45-degree line is closely followed by the cumulative hazard vs. cox-Snell residuals curve, suggesting that the model matches the data. (Figure 10)

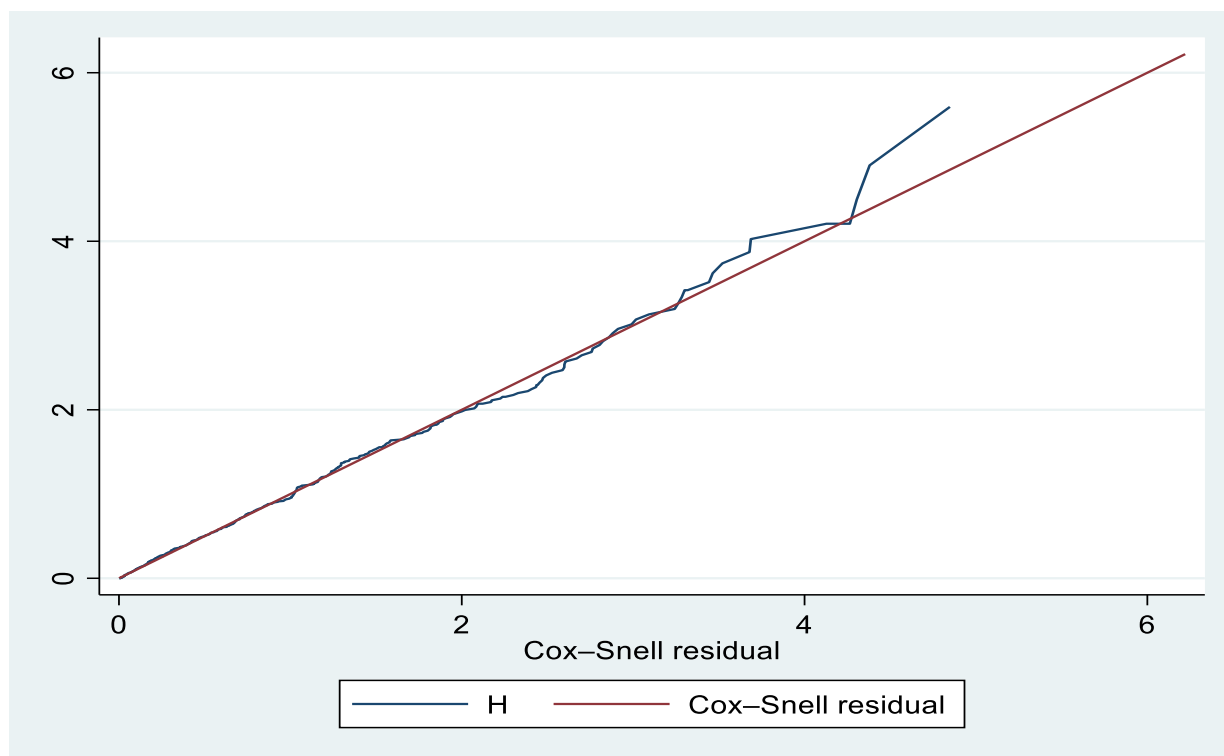


Figure 9: Final model adequacy graph based on Nelson Alan and cox Snell residual test for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals.

5.10. Predictors of stabilization among children admitted with SAM

After performing bi-variate analysis, variables like immunization status, severe pneumonia on admission, duration of diarrhea, intractable vomiting, hypoglycemia, level of dehydration, tuberculosis, hospital acquired infections, Measles, sepsis, NG tube, feeding given, shock and vitamin A supplementation were selected as a candidate for multivariable Weibull regression having p-value of less than 0.25. To control for possible confounders and identify predictors of time to stabilization, multivariable Weibull regression model was fitted and variables with p-value less than 0.05 on the final model was selected as predictors of time to stabilization.

According to the findings of a multivariable Weibull regression analysis, children without severe pneumonia on admission had 2.17 fold more chance to stabilize than those with the disease (AHR: 2.17, CI: (1.74-2.70)). Those children who were not fully vaccinated had 34% less chance of stabilization than those who were fully immunized for their age (AHR: 0.66, CI: (0.54-0.82)). When compared to their counterparts, those children who didn't get hospital acquired infections had 1.34 higher likelihood of early stabilization (AHR: 1.34 CI: (1.09-1.65)). Furtherly, lack of Vitamin A supplementation was associated with 39% delay in stabilization time than who get supplement (AHR: 0.61, CI: (0.49-0.77)).

