

Relapse of undernutrition and food insecurity in a nutritional program in HIV care: mixed-methods study in Tigray region, Ethiopia.

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16

17 **Abstract**

18 **Background:** Food insecurity is one of the major contributors to poor attainment of nutritional
19 recovery among people living with HIV who are enrolled in nutritional programs. Food
20 insecurity also significantly contributes to high rates of relapse after nutritional recovery among
21 the beneficiaries of nutritional programs. Nevertheless, nutritional programs in HIV care
22 settings implemented in many countries are not designed to address food insecurity. This
23 study in Tigray Ethiopia examined relapse of undernutrition, and in particular how food
24 insecurity had an impact on effectiveness of the nutritional program, specifically relapse of
25 undernutrition after nutritional recovery.

26 **Methods:** This study employed mixed-methods approach involving quantitative and
27 qualitative methods. In the quantitative part, hospital records were collected of 1757 adults
28 and 236 children people living with HIV who were enrolled in the nutritional program. Logistic
29 and cox-regression analysis were used to examine the frequency and determinants of relapse
30 of undernutrition. In the qualitative study, data was collected through in-depth interviews with
31 20 adults, 15 caregivers of children living with HIV, and 13 health providers and program
32 managers. Thematic framework analysis was used to analyse the qualitative data.

33 **Results:** Among those who graduated from the nutritional program, 18% of adults and 7% of
34 children relapsed to undernutrition. The mean time to relapse for adults was 68.5 months (95%
35 CI, 67.0–69.9). It was not possible to calculate the average time to relapse in children because
36 of the small sample size. Lower educational status (primary and secondary), no membership
37 of a community HIV support group, ambulatory and bedridden functional status, longer periods
38 on ART (more than 24 months), presence of an opportunistic infection and poor baseline
39 nutritional status were associated with relapse of undernutrition. Furthermore, those from rural
40 areas, who did not attend formal education, were employed, and had bedridden functional
41 status, anaemia and worst nutritional status were likely to have more frequent episodes of

relapse than their counterparts. Findings of the qualitative study also highlighted that poverty, poor livelihood, and food insecurity were the fundamental challenges to the effectiveness of nutritional programs in HIV care. Household food insecurity contributed to the selling and sharing of the nutritional supports and negatively impacted the program effectiveness, delaying nutritional recovery and contributing to relapse of undernutrition.

Conclusions: Unless nutritional programs take into consideration the underlying determinants of food insecurity in the design, implementation, and funding of nutritional programs in HIV care, the success of the nutritional programs like those implemented in Ethiopia will be undermined and the vicious cycle of undernutrition amongst people living with HIV will continue.

Keywords: Food insecurity. Relapse, Mixed methods, Poverty and poor livelihood.

Background

Household food insecurity is generally defined as “the ability of the household to acquire the food needed by its members” [1]. Food insecurity is a broad concept with varying indicators across context and usually depends on the target population and scale of measurements – for example, country, household and individual levels [2]. Broadly, food security encompasses the quantity and quality of food accessed by a country, household or an individual [1, 2]. The most common measure of household food insecurity among people living with HIV/AIDS in sub-Saharan Africa is the Household Food Insecurity Access scale (HFIAS) [2]. HFIAS is a simple tool (questionnaire) designed to measure (assess, evaluate and monitor) the level of access of households to basic food [3] but it can be customised to specific countries or contexts.

Food insecurity and human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) are highly linked. Food insecurity in this study is referring to household food insecurity. Evidence suggests a high prevalence of food insecurity among people living with HIV [4-6]. For example, Nagata and colleagues found that 79% and 21% of HIV patients in a study conducted in Kenya were severely and moderately food insecure respectively [6]. Similarly, a study conducted in Ethiopia reported food insecurity among 63% of people living with HIV enrolled in HIV care [7].

