



OPEN Associated factors with nutrient intake and nutritional status of HIV positive breastfeeding mothers in apac district: a cross-sectional study

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Undernutrition among HIV/AIDS patients impedes the achievement of sustainable development goals by placing additional strain on healthcare systems. HIV causes nutrient loss and malabsorption, increasing nutritional requirements, particularly in lactating women. HIV-infected breastfeeding mothers are at greater nutritional risk than their non-HIV counterparts. Although global studies have addressed maternal undernutrition, few in Uganda have focused on factors affecting nutrient intake and nutritional status among HIV-positive breastfeeding women. This study aimed to explore these factors in Apac District. A cross-sectional study involving 220 HIV-positive breastfeeding mothers was conducted. A pre-tested 24-hour recall questionnaire, using the dietary diversity score for women (DDS-W), was used to collect data. Nutritional status was assessed using body mass index (BMI), while nutrient intake was determined by entering actual intakes into an Excel sheet to calculate total nutrient intake per individual, from which mean nutrient intake and mean adequacy ratio (MAR) were calculated. Data were analysed using Stata version 15 at univariate, bivariate, and multivariate levels. The level of significance was set at 5%, with a 95% confidence interval; the null hypothesis was rejected when p-values were less than 0.05. A total of 10.6% of participants were undernourished, with a dietary diversity score of 4.3 food groups, while 21% had a poor dietary diversity score. Participants met 61% of their recommended micronutrient intake, with energy, lipid, zinc, calcium, and vitamins A, C, B6, and B12 intakes below recommendations. Factors associated with nutritional status included maternal age [AOR = 1.94, 95% CI (1.05–3.59)], presence of a market [AOR = 0.42, 95% CI (0.223–0.784)], means of obtaining food [AOR = 0.55, 95% CI (0.234–0.94)], and presence of cultural food taboos [AOR = 0.44, 95% CI (0.136–0.998)]. Factors associated with nutrient intake were presence of a market [$p = 0.018$, 95% CI (0.010–0.104)], income [$p = 0.010$, 95% CI (0.007–0.048)], DDS [$p < 0.001$, 95% CI (0.022–0.058)], and household head [$p = 0.049$, 95% CI (–0.095–0.001)]. There is a prevalence of undernutrition among HIV-positive breastfeeding mothers in Apac District, accompanied by poor dietary diversity scores and low micronutrient intake. Interventions to increase dietary diversity scores, provide nutrition education, and improve income should be promoted.

The Sustainable Development Goals (SDGs) are severely hampered by the undernutrition of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) patients¹, as once a patient is hospitalised, acute undernutrition increases the pressure on healthcare systems^{2,3}. The nutritional needs of HIV-infected breastfeeding mothers are further increased by the additional nutrient loss and malabsorption caused by HIV infection, in addition to the extra nutrients required due to the body's increased nutritional demands during lactation. Besides raising the breastfeeding mother's nutritional needs, HIV infection also makes her more susceptible to other infections, increasing her risk of undernutrition and posing additional risk to the unborn child. Undernutrition among women of reproductive age has a significant negative impact on both their own health and that of their children⁴.

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Globally, there were 1.3 million pregnant women living with HIV in 2021; 81% of these women are estimated to have taken antiviral medications to prevent mother-to-child transmission⁵. Despite encouraging global progress, the prevalence of undernutrition among pregnant women in Africa is 23.5%, making it the continent with the highest rates of pregnancy undernutrition⁶. A total of 8,485,854 pregnant women were newly tested for HIV in Uganda between 2015 and 2018 during antenatal care (ANC), labour and delivery, and lactation phases. Of these, 200,786 (2.4%) tested HIV-positive⁵. According to the Uganda Population-based HIV Impact Assessment (UPHIA)⁵, HIV prevalence among pregnant women in Uganda is 7.2%. Currently, 815 million people (11%) suffer from hunger and undernutrition in all its forms due to various circumstances, with wars and climate change being the two main causes⁷.

Evidence suggests that 13% of women worldwide are underweight and 33% are anaemic, at least half of whom are affected by iron deficiency, while these percentages rise to 20–25% for underweight and 48–57% for anaemia in underdeveloped nations⁸ in underdeveloped nations. Women in low-income countries frequently have low body mass indices ($< 18.5 \text{ kg/m}^2$) and/or short stature (height $< 145 \text{ cm}$), with the highest rates in southern and southeastern Asia, followed by sub-Saharan Africa (SSA)^{9,10}. Additionally, statistics from 2000 to 2015 in SSA show that undernourishment affects those aged 15 to 49 in the region, with the lowest rates in Swaziland (3.2%) and the highest rates in Eritrea (37.3%)¹¹. Hunger and undernutrition affect women's ability to perform physical labour, attend school, and earn income⁸. Poor nutrition costs Africa and Asia 11% of their Gross Domestic Product (GDP) each year, while undernutrition also has a negative economic impact¹².

Maternal undernutrition is a significant issue in SSA countries due to insufficient food intake, high energy expenditure, frequent menstrual cycles, and frequent infectious diseases such as malaria and human immunodeficiency virus (HIV), resulting in unacceptably high rates of morbidity and mortality, and negatively impacting socioeconomic conditions^{13,14}.

