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Prevalence and Factors Associated with Stunting and Wasting among HIV-Infected Children Aged 6 Months to 14 Years Attending Care and Treatment Clinics in Moshi Municipality, Northern Tanzania

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Abstract

Background: Although antiretroviral therapy (ART) coverage has improved, malnutrition is still a common problem for children living with HIV in sub-Saharan Africa. HIV raises energy needs, makes it harder for the body to absorb nutrients, and leads to more frequent infections, which together worsen undernutrition. Understanding the burden and determinants of stunting and wasting in this population is critical for guiding targeted nutritional interventions and improving survival and quality of life. This study looked at how common stunting and wasting are, and what factors are linked to them, among HIV-infected children aged 6 months to 14 years who attend Care and Treatment Clinics (CTCs) in Moshi Municipality, Tanzania. **Methodology:** A facility-based cross-sectional analytical study was conducted from October 2024 to May 2025. A total of 255 HIV-infected children were consecutively recruited from all 10 CTCs in Moshi Municipality. Nutritional status was classified according to the World Health Organization (WHO) Child Growth Standards. Logistic regression analyses were performed to quantify the associations between potential risk factors and the prevalence of each type of malnutrition. An adjusted odds ratio with a 95% confidence interval was calculated, and a p-value of less than 0.05 was considered to be statistical significance. **Results:** A total of 255 HIV-infected children were enrolled, of which 53.3% were children aged 10 - 14 years, and the majority were female (52.5%). The prevalence of stunting and wasting was 40.8% and 14.1%, respectively. A total of 94.9%

of children achieved minimum dietary diversity, whereas only 50.6% met the recommended minimum meal frequency. Multivariable analysis indicated that advanced WHO HIV clinical stage (III/IV) is strongly associated with both stunting and wasting. Children in stage III or IV have 11-fold higher odds of stunting compared to those in earlier stages (AOR = 11.0, $p < 0.001$) and approximately 4-fold higher odds of wasting than their counterparts (AOR = 3.83, $p = 0.014$). Inadequate minimum meal frequency was independently associated with both stunting and wasting. Children who received inadequate meal frequency exhibited three times higher odds of experiencing stunting and wasting compared to their counterparts. **Conclusion:** Stunting and wasting remain highly prevalent among HIV-infected children in Moshi Municipality. Advanced disease stage and inadequate meal frequency are the major modifiable drivers of undernutrition. There is an urgent need to integrate comprehensive nutrition assessment, counselling with emphasis on meal frequency, and support into routine paediatric HIV care services.

Keywords

Paediatric HIV, Malnutrition, Nutritional Status, Minimum Meal Frequency, Dietary Diversity, Sub-Saharan Africa

1. Introduction

Childhood growth is a sensitive indicator of overall health and well-being, reflecting the complex interplay of nutrition, care, illness, and environment. For children living with Human Immunodeficiency Virus (HIV), this trajectory is frequently disrupted by the bidirectional relationship between the virus and malnutrition [1]. HIV infection significantly increases resting energy expenditure and daily caloric requirements, often by 10% to 100% in complicated cases, with some situations necessitating up to 150% of normal intake for recovery. Additionally, HIV induces chronic inflammation, impairs nutrient absorption due to gastrointestinal damage, suppresses appetite, and predisposes children to recurrent opportunistic infections, such as diarrhoea, pneumonia, and oral thrush [1] [2]. In turn, undernutrition weakens immune function, accelerates HIV disease progression, increases susceptibility to infections, and reduces the effectiveness of antiretroviral therapy (ART) [1] [2]. This vicious cycle contributes to higher morbidity and mortality, delayed neurodevelopment, and poor long-term health outcomes.

In sub-Saharan Africa, where over 85% of the world's children live with HIV reside, malnutrition remains highly prevalent despite expanded access to ART. A systematic review and meta-analysis of East African studies reported pooled prevalence of stunting at 49.7%, underweight at 41.6%, and wasting at 24.7% among HIV-positive children [3]. In Tanzania, analysis of routine national data from 70,102 children and adolescents on ART (aged 5 - 19 years) between January and December 2021 revealed stunting in 36.0%, underweight in 28.9%, and wasting in

13.0%, with significant regional variations [4]. These figures highlight that even with improved viral suppression, nutritional vulnerability persists, particularly among children who present late or have incomplete immune recovery.

Feeding practices are pivotal in breaking this cycle. The World Health Organization (WHO) and The United Nations International Children's Emergency Fund (UNICEF) recommend exclusive breastfeeding (EBF) for the first six months, the timely introduction of safe complementary foods at six months, and continued breastfeeding up to two years or beyond, alongside adequate minimum meal frequency (MMF) and minimum dietary diversity (MDD) [5] [6]. Despite these recommendations, many caregivers of HIV infected children find it difficult to consistently follow these guidelines. Some of factors contributing to failure to adhere to the guidelines include HIV disclosure and transmission, caregiver workload, food insecurity, cultural beliefs, and inadequate nutrition counselling. Suboptimal complementary feeding practices have been associated with increased risk of diarrhoea among HIV exposed infants in Tanzania [7], and similar feeding challenges are relevant to HIV infected children. In addition, studies incomparable settings indicate poor dietary intake is also often linked to opportunistic infections [8]. While most research has focused on infants and children under five years, older children (up to 14 years) face distinct challenges, such as reduced caregiver supervision, inconsistent school feeding, and the psychosocial impact of stigma, all of which can further compromise nutritional intake [9].

Moshi Municipality, in Tanzania's Kilimanjaro region, is a semi-urban area with a notable HIV burden and relatively better healthcare infrastructure than in rural areas. Despite this, comprehensive local data on the nutritional status and feeding practices of HIV-infected children across the full age range of 6 months to 14 years remain scarce. This gap limits the development of age-appropriate and context-specific interventions. The current study therefore aimed to determine the prevalence of stunting and wasting and to identify associated socio-demographic, clinical, and feeding-related factors among HIV-infected children attending CTCs in Moshi Municipality. By generating localised evidence, the study seeks to inform targeted nutritional support strategies within paediatric HIV care programmes in Tanzania and similar high-burden settings.