Table 7: Bivariate and multivariable Weibull regression analysis for time to stabilization and its predictors among 6 to 59 month's children admitted to TFC of selected hospitals.

Variables	Status		CHR(95% CI)	AHR (95%CI)	P-value
	Event	Censored			
Fully immunized					
Yes	168	24	1	1	
No	289	48	0.63 (0.52-0.77)	0.66 (0.54-0.82)	0.000
Severe pneumonia					
No	297	47	2.02 (1.64-2.50)	2.17 (1.74-2.70)	0.000
Yes	160	25	1	1	0.309
Duration of diarrhea					
< 14 days	218	46	1	1	
≥ 14 days	66	9	0.82 (0.62-1.09)	0.85 (0.63-1.15)	
Intractable vomiting					
Yes	121	25	1	1	
No	336	47	0.81 (0.66-1.00)	1.01 (0.81-1.27)	0.875
Hypoglycemia					
Yes	98	38	1	1	
No	359	34	1.14 (0.91-1.43)	1.20 (0.95-1.52)	0.117
Level of dehydration					
Some	56	5	1	1	
Moderate	28	2	0.73 (0.46-1.16)	0.90 (0.56-1.44)	0.668
Severe	13	6	0.65 (0.35-1.19)	0.86 (0.46-1.65)	0.687
Anemia					
yes	206	24	1	1	
No	251	48	1.35 (1.12-1.62)	1.19 (0.98-1.44)	0.075
Tuberculosis					
Yes	98	16	1	1	
No	359	56	1.32 (1.06-1.66)	1.16 (0.91-1.47)	0.211
Measles					
Yes	91	10	1	1	
No	366	62	1.23 (0.98-1.55)	1.21 (0.95-1.54)	0.120
Shock					
Yes	18	8	1	1	
No	439	64	1.50 (0.93-2.40)	0.98 (0.58-1.63)	0.942
Sepsis					
Yes	45	18	1	1	
No	412	54	1.26 (0.93-1.72)	1.03 (0.72-1.39)	0.980
HAI					
No	298	42	1.47 (1.21-1.79)	1.34 (1.09-1.65)	0.005
Yes	159	30	1	1	

Variables	Status		CHR(95% CI)	AHR (95%CI)	P-value
	Event	Censored			
NG tube					
Yes	84	31	1	1	
No	373	41	1.17 (0.92-1.48)	1.24 (0.96-1.59)	0.092
Feeding					
F-75 & F-100	118	28	1	1	
F-75 & RUTF	339	44	1.16 (0.94-1.43)	1.06 (0.84-1.32)	0.600
Vitamin A					
Yes	159	27	1	1	
No	206	27	0.48 (0.39- 0.59)	0.61 (0.49-0.77)	0.000

CHR: crude hazard ratio, AHR: adjusted hazard ratio, 95% CI: confidence interval at 95 percent, HAI: hospital acquired infections, NG tube: Nasogastric tube, 1: Reference, * significant variables

6. DISCUSSION

This study aimed to determine the median time to stabilization among children admitted to inpatient care with severe acute malnutrition in selected hospitals of Western Oromia between 2020 and 2024. The stabilization rate of 81.6 per 1000 children days with a median stabilizing time of 11 days was reported for this study. None of the children stayed in inpatient care for more than 22 days. Overall, the result of the current study indicates that severe pneumonia, immunization status, hospital acquired infections and vitamin A supplementation were independent predictors of stabilization time. Out of 529 study participants, 86.39% were stabilized and transferred to outpatient care, while 4.16% defaulted and 3.97% died. These findings align with the SPHERE standards for management of severe acute malnutrition, which recommend a recovery rate above 75%, a death rate below 10%, and a default rate under 15% (78). Similarly, the pattern of results is consistent with the previous study conducted in Northern Ethiopia (85.8%)(34). However, compared to study conducted in Tigray, lower stabilization proportion was observed in this study, which could be due to logistic support provided by united nation (UN) and other NGOs for hospital, making improvement in SAM treatment and care (15).