According to the Uganda Demographic and Health Survey (UDHS) (2016), the national prevalence of undernutrition among women of reproductive age is 8.6%, while in the Lango sub-region, the prevalence is 12.8%, which is above the national average. According to the District Health Information System (DHIS II) (2021), over the past three years from 2019 to 2021, there has been an increasing trend of undernutrition among HIV-positive breastfeeding mothers. This has led to an increase in the prevalence of undernutrition among HIV-exposed infants from 10% to 35%. This is a worrying trend because the Ministry of Health Uganda advises HIV-positive mothers to breastfeed their infants exclusively for the first six months of life and to continue nursing for at least another 12 months while supplementing their diets. This means the infant depends on the mother's nutrient supply for growth and development. However, HIV-positive mothers face the double burden of breastfeeding and HIV disease, which affects the body's ability to absorb nutrients on which the infants depend. According to a study by Kyamwine et al.¹⁵ on the pattern of wasting among pregnant and lactating women, northern Uganda had high and rising rates of wasting. The authors advised the Ministry of Health (MoH) to maintain nutritional interventions for undernutrition with special attention to these regions and to conduct a causal analysis to clearly understand the factors underlying undernutrition among these mothers. In addition, few studies have examined the factors associated with nutrient intake and nutritional status among HIV-positive lactating women. In Apac specifically, there is limited published evidence on this subject. Therefore, this study aimed to determine the factors associated with nutrient intake and nutritional status among HIV-positive breastfeeding mothers in Apac district. This could help policymakers design appropriate and effective interventions to enable HIV-positive breastfeeding mothers to benefit from various projects. The study could also raise awareness and contribute to the existing body of knowledge.

Materials and methods

Study area

The study was conducted in Apac District in northern Uganda, where four government health facilities – Apac General Hospital, Teboke Health Centre (HC) III, Akokoro HC III, and Ibuje HC III – were selected to provide a representative sample of the district. The distance between Kampala and Apac District is approximately 250 km. The district is located between latitudes 2°N and 3°N and longitudes 32°E and 34°E. It is bordered by Kilelesh District to the north, Dokolo District to the east, Masindi District to the west, and Amolatar District to the south. The district covers a total area of 2,946.6 km², of which 76% is suitable for habitation and 11% is covered by open water and woodland. The population distribution is uneven, with 93.8% living in rural areas and 6.2% in urban areas. Apac General Hospital has an active HIV clinic with 4,540 active clients, of whom 2,803 are women of childbearing age. There are 432 active clients in the mother-baby care clinic, with about 40 clients attending daily.

Study design

The study used a cross-sectional design with a quantitative data collection method, chosen for its efficiency and cost-effectiveness in examining multiple variables. This approach enables extensive statistical analysis and supports drawing significant inferences from the data collected.

Study population

The study population comprised HIV-positive breastfeeding mothers attending the Early Infant Diagnosis (EID) care clinic in Apac district during the study period. The target population was HIV-positive breastfeeding mothers within the district.

Sample size calculation

The sample size was calculated using the Kish Leslie (1965) formula for single proportions as follows:

$$n = Z^2 PQ / e^2$$

Where n=sample size.

p=prevalence of undernourished HIV positive breastfeeding mothers, = 15.4%¹⁶ = 0.154.

q = 1 - 0.154 = 0.846.

z = 1.96 (the z score corresponding to 95% confidence interval).

e = maximum error = 0.05.

1. $1.96^2 \times 0.154 \times 0.846$.

2. 0.0025.

= 200.

Additional 10% was added to cater for non-respondents giving a total of 220 participants.

Inclusion and exclusion criteria

Inclusion criteria

HIV-positive breastfeeding mothers attending the exposed infant clinic during the study period who consented to participate in the study.

Exclusion criteria

HIV-positive breastfeeding mothers attending the exposed infant clinic during the study period who were critically ill or on alternative feeding.

Sampling procedures and techniques

Three research assistants, all nurses with degree qualifications, were recruited as data collectors for this study. Before data collection, all research assistants completed three days of training to ensure consistency and accuracy. This training was necessary due to the complexity of the instruments and the need for standardised procedures. The principal investigator and co-authors facilitated the training, providing both theoretical guidance and practical demonstrations. For data collection, the study used a simple random sampling approach, giving each participant an equal chance of selection. Before data collection at the EID clinic, a research assistant at the mother-baby clinic informed the women about the study. Those who met the criteria were individually given information and a consent form before completing the questionnaires.

Study variables

The study included both dependent and independent variables. The dependent variables were the level of nutrient intake and nutritional status.