2. Methodology

2.1. Study Design and Population

This study was hospital based cross sectional study conducted from October 2024 to May 2025 in all 10 CTCs providing paediatric HIV services in Moshi Municipality, Kilimanjaro region, northern Tanzania. These clinics are government and faith based serving both urban and peri-urban populations and operate Monday to Friday from 7.30 a.m. to 3.30 pm. The study population comprised all HIV-infected children aged 6 months to 14 years attending routine CTCs visits during the study period.

2.2. Recruitment and Consenting Procedures

Following ethical approval, the research team worked in close collaboration with clinic staff, who facilitated the identification of eligible HIV-infected children aged 6 months to 14 years during routine clinic visits for recruitment. Trained research assistants approached parents or legal guardians immediately after the child's consultation.

Both verbal and written explanations of the study objectives, procedures, potential risks, and benefits were provided. Participation was clearly stated as voluntary and independent of routine care. Participant recruitment was conducted from October 2024 to May 2025 at all 10 Care and CTCs in Moshi Municipality. Written informed consent was obtained from parents or legal guardians at the CTCs during routine clinic visits prior to enrolment. For children aged 7 years and older, age-appropriate assent was also obtained. Recruitment and consent procedures were conducted in private areas within the clinics to ensure confidentiality and minimize external influence. During the study period, 274 HIV-infected children aged 6 months to 14 years attending the 10 CTCs were assessed for eligibility and approached for participation. Of these, 19 were not enrolled: 4 were excluded due to recent hospitalisation within the two weeks prior to data collection, 7 caregivers declined participation, and 8 attended solely for a drug refill without a full clinic consultation on the day of data collection. The remaining 255 children were enrolled consecutively across all clinic operating days until the target sample size was reached.

2.3. Inclusion and Exclusion Criteria

Children were enrolled if they met all the inclusion criteria: Confirmed HIV infection, age 6 months to 14 years, on ART for at least three months and a caregiver willing to provide informed consent. Participants were excluded from enrolment if they fulfilled any of these criteria: Children admitted to the hospital within the two weeks prior to data collection or caregivers who declined participation.

2.4. Sample Size and Sampling Technique

This was a descriptive study without hypothesis testing, and hence, the sample size was determined by estimation rather than power calculations. The sample size was determined using the single population proportion formula with finite population correction. A total of 255 participants was considered sufficient to estimate the prevalence of malnutrition, assuming a 50% prevalence at the 95% confidence level with a 5% margin of error. Consecutive sampling of eligible children was employed until the required sample size was achieved.

2.5. Outcome Definitions (Stunting and Wasting)

Stunting was defined as length/height-for-age Z-score (HAZ) less than −2 SD, and wasting as weight-for-height Z-score (WHZ) less than −2 SD, based on the WHO Child Growth Standards, for children aged 6 - 59 months. For children aged 5 - 14 years, stunting was defined as HAZ less than −2 SD and wasting as body mass

index-for-age Z-score (BAZ) less then −2 SD, based on the WHO Growth Reference (WHO Anthro Plus), since WHZ is not validated beyond 5 years of age.

2.6. Data Collection Tools and Procedures

All eligible participants present at the clinics during data collection days were approached by the principal investigation (PI) assisted by trained research assistants' introduction of the study was done in a private designated room at each clinic after routine clinic services to ensure confidentiality and a comfortable environment. Written informed consent was obtained from caregivers prior to participation and children's assent was sought where appropriate according to age. A pretested structured questionnaire adapted from WHO and IYCF indicators was used to collect socio-demographic information, feeding practices (breastfeeding history, age at introduction of complementary foods), and household food security. MMF and MDD were assessed using 24-hour dietary recall per WHO/UNICEF guidelines. Clinical data including WHO HIV clinical stage, ART regimen, viral load, CD4 count, co-trimoxazole prophylaxis, and history of hospitalization were extracted from CTC registers and patient files using a standardised checklist. Anthropometric measurements were performed in a designated quiet room. Weight was measured using a calibrated SECA 384 digital scale (accuracy 0.1 kg) and length/height using a UNICEF infant/child length board. Measurements were taken in duplicate (or triplicate if difference exceeded 100 g for weight or 0.5 cm for height), and the mean was recorded.

Data were collected electronically using Kobo Toolbox (Enketo version 7.5). The application was installed on a password-protected computer dedicated to the study, with access restricted to the principal investigator. Trained research assistants initially collected data using a structured questionnaire, the PI then transferred the data to Kobo Toolbox using login credentials to access the database.

2.7. Feeding Indicator Definitions and Age Applicability (MDD/MMF)

Minimum Dietary Diversity (MDD) and Minimum Meal Frequency (MMF) were assessed according to WHO/UNICEF IYCF indicator definitions, which are formally validated for children aged 6 - 23 months. MDD was defined as consumption of foods from at least 5 of 8 defined food groups in the previous 24 hours. MMF was defined as receiving the age- and breastfeeding-status-specific minimum number of meals and/or milk feeds in the previous 24 hours. As only 9 children in this cohort fell within the WHO-validated 6 - 23-month age range, MDD and MMF were additionally applied descriptively to children aged 2 years and older, using the same food-group and meal-frequency framework, to provide a comparable measure of dietary quality and feeding regularity across the full study population. Findings for children aged 2 years and older should be interpreted as an extension of the IYCF framework beyond its formally validated age range, rather than as standard indicator estimates.