Food insecurity has a range of impacts on people living with HIV such as undernutrition, non-adherence to ART and poor HIV treatment outcomes [5, 8, 9]. Research has identified food insecurity as a key barrier to ART adherence among people living with HIV [5, 10]. Food insecurity can also increase susceptibility to HIV acquisition due to affected individuals' engagement in risky sexual practices to overcome issues of food insecurity [11]. HIV infection, on the other hand, increases susceptibility to food insecurity because of loss of economic productivity and increased dependency of those living with HIV [12, 13]. In addition, in areas severely affected by the epidemic, HIV/AIDS-related mortality and morbidity results in household labour shortage, a decline in household assets, loss of essential skills and an increasing cost for the care of sick adults and orphaned children [14].

The overall aim of nutritional programs in HIV care settings is to improve nutritional status, HIV treatment outcomes, and ART adherence for people living with HIV. The types of nutritional programs and mechanisms for their implementation vary widely across countries. Many nutritional programs in sub-Saharan Africa provide ready to use therapeutic foods (RUTF) or Ready to Use supplementary foods (RUSF) for a short period of time to tackle undernutrition amongst people living with HIV [15, 16]. Alongside nutritional support, nutritional assessment and counseling are the essential components of nutritional programs in HIV care in sub-Saharan Africa [17].

Clinic-based short term food assistance programs have been proven to be beneficial for food-insecure HIV patients to improve ART adherence and temporary weight gain but do not sustainably overcome the long term nutritional needs of people living with HIV [18-21]. The absence of long term positive impact of food assistance on nutritional status among people living with HIV may be related to a narrow focus of the programs.

Various demographic and socioeconomic factors contribute to food insecurity among people living with HIV. Sociodemographic factors such as household family size, marital status (not married) and older age were associated with food insecurity among people living with HIV in Kenya [6]. An Ethiopian study reported that elementary or lower educational status, below-average monthly family income, and lower food diversity were associated with food insecurity among people living with HIV who were on ART [7, 22]. Other studies from other parts of sub-Saharan Africa have also shown that lower educational status, absence of nutritional support and low socioeconomic status were associated with poorer food insecurity [23, 24].

Research suggests that food insecurity is one of the major contributors to low attainment of nutritional recovery among people living with HIV enrolled in a nutritional care [25, 26]. Drop out (default) from the nutritional program in HIV care settings have also been found to be related to household food insecurity in sub-Saharan Africa [25, 26]. However, despite the high magnitude of food insecurity amongst people living with HIV and the role of demographic and socioeconomic issues to undernutrition, nutritional programs in HIV care settings are not designed to respond to such issues.

Nutritional programs in HIV care neither consider nor assess individual or household food insecurity when enrolling people living with HIV into nutritional programs. For this reason, maintaining nutritional status after nutritional recovery is a major challenge for both adults and children enrolled in the programs [25-28]. A study from Ethiopia showed that nutritional programs in HIV care settings were characterised by high (20%) relapse of undernutrition after nutritional recovery [25]. A small number of studies have highlighted that sharing and selling of the nutritional support are common practices among food insecure households [25, 29].

However, none of these studies have examined the impact of food insecurity on the effectiveness of the nutritional program, particularly when it comes to relapse of undernutrition. In addition, in a study that examined the use, perception, and acceptability of a nutritional support in HIV care, food insecurity was common among those enrolled in the nutritional program, though the impact on effectiveness of the nutritional programs was not explored [30]. Overall, there is a lack of evidence on how food insecurity may influence the effectiveness of nutritional programs in HIV care in Ethiopia—particularly in relation to relapse of undernutrition after nutritional recovery. Hence, this study aims to address this gap by examining the extent and predictors of relapse of undernutrition for patients enrolled in the nutritional program in HIV care in Ethiopia, with a particular focus on how food insecurity contributed to the problems of effectiveness of the nutritional program in terms of relapse of undernutrition.