Determination of nutrient intake

The breastfeeding mothers were asked to recall all foods and drinks, including snacks, consumed during the previous 24-hour reference period. Portion sizes were obtained from respondents, and food descriptions were confirmed using food models of known weight, then converted to grams using weighing scales. The nutrient intakes of the breastfeeding mothers were calculated using the food composition table compiled by Harvest Plus¹⁷, with multiple Microsoft Excel sheets. Adequate intake was defined as meeting or exceeding the recommended dietary allowance (RDA) value for each nutrient and was computed as percentage adequacy¹⁸. The nutrient intake adequacy ratio (NAR) for each selected nutrients was also calculated based on the RDA and recommended nutrient intake (RNI) cited above. The NAR was used to assess nutrient intake, while adequate nutrient intake was determined using the mean adequacy ratio (MAR). The MAR for micronutrients was calculated for 11 micronutrients: calcium, iron, vitamin A, vitamin B6, vitamin C, vitamin B12, zinc, thiamine, niacin, riboflavin, and folate¹⁹. The actual NAR values were truncated at 1 in the computation of MAR so that a nutrient with a high NAR could not compensate for a nutrient with a low NAR²⁰.

$$\text{NAR} = \frac{\text{Nutrient intake}}{\text{Recommended intake}} \times 100\%$$

$$\text{MAR} = \frac{\sum \text{NAR (each truncated at 1)}}{\text{Number of nutrients}}$$

Truncation to 1 was done in such a way that any value of NAR less than 1 was not truncated e.g., 0.1, 0.95 etc. Any value of NAR greater than 1 e.g., 3.3, 1.7 were truncated to 1.0 so that all the values of MAR ranges from 0 to 1.

Determination of diet quality

Diet quality was assessed using the dietary diversity score, following the recommendations of the FAO and Food and Nutrition Technical Assistance (FANTA) III for the minimum dietary diversity for women (MDD-W)²¹. Food was divided into 10 categories: (1) Grains, white roots and tubers, and plantains; (2) Pulses (beans, peas and lentils); (3) Nuts and seeds; (4) Milk and milk products; (5) Meat, poultry and fish; (6) Eggs; (7) Dark green leafy vegetables; (8) Other vitamin A-rich fruits and vegetables; (9) Other vegetables; and (10) Other fruits. Respondents were asked whether they had consumed any of the 10 food groups in the past 24 h. Each food group consumed was awarded one point, while each food group not consumed received zero points. These

points were summed to produce the Individual Dietary Diversity Score (IDDS). Respondents who consumed fewer than three food groups were classified as having poor dietary diversity; those who consumed four to five food groups were categorised as having moderate DDS; and those who consumed six or more food groups were classified as having high DDS²². The following assumptions were made: foods were cooked uniformly across all participants, nutrient levels were the same in all ingredients consumed, and all respondents had the same efficiency of digestibility and absorption.

Determination of nutritional status

Body mass index (BMI) was used to assess nutritional status. The weight of breastfeeding mothers was measured with an adult weighing scale, and their height was measured with a portable height metre with a movable headpiece. The accuracy of the instrument was checked daily against a standard weight. After weighing each lactating participant, the indicator's calibration was confirmed at zero. BMI was calculated for each participant as weight (kg) divided by height squared (m^2). Women were classified as underweight if their BMI was less than 18.5 kg/m^2 , normal if their BMI was between 18.5 and 24.99 kg/m^2 , and overweight if their BMI was over 25 kg/m^2 ²³.

Independent variables

Independent variables included age, education level, income level, marital status, religion, food taboos, presence of a market, occupation, and household size.

Data collection Tool

A 24-hour recall questionnaire for women was used to determine the food groups consumed, level of nutrient intake, and dietary diversity score (DDS). Food models were used to estimate the portion sizes of different food items consumed. The questionnaire was structured into sections on socio-demographic information, quantity of food consumed in the past 24 h, food groups consumed, weight, height, and BMI.

Data quality control

To ensure reliability, the researchers used test-retest techniques conducted by a single individual for consistency. To ensure validity, the researcher applied content validity, designing the items to cover the domains of the attributes they were intended to measure. Trained research assistants with knowledge of the local language were recruited to collect data under supervision. The data collection tool was pretested at Oilepek Health Centre III to improve its validity and reliability. Regular meetings were held with the research team to identify any challenges encountered and to determine how to address them for uniformity. The health centres were selected to ensure representation of the district.

Data management and analysis

Stata version 15 was used for data analysis. Univariate analysis was conducted to produce descriptive statistics such as mean, standard deviation, median, frequency, and percentages. Bivariate analysis was conducted to assess the relationship between independent and dependent variables. Multivariate tests such as logistic regression was used to identify factors associated with nutritional status, and multiple linear regression was used to identify factors associated with nutrient intake (adequacy) among HIV-positive breastfeeding mothers. For categorical variables such as DDS, the 'moderate' category was used as the reference group in regression models to provide a balanced baseline, enabling comparisons with both the 'poor' and 'high' categories. Income was log-transformed to correct for skewness and reduce the influence of outliers. This transformation was necessary to improve model fit and ensure valid regression estimates. The level of significance was set at 5%, with a 95% confidence interval.

Results

Sociodemographic characteristics of HIV positive breastfeeding mothers in Apac district

The findings in Table 1 indicate that all 220 participants in the calculated sample size responded, resulting in a response rate of 100%. The mean age of respondents was 28.7 ± 6.5 years. The majority (52.7%) were married, and most household heads were fathers (60.5%). Most respondents (81.4%) had attained primary education, with the majority (68.6%) being peasants. The mean monthly income was $266,771 \pm 5,000$ Ugandan shillings. Christianity was the predominant faith (84.1%), and the average household size was 5.6 ± 2.0 members. The main source of food for most households was own production (65.6%), and the mean monthly household expenditure on food was $76,172 \pm 70,000$ Ugandan shillings.