In this study, the median time to stabilization was 11 days. This finding was not consistent with study conducted in tertiary hospitals of Northwest Ethiopia which reported longer stabilization time of 13 days (34). The observed difference could be attributable to the inclusion of less than 6 months children into their study, whose stabilization time might be prolonged. Because, less than six months children with prospect of breast feeding should stay in stabilization until successful re-lactation and effective breast feeding has been achieved, while those with no prospect of breast feeding are kept in stabilization center until they have Weight for age (WFH) of ≥ -2 and no bilateral pitting edema, indicating that stabilization hinges on timely establishment of re-lactation and exclusive breast feeding.

The finding of our study is prolonged when compared with the National Guidelines for SAM management in Ethiopia, which indicates children with complicated severe acute malnutrition should be stabilized and transferred to OTP in 7 to 10 days (10). Similarly, prospective cohort study conducted in Tigray reported shorter stabilization time of 8 days (15). A possible explanation for the difference might be due to involvement of high number of humanitarian organization in the study area; providing more logistic support for the hospital and patient. This shows presence of potential bottlenecks in resource availability and staff capacity. Therefore,

collaborative efforts from all stakeholders, including governmental and non-governmental organizations, are crucial for delivering this essential support in the malnutrition affected area. According to study conducted in Sidama region, the median time to stabilize was 8 days (36). This difference might be due to the fact that the study assumes recovery time after children complete the stabilization phase and enter the transitional phase.

Regarding predictors, absence of severe pneumonia upon admission was significantly associated with early stabilization, with children lacking this condition being 2.17 times more likely to stabilize. This finding is in line with similar study conducted in Northwest Ethiopia (34) and Amhara region (35). This could be due to the fact that in children with SAM, pneumonia exerts a considerable physiological stress on the body, increases metabolic demands, diverting energy from weight gain, worsening nutrient loss and impeding nutritional rehabilitation. (79). This leads to a vicious cycle in which starvation slows the resolution of infections and infection delays nutritional recovery (30). Furthermore, the compromised respiratory activity that is feature of pneumonia could directly interfere with a child's ability to feed effectively. The elevated mortality risk and delayed stabilization associated with the co-occurrence of SAM and pneumonia further emphasizes the need for integrated management strategies. Given frequent co-occurrence of the condition, it is imperative that SAM management protocols incorporate routine screening for pneumonia, and early administration of antibiotics.

Immunization status was another independent predictors of time to stabilization. This study found that children who were not fully immunized or up to date for their age had 34% less chance to stabilize early than those who were fully immunized/up to date. This was congruent with study conducted in North west Ethiopia (65). This can be explained by the fact that the impacts of SAM could be worsened by immune system dysregulation related to lack of immunization, leading to break down of both innate and acquired immune response (80). Therefore, to reduce additional burden of infection in SAM, bolstering their immunity by ensuring all children receive timely immunization is crucial.

Another finding was that hospital-acquired infections (HAIs) significantly delay stabilization, with a 1.47-fold increased likelihood of stabilization among patients without hospital-acquired infections. This finding is consistent with study conducted in central (81) and Northwest Ethiopia (34). Children with SAM are more prone to HAIs. This is as a result of immune parameters affected by malnutrition like decreased gastric acid production, secretory immunoglobulin, increased gut permeability and delayed type hypersensitivity reactions which makes them

susceptible to those infections (82). Consequently, HAIs can lead to the acquisition of additional complications, which necessitate further interventions and consequently prolong the child's stay in the hospital. These acquired infections necessitate the use of strong antibiotics and a prolonged course of therapy. It is also confirmed that the small bowel of malnourished children is often colonized with abundant bacteria, and their pattern of commensal flora is usually altered (82). Moreover, presence of infections in child's body contribute to increased metabolic demands, increase energy requirement and impede weight gain (81). Study done in Bangladesh also reported that children admitted with SAM had 2.5 time more chance of getting HAIs (83). In our study, prevalence of HAIs was 35.73%, indicating a significant burden on patient health and healthcare resources. Therefore, adherence to strict hygiene practices, with a special emphasis on thorough and frequent handwashing is crucial in preventing the transmission of infections and minimizing the occurrence of cross-contamination once it has occurred.

