

Prevalence and Predictors of Undernutrition Among Hospitalized Children in Orotta National Referral and Teaching Hospital in Asmara, Eritrea: A Cross-Sectional Study

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Background: Undernutrition remains a significant global public health concern, contributing to physical and cognitive impairment, as well as high morbidity and mortality rates, particularly in children under five years of age. The aim of the study was to determine the prevalence of undernutrition and its predictors among children under five admitted to Orotta National Referral and Teaching Hospital (ONRTH).

Methods: A cross-sectional study was conducted between February 1 and April 30, 2022, among pediatric patients at the ONRTH. A data collection tool adopted from WHO Child Growth Standards was used to capture the necessary data. Descriptive analysis and multivariable logistic regression were employed using SPSS (Version 26) and R (Version 4.2).

Results: A total of 218 children under the age of five were enrolled, with a median age of 12.0 months (Interquartile Range [IQR]=24.0). The overall prevalence of undernutrition was found to be 59.2% (95% CI: 52.6, 65.5), with severe acute undernutrition accounting for 39.9% and moderate acute undernutrition for 19.3%. Multivariable analysis revealed that children residing outside Asmara had significantly higher odds of undernutrition (Adjusted Odds Ratio [AOR]=2.81, 95% CI: 1.17, 6.73) compared to those within the city. Similarly, patients who received inadequate food servings per day were found to have substantially higher odds of undernutrition (AOR=12.55, 95% CI: 4.43, 35.52). In contrast, children admitted with infections had significantly lower odds of undernutrition compared to those with cardiac complications (AOR=0.14, 95% CI: 0.03, 0.78).

Conclusion: The prevalence of undernutrition among the hospitalized children in this study was found to be exceptionally high. This highlights undernutrition as a critical public health crisis requiring urgent intervention in this low-resource setting.

Keywords: prevalence, undernutrition, predictor, anthropometric indices, eritrea, hospitalized children

Introduction

Malnutrition, characterized as an imbalance or inadequate intake of essential energy and nutrients, represents a major worldwide public health issue and it constitutes a central objective of Sustainable Development Goal 2.¹ This condition has multiple forms, primarily undernutrition, which is characterized by stunting, wasting, underweight, and various micronutrient deficiencies.

Based on its etiology, undernutrition can be categorized as illness-related (secondary to disease or injury), non-illness-related (due to environmental or behavioral factors), or a combination of both.² The public health consequences of undernutrition, which include stunting, wasting, being underweight, marasmus, and kwashiorkor, are a direct result of deficiencies in macronutrients and micronutrients.³ In hospitalized children, undernutrition is a critical condition and a risk factor for a number of unfavorable outcomes, such as prolonged hospital stays, delayed recovery, and higher

healthcare costs.⁴ The primary causes of undernutrition in a hospital setting are a reduction in dietary intake and an increase in the body's energy requirements.⁵

In an effort to address the worldwide issue of undernutrition in children under five, the World Health Organization's member states recently agreed to nine global targets to be met by 2025. These goals include reducing childhood stunting by 40%, keeping childhood wasting below 5%, preventing an increase in the number of overweight children, and eliminating all forms of undernutrition by 2030. Although a notable global decrease in childhood stunting has occurred, millions of children still suffer from stunting, wasting, and overweight.^{3,6} The 2030 Agenda for Sustainable Development and the UN Decade of Action on Nutrition (2016–2025) urge all nations and stakeholders to collaborate to end hunger and prevent all forms of undernutrition by 2030.⁷

Undernutrition represents a persistent and significant global health problem, posing a substantial burden of disease, particularly in low- and middle-income countries. The condition is a leading contributor to morbidity and mortality, serving as an underlying cause of approximately 45% of all child deaths worldwide.⁸ While some progress has been made in reducing overall prevalence, undernutrition continues to be a major health burden.⁹

Recent data indicate that Africa has the highest global prevalence of undernourishment, affecting a substantial portion of its population.¹⁰ Within the continent, the distribution of undernutrition varies, with the highest rates of stunting and wasting concentrated in Central and Eastern Africa.¹¹ Furthermore, this prevalence is linked to socioeconomic factors, as a child's nutritional status is strongly correlated with variables such as household wealth and maternal education.¹²

The most relevant conceptual framework for the potential determinants of undernutrition among hospitalized patients that fits with the setting and context of Eritrea is that of Mehta et al.² The first category of determinants includes child-related factors such as child's age,^{13,14} sex of the child,¹³ low birth weight,^{13,15} birth size,¹³ diarrheal episode,^{13,15,16} lack of vaccination,¹⁴ diet,¹⁴ non-exclusive breastfeeding,¹⁷ having the chronic disease,¹⁶ early introduction of food and early weaning.¹⁸ The maternal/paternal related determinants of undernutrition include a low mother's educational level,^{14–17,19–24} low mother's BMI,¹⁵ and low father's education.^{16,25} Household-related determinants of child undernutrition were mainly residence¹³ family income,^{13,15,16,18,25} and source of drinking water.^{13,16}

In Eritrea, undernutrition is a highly understudied area, with no records since 2010. The results of two demographic health surveys conducted in 2002 and 2010 showed substantial rates of stunting, wasting, and underweight.^{26,27} There has been no study conducted among hospitalized children in Eritrea. Therefore, the objective of this study was to assess the prevalence of undernutrition and its associated factors among hospitalized children in a pediatric tertiary center in Orotta National referral hospital, Asmara, Eritrea. Determining prevalence and identifying predictors will help plan proper interventions to address child undernutrition.