2.8. Data Management and Statistical Analysis

The PI rotated across all study sites with support from research assistants, the PI had exclusive access to the study database and was responsible for data entry, management and all data were reviewed for completeness and consistency. Data cleaning and preparation was done in STATA version 18. Z-scores were calculated according to the World Health Organization (WHO) Child Growth Standards. The STATA WHO Anthro and Anthro Plus macros were used for children under 5 years and those aged 5 years and above, respectively. Continuous variables were described using medians and interquartile ranges. Categorical variables were summarised as frequencies and percentages. Associations between categorical variables and malnutrition outcomes were assessed using the Chi-square test or Fisher's exact test, as appropriate. A variable associated with the outcome was then considered for logistic regression. Univariate and multivariate logistic regression analyses were conducted to quantify the association between potential risk factors and the prevalence of each form of malnutrition. Variables with a p-value < 0.05 in the univariate analysis were included in the multivariate model. Adjusted odds ratios (AOR) with 95% confidence intervals were reported. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using STATA version 18 (StataCorp, College Station, TX, USA). R Statistical Software version 3.4.3 (https://www.r-project.org/) was used for graphical visualizations. Age and sex were retained a priori in the multivariable models as biologically plausible confounders regardless of their univariate significance, while other candidate variables were entered based on the $p<0.05$ univariate threshold to reduce the risk of overfitting given the sample size.

2.9. Ethical Considerations

The study was conducted after obtaining ethical approval from KCMC University Research and Ethical Review Committee (KURERC) no PG.21/2024. Permission to conduct the study was also obtained from regional and facility authorities at each clinic. To ensure confidentiality, all participants were assigned unique study identification numbers that replaced names and personal identifiers at the point of entry. The anonymised data were stored securely on a password-protected computer and maintained throughout the study period.

3. Results

3.1. Socio-Demographic and Clinical Characteristics of Participants

A total of 255 HIV-infected children were enrolled. The majority (53.3%) were aged 10 - 14 years, female (52.5%), and resided in urban areas (73.7%). Most children (88.6%) had at least one biological parent alive. Over half (63.1%) had a history of hospitalisation, and 51.4% were in advanced WHO HIV clinical stages (III/IV). Recent viral load was suppressed (<50 copies/mL) in 79.2%, and CD4 count was >500 cells/μL in 94.1%. The most common ART regimen was Abacavir (ABC) + Lamivudine (3TC) + Dolutegravir (DTG) (60.4%). Only 5 children (2.0%) had been diagnosed with tuberculosis (TB). Co-trimoxazole

prophylaxis was used by 49.8% of the children (Table 1 and Table 2). About 37% of children had severe immunosuppression (CD4 < 200 cells/μL) before starting ART.

Table 1. Socio-demographic characteristics of study participants (N = 255).

Parameter	Value
N	**255**
Residence	
Urban	188 (73.7)
Rural	67 (26.3)
Sex	
Male	121 (47.5)
Female	134 (52.5)
Age, median (IQR), years	10.3 (6.7 - 12.5)
<2	9 (3.5)
2 - 5	31 (12.2)
5 - 10	79 (31.0)
>10	136 (53.3)
Number of the children in household	
<2	44 (17.3)
2 - 5	163 (63.9)
>5	48 (18.8)
Child-birth order	
First	106 (41.6)
Second	84 (32.9)
Third	42 (16.5)
Fourth and above	23 (9.0)
Are the biological parents of the child alive	
Yes	226 (88.6)
No	29 (11.4)
Birth weight (grams)	
≤2500	28 (11.0)
>2500	227 (89.0)
What is the source of hospital payment to the child	
Cash	133 (52.2)
Health insurance	26 (10.2)
Social welfare	96 (37.6)

Note: Values are presented as n (%).

Table 2. Clinical characteristics of study participants (N = 255).

Parameter	Value
Is the child up to date on the vaccination schedule?	
Yes	254 (99.6)
No	1 (0.4)
Age of the child at diagnosis (in years)	
<2	152 (59.6)
2 - 5	80 (31.4)
>5	23 (9.0)
Has the child ever been hospitalized	
Yes	161 (63.1)
No	94 (36.9)
If Yes How many times (n = 161)	
≤3 times	78 (48.4)
>3 times	83 (51.6)
Is the child on Co-trimoxazole	
Yes	127 (49.8)
No	128 (50.2)
If yes on Co-trimoxazole (n = 127)	
≤5 years	35 (27.6)
>5 years	92 (72.4)
Has the child ever had Tuberculosis	
Yes	5 (2.0)
No	250 (98.0)
HIV clinical stage of the child	
Stage I	39 (15.3)
Stage II	85 (33.3)
Stage III	127 (49.8)
Stage IV	4 (1.6)
The recent CD4 Counts	
≤500	15 (5.9)
>500	240 (94.1)
The recent viral load (copies)	
≤50	202 (79.2)
>50	53 (20.8)
ART regimen child in	
ABC/3TC/DTG	154 (60.4)
TLD	101 (39.6)

Note: Values are presented as n (%), Abacavir (ABC), Lamivudine (3TC), Dolutegravir (DTG), Tenofovir, Lamivudine Dolutegravir (TLD).

3.2. Socio-Demographic Characteristics of Caregivers

The median age of caregivers was 38 years (IQR 34.7 - 42.8). Most were married/Cohabiting (61.6%), had a primary education (57.7%), and were farmers (66.3%). Over half (58.8%) had disclosed their HIV status to their partner (Table 3).

Table 3. Socio-demographic characteristics of caregivers (N = 255).