Another independent predictor of time to stabilization was vitamin A supplementation; where those who didn't received supplementation had 39% less chance of timely stabilization than their counterparts. This finding is consistent with similar study done in Northwest Ethiopia (50). This can be explained by the fact that vitamin A helps to support immune function; enhance recovery by reducing the severity and duration of common infection in malnutrition like measles, severe diarrhea and respiratory infections especially in those with edematous malnutrition (84). Vitamin A deficiency impair both epithelial integrity and the function of the systemic immune system. For instance, vitamin A is used to mitigate diarrhea in children with SAM through the repair of the gut epithelium or immune pathways that restore balance between T-cell subsets (84). Furthermore, daily low dose of vitamin A throughout duration of treatment for children with SAM highly correlated with lower incidence and shorter duration of respiratory disease (85). By encouraging the production and maintenance of healthy bones, teeth, tissues, and other structural proteins, vitamin A supports growth and development and helps malnourished children to have adequate weight gain and discharged early. Even after recovery from SAM, children with vitamin A deficiency had 43% higher odd of being stunted later in life (86). For these reasons, strict adherence to guideline in providing daily dose of vitamin A for all children with SAM and high dose in children who exhibit vitamin A deficiency, measles, or severe diarrhea is encouraged.

Moreover, a significant variation in the median time to stabilization was observed among the three hospitals (LR test of theta = 17.71, $P < 0.001$). While children admitted to Jimma University Medical Center (JUMC) had a median stabilization time of 10 days (IQR: 8-13), those admitted

to MKCSH exhibited a longer median stabilization time of 12 days (IQR: 9-15). The observed difference might be related to resource availability, specialization, and the academic environment. The availability of advanced medical expertise in JUMC and WUCSH facilitates accurate diagnosis of additional life threatening comorbidities than MKCSH. The nature of these institutions as teaching hospitals, characterized by the presence of medical interns and residents, is likely to facilitate enhanced patient care. WHO stated that having advanced medical technology like MRI and CT scan, highly capable laboratory facilities, and the latest surgical equipment can greatly improve how accurately doctors diagnose illnesses and how effectively they treat them (2). Consequently, the implementation of interdisciplinary bedside rounds, which integrate various levels of medical expertise and incorporate case discussions for educational purposes, becomes paramount. Such practices can improve patient outcomes by fostering stronger patient-provider relationships through enhanced communication and empathy, ultimately leading to better adherence to treatment plans. Moreover, the level of a hospital directly reflects its resource availability, determining its capability to deliver specialized care, employ cutting-edge technology, and provide extensive patient support.

6.2. Implications to clinical practice

The predictors of stabilization time which have been reported in this study offers significant insights into current clinical practices. We can understand that children in developing countries are still facing burden of under vaccination and suboptimal family immunization practices. This could be due to combination of factors including inadequate knowledge within family on importance of immunization or low supply chain of vaccines to the areas. Although the national management protocol recommends vitamin A supplementation on day 1 of admission for all children in stabilization centers, the actual number of children receiving supplementation remains low. This suggests either poor adherence to the guideline or an insufficient supply of vitamin A to the hospitals. Furthermore, high rate of hospital-acquired infections in these areas suggests inadequate infection control practices and sterility of the procedures. The demonstrated improvements in patient outcomes associated with interdisciplinary bedside rounds, involving all relevant disciplines, indicate that the lack of this coordinated approach in certain non-teaching hospital settings.

6.1. Strength and Limitations of the study

6.1.1. Strengths

Data were collected from multi center making generalizability of findings more realistic than single setting.

6.1.2. Limitations

Despite the valuable insights provided, certain limitations must be acknowledged. The main limitation of this study was the study used secondary data (patient charts), which restricts the investigator to come up with some important variables like maternal demographic characteristic, socioeconomic status of the family, including income, living and sanitary conditions. A further limitation is the lack of sufficient comparable studies, which hinders a thorough comparative analysis of our results.

7. CONCLUSION AND RECOMMENDATION

7.1. CONCLUSION

This study aimed to determine stabilization time of life threatening medical complications among children admitted with complicated severe acute malnutrition. The current study found that the median time it took children to stabilize from complicated severe acute malnutrition was 11 days, which is longer than standard set by Ethiopian national management of severe acute malnutrition protocol. This study concluded that lack of vaccination, having severe pneumonia on admission, Acquiring hospital acquired infections during treatment, and lack vitamin A supplementation were independent predictors of prolonged stabilization time.

7.2. RECOMMENDATIONS

Based on our findings, we recommend a collaborative effort involving all stakeholders to improve the care of children with severe acute malnutrition for:

Health care providers: They are expected to campaign awareness regarding importance of immunization among families and communities. Next, it is recommended that health professionals should be aware of and implement strategies to reduce occurrence of hospital acquired infections among children admitted with severe acute malnutrition. Furthermore, health professionals should give special attention to those children who have additional comorbid illness and medical complications which may impede treatment response and delay stabilization. Lastly, it is advisable health professionals to consistently provide vitamin A supplementation for children who admitted with severe acute malnutrition on the admission to mitigate the severity and duration of infections associated with malnutrition and aiding tissue repair.