Nutritional status of breastfeeding HIV positive mothers in Apac district

As shown in Table 2, the mean body mass index (BMI) was $21.8 \pm 3.0 \text{ kg/m}^2$. The distribution of BMI categories shows that the majority (80.7%) were classified as normal weight, while smaller percentages were undernourished (10.6%), overweight (7.3%), or obese (1.4%). Thus, the prevalence of undernutrition was 10.6%.

Dietary diversity score (DDS) and food group consumption of HIV positive breastfeeding mothers in Apac district

The dietary diversity score of the study participants was 4.23 ± 1.16 , indicating that, out of 10 food groups, they had consumed 4 food groups in the 24 h preceding the interview. Regarding DDS achievement, 21% of the breastfeeding mothers had a poor dietary diversity score, as shown in Table 3. Among the food groups consumed, plant-based sources were dominant. The most commonly consumed food group was cereals, roots, and tubers (22.68%), while the least consumed were eggs and other fruits (0.83%), as shown in Fig. 1.

Characteristics	n (%) / mean ± SD
Age in years: mean (SD)	28.7(6.5)
Marital status: Single, n (%)	35(15.9)
Divorced, n (%)	63(28.6)
Married, n (%)	116(52.7)
Widowed, n (%)	6(2.7)
Household head: Father headed	133(60.5)
Mother headed	58(26.4)
Elderly headed	24(10.9)
Caretaker headed	5(2.2)
Education level: No formal education	7(3.2)
Primary	179(81.4)
Secondary	27(12.3)
Diploma	6(2.7)
Degree	1(0.5)
Occupation: Salary earner	14(6.4)
Peasant	151(68.6)
Not employed	5(2.3)
Business	50(22.7)
Monthly income in Ugandan shillings: mean (SD)	266,771(5000)
Religious affiliation: Christianity	185(84.1)
Islamic	32(14.6)
Others	3(1.4)
Household size in numbers: mean (SD)	5.6(2.0)
Main source of food: Own production	143(65.6)
Purchase	74(34.4)
Monthly expense on food: mean (SD)	76,172(70,000)

Table 1. Sociodemographic characteristics of HIV positive breastfeeding mothers in Apac district ($n = 220$).

Characteristics	n (%) or (Mean ± SD)
BMI mean (SD)	21.8(3.0)
BMI category: Underweight	23(10.6)
Normal	176(80.7)
Overweight	16(7.3)
Obese	3(1.4)

Table 2. Nutritional status of breastfeeding HIV positive mothers in Apac district ($n = 220$).

DDS Category	Frequency (n)	Percentage (%)
Poor	47	21.5
Moderate	136	62.1
High	36	16.4

Table 3. Dietary Diversity Score (DDS) of HIV positive breastfeeding mothers in Apac district ($n = 220$).

The level of nutrient intake by HIV positive breastfeeding mothers in Apac district

The mean adequacy ratio (MAR) was 0.61 ± 0.16 , indicating that the breastfeeding mothers were meeting only 61% of their micronutrient intake recommendations. As shown in Table 4, the intake of vitamin A, folate, vitamin B6, vitamin B2, vitamin B1, vitamin C, iron, calcium, carbohydrates, lipids, and energy significantly deviated from the recommended levels ($p < 0.001$), except for vitamin B3 ($p > 0.05$). Some nutrients exceeded the recommended values (e.g., lipids and iron), while others were below (e.g., vitamin A, vitamin B12, vitamin B6, etc.). Notably, no participant met the RDA for vitamin A, while the nutrients consumed above average were carbohydrate (88.4%), iron (84.0%), folate (77.8%), and vitamin B1 (66.2%).