Methods

Study Design and Setting

An observational cross-sectional study with quantitative approach was conducted between February 2022 and April 2022 in Orotta National Referral and Teaching Hospital (ONRTH), a tertiary hospital located in Asmara (the capital city of Eritrea). Eritrea, a small nation located in the Horn of Africa, is divided into six administrative zones namely: Maekel, Anseba, Gash Barka, Debub, Debubawi Keih Bahri, and Seminawi Keih Bahri.

The hospital has various departments including pediatrics, adult medical, surgical, gynecology and obstetrics, ENT, and maxillofacial. The study was specifically conducted in the department of pediatrics. This department operates as the national referral center for pediatric patients across the country, making it the most suitable site for capturing the target study population of children aged 3 months up to 5 years.

The pediatric department includes an emergency ward, out-patient department (OPD), intensive care unit (ICU), and five other wards for patients of different age groups accept patients according to their age. The three wards accept patients for medical treatments from 1 month to 12 months, 1 year up to 3 years and above 3 years up to 5 years at the respected wards, and all these three wards have bed occupancy capacity of around 110. In these three wards, there is management of undernutrition in addition to the other medical care. The other wards are one for neonates less than 1 month, and the other is for pediatrics surgical cases accepts children less than 5 years. The emergency is a transition for

critical management, for short-time resuscitation and some procedures of cases. There is also an intensive care unit (ICU) after stabilization transfers patients to their respective wards. There are six senior pediatricians who are guiding the teaching process on top of their daily hospital activities. So according to our plan of study, patients including 3 months up to 5 years with the exception of ICU, Neonatal, Emergency and pediatric surgical ward, were included if there were no other exclusion criteria. The MOH, with support from UNICEF, offers therapeutic feeding to malnourished children using products like Unimix, Ready-to-use therapeutic food (RUTF), Therapeutic diet food (F-75 and F-100), and ReSoMal, which is provided in Orotta pediatric department for inpatient and at discharging time.

Target Population

The study focused on patients admitted to the pediatric ward who were between the age of 3 months and 5 years and had been hospitalized for at least 24 hours. Exclusion criteria included children admitted for non-accidental injury assessment, those with unstable medical conditions affecting growth parameters, and children with known syndromic diagnoses where normal growth charts were not applicable.

Data Collection Procedure

Each morning during the study period, a list of all admissions from the preceding 24 hours in each child's medical ward was reviewed. After applying the exclusion criteria, a list of eligible patients for enrollment was created. The parents/guardians of all patients were approached, and informed consent was obtained prior to conducting the interviews. Basic demographic and socioeconomic data, as well as medical factors, were collected. The questionnaire was completed with information gathered from the child's caregiver through an interview, following the acquisition of informed consent in every pediatric ward of Orotta Pediatric Hospital. Finally, anthropometric measurements, including weight, height, and mid-upper arm circumference (MUAC) for children under five years of age, were taken for each selected case.

Data Collection Tool and Approach

A structured pre-designed tool was used to collect data. The tool was developed through a review of similar published studies,^{28,29} ensuring that core variables are necessary for identifying undernutrition. Besides, the Eritrean pediatric admission clinical card was also incorporated into the tool for the study.

The data collection tool consisted of two parts: one section with 17 questions regarding patients' demographic information and another with 12 questions on clinical parameters. After the questionnaire was developed, it was pre-tested on 10 patients to evaluate its comprehensiveness and feasibility, as well as the data collectors' (two physicians) ability to gather reliable data for analysis. Furthermore, the data collectors received thorough training to conduct interviews and collect anthropometric measurements. Throughout the data collection process, all ethical and professional guidelines for interviewing were strictly followed.

Variable Measurement

Demographic Variables

Patient age (months), sex (male, female), address (Asmara, outside Asmara), ethnicity (Tigrigna, Tigre, Saho, Bilen, Afar, Kunama, Nara, Rashaida, Hidarb), father's educational level (no education, primary, middle, secondary or above), mother's educational level (no education, primary, middle, secondary or above), father's age (years), mother's age (years), mother's marital status (single, married, divorced, widowed, died), mother's work (employed, housewife), household income (Nakfa-local currency), family size (number), water source (tap water, spring, tanker, well), number of living rooms (number), any death in siblings (yes, no) were taken from the care giver through interview.

Anthropometric Parameters

Body weight (for children under 5 kg or less than 2 years age, body weight was measured using a calibrated weighting scale (*Seca gmbn and co. kg, Hamburg, designed in Germany, Made in China*) with a precision of 10g on lying position. For children at or over 15 kg or greater than 2 years old on standing position by the standing weighing scale (*Seca gmbn and co. kg, Hamburg, designed in Germany, Made in China*). Body height: Body height measurement among the children

was performed by measure board (*shorrBoard*[®], U.S.A) with a precision of one millimeter on lying or standing positions. Mid-upper arm circumference: Measurement tapes provided by UNICEF were used to measure the left mid-upper arm circumference (MUAC) in cm with a precision of one millimeter.

Other Clinical Parameters

Pedal edema (yes, no), Initiation of breast feeding immediately after birth (yes, no), exclusive breast feeding for the first 6 months (Yes, No), frequency of breast feeding (≥ 8 or < 8), duration of breast feeding (months), birth weight (kg), gestational age at birth (weeks), weaning time (months), food servings per day (adequate, inadequate), supervision (active, passive), duration of hospitalization (days), admission diagnosis (name of admission illness), discharge weight (kg), outcome (improved, same, died); were taken from the care provider and chart or card of the patient.