Hospital managers: Should actively supervise their workers to ensure adherence to protocols designed to prevent occurrence of hospital acquired infections, thereby minimizing prolonged stabilization related to it. To further reduce the spread of HAIs, it is crucial to make sure that therapeutic feeding facilities have enough staff members, resources to maintain a clean and safe environment, and protocol for properly isolating children who are already infected.

Policy makers: are expected to collaborate with various stakeholders to identify possible obstacles and address the underlying causes of low immunization coverage and vitamin A supplementation. Furthermore, ensuring that referral hospitals are adequately supplied with essential materials and human resources would enhance patient outcomes.

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APPENDIXES

Annex I: Information sheet

This data collection tool is designed to assess ‘time to stabilization and its predictors among 6 to 59 months children admitted to TFC of WUCSH, MKCSH and JUMC with SAM’

Data Collector agreement

“I certify that I have filled the data abstraction tool in accordance with the training that is given to me and instructions stated in it. I have confirmed that the information ‘filled is correct.”

Signature_____Date_____

Name of hospital_____

Medical Record number (code) _____

Checked by supervisor for completeness:

Supervisors Name_____ signature_____

Annex II: Questionnaires

A. Baseline data at admission

Part I: Socio demographic characteristics

MRN: _____		
Code	Question	Response
101	Age (in months)	_____
102	Sex	1. Male 2. Female
103	Residence	1. Rural 2. Urban

Part II: Clinical conditions at admission

Code	Question	Response	Skip
201	Admission type	1. New 2. Readmission after default 3. Re-admission after relapse	
202	Admission weight	_____ kg	
203	Currently breast feeding?	1. Yes 2. No	
204	Appetite test done?	1. Yes 2. No	If no, skip to Q 206
205	If yes to question no 204, what is the result of the test?	1. Passed 2. Failed	
206	Severe pneumonia?	1. Yes 2. No	
207	Persistent diarrhea?	1. Yes 2. No	
208	Intractable vomiting?	1. Yes 2. No	
209	Fever >38.5°C?	1. Yes 2. No	
210	Malaria?	1. Positive 2. Negative	
211	Hypothermia (axillary T° < 35.0°C)?	1. Yes 2. No	
212	RBS less than 54mg/dl?	1. Yes 2. No	
213	Lethargy/unconsciousness?	1. Yes 2. No	
214	Palmar pallor/anemia?	1. Yes 2. No	
215	Convulsion?	1. Yes 2. No	
216	Dehydration?	1. Yes 2. No	If no, skip to Q 219

217	If yes to Q 218, level of dehydration?	1. Some Severe 2. Moderate 3.	
218	Diagnosis?	1. Marasmus 2. Kwashiorkor 3. Marasmic-kwash	
219	Fully immunized?	1. Yes 2. No	
220	HIV/AIDS?	1. Yes 2. No	
221	Tuberculosis	1. Yes 2. No	
222	Measles	1. Yes 2. No	
223	Shock	1. Yes 2. No	
224	Sepsis	1. Yes 2. No	
225	HAI	1. Yes 2. No	If no skip Q 228
226	If yes to Q 225, specify		
227	Other comorbidities	_____	

Admission Anthropometric measurement of the patients

228	MUAC:	_____	
229	Edema:	1. Yes 2. No	If no, skip to Q 231
230	If yes, grade of edema:	1. Grade I 2. Grade II 3. Grade III	
231	Weight for age (WFA)	_____	
232	Weight for height (WFH)	_____	
233	Height/Length for age	_____	

B. Non-baseline Data

Part III: Treatment, routine medications and feeding

Code	Question	Possible responses
301	Patient transfused?	1. Yes 2. No
302	Patient infused?	1. Yes 2. No
303	NG Tube feeding?	1. Yes 2. No
304	Feeding type/s given	1. F-75 2. F-100 3. F-75 and F-100 4. RUTF
305	Appropriate CF?	1. Yes 2. No
306	Vitamin A?	1. Yes 2. No

307	Amoxicillin?	1. Yes 2. No
308	Ampicillin and gentamycin	1. Yes 2. No

Part IV: Discharge conditions

Code	Question	Response
501	Admission date	____ / ____ / ____
502	Discharge date	____ / ____ / ____
503	LoS in days	_____
504	Outcome	1. Stabilized and transferred to OTP 2. Cured 3. Defaulted 4. Referred 5. Dead: cause of death _____

Annex 3: Supportive files

There were no variable that violated proportional hazard assumption, and the overall global test of the model was 0.347, which shows fulfilment of PHA (Table 1).