Methods

Description of the nutritional program and study settings

This study was conducted in three purposively selected general hospitals (Mekelle, Lemlem Karl, and Shul) in the Tigray region, Ethiopia. In the Tigray region, there were 37 hospitals including 20 primary district hospitals, 15 general hospitals and 2 regional referral hospitals at the date of data collection (August 2016) [31]. The three hospitals were selected based on the distance from where health service was managed, coordinated and supervised in Tigray region. One hospital (Mekelle hospital) was the closest and located in Mekelle city where the health system in the region was managed and supervised while the remaining two (hospitals Shul and Lemlem Karl) were far from Mekelle city with approximately comparable distance from the centre. The selection of these hospitals was also made to minimize double-counting due to inter-hospital transfer of the study participants.

In Ethiopia, all HIV patients enrolled in chronic HIV care are regularly screened for undernutrition during their follow up visits for HIV care services. After enrolment in the nutritional program, sociodemographic, clinical, anthropometric, and nutritional outcome data is collected for monitoring and provision of RUTF or RUSF nutritional support. The enrolment and exit criteria and ration sizes are different for children and adult HIV patients enrolled in the nutritional program. While RUTF is given to individuals with severe acute undernutrition, RUSF is provided to moderate and mild undernutrition. Depending on the severity of undernutrition, adult and child patients are provided with two sachets of RUSF daily for a maximum of three months for moderate acute malnutrition (MAM) or body mass index (BMI) of ≤ 17.99 . For individuals with severe acute undernutrition, four sachets of RUTF daily for a maximum of six months for severe acute undernutrition (SAM) or BMI ≤ 16 , together with counselling is provided [25, 32].

An HIV patient (adult or a child) enrolled in the nutritional program is recorded as having an outcome of 'recovery', 'non-response', 'default' or 'relapse' after nutritional support for the program durations, summarised below (Table 1):

Table 1: Nutritional program outcomes in the nutritional program in Ethiopia.

Outcome	Definition	
	Adults	Children
Recovery	Reaching BMI of 18.5kg/m^2 for two consecutive visits	For children 6 months to 14.9 years, weight for length percent (W/L %) or weight for height percent (W/H $\geq 85\%$) on more than one occasion and absence of oedema for 10 days

Non-response	Participant did not reach a BMI of 18.5kg/m ² for two consecutive visits	All children who do not fulfill the criteria above recovery/discharge criteria for the duration
Default	Did not reach a BMI of 18.5kg/m ² and dropped out of the program	Child dropped out of the program before meeting the criteria for recovery
Relapse	Participants return either with SAM or MAM after declared nutritionally recovered	Child returned with either SAM or MAM after declared recovery and discharged from the nutritional program

Study design

This study employed a concurrent mixed-methods approach where the sequence of data collection for both the quantitative and qualitative study was irrelevant but intended to complement each other [33-35], with mixing of the two studies in the interpretation stage.

Sample size and recruitment

Quantitative and qualitative data were collected between March and July 2016. Quantitative data included records of 1756 adults and 236 children living with HIV (from November 2010 to February 2016). Data were retrieved from a paper-based database in the three selected hospitals. Records with no baseline demographic, socioeconomic, clinical, immunological, nutritional and anthropometric characteristics were excluded - a total of 24 adult and 9 child records.

The qualitative study involved in-depth interviews with 48 purposively selected individuals - 20 adults living with HIV, 15 caregivers of children living with HIV, 11 health providers, and 2 program managers. Adults and caregivers were recruited for the in-depth interviews at the health facility during their regular follow up for HIV services including the nutritional program. Health providers provided information to them about the project inviting them to contact the researcher to participate in the research if they were interested. They were assured that their participation or otherwise in the research would be confidential and have no impact on their access to services. Health providers and program managers were identified as working in the program for more than 1 year and invited to participate in the research by email, where they could contact the researcher if they would like to be involved. Participant recruitment continued until data saturation was achieved. Interviews were conducted at a venue convenient to participants, largely the HIV service while the program managers were interviewed at their workplace (Tigray regional Health Bureau head office).