Frequency of feeding was measured in a binary manner as adequate and inadequate. A child within the age range of 6 to 12 months, 13 to 24 months, and 25 to 60 months is considered as adequately fed if the frequency of feeding is at least 3 times a day and was on breastfeeding, 5 times, 5 times, and 3 times, respectively. Otherwise, the child was considered as having inadequate breast-feeding according WHO Guideline on feeding based on age of the child.³⁰

Core Variable Definition and Computation

Stunting

Stunting or chronic wasting was assessed using height-for-age z-scores (HFAz). Children having HFAz between $-2SD$ to $-3SD$ were considered as stunted while HAZ less than $-3SD$ was severely stunted, which gives us information on chronic undernutrition.

Acute Wasting/Acute Undernutrition

This index was assessed using weight-for-height z-scores (WFHz) for children between 65 and 120 cm as per the WHO criteria. Children with WFHz between $-2SD$ to $-3SD$ were considered as wasted while WFHz less than $-3SD$ were severely wasted.

Underweight

Weight-for-age z-scores (WFAz) was used to assess the underweight (between $-2SD$ and $-3SD$) and severely underweight (less than $-3SD$). As underweight is influenced by weight, age and implicitly by height of the child, it incorporates both chronic and acute undernutrition.

Thinness

BMI-for-age z-scores (BMIFAz) was used to assess the thinness of the admitted children. They were categorized as obese ($BMIFAz > 2SD$), overweight ($BMIFAz$ between $1SD$ and $2SD$), thin ($BMIFAz$ between $-2SD$ and $-3SD$), and severely thin ($BMIFAz < -3SD$).

WHO Criteria

Weight-for-height z-scores, MUAC and presence of edema were simultaneously assessed to classify the admitted children as severe acute undernutrition ($WFHz < -3$ or $MUAC < 11.5$ or bilateral pitting edema present) and moderate acute undernutrition ($-2 \leq -3$ or $11.5 \leq MUAC < 12.5$).

Data Analysis

Data collectors were instructed to submit each completed questionnaire to the researcher on the same day to ensure its completeness and make any necessary corrections. Moreover, upon patient discharge, they were required to record the discharge date, outcome, and discharge weight. Data analysis was conducted using R (Version 4.2) and SPSS (Version 26), starting with descriptive statistics followed by the appropriate inferential analyses.

Z-scores of the anthropometric indices (weight-for-height, height-for-age, weight-for-age, BMI-for-age) were computed in R using the Z-scorer package and add WGSR() function. These Z-scores are calculated using the WHO Child Growth Standards for children aged between zero and 60 months^{31,32} or the WHO Growth References for school-aged children and adolescents.³³

Categorical variables were mainly summarized using number and percentage whereas the numerical variables were described using M (SD) or Md (IQR), as appropriate after assessing normality. Prevalence of undernutrition was computed along with the 95% confidence intervals. To find out the predictors of undernutrition, bivariate logistic regression was used at first and then followed by multivariable logistic regression model for the retained variables. Crude odds ratio (COR) and adjusted odds ratio (AOR) were computed to determine the magnitude of association of the predictors and undernutrition. Multicollinearity among the predictor variables in the multivariable model was assessed by calculating the Variance Inflation Factor (VIF). A VIF value greater than 5 was used as the criterion to identify and exclude highly correlated variables. The overall goodness-of-fit of the final multivariable logistic regression model was assessed using the Hosmer–Lemeshow test. A non-significant p -value ($p>0.05$) indicates that the model fit is adequate.

Results

General Background Characteristics of the Children

A total of 218 children under 5 years, having a median age of 12.0 (IQR=24.0) months were admitted to the hospital [Table 1]. Almost six out of ten of the admitted children (60.1%) were males and 43.6% were residing in Asmara. Majority (83.5%) of them were from Tigrigna ethnic group.

Parental and Household Related Background Characteristics

The median age of the fathers was 40 (IQR=10) years and more than three out of four of the fathers were in the age range 31 to 50 years. The median age of the mothers was 30 (IQR=8) years, in which almost six out of ten were in the age range of 26 to 35 years. The percentage of the patients' fathers who attained secondary or above level of education was almost sixty percent (61.9%) while that of mothers was 47.5%. The mothers of the patients were pre-dominantly married (95.4%) and unemployed/housewives (85.6%). More than ninety percent of the patients had no any sibling death [Supplementary Table 1].

The average/median income of the households was 650 (IQR=900) Nakfa per month (1USDollar=15 Nakfa), in which more than sixty percent had an income less than or equal 1000 Nakfa. Almost fifty percent of the admitted patients live in one room and the main source of drinking water was tap water (74.8%). More than three out of four (76.0) had a family size in the range 4 to 8. Almost two out of five of the patients were using their privately owned latrine while one out of three were using shared latrine [Supplementary Table 1].

Table 1 General Background Characteristics of the Admitted Children

Variable	Frequency	Percentage
Age of patient (Md, IQR: 12.0, 24.0 months)		
3 to 24	168	77.1
25 to 60	50	22.9
Sex		
Male	131	60.1
Female	87	39.9
Address		
Asmara	95	43.6
Outside Asmara	123	56.4
Ethnicity		
Tigrigna	182	83.5
Tigre	28	12.8
Others*	8	3.8

Notes: Md (IQR): Median (Interquartile Range); Others* include Saho, Bilen, Kunama, Rashaidda, and Afar

Anthropometric Measures During Admission, at Birth and After Admission

Measurements of weight, height, and MUAC of the admitted children were available during admission [Supplementary Table 2].