Parameter	Value
N	**255**
Age, median (IQR), years	38.0 (34.7 - 42.7)
≤30	23 (9)
30 - 40	125 (49)
>40	107 (42)
Maternity leave given for this child	
Yes	33 (12.9)
No	222 (87.1)
Marital status	
Married/Cohabiting	157 (61.6)
Divorced	55 (21.6)
Single	43 (16.9)
Education level	
No formal education	11 (4.3)
Primary	147 (57.6)
Secondary	83 (32.5)
Tertiary	14 (5.5)
Employment status	
Unemployed	35 (13.7)
Employed	30 (11.8)
Self employed	21 (8.2)
Farmer	169 (66.3)
Family income (Tanzanian shillings)	
<100,000	45 (17.8)
100,000 - 250,000	102 (40.3)
>250,000	106 (41.9)
Does the caregiver consume alcohol	
Yes	41 (16.1)
No	214 (83.9)
Partners HIV status disclosure	
Yes	150 (58.8)
No	105 (41.2)
Aware on HIV related nutritional requirements	
Yes	216 (84.7)
No	39 (15.3)

Note: Values are presented as n (%).

3.3. Feeding Practices

Table 4 presents feeding practices among HIV infected children. Breastfeeding was nearly universal (95.7%). Among children under 5 years, 92.50% were exclusively breastfed for the first 6 months. Timely introduction of complementary feeding at six months was observed in 54.1%. Minimum dietary diversity was achieved by 94.9% of children and was more common among children over two years of age (96.8%) than among those under two years (44.4%) (Figure 1). However, minimum meal frequency was adequate in only 50.6%, Figure 2. Only 22.4% of caregivers reported following a structured feeding schedule. Figure 3 shows that household food insecurity is widespread, with many households experiencing limited diet variety, undesired foods, and reduced intake. Severe food insecurity, such as complete food shortages or going to bed hungry, occurs less often but remains a concern. Minimum meal frequency showed the inverse age pattern to MDD: adequate in 88.9% (8/9) of children under 2 years, compared with only 49.2% (121/246) of children 2 years and older.

Table 4. Feeding practices among HIV infected children attending CTCs in Moshi Municipal (N = 255).

Parameter	Value
Has the child ever been breast fed	
Yes	244 (95.7)
No	11 (4.3)
Time of introduction of complementary feeding	
<6 months	117 (45.9)
≥6 months	138 (54.1)
Minimum meal frequency	
Adequate	129 (50.6)
Not adequate	126 (49.4)
Minimum dietary diversity	
Adequate	242 (94.9)
Not adequate	13 (5.1)
Does the child follow any feeding schedule	
Yes	57 (22.4)
No	198 (77.6)
Has the caregiver received HIV related feeding counsel during ANC?	
Yes	208 (81.6)
No	47 (18.4)
Is the caregiver aware of the HIV-related nutritional requirements of the child?	
Yes	216 (84.7)
No	39 (15.3)

Note: Values are presented as n (%).

3.4. Prevalence of Stunting and Wasting

Overall prevalence of stunting was 40.8%, and wasting was 14.1%. Only 35.3% of the children had a normal nutritional status. Figure 4 presents the prevalence of stunting and wasting stratified by sex (panel A), age (panel B), HIV clinical stages (panel C), and minimum meal frequency (panel D). Stratified by area of residence, stunting was 38.3% among urban-residing children compared with 47.8% among rural-residing children, and wasting was 12.2% among urban-residing children compared with 19.4% among rural-residing children (Table 5).

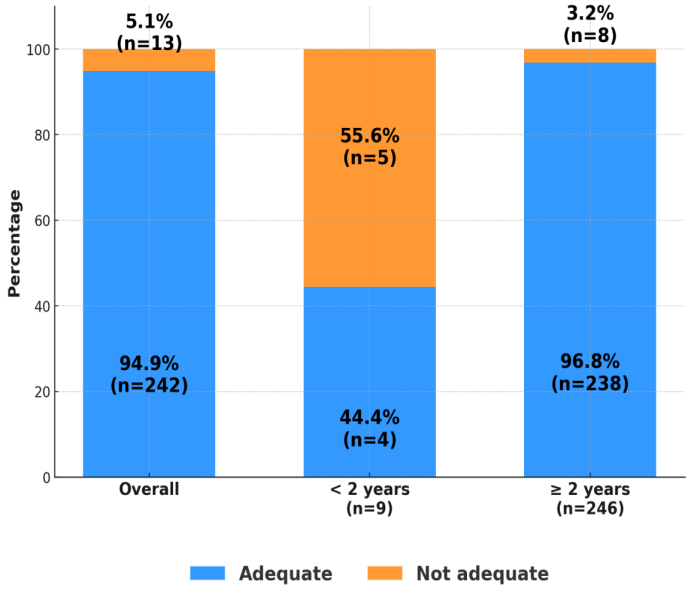


Figure 1. Fulfilment of MDD among 255 HIV infected children attending CTC in Moshi Municipality according to the age groups.