Table 1: Test for proportional hazard assumption for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of WUCSH, MKCSH and JUMC from January 2020 to December 2024, West Oromia

Variables	Rho	chi2	df	P-value
Fully Immunized	-0.05214	1.29	1	0.2568
Pneumonia	0.03343	0.54	1	0.4616
Duration	-0.01684	0.14	1	0.7125
Vomiting	-0.08440	3.16	1	0.0755
RBS	-0.05589	1.49	1	0.2225
Anemia	-0.03704	0.63	1	0.4264
Level of DHN	0.01401	0.10	1	0.7566
Tuberculosis	0.02063	0.20	1	0.6551
Measles	-0.03950	0.74	1	0.3887
Shock	0.04086	0.73	1	0.3931
Sepsis	-0.01714	0.15	1	0.7026
HAI	0.01822	0.16	1	0.6927
Ng-tube	0.06561	2.15	1	0.1429
Feeding	0.06382	2.02	1	0.1554
Vitamin A	-0.01537	0.12	1	0.7342
Global Test	20.82	19		0.3470

Rho: correlation coefficient, Chi2: chi-squared statistic, DF: degree of freedom, DHN: dehydration, HAI: hospital acquired infections, NG tube: Nasogastric tube

Proportional hazard assumption (graphical)

To check PHA assumption, log(-log) plot was checked for every variable. Then, parallalism of the curve on the graph were used to declare fulfilment of PHA as shown in figures below.

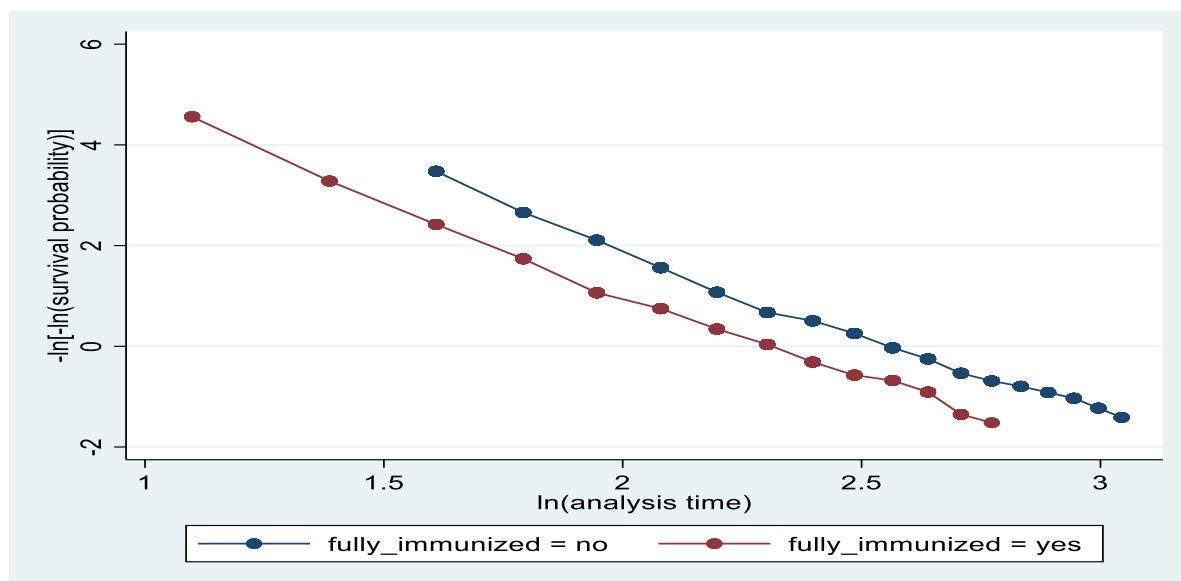


Figure 1: log(-log) plot by immunization status for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of WUCSH, MKCSH and JUMC from January 2020 to December 2024, west Ethiopia