Majority (74.3%) of the admitted patients had a weight of more than 2.5 kg at birth while almost ten percent (11.5%) had weight that ranged from 1.5 to 2.5 kg. Almost all (97.7%) were found to have a gestational age of more than 37 weeks but only 2.7% were with 32 to 37 weeks of gestation at birth.

Almost 97% of the admitted children had initiated their breast milk immediately after birth except few, due to common reasons such as butter prelactal, cleft palate, and poor breast milk. Moreover, 84.9% took exclusive breast feeding for the first 6 months. The main articulated reasons for not taking exclusive breast feeding were low breast milk, sickness of mother, and mother employed. Almost ninety percent (89.4%) had eight or more frequency of breast feeding. Almost half (49.1%) of the children were breast fed for 13 to 24 months, and 2.8% were fed for 25 or more months. More than ninety percent (92.2%) of the admitted children had started weaning, out of which almost eighty percent (77.1%) had started at the age of 6 months. More than sixty percent of the care givers responded that the serving was adequate (61.7%) and ninety percent responded that there was active supervision (90.0%) while feeding. Eight out of ten (81.1%) of the care providers also reported that there was no sharing while feeding the children.

The five most commonly used types of weaning foods, for the 201 weaned children, were *sibko* (39.3%), DMK (15.4%), *tihni* (14.4%), milk (10.2%), and *Gigoz1* (7.4%) [Figure 1].

History of Admission and Current Admission Related Parameters

The current admission diagnoses in descending order of occurrence were respiratory (24.3%), gastrointestinal/liver (19.2%), neurologic (13.2%), cardiac and other infections (each 11.3%), others like diabetes, arthritis, neuroblastoma (8.9%), renal disease (6.6%) and hematology (5.3%) [Table 2]. Less than half (44%) of the admitted children were found to have history of past admission. The previous admission diagnosis in descending order of occurrence was respiratory (31.6%), gastrointestinal (15%), cardiac (12.8%), neurologic (12.8%), other infections (10.5%), others like diabetes, arthritis, neuroblastoma (7.5%), hematology (6%) and renal disease (3.8%). The median days of hospitalization is 8 (IQR=8.5), in which six out of

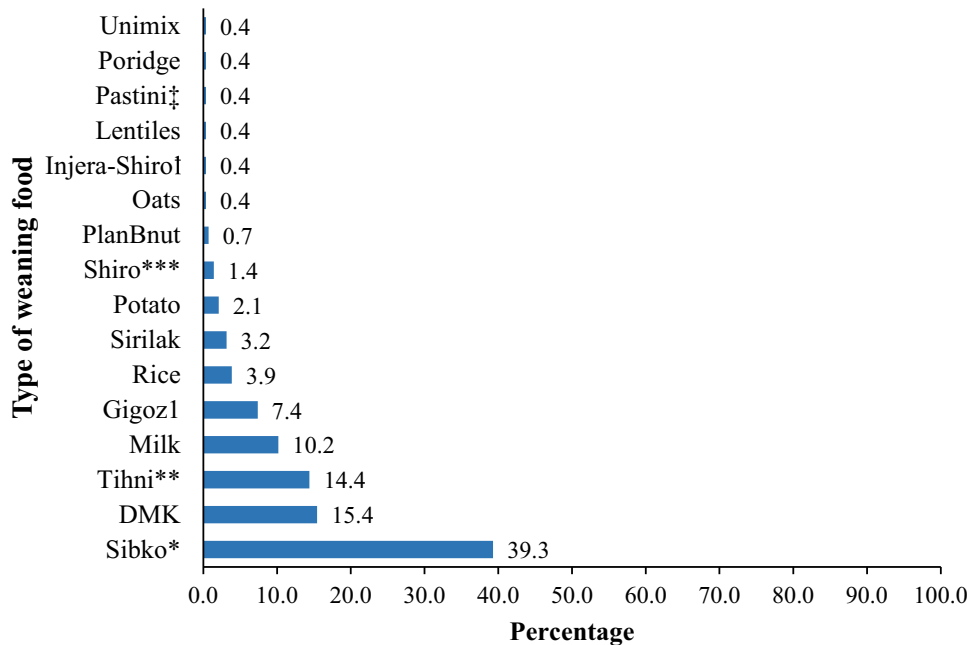


Figure 1 Type of weaning foods used for admitted patients under 5 years. Sibko*: Boiled roasted flour of cereals; Tihni**: Flour made of roasted barley; Shiro***: Flour made by mixing pea, beans, red pepper, garlic, and other spices; Injera-Shiro 1: A pancake-like bread traditionally made from fermented teff flour or sorghum, a traditional food of Eritrea mixed with the shiro; Pastini‡: Shaped and dried dough made for kids from flour and water and sometimes egg. DMK: A traditional weaning food containing protein, vitamins and other nutrients that help children get balanced diet.