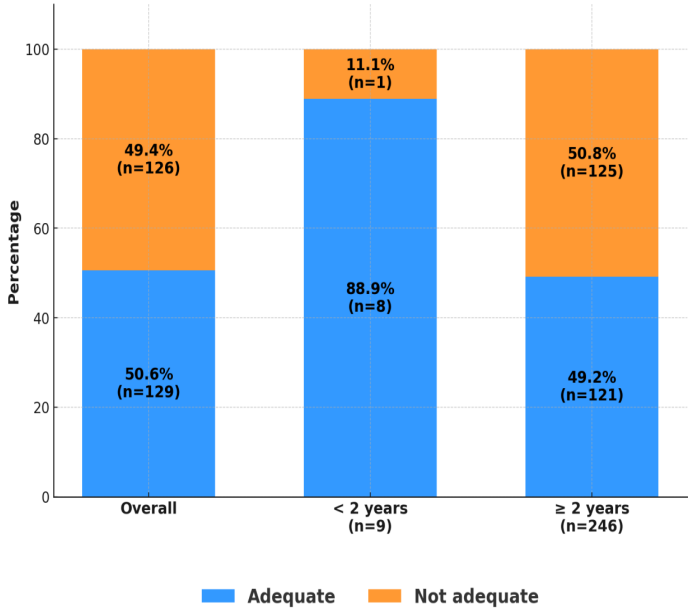
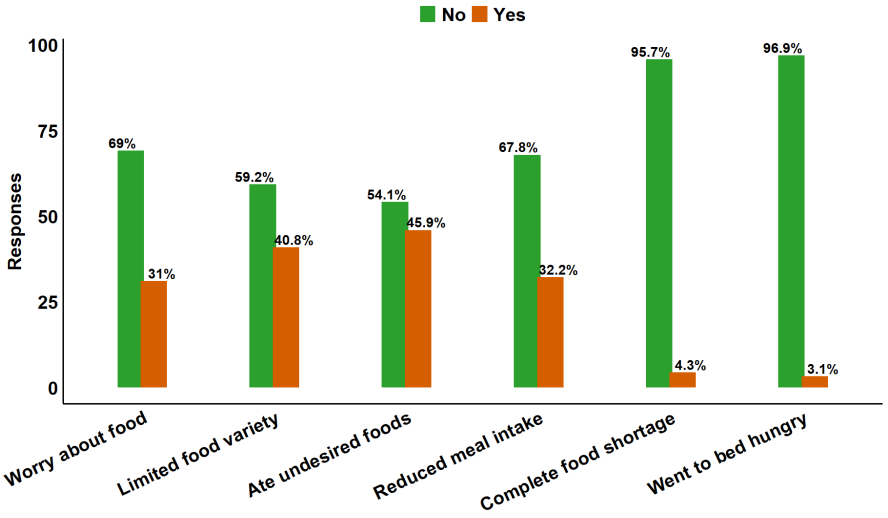


Figure 2. Fulfilment of MMF among 255 HIV infected children attending CTC in Moshi Municipality according to the age groups.



Green bars ("No") indicate food security for that specific item; orange bars ("Yes") indicate an experience of food insecurity within the household recall window

Figure 3. Household food insecurity experiences.

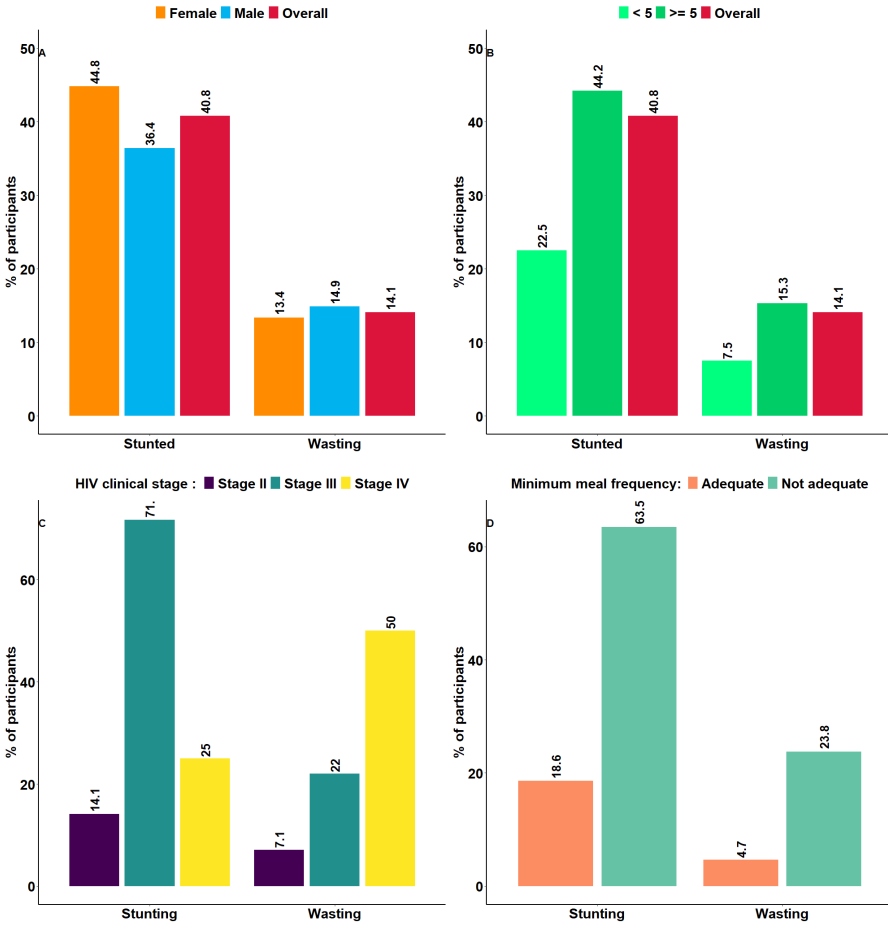


Figure 4. Prevalence of mixed forms of malnutrition among 255 children in Moshi Municipality. Panel A; distribution of malnutrition status by sex, panel B; malnutrition status by age, panel C; malnutrition status by HIV clinical stage and panel D; malnutrition status by minimum meal frequency received.

Table 5. Factors influencing stunting among HIV infected children attending CTCs in Moshi Municipal.