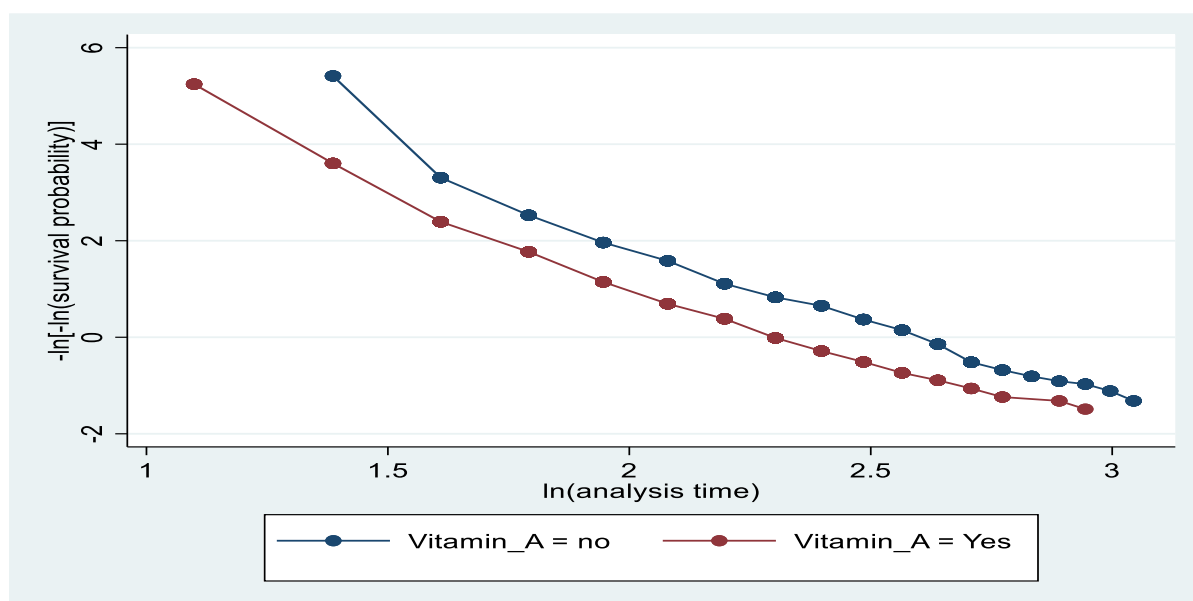


Figure 2: Log-log survival curve by vitamin A supplementation for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of WUCSH, MKCSH and JUMC from January 2020 to December 2024, west Ethiopia

Multi collinearity

No multi collinearity were detected among independent variables in this study, as shown by mean variance inflation factor (VIF) of 1.50 and tolerance of 0.70 (Table 2).

Table 2: multi collinearity among predictor's variables for time to stabilization and its predictors among 6 to 59 months children admitted to TFC of selected hospital between 2020 and 2024

Variable	VIF	1/VIF
EDEMA	3.48	0.28
DIAGNOSIS	3.17	0.31
AGE	2.88	0.34
WEIGHT	2.38	0.41
EBF	1.97	0.50
DHN	1.87	0.53
WFH	1.68	0.59
SHOCK	1.64	0.61
WFA	1.51	0.66
INFUSED	1.40	0.71
DIARRHEA	1.39	0.71
MUACcat	1.39	0.71
VITAMIN_A	1.37	0.72
APPROPRIATE CF	1.34	0.74
BLOOD_TRANSFUSION	1.34	0.74
SEPSIS	1.33	0.75
HFA	1.32	0.75
VOMITING	1.32	0.75
HIV_AIDS	1.32	0.75
FULLY_IMMUNIZED	1.28	0.77
NG_TUBE	1.25	0.80
MENTAL_STATUS	1.24	0.80
ANEMIA	1.24	0.80
MEASLES	1.23	0.81
TUBERCULOSIS	1.21	0.82
FEVER	1.20	0.83
AMOXACILLIN	1.19	0.84
CONVULSION	1.18	0.84
RBS	1.17	0.85
ADMISSION TYPE	1.17	0.85
HAI	1.17	0.85
AMP_GENTAMYCIN	1.17	0.85
APPETITE_TEST	1.16	0.85
RESIDENCE	1.16	0.86
FEEDING	1.10	0.90
SEX	1.10	0.91
PNEUMONIA	1.08	0.92
Mean	1.50	0.7