Table 2 Percentage Distribution of Admitted Children's History of Admission and Current Admission-Related Characteristics

Variable	Frequency	Percentage
Admission diagnosis		
Cardiac	26	11.9
Respiratory	64	29.4
Gastrointestinal/liver	53	24.3
Neurology/Central nervous system	25	11.5
Renal disease	10	4.6
Hematology	6	2.8
Other infections [†]	20	9.2
Others*	14	6.4
Ever admitted previously		
Yes	97	44.5
No	121	55.5
Previous admission diagnosis		
Cardiac	14	14.4
Respiratory	36	37.1
Gastrointestinal/liver	15	6.9
Neurology/Central nervous system	9	4.1
Renal disease	2	0.9
Hematology	4	1.8
Other infections [‡]	13	6
Others*	4	1.8
Duration of hospitalization (Md, IQR: 8.0, 8.0 days)		
6 or less	86	39.6
7 to 30	127	58.3
More than 30	4	1.8
Outcome		
Improved	210	96.3
Same	6	2.8
Died	2	0.9

Notes: Others* mainly include diabetes, followed by arthritis, neuroblastoma, allergy, rickets, etc... Other infections[†]: UTI, brucellosis, cellulitis, sepsis, impetigo, lymphadenitis, osteomyelitis, typhoid fever etc. Other infections[‡]: cellulitis, brucellosis, neonatal sepsis, and UTI.

ten (61.5%) were admitted from 7 to 30 days. Nine out of ten (90.1%) of the children did not have pedal edema during the admission. Out of the admitted children, 96% had improved, 2% did not improve and 2% died.

Prevalence of Under-Nutrition

Table 3 shows the prevalence of undernutrition among the under five years admitted patients using various anthropometric indicators. The prevalence of severe acute and moderate acute undernutrition, using the WHO definition, was 59.2% (95% CI: 52.6, 65.5); in which majority (39.9%) were in the category of severe [Figure 2].

The prevalence of admitted children having acute undernutrition (severe wasting = 30.7% and wasting = 20.3%) was 51.3%. On the other hand, the prevalence of chronic undernutrition, as per the HFA index, was 34.4%, in which 17% had severe stunting, while 17.4% had stunting only. The prevalence of severely underweight and underweight was 35.3% and 22.5%, respectively. According to the BMIFA index, 50.5% were found to have undernutrition, in which 31.2% and 19.3% were severely thin and thin, respectively.

Table 3 Prevalence of Undernutrition Among the Admitted Patients Under 5 Years Using Different Anthropometric Indices

Anthropometric Index	Criteria	Type	Frequency	Percentage
WFH				
Undernutrition			112	51.3
	$z < -3$	Severe wasting	67	30.7
	$-3 < z \leq -2$	Wasting	45	20.6
Normal nutrition				
HFA	Otherwise	Absent	106	48.6
Undernutrition			75	34.4
	$z < -3$	Severe stunting	37	17
	$-3 < z \leq -2$	Stunting	38	17.4
Normal nutrition				
WFA	Otherwise	Absent	143	65.6
Undernutrition			126	57.8
	$z < -3$	Severe Underweight	77	35.3
	$-3 < z \leq -2$	Underweight	49	22.5
Normal nutrition				
BMIFA	Otherwise	Absent	92	42.2
Undernutrition			110	50.5
	$z < -3$	Severely thin	68	31.2
	$-3 < z \leq -2$	Thin	42	19.3
Normal nutrition			108	54
	$-2 < z \leq 1$	Normal	103	47.2
	$1 < z \leq 2$	Overweight	4	1.8
	$z > 2$	Obese	1	0.5
WFH and MUAC				
Undernutrition			129	59.2
	WFH $z < -3$ or MUAC < 11.5 or bilateral pitting edema present	Severe acute Undernutrition	87	39.9
	$-2 < \text{WFH} z \leq -3$ or $11.5 \leq \text{MUAC} \leq 12.4$	Moderate acute Undernutrition	42	19.3
Normal nutrition				
	Otherwise	Normal	89	40.8

Prevalence Stratified Across Categories of Selected Variables

The prevalence of undernutrition among males and females was 59.5% (95% CI: 51.0, 67.7) and 58.6% (95% CI: 48.1, 68.5), respectively. The prevalence of undernutrition among the children who live in Asmara and outside Asmara was 45.2% (95% CI: 35.5, 55.3) and 70% (95% CI: 61.4, 77.5), respectively [Table 4].

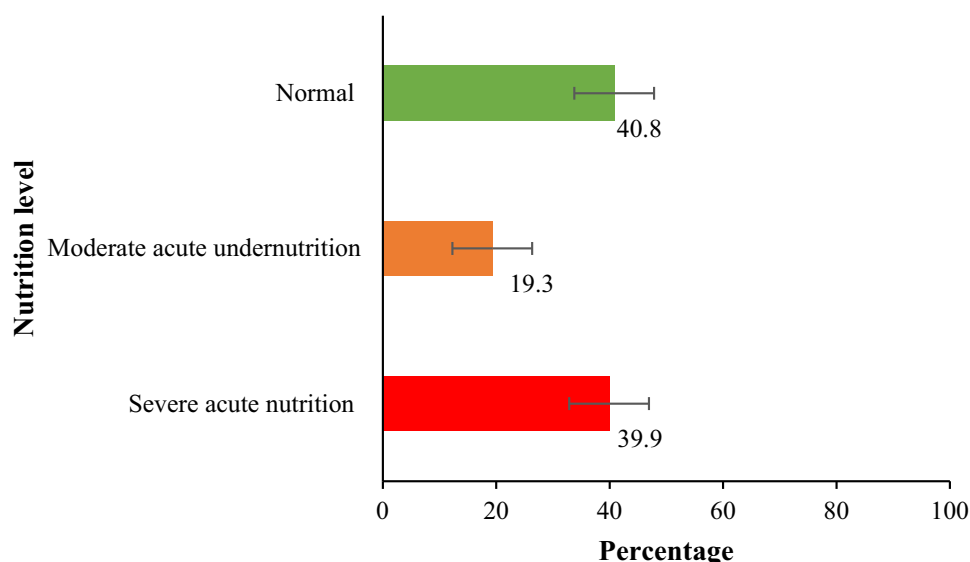


Figure 2 Prevalence of severe acute and moderate acute undernutrition for admitted patients under 5 years as per the WHO definition.