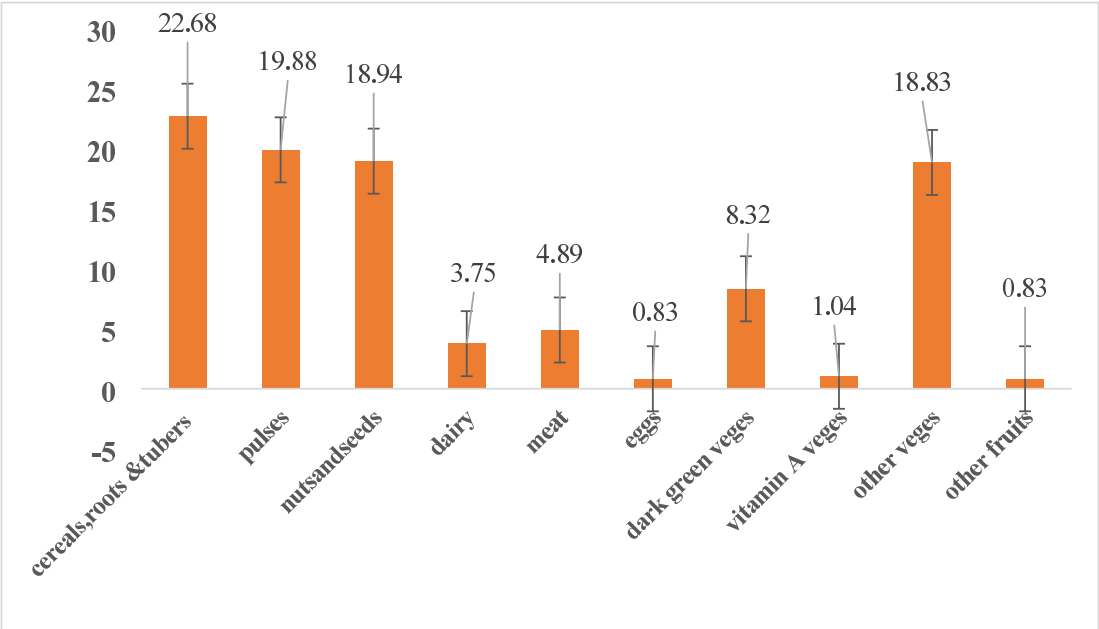


Fig. 1. Different food groups consumed by HIV positive breastfeeding mothers in Apac district.

Variables	Mean	SD	Recommended Daily intake	Percentage meeting the recommendations	t(p-value)
Vitamin A (µg)	154.52	179.31	1300	0.0	95.8(<0.001)
Vitamin B12 (µg)	1.66	5.42	2.8	10.2	-3.14(0.0019)
Folate (µg)	756.46	364.99	500	77.8	10.53(<0.001)
Vitamin B6 (mg)	1.45	1.01	2	18.7	-8.18(<0.001)
Vitamin B3 (mg)	24.66	201.35	17	18.2	1.71(0.088)
Vitamin B2 (mg)	5.75	9.94	1.6	44.0	6.3(<0.001)
Vitamin B1 (mg)	1.72	0.93	1.4	66.2	5.2(<0.001)
Vitamin C (mg)	65.74	58.05	120	15.1	14.02(<0.001)
Zinc (mg)	11.28	6.59	12	36.9	-1.65(0.101)
Iron (mg)	17.10	10.01	9	84.0	12.2(<0.001)
Calcium (mg)	533.84	591.73	1000	13.3	11.8(<0.001)
Carbohydrate (g)	399.32	186.50	210	88.4	15.2(<0.001)
Lipid (g)	34.28	36.58	66	15.6	13.0(<0.001)
Protein (g)	84.73	109.00	71	46.2	-2.08(0.038)
Energy (kcal)	2234.48	1047.83	2380	40.9	1.89(0.06)

Table 4. The level of nutrient intake by HIV positive breastfeeding mothers in Apac district (n = 220).

Bivariate analysis of factors associated with nutritional status of HIV positive breastfeeding mothers in Apac district

This bivariate analysis examined several factors associated with nutritional status. Age was significant, with individuals over 28 years having a higher prevalence of undernutrition compared to those under 28 (37.6% vs. 25.4%, $p=0.049$). Cultural food taboos were also significant, as those without such taboos had a higher prevalence of undernutrition (29.1% vs. 48.1%, $p=0.045$). The main means of obtaining food was significant as well, with those who purchased food having a higher prevalence of undernutrition compared to those who produced their own food (21.3% vs. 37.2%, $p=0.016$). The presence of a nearby market was also significant, with individuals living near a market having a lower prevalence of undernutrition (45.0% vs. 26.4%, $p=0.008$), as shown in Table 5.

Multivariate analysis of factors associated with nutritional status of HIV positive breastfeeding mothers in Apac district

In the multivariate analysis, age remained significant, with individuals aged 28 and above having a 94% higher chance of being undernourished (AOR = 1.94, $p=0.036$) compared to those younger than 28. For food access,

Variable	Nutritional status		X ²	df	p-value
	Normal	Non-normal			
Age in years					
≤28 years	83(74.1)	29(25.9)	3.84	1	0.049*
>28 years	67(62.0)	41(38.0)			
Marital status					
Single	24(68.6)	11(31.4)	0.719	3	0.869
Married	80(68.4)	37(31.6)			
Divorced	41(66.1)	21(33.9)			
Widowed	5(83.3)	1(16.7)			
Education level					
No formal education	6(85.7)	1(14.3)	1.56	3	0.668
Primary	119(66.5)	60(33.5)			
Secondary	20(74.1)	7(26.0)			
Tertiary	5(71.4)	2(28.6)			
Occupation					
Peasant	106(68.0)	50(32.0)	0.001	1	0.977
Salary/business	44(68.7)	20(31.3)			
Average monthly Income (UGX)					
≤100,000	47(64.4)	26(35.6)			
100,001–200,000	34(68.0)	16(32.0)	1.35	3	0.717
200,001–300,000	25(75.8)	8(24.4)			
Above 300,000	36(67.9)	17(32.1)			
Religion					
Christian	128(69.2)	57(30.8)	0.64	1	0.424
Islam	22(62.9)	13(37.1)			
Religious food taboos					
Yes	8(61.5)	5(38.5)	0.321	1	0.571
No	145(69.0)	65(31.0)			
Cultural food taboos					
Yes	14(51.9)	13(48.1)	4.01	1	0.045*
No	136(70.5)	57(29.5)			
Household size					
≤5	78(71.6)	31(28.4)	10.86	1	0.353
>5	72(64.9)	39(35.1)			
Main means of obtaining food					
Own production	89(62.7)	53(37.2)	5.78	1	0.016*
Purchase	59(78.7)	16(21.3)			
Presence of nearby market					
Yes	33(55.0)	27(45.0)	7.06	1	0.008*
No	117(73.1)	43(26.9)			
Dietary diversity score					
Poor	33(70.2)	14(29.8)	0.07	2	0.964
Moderate	98(67.6)	47(32.4)			
High	19(67.9)	9(32.1)			