Parameter	N	Stunted	Univariate analysis		Multivariate analysis	
			COR (95% CI)	p-value	AOR (95% CI)	p-value
N	255	104 (40.8)				
Information of the child						
Age (years)						
≤5	40	9 (22.5)	1			
>5	215	95 (44.2)	2.73 (1.24, 6)	0.013	0.9 (0.31, 2.63)	0.848
Sex						
Male	121	44 (36.4)	1			
Female	134	60 (44.8)	1.42 (0.86, 2.35)	0.173		
Residence						
Urban	188	72 (38.3)	1			
Rural	67	32 (47.8)	1.47 (0.84, 2.58)	0.177		
Clinical characteristics						
Age of the child at diagnosis (in years)						
<2	152	52 (34.2)	1			
2 - 5	80	34 (42.5)	1.42 (0.82, 2.48)	0.215	1.12 (0.53, 2.36)	0.764
>5	23	18 (78.3)	6.92 (2.43, 19.7)	<0.001	2.86 (0.77, 10.59)	0.116
Has the child ever been hospitalized						
Yes	161	73 (45.3)	1		1	
No	94	31 (33.0)	0.59 (0.35, 1.01)	0.054	0.45 (0.22, 0.93)	0.032
Is the child on Co-trimoxazole						
Yes	127	48 (37.8)	1			
No	128	56 (43.8)	1.28 (0.78, 2.11)	0.334		
What is the source of hospital payment						
Cash	133	56 (42.1)	1			
Health insurance	26	9 (34.6)	0.73 (0.3, 1.75)	0.479		
Social welfare	96	39 (40.6)	0.94 (0.55, 1.6)	0.823		
HIV clinical stage						
Stage I + II (Early stage)	124	12 (9.7)	1		1	
Stage III + IV (Late stage)	131	92 (70.2)	22.02 (10.9, 44.48)	<0.001	11.29 (4.99, 25.5)	<0.001
Viral load (copies)						
≤50	202	71 (35.1)	1			
>50	53	33 (62.3)	3.04 (1.63, 5.69)	<0.001	1.2 (0.54, 2.67)	0.654
ART regimen child in						
ABC/3TC/DTG	154	62 (40.3)	1			
TLD	101	42 (41.6)	1.06 (0.63, 1.76)	0.833		

Continued

Information of the caregivers						
Age of caregivers						
≤30	23	10 (43.5)	1			
30 - 40	125	44 (35.2)	0.71 (0.29, 1.74)	0.45		
>40	107	50 (46.7)	1.14 (0.46, 2.83)	0.777		
Marital status of the caregiver						
Married/Cohabiting	157	55 (35.0)	1			
Divorced	55	28 (50.9)	1.92 (1.03, 3.58)	0.039	0.97 (0.42, 2.22)	0.939
Single	43	21 (48.8)	1.77 (0.9, 3.5)	0.101	0.92 (0.37, 2.3)	0.863
Employment status of caregiver						
Unemployed	35	14 (40.0)	1			
Employed	30	14 (46.7)	1.31 (0.49, 3.52)	0.589		
Self employed	21	9 (42.9)	1.13 (0.38, 3.37)	0.833		
Farmer	169	67 (39.6)	0.99 (0.47, 2.07)	0.969		
Family income (Tanzanian shilling)						
≤100,000	45	21 (46.7)	1			
100,000 - 250,000	102	47 (46.1)	0.98 (0.4, 1.97)	0.947		
>250,000	106	35 (33.0)	0.56 (0.28, 1.15)	0.114		
Feeding Practices						
Minimum meal frequency						
Adequate	129	24 (18.6)	1		1	
Not adequate	126	80 (63.5)	7.61 (4.29, 3.49)	<0.001	3.12 (1.44, 6.77)	0.004
Minimum dietary diversity						
Adequate	242	98 (40.5)	1			
Not adequate	13	6 (46.2)	1.26 (0.41, 3.86)	0.686		
Did the Caregiver received Nutritional education during ANC visits						
Yes	208	81 (38.9)	1			
No	47	23 (48.9)	1.5 (0.8, 2.84)	0.21		
Is the caregiver aware on HIV related nutritional requirements						
Yes	216	85 (39.4)	1			
No	39	19 (48.7)	1.46 (0.74, 2.9)	0.275		

COR; crude odds ratio, AOR; adjusted odds ratio, CI; Confidence interval.

3.5. Factors Associated with Stunting

In multivariable logistic regression, advanced WHO HIV clinical stage (III/IV) was 11 times more likely to be stunted than those in earlier stages (AOR = 11.29, 95%, $p < 0.001$). Children who had never been hospitalised had 55% lower odds of stunting than those who had been hospitalized (AOR = 0.45, $p = 0.032$). Inadequate

MMF tripled the odds of stunting (AOR = 3.12, p = 0.004). In the univariate analysis a higher risk of stunting among children aged ≥ 5 years (OR = 2.73, p = 0.013), those diagnosed more than five years ago from the time of enrolment (OR = 6.92, p < 0.001), those with viral loads ≥ 50 copies/mL (OR = 3.04, p < 0.001), and those living with divorced caregivers (OR = 1.92, p = 0.039). However, these risk factors were not statistically significant in multivariate analysis (Table 5).

3.6. Factors Associated with Wasting

Table 6 presents factors associated with wasting. HIV infection was a significant risk factor, with children in late-stage HIV infection (stage III/IV) having about four times higher odds of being wasted than those in early HIV stages (AOR = 3.83, p = 0.014). Children who received inadequate MMF were three times more likely to be wasted than those who received adequate MMF (AOR = 3.04, p = 0.039). Children without a history of hospitalization were more than twice as likely to experience wasting compared to those who had been hospitalized previously (AOR = 2.37, p = 0.032).

Table 6. Factors influencing wasting among HIV infected children attending CTCs in Moshi Municipal.

Parameter	N	Wasting	Univariate analysis		Multivariate analysis	
			COR (95% CI)	p-value	AOR (95% CI)	p-value
	255	36 (14.1)				
Information of the child						
Age (years)						
≤5	40	3 (7.5)	1			
>5	215	33 (15.3)	2.24 (0.65, 7.68)	0.201		
Sex						
Male	121	18 (14.9)	1			
Female	134	18 (13.4)	0.89 (0.44, 1.8)	0.741		
Residence						
Urban	188	23 (12.2)	1			
Rural	67	13 (19.4)	1.73 (0.82, 3.64)	0.151		
What is the source of hospital payment						
Cash	133	18 (13.5)	1			
Health insurance	26	2 (7.7)	0.53 (0.12, 2.45)	0.418		
Social welfare	96	16 (16.7)	1.28 (0.61, 2.66)	0.511		
Clinical characteristics						
Age of the child at diagnosis (in years)						
<2	152	22 (14.5)	1			
2 - 5	80	11 (13.8)	0.94 (0.43, 2.06)	0.881		
>5	23	3 (13.0)	0.89 (0.24, 3.24)	0.855		