Predictors of Undernutrition

Age of the patient, the place at which the patient resides, mother's educational level, mother's employment status, income of the household, duration of breast feeding, admission diagnosis, and food servings per day were found to be significantly associated with undernutrition at bivariate level [Table 5].

However, only three variables, namely: the place at which the patient resides, admission diagnosis, and food servings per day, were the significant determinants at multivariable level. The odds of undernutrition among the children who reside outside Asmara were almost three times (AOR=2.81, 95% CI: 1.17, 6.73) more as compared to those who reside in Asmara ($p=0.021$). The odds of undernutrition having other infections were 86% (AOR=0.14, 95% CI: 0.03, 0.78) less compared to those having cardiac problem [Table 5].

Table 4 Prevalence of Undernutrition Along with the 95% CI Across Categories of Selected Characteristics

Variable	Prevalence of Undernutrition			95% CI of Overall	Frequency
	Severe	Moderate	Overall		
Age of child (Months)					
3 to 24	48.2	17.9	66.1	58.7, 72.9	168
25 to 60	12	24	36	23.8, 49.8	50
Sex					
Male	41.2	18.3	59.5	51.0, 67.7	131
Female	37.9	20.7	58.6	48.1, 68.5	87
Address					
Asmara	30.5	14.7	45.2	35.5, 55.3	95
Outside Asmara	47.2	22.8	70	61.4, 77.5	123
Income of household					
Less than 1000	45.9	20.7	66.6	58.4, 74.2	135
1001 to 2000	28.8	23.1	51.9	38.5, 65.1	52
2001 or more	32.3	6.5	38.8	23.2, 56.2	31

(Continued)

Table 4 (Continued).

Variable	Prevalence of Undernutrition			95% CI of Overall	Frequency
	Severe	Moderate	Overall		
Family size					
Less than 3	40.5	21.4	61.9	46.8, 75.4	42
4 to 8	41.2	18.2	59.4	51.8, 66.7	165
9 or more	20	30	50	22.4, 77.6	10
Mother's educational level					
Primary or below	41.3	28.3	69.6	55.4, 81.4	46
Middle	50	14.7	64.7	52.9, 75.3	68
Secondary or above	33	18.4	51.4	41.9, 61.0	103
Father's educational level					
Primary or below	42.9	28.6	71.5	55.2, 84.3	35
Middle	42.6	23.4	66	51.8, 78.2	47
Secondary or above	39.1	15.8	54.9	46.4, 63.2	133
Duration of breast feeding (Months)					
A year or less	45.7	20	65.7	56.3, 74.3	105
13 to 24	36.4	17.8	54.2	44.8, 63.4	107
25 or above	0	33.3	33.3	7.7, 71.4	6
Admission diagnosis					
Cardiac	53.8	26.9	80.8	62.9, 92.3	26
Respiratory	34.4	20.3	54.7	42.5, 66.5	64
Gastrointestinal/liver	64.2	18.9	83.2	71.3, 91.3	53
Neurology	8	16	24	10.7, 42.9	25
Renal disease	20	10	30	9.3, 60.6	10
Hematology	83.3	0	83.3	44.2, 98.1	6
Other infections	5	25	30	13.6, 51.7	20
Others*	50	14.3	64.3	38.5, 84.9	14
Overall	39.9	19.3	59.2	52.6, 65.5	218

Notes: Others* mainly include diabetes, followed by reactive arthritis, neuroblastoma, allergy, and rickets.

Table 5 Predictors of Undernutrition Among Patients Under 5 Years Old Using Bivariate Logistic and Multivariable Logistic Regression

Variable	COR (95% CI)	p-value	AOR (95% CI)	p-value
Age of patient				
3 to 24	3.46 (1.79, 6.70)	<0.001	1.88 (0.73, 4.81)	0.188
25 to 60	Reference		Reference	
Sex				
Male	1.04 (0.60, 1.80)	0.892	—	—
Female	Reference			
Address				
Outside Asmara	2.81 (1.61, 4.91)	<0.001	2.81 (1.17, 6.73)	0.021
Asmara	Reference		Reference	
Father's age				
30 or less	1.09 (0.30, 3.91)	0.896	—	—
31 to 50	1.17 (0.42, 3.30)	0.763		
51 or above	Reference			

(Continued)

Table 5 (Continued).