Table 5. Bivariate analysis of factors associated with nutritional status of HIV positive breastfeeding mothers in Apac district. *Significant at 5%; X² – Chi-Square, df= Degree of freedom.

those who purchased food rather than producing it themselves had 45% lower odds of being undernourished (AOR=0.55, $p=0.037$). The absence of a nearby market significantly increased the likelihood of being undernourished (AOR=0.42, $p=0.007$). Moreover, individuals without cultural food taboos had 56% lower odds of being undernourished (AOR=0.44, $p=0.050$) compared to those with such taboos, as detailed in Table 6.

Associated factors with nutrient intake adequacy of HIV positive breastfeeding mothers in Apac district

Table 7 presents significant factors associated with micronutrient intake adequacy and mean adequacy ratios. The absence of a nearby market was significant (coefficient 0.057, $p=0.018$), indicating that individuals in areas without a market had higher micronutrient intake adequacy (MAR). Higher log income also had a

Variable	Nutritional status		AOR	z	p-value	[95% CI]
	Normal	Non-normal				
Age						
≤ 28	85(74.1)	29(25.9)	1.00			
> 28	68(62.4)	41(37.6)	1.94	2.10	0.036*	1.05–3.59
Means of accessing food						
Own production	89(62.7)	53(37.2)	1.00			
Purchase	59(78.7)	16(21.3)	0.55	−2.39	0.037*	0.234–0.94
Dietary diversity score						
Poor	33(70.2)	14(29.8)	-	-		
Moderate	98(67.6)	47(32.41)	1.00			
High	19(67.9)	9(32.1)	0.68	1.42	0.429	0.258–1.78
Presence of nearby market						
Yes	33(55.0)	27(45.0)	1.00			
No	117(73.1)	43(26.9)	0.42	−2.72	0.007*	0.223–0.784
Cultural food taboos						
Yes	14(51.9)	13(48.1)	1.00			
No	136(70.5)	57(29.5)	0.44	−2.06	0.050*	0.136–0.998

Table 6. Multiple logistic regression analysis of factors associated with nutritional status of HIV positive breastfeeding mothers in Apac district. *Significant at 5%, AOR=Adjusted odds ratio; CI=Confidence interval; 1.00 = reference category.

Mean adequacy Ratio	Coefficient	Std. error	t	p-value	[95% CI]
Presence of market					
Yes (ref)					
No	0.057	0.024	2.380	0.018*	0.010–0.104
Log Income	0.027	0.010	2.600	0.010*	0.007–0.048
Religion					
Christians (ref)					
Islamic	−0.045	0.032	−1.420	0.158	−0.108–0.018
Others	−0.156	0.106	−1.470	0.143	−0.366–0.053
Cultural Food Taboos					
Yes (ref)					
No	−0.052	0.035	−1.48	0.141	−0.121–0.017
Household Head					
Father Headed (ref)					
Mother Headed	−0.048	0.024	−1.98	0.049*	−0.095–0.001
Care Taker Headed	0.121	0.076	1.59	0.113	−0.029–0.272
Occupation					
Salary/Business (ref)	Ref				
Peasant Farmer	−0.034	0.023	−1.44	0.151	−0.080–0.012
Dietary Diversity Score	0.040	0.009	4.32	<0.001	0.022–0.058
Constant	0.157	0.139	1.13	0.260	−0.117–0.430

Table 7. Multiple linear regression analysis of factors associated with mean adequacy ratio among HIV positive breastfeeding mothers in Apac district. * Indicates significant variable at 5%; ref=reference category.

positive impact on micronutrient intake adequacy (coefficient 0.027, $p=0.010$). Dietary diversity score had a significant positive effect (coefficient 0.040, $p<0.001$); therefore, individuals with more diverse diets had better micronutrient intake adequacy.

Discussion

Nutritional status of breastfeeding HIV positive mothers in Apac district

The study revealed notable cases of both undernutrition and overnutrition within the same population. This coexistence of undernutrition alongside overweight and obesity highlights the double burden of malnutrition among the mothers studied. The prevalence of undernutrition is above the national prevalence of wasting

among pregnant and lactating mothers in Uganda, which stands at 5.5%. However, it is below the prevalence of wasting among pregnant and lactating mothers in the Lango sub-region, which stands at 17%¹⁵. This rate of undernutrition is higher than findings from other African countries, such as Nigeria with 4.7%⁴ and Zambia with 3.4%²⁴. These differences may be attributed to the socio-demographic backgrounds of the study populations and other contextual factors. However, the prevalence of undernutrition here is lower than findings from countries such as India, where the prevalence is 50%²⁵, Iran with 23%²⁵, and Ethiopia with 33.6%²⁶. The differences in prevalence rates compared to the current finding may be explained by socio-demographic backgrounds and other contextual factors when these countries are compared to Uganda in general and Apac district in particular.