Continued

Has the child ever been hospitalized						
Yes	161	17 (10.6)	1		1	
No	94	19 (20.2)	2.15 (1.05, 4.37)	0.035	2.37 (1.08, 5.2)	0.032
Is the child on Co-trimoxazole						
Yes	127	24 (18.9)	1		1	
No	128	12 (9.4)	0.44 (0.21, 0.93)	0.032	0.5 (0.22, 1.12)	0.09
HIV clinical stage						
Stage I + II (Early stage)	124	6 (4.8)	1		1	
Stage III + IV (Late stage)	131	30 (22.9)	5.84 (2.34, 14.6)	<0.001	3.83 (1.31, 11.26)	0.014
Viral load (copies)						
≤50	202	27 (13.4)	1			
>50	53	9 (17.0)	1.33 (0.58, 3.02)	0.502		
ART regimen the child is on						
ABC/3TC/DTG	154	28 (18.2)	1			
TLD	101	8 (7.9)	0.39 (0.17, 0.89)	0.025	0.47 (0.19, 1.15)	0.097
Information of the caregivers						
Age of caregivers						
≤30	23	1 (4.4)	1			
30 - 40	125	18 (14.4)	3.7 (0.47, 29.19)	0.214		
>40	107	17 (15.9)	4.16 (0.52, 32.93)	0.177		
Marital status of caregiver						
Married/Cohabiting	157	18 (11.5)	1			
Divorced	55	9 (16.4)	1.51 (0.63, 3.59)	0.351		
Single	43	9 (20.9)	2.04 (0.84, 4.95)	0.113		
Employment status of caregiver						
Unemployed	35	5 (14.3)	1			
Employed	30	3 (10.0)	0.67 (0.15, 3.06)	0.602		
Self employed	21	2 (9.5)	0.63 (0.11, 3.59)	0.604		
Farmer	169	26 (15.4)	1.09 (0.39, 3.07)	0.869		
Family income (Tanzanian shilling)						
≤100,000	45	9 (20.0)	1			
100,000 - 250,000	102	14 (13.7)	0.64 (0.25, 1.6)	0.337		
>250,000	106	13 (12.3)	0.56 (0.22, 1.42)	0.222		
Feeding Practices						
Minimum meal frequency						
Adequate	129	6 (4.7)	1		1	
Not adequate	126	30 (23.8)	6.41 (2.56, 16.02)	<0.001	3.04 (1.06, 8.72)	0.039

Continued

Minimum dietary diversity				
Adequate	242	35 (14.5)	1	
Not adequate	13	1 (7.7)	0.49 (0.06, 3.91)	0.503
Did the Caregiver received Nutritional education during ANC visits				
Yes	208	31 (14.9)	1	
No	47	5 (10.6)	0.68 (0.25, 1.85)	0.45
Is the caregiver aware on HIV related nutritional requirements				
Yes	216	28 (13.0)	1	
No	39	8 (20.5)	1.73 (0.72, 4.15)	0.217

COR; crude odds ratio, AOR; adjusted odds ratio, CI; Confidence intervals; Tanzanian shillings.

4. Discussion

The findings in this study indicate a high burden of malnutrition among HIV-infected children in Moshi Municipality, with an overall prevalence of stunting at 40.8% and wasting at 14.1%. Notably, even among children residing in urban areas, where healthcare access and living conditions are generally presumed to be better, stunting affected 38.3% and wasting 12.2%, compared with 47.8% and 19.4% respectively among rural-residing children. This finding is important because malnutrition is often assumed to be predominantly a rural problem; our data show that, in this HIV-infected paediatric population, urban residence does not confer strong protection against chronic and acute undernutrition, likely reflecting the added burden of HIV-related immunological and metabolic stress that persists regardless of setting. Both stunting and wasting were also strongly influenced by HIV clinical stage and inadequate MMF.

The prevalence of 40.8% fall in a wide range of stunting, with the studies conducted in East Africa and sub-Saharan Africa, 5.5% - 77.0% among HIV-positive children, and closer to the pooled estimate of 46.7% [2] [3]. Unlike community-based surveys, hospital-based Care and Treatment Clinics (CTCs) naturally capture a higher concentration of children presenting with complex clinical profiles. Higher stunting has been reported in other facility-based studies, such as the 61.9% stunting prevalence found among children attending CTCs in the Tanga region of Tanzania [10], and prevalence ranging between 45.2% and 56.9% in specialized paediatric hospital clinics across Ethiopia [9] [11].

We found the prevalence of wasting was 14.1%, which falls within a range of studies conducted in East African and sub-Saharan African countries, 2.5% - 52.0% and close to the pooled estimate of 23.0% [2] [3]. The estimate found in this study is four times lower compared to 52% in a study done in Senegalese children [12]. This difference may be explained by the significantly higher proportion of delayed treatment initiations in the Senegalese cohort compared to our study population. In our study, 37% of the children presented with severe immunosuppression (CD4 count < 200 cells/μL) prior to the initiation of ART, whereas in the

study in Senegalese children, 84% of the children initiated ART at a late, advanced stage of infection [12]. On the other hand, it is similar to the national prevalence of 13.0% [4], despite differences in study settings. This is because wasting reflects acute, short-term nutritional deficits or transient clinical insults such as recent diarrheal illness or seasonal household food insecurity and hence our observed wasting prevalence is likely driven by general paediatric environmental and socioeconomic vulnerabilities common across Tanzania, rather than unmitigated, HIV-driven metabolic failure.