Variable	COR (95% CI)	p-value	AOR (95% CI)	p-value
Mother's age				
25 or less	1.67 (0.65, 4.25)	0.285	—	—
26 to 35	1.21 (0.61, 2.40)	0.578		
36 or above	Reference			
Father's educational level				
Primary or below	2.06 (0.92, 4.61)	0.081	—	—
Middle	1.59 (0.80, 3.19)	0.188		
Secondary or above	Reference			
Mother's educational level				
Primary or below	2.16 (1.03, 4.51)	0.041	1.54 (0.48, 4.93)	0.465
Middle	1.73 (0.92, 3.25)	0.088	1.10 (0.43, 2.84)	0.848
Secondary or above	Reference		Reference	
Mother's employment status				
Housewife	2.28 (1.05, 4.93)	0.037	0.97 (0.27, 3.50)	0.964
Employed	Reference		Reference	
Income				
1000 or less	3.62 (1.41, 7.09)	0.005	1.67 (0.42, 6.59)	0.465
1001 to 2000	1.71 (0.69, 4.23)	0.245	1.58 (0.39, 6.45)	0.521
2001 or above	Reference		Reference	
Number of living rooms				
One	1.06 (0.62, 1.82)	0.832	—	—
Two or more	Reference			
Family size				
4 to 8	0.90 (0.45, 1.81)	0.767	—	—
9 or more	0.62 (0.15, 2.46)	0.493		
3 or less	Reference			
Gestational age at birth				
32 to 37	2.82 (0.31, 25.62)	0.358	—	—
More than 37	Reference			
Exclusive breast feeding				
Yes	0.69 (0.31, 1.50)	0.344	—	—
No	Reference			
Frequency of breast feeding				
Eight or more	0.48 (0.18, 1.27)		—	—
Less than eight	Reference			
Duration of breast feeding				
A year or less	1.62 (0.93, 2.82)	0.088	—	—
25 or more	0.42 (0.07, 2.41)	0.332		
13 to 24	Reference			
Weaning				
Yes	1.70 (0.63, 4.60)	0.294	—	—
No	Reference			
Weaning age				
Less than six	1.41 (0.64, 3.10)	0.398	—	—
More than six	1.13 (0.35, 3.60)	0.842		
At six	Reference			
Frequency of feeding				
Inadequate	1.09 (0.60, 1.99)	0.782	—	—
Adequate	Reference			

(Continued)

Table 5 (Continued).

Variable	COR (95% CI)	p-value	AOR (95% CI)	p-value
Previous admission				
Yes	1.67 (0.96, 2.90)	0.068	–	–
No	Reference			
Admission diagnosis				
Respiratory	0.29 (0.10, 0.86)	0.025	0.37 (0.1, 1.60)	0.185
Gastrointestinal/liver	1.16 (0.35, 3.91)	0.806	2.10 (0.42, 10.54)	0.366
Neurology	0.08 (0.02, 0.29)	<0.001	0.21 (0.04, 1.13)	0.069
Renal disease	0.10 (0.02, 0.54)	0.007	0.29 (0.04, 2.33)	0.245
Hematology	1.19 (0.11, 12.59)	0.885	0.44 (0.03, 7.05)	0.562
Infections	0.10 (0.03, 0.40)	0.001	0.14 (0.03, 0.78)	0.025
Others	0.43 (0.10, 1.86)	0.257	0.78 (0.11, 5.28)	0.796
Cardiac	Reference		Reference	
Food servings per day				
Inadequate	17.51 (7.07, 43.39)	<0.001	12.55 (4.43, 35.52)	<0.001
Adequate	Reference		Reference	
Supervision of feeding				
Active	1.59 (0.63, 4.00)	0.329	–	–
Passive	Reference			

Notes: Others* mainly include diabetes, followed by reactive arthritis, neuroblastoma, allergy, and rickets.

Discussion

This study sought the prevalence of undernutrition in such a way as to reveal the stunting, wasting, and underweight that represent different physiological manifestations, they all share similar predictors. The result showed that more than half (59.2%) had acute undernutrition (two out of five with severe wasting and 19.3% moderate wasting); while chronic undernutrition/stunting was in 34.4%. The prevalence of “severely underweight” and “underweight” was 35.3% and 22.5%, respectively. Using the BMIFA index, 50.5% were found to have undernutrition, in which 31.2% and 19.3% were “severely thin” and “thin”, respectively.

Numerous studies in various countries have shown substantial prevalence rates of undernutrition in hospitalized children. In sub-Saharan Africa (SSA), a comprehensive systematic review and meta-analysis published in 2025 emphasized the persistent high burden of childhood undernutrition, highlighting its correlation with infectious diseases and socioeconomic factors, which aligns with the overall context of our findings.³⁴ The prevalence of undernutrition, among hospitalized patients, in Bugando Medical Center, Tanzania (55.8%, of which 24.7% were severe)¹⁴ similar to our findings. Comparatively, lower prevalence were observed in Nigeria (35.1%, of which 18.3% were severe),¹⁷ Kenya (having 9.8% severe cases),³⁵ Omdurman Pediatric Hospital (having 6.5% severe cases),³⁶ and Hanoi-Vietnam (7% of Severe Acute Undernutrition, as per the WHO classification criteria)³⁷ and substantial in Turkey (which revealed that the prevalence by weight-for-height and BMI was found to be 11.2% and 9.5% respectively).³⁸ Moreover, a study done in Egypt in 2019 among children less than 3 years admitted to a hospital showed that the prevalence of undernutrition based on weight for age (underweight), height for age (stunting), weight for height (wasting) was 57.8%, 58.4% and 62.4%, respectively.³⁹ A meta-analysis conducted in the Middle East and North Africa *region revealed that the pooled prevalence of stunting in children aged 2–5 years old was 25.7%.⁴⁰

One of the potential reasons for the relatively higher percentage of undernutrition in our study could be because the study was conducted at the only National Pediatric Referral Hospital, in which highly sick children are admitted, probably mostly come referred from outside Asmara or self-referral after they get sicker-as there is no control of the referral system from primary to tertiary hospitals.