On average, the dietary diversity observed was slightly higher than that documented in comparable studies from other countries, such as Ghana, where the dietary diversity score (DDS) among breastfeeding mothers was 4, and Haiti, where the mean DDS was 3 in the same population group²⁷. Furthermore, a significant proportion of respondents had poor DDS, indicating they did not meet the minimum dietary diversity score of at least four food groups for women. This finding is lower compared to other countries with a very high proportion of breastfeeding mothers not meeting the minimum DDS, such as Ethiopia with 74%²⁸ and Lebanon with 46%²⁹. Although the proportion of breastfeeding mothers with poor DDS in the current study is higher than that of Vietnam (17.4%), it is lower than that of Bangladesh, which is 31%³⁰. The differences in these findings could be attributed to socio-economic background differences among the population groups from which the data were collected. For example, Ethiopia has been suffering from wars in some parts of the country in addition to prolonged drought, which has affected food production; Lebanon has been experiencing economic and political instability, such as refugee influx and wars; Haiti and Bangladesh have stronger food taboos that restrict women's access; and some parts of Ghana have poor food variety, unlike Uganda.

Breastfeeding mothers in the study consumed less energy than recommended for their daily needs. This deficit indicates that their diets did not fully meet the energy requirements necessary to support both maternal health and lactation. This finding is consistent with other studies in Iran, Brazil, and Bangladesh, which also found that the mean energy intake of breastfeeding mothers was below recommendations^{31–34}. This deficiency means the women are unable to meet the energy needs of their children, let alone the increased needs due to their own health status. However, the findings on energy intake in this study disagree with other studies where the mean energy intake among breastfeeding mothers was above recommendations^{35,36}. This difference is related to the different contexts in which the studies were conducted. The level of carbohydrate intake was 90% above recommendations, which correlates with food group consumption, as cereals, roots, and tubers were the most consumed group. High carbohydrate intake can put individuals at risk of non-communicable diseases and disorders such as overweight, obesity, diabetes, and cancer. This finding contrasts with results from Spain, where the level of carbohydrate intake was below recommendations³⁷. This may be explained by the socio-demographic status of the study participants. The mean protein intake was 19.3% above the recommendations, in contrast to findings from China, where breastfeeding mothers had a protein deficit of 37%³⁵. The level of lipid intake was below the recommendation. A previous study found that lipid intake by breastfeeding mothers was well above the recommended value³⁷. This difference could be attributed to the different study contexts and designs. While the current study used a cross-sectional design, the study by Aparicio et al.³⁷ used a longitudinal design.

Among the nutrients consumed according to the recommendations were vitamins B1, B2, and B3, as well as folate and iron. This may be attributed to the appreciable consumption of dark green vegetables by the study participants. However, other micronutrients consumed below recommended levels included vitamins A, B6, C, and B12, as well as zinc and calcium. The respondents did not consume many vitamin A-rich vegetables, which explains the deficiency. The low intake of dairy products could account for the low calcium intake. This suggests a poor calcium supply to breastfed children, which could lead to poor bone development. The findings partly agree with a study in China, where the intake of micronutrients among breastfeeding mothers was highly inadequate for vitamins A, D, B2, B5, B6, B9, and C, as well as potassium, calcium, magnesium, zinc, copper, and iodine³¹. On the other hand, vitamins B1, B2, and B3 were found to be sufficiently consumed. Although the consumption levels of folate, B1, B2, B3, and iron met the recommendations in the current study, a previous study in Iran found the intake of iron, folate, and vitamins B1, B2, B6, and B12 to be below recommendations³⁵. The difference may be attributed to the different contexts in which the studies were conducted. The findings in this study partly agree with a previous study that found a marginal level of zinc intake meeting the recommendations. However, this study found insufficient intake of vitamin A³⁸. The deficiencies observed in energy, lipids, vitamins A, B6, C, B12, zinc, and calcium among HIV-positive breastfeeding mothers in Apac District are significant as they compromise both maternal and infant health. In mothers, these inadequacies worsen HIV-related immune suppression, increase the risk of anaemia and osteoporosis, and reduce the effectiveness of antiretroviral therapy (ART). For infants, inadequate nutrient transfer through breastmilk increases vulnerability to stunting, anaemia, and infections. From a policy perspective, these findings highlight the urgent need for integrated nutrition interventions alongside ART in Apac District among HIV-positive breastfeeding mothers to safeguard maternal wellbeing and infant development. Additionally, these nutrient deficiencies are interrelated rather than isolated. For example, inadequate energy and lipid intake reduce the absorption of fat-soluble vitamins such as vitamin A, while deficiencies in vitamins B6, B12, and C interact to worsen anaemia through impaired haemoglobin synthesis and reduced iron absorption. Zinc deficiency further weakens immune function, increasing susceptibility to opportunistic infections. Calcium deficiency, compounded by low energy and protein intake, accelerates maternal bone loss during lactation. Together, these deficiencies create a synergistic cycle that compromises maternal health, breastmilk quality, and infant nutrition.