Advanced WHO HIV clinical stages are strongly associated with stunting, as children in stage III or IV demonstrate 11 times higher odds of stunting compared to those in earlier stages. Similarly, children in stage III or IV have four times higher odds of wasting than their counterparts. Previous research indicates that advanced clinical staging and severe immunosuppression are primary contributors to both short-term and long-term growth problems among children in sub-Saharan Africa [2] [8] [9]. These associations are biologically plausible because advanced AIDS reduces appetite in children through opportunistic infections, resulting in undernutrition. Advanced HIV disease is also characterized by persistent immune activation and systemic inflammation, which increase metabolic demands and divert energy from growth processes [13] [14]. This negative energy balance impairs linear growth and leads to acute weight loss [2] [3].

MMF reflects the energy density and caloric adequacy of a child's diet. Inadequate MMF often indicates household food insecurity, including reduced meal frequency and limited food variety, both of which were prevalent in this study population. According to the WHO, meeting this standard helps prevent malnutrition in infants and toddlers and ensures adequate calorie intake [14]. Strikingly, about half of the study population did not meet the MMF threshold. Our findings indicate that children who did not meet this standard were three times more likely to experience stunting and wasting. This significant association highlights a distinct dietary dissociation within this vulnerable population. Previous studies have similarly demonstrated that inadequate MMF is strongly associated with poor growth outcomes [15] [16], emphasizing that the quantity and regularity of feeding are more critical than dietary variety alone in this population [10] [17]. High caregiver workload, competing household demands, and limited attention to older children often lead to irregular feeding routines and reduce the likelihood of meeting minimum meal frequency standards. Notably, MDD and MMF showed divergent patterns by age in this cohort: younger children (<2 years) had poorer dietary diversity (44.4% adequate) but better meal frequency (88.9% adequate), while older children (≥2 years) showed the reverse—excellent dietary diversity (96.8% adequate) but poor meal frequency (49.2% adequate). This likely reflects differing caregiving priorities: infants and young children may be fed frequently but with limited variety, relying on staple or milk-based diets, whereas older children access a more varied family diet but are fed less regularly and often unsupervised, as caregiver attention shifts toward younger siblings. Given that only 9 children fell within the WHO-validated 6 - 23-month age range for these indicators, the <2-

year estimates should be interpreted with caution due to the very small subgroup size and should be confirmed in larger samples. This pattern contrasts with findings from a comparable population in Tanga region, Tanzania, where Sunguya *et al.* [10] studied 748 HIV-positive children aged 6 months to 14 years across 9 CTCs and found considerably poorer feeding practices, with 88.1% fed below the recommended frequency and 62.3% having low dietary diversity, despite Tanga being a food-secure, high-production region. Taken together with our findings, this suggests that food availability alone does not guarantee adequate feeding practices, and that structured caregiver counselling on feeding frequency and diversity, rather than food access alone, may be central to improving adherence to IYCF recommendations in HIV-affected households.

A history of hospitalisation was independently associated with both stunting and wasting. Children without prior hospitalisation exhibited a 55% lower likelihood of stunting but were more than twice as likely to experience wasting. Hospitalisation history likely serves as a proxy for recurrent severe infections and episodes of acute illness that further deplete nutritional reserves and interrupt growth [8]. Notably, children who had never been hospitalised demonstrated lower odds of stunting, indicating that undetected or unmanaged acute events in the community may still contribute to chronic nutritional deficits. This divergence may reflect the differing time-courses of the two conditions: hospitalisation is a proxy for recurrent severe illness and cumulative morbidity, plausibly driving chronic linear growth faltering (stunting). Wasting, by contrast, is an acute condition that may be treated during admission through nutritional rehabilitation or therapeutic feeding, potentially resolving by the time of assessment. Wasted children with no hospitalisation history may therefore represent cases of ongoing, undetected acute malnutrition in the community that have not yet prompted clinical intervention, a group warranting targeted community-level screening.

The study has several notable strengths. It included children aged 6 months to 14 years, enabling assessment of nutritional indicators across key developmental stages, and used comprehensive sampling from all 10 Care and Treatment Clinics (CTCs) in the municipality, increasing representativeness of the local HIV-infected paediatric population.

However, it has important limitations. The cross-sectional design prevents causal inference, so specific factors cannot be concluded to have caused stunting or wasting. Dietary behaviours (MMF and MDD) were assessed using maternal or caregiver 24-hour recall, which is subject to recall and social desirability biases and may lead to inaccurate reports of usual dietary patterns and food insecurity.

Further limitations should be noted. Although MDD and MMF have been formally validated only for children aged 6 - 23 months, several studies have applied them to older children. In the present study, the 6 - 23-month subgroup included only nine children, so estimates for this group should be interpreted with caution. Extension of these indicators beyond the validated age range should be regarded as descriptive. Finally, as a facility-based sample restricted to children actively attending CTC visits, the findings may not be generalisable to HIV-infected chil-

dren who are lost to follow-up, undiagnosed, or not engaged in routine care.

5. Conclusion

Stunting and wasting remain common among HIV-infected children in Moshi Municipality. Advanced HIV disease and inadequate meal frequency are the main modifiable risk factors. These results highlight the complex interactions between biomedical and socio-behavioural factors that contribute to malnutrition in this population.

Recommendations

Integrate routine nutritional screening and counselling, with strong emphasis on minimum meal frequency, into every CTC visit. Prioritise intensified nutrition support for children in WHO stage III/IV and those with history of hospitalisation. Strengthen caregiver education programmes and multisectoral food security initiatives. Future longitudinal studies should assess the impact of targeted feeding interventions on growth outcomes, particularly approaches such as structured feeding schedules and micronutrient supplementation among HIV-infected children.

Author Contributions

SMB conceived and designed the study, collected data, performed analysis, and drafted the manuscript. AS, GK, and RP supervised the study and critically reviewed the manuscript. AA performed analysis and reviewed the manuscript.

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Conflicts of Interest

The authors declare that they have no financial, personal, or institutional conflicts of interest related to this study.

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