In the assessment of predictors of undernutrition, among the child-related determinants of undernutrition; admission diagnosis and inadequate food servings per day were found to be significant predictors at multivariable level. The reason

for the higher odds of undernutrition among children with cardiac complications is multifactorial, stemming from both increased nutritional demands (hypermetabolism) and compromised caloric intake (fatigability).^{41,42} Cardiac conditions often result in an elevated basal metabolic rate due to the heart's increased work and chronic circulatory stress,^{42,43} requiring a caloric intake that can exceed 100–150 kcal/kg/day.⁴⁴ Simultaneously, these patients experience easy fatigability because feeding itself is a physically demanding exercise,⁴² leading to reduced feeding time and overall inadequate oral caloric consumption.^{41,42} Even for patients whose cardiac status allows for hospital admission, this complex interplay of hypermetabolism and feeding difficulty makes them a group uniquely predisposed to undernutrition. Inadequate food servings per day were also found to be a significant predictor of undernutrition in a Tanzanian study¹⁴ and among Indonesian children.¹⁶

There was no significant risk factor that predict from the paternal/maternal determinants of undernutrition. Although mother's educational level is one of the most common predictors, it was not so, at multivariable level. Evidence in many studies revealed that low maternal educational level as a predictor: sub-Saharan African countries,¹³ Tanzania,¹⁴ Nigeria¹⁷ Indonesia¹⁶ Mekelle City, Tigray-Ethiopia,¹⁹ Northeastern Brazil,²⁰ Myanmar,²¹ Indonesia,¹⁶ Bangladesh (Dhaka City),^{22,25} Palestine,²³ Libya,⁴⁵ Medebay Zana woreda, shire Indasilassie-Ethiopia (Tigray Region),²⁴ and Urmia (Northwest of Iran).⁴⁶ The social and cultural integrity in the community might have a considerable effect toward addressing the gap of knowledge in nutrition for those mothers with low educational level. Another potential reason could be the high coverage of exclusive breastfeeding (84.9%), as evidenced in this study. Provision of maternal feeding card and education for the antenatal care visiting mothers in all the health facilities in the country might also minimize the difference in knowledge among the mothers. Still, other confounding factors could not be excluded.

Among the household-related determinants, the place at which the patient resides was the only significant determinant of undernutrition. The results showed that odds of undernutrition among the children who reside outside Asmara were almost three times more as compared to those who reside in Asmara. Similar results were obtained in studies conducted in Ecuador,⁴⁷ Bangladesh,²⁵ low- and middle-income countries,⁴⁸ sub-Saharan African Countries¹³ and Indonesia.¹⁶ The persistence of this disparity is echoed in a recent systematic review on sub-Saharan Africa, which confirmed that rural residence is a significant, persistent, and independent determinant of childhood undernutrition, linked to poor access to health services and lower socioeconomic status.³⁴ While acknowledging the Ministry of Health's ongoing commitment to expanding healthcare access across all regions of Eritrea, the observed disparities warrant closer examination. Specifically, the potential for less adequate services and resources outside Asmara, coupled with a higher prevalence of undernutrition among patients from these areas, suggests that current public health policies and resource allocation strategies may require refinement to achieve consistently equitable reach across the entire population. To mitigate the risks associated with undernutrition, health-care facilities should enhance nutritional screening for all children under five upon hospital admission. This ensures that undernutrition is systematically identified, regardless of the primary reason for admission. Moreover, integrating nutritional education into school curricula and community outreach programs can enhance awareness of parents/guardians and reduce the prevalence. The government should invest in a national surveillance system to systematically collect data on pediatric undernutrition. This would allow for continuous monitoring of trends, identification of high-risk regions, and evaluation of the effectiveness of implemented policies.

Limitation of the Study

Due to the cross-sectional nature of the study, cause-and-effect relationship could not be established. Moreover, the results from this study could not be generalized to the whole country. A second important limitation is the method used to capture birth weight data. This information was collected through questionnaires from participants who were enrolled at ages three and above, which introduces the possibility of recall bias on the part of the parents or guardians. This limitation should be acknowledged when interpreting the findings related to birth weight.

Conclusion

The prevalence of undernutrition, encompassing both acute and chronic forms, is high among hospitalized children admitted to the Orotta National Referral Hospital, underscoring a critical public health crisis in this low-resource setting. The study identified key factors significantly associated with undernutrition, which include residing outside Asmara, receiving inadequate food servings per day, and admission for cardiac complications.

Based on the high undernutrition prevalence among admitted children, the core recommendation is to implement integrated and targeted nutritional interventions. These should focus on rigorously promoting optimal infant and young child feeding (IYCF) practices, including the use of nutrient-dense complementary foods like DMK. Crucially, this must be coupled with strengthening programs for the early detection and management of low-birth-weight infants and intensifying efforts to prevent and manage common childhood infections such as diarrhea.

Abbreviations

AOR, Adjusted Odds Ratio; BMIFA, Body mass index-for-Age; CI, Confidence Interval; COR, Crude Odds Ratio; HFA, Height-for-Age; IQR, Interquartile Range; Md, Median; MoH, Ministry of Health; MUAC, Mid Upper Arm Circumference; ONRTH, Orotta National Referral and Teaching Hospital.

Data Sharing Statement

The data used in this study are available from the corresponding author and can be accessed upon reasonable request.

Ethical Consideration

Initially, ethical approval was obtained from Orotta College of Medicine and Health Sciences Ethics and Research Committee. The Ministry of Health (MoH) Research Ethics and Protocol Review Committee (Reference Number: 03/01/2022) also approved it. Study participants were informed about the study's purpose and written informed consent was obtained from parents/guardians. All the data obtained was kept confidential and used solely for the study's purposes. This study conforms to the principles outlined in the Declaration of Helsinki.

Patient Consent for Publication

Informed consent was secured from the caregivers after a thorough explanation of the study's objectives. The names and other identifying information of the patients were anonymized and kept strictly confidential.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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