HIV-positive breastfeeding mothers over 28 years old had an increased likelihood of being undernourished, which may be associated with larger family size and competing financial demands. However, this finding contrasts with previous research, which found that younger breastfeeding mothers were at greater risk of undernutrition than older ones³⁹, possibly due to different study contexts. The absence of a nearby market increased the

likelihood of undernutrition among participants, possibly because limited access to diverse foods from different groups results in a lower dietary diversity score and poorer nutritional status. Similarly, those who obtained food through purchase had decreased odds of being undernourished, possibly because their ability to buy a variety of foods allowed them to achieve a higher dietary diversity score. However, in the event of economic shocks, these individuals could be at greater risk of undernutrition⁴⁰. Finally, breastfeeding mothers without cultural food taboos had decreased odds of being undernourished, likely because the absence of cultural barriers enabled them to consume a wider range of foods and achieve a higher dietary diversity score. Cultural habits have been found to influence dietary practices, including nutrient intake among breastfeeding mothers¹³. DDS was not a significant factor for nutritional status, probably because DDS is used only as a proxy for micronutrient adequacy and dietary quality, rather than as a direct measure of anthropometric outcomes⁴¹. Furthermore, nutritional status is influenced by several factors beyond dietary intake, such as infection, household food security, and cooking practices, which may overshadow the independent effect of DDS in multivariate models⁴². Finally, DDS, which was measured over the preceding 24 h, captures only short-term dietary diversity, whereas nutritional status reflects longer-term cumulative exposures⁴³.

Absence of a nearby market positively affected nutrient intake adequacy, implying that mothers without a nearby market had higher MAR. This may be explained by greater reliance on own food production and traditional diets among these respondents, which could provide more consistent nutrient adequacy compared to purchased foods⁴⁴. However, this finding contrasts with the association between market absence and poorer nutritional status⁴⁵, highlighting the complex relationship between food access, diet quality, and health outcomes. Higher log income had a positive effect on nutrient intake adequacy, as higher income increases affordability and thus nutrient intake adequacy. This is consistent with a previous study by Black et al.⁴⁶, that found income to be a significant factor in predicting the level of nutrient intake. A higher DDS indicates a greater supply of nutrients to the body. The finding here is consistent with previous studies in which dietary diversity score significantly affected nutrient intake, as observed in Nepal and Brazil^{39,47}.

Study limitations

Some limitations of the study include the following: mothers were asked about their dietary intake in the preceding 24 h during the dietary diversity assessment, which is subject to recall bias and potential unmeasured confounders. Additionally, assumptions such as similar cooking methods, uniform nutrient content in all food ingredients, and uniform digestibility and absorption efficiency among respondents may not always hold true, potentially leading to overestimation or underestimation. Seasonality, which can significantly influence food availability and nutrient intake adequacy, is another limitation. The same study could be conducted in different seasons to validate the current findings. Furthermore, future studies should consider examining eating patterns using a 7-day recall or a food frequency questionnaire (FFQ), as this study assessed intake at only a single point in time.

Conclusion

This study examined the factors associated with nutrient intake and nutritional status among HIV-positive breastfeeding mothers in Apac district. The prevalence of undernutrition among participants was 10.3%. The mean dietary diversity score (DDS) was 4.3 food groups, with 21% of participants having a poor DDS. Participants met 61% of their micronutrient recommendations. Intake of energy, lipids, vitamins A, B6, C, and B12, calcium, and zinc was below recommended levels. For macronutrient intake, breastfeeding mothers consumed carbohydrates and protein above recommended values, while energy and fats were consumed below recommended values. Factors associated with nutritional status included age, presence of a market, means of obtaining food, and presence of cultural food taboos. Factors associated with nutrient intake included presence of a market, log of income, DDS, and household head. Therefore, there is a need to sensitise and raise awareness among cultural leaders about food taboos, which affect the eating patterns of this vulnerable population. There is also a need to support and improve the economic status of HIV-positive breastfeeding mothers to ensure that the majority can afford and consume a diverse diet to meet the recommended DDS, and to strengthen health education during antenatal care to improve maternal nutrition.

Data availability

The data used in the current study is available upon a reasonable request to the corresponding author.

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Author contributions

AVS, AB & OB: conceptualization, project administration, resources, supervision, investigation, methodology, formal analysis, writing, review and editing; AVS and AB: investigation, methodology, and writing original draft; AVS: writing original draft; investigation and facilitation of fieldwork. AVS, AB, OB, OJ: Methodology, writing -review and editing. All the authors reviewed and approved the final manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

This study adhered to the Declaration of Helsinki, and to this effect, formal clearance and approval to conduct the study was obtained from Gulu University Research Ethics Committee (GUREC), with registration number GUREC – 2022 – 364. Administrative permission was sought from Apac district health office that forwarded to facilities that the study was going to be conducted. At facility level permission was obtained from the facility in charge who introduced the research assistants to EID care clinic in charge where data was collected from HIV positive breastfeeding mothers. Informed voluntary consent was sought from the participants. The participants were as well assured of privacy and confidentiality of the information collected.

Additional information

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