Data collection procedure

Nine data collectors (three in each hospital) familiar with the hospital data management system were recruited and trained to collect quantitative data. Two different checklists for adults and children were designed covering demographic, socioeconomic, clinical, immunological, nutritional and anthropometric variables. Data were retrieved from multiple sources enabling cross-matching and included: a) nutritional program follow up form; b) HIV care follow up form, and c) ART pharmacy database. Unique ART and pre-ART number were used to match or relate data from the various sources

For the qualitative data, interview guides were developed covering issues around participants' knowledge of the nutritional program and factors enabling or constraining program utilisation. The interview guide was field-tested and further refined based on emerging concepts and ideas. In-depth interviews were conducted by the first author (FT) in the local language Tigrigna and audio-recorded. Comprehensive field notes were taken during the fieldwork.

Data management and analysis

Quantitative data analysis involved description of the demographic, socioeconomic, clinical, immunological, nutritional and anthropometric characteristics of adult and child records. In addition, description of the outcome variables such as relapses of undernutrition and frequency of relapse of undernutrition were done. For relapses of undernutrition after nutritional recovery, Kaplan Meier curve was used to estimate the average time to relapses.

To identify the baseline determinants of relapse of undernutrition, bivariate Cox regression analysis was used to estimate the crude hazard ratio. Independent variables which were statistically significant at $p < 0.3$ were taken to multivariate Cox regression to estimate the adjusted hazard ratio, with 95% CI. In multivariate Cox regression, statistical significance was declared at $p < 0.05$ and the hazard ratio was used to interpret the results.

The second outcome variable was the frequency of relapse of undernutrition. To identify the determinants of frequency of relapse of undernutrition, bivariate logistic regression was conducted to estimate the crude odds ratio and statistical significance was considered at $p\text{-value} < 0.3$. Assumptions of logistic regression such as multicollinearity and homogeneity of variance were checked and no collinearity was identified. Factors that were found to be statistically significant at $p < 0.3$ were taken to multivariate logistic regression model to determine the independent predictors of the frequency of relapse. Adjusted odds ratio with 95% CI were used to determine the magnitude and direction of relationship and statistical significance was considered at $p < 0.05$.

Qualitative interviews were translated and transcribed into English by the first author (FT). Framework thematic analysis [36] was used to analyse the qualitative data. A coding framework was developed and discussed in the team meetings until a consensus was reached among the authors. Three interviews were double coded by the authors and differences were discussed until consensus was reached. Data was analysed using QSR NVivo and themes and categories emerged after thorough reading and understanding of the interview data, field notes, and memos. Illustrative quotes are used to describe themes and categories.

Results of quantitative study

Demographic and socioeconomic characteristics of adults and children living with HIV

The most common age group for adults was the 26-35 age group (42.6%), 63% were female and two-thirds lived in urban areas (**Table 2**). More than 40% were married, and over three quarters (76.6%) had children, with the majority of people living in a household of less than 5 people. Nearly 62% of adults attended at least primary and secondary education and a large proportion of adults and parents of children living with HIV were unemployed. The vast majority of people reported their religion as Orthodox or other Christian religion. Over three quarters had disclosed their positive HIV status to at least someone, and 81% of adults were not members of a community HIV support group.

The most common age group for children was 5-10 years (43.2%) and 47.5% were female. The vast majority of children (82.6%) of children lived with their parents (of whom more than half were living together), and three quarters lived in urban areas. There were similar proportions of the children who were the first, second, third and fourth-child in their family. Most children attended school.

241 **Table 2:** Demographic and socioeconomic of adults and children enrolled in the nutritional program.

Adults (N=1757)				Children (N=236)			
Variables	Categories	Number	Percent	Variables	Categories	Percent	Number
Age	<25	216	12.3	Age	< 5 years	62	26.3
	26-35	749	42.6		5-10 years	102	43.2
	36-45	531	30.2		>10 years	72	30.5
	>46	261	14.9	Sex	Male	124	52.5
Sex	Male	649	36.9		Female	112	47.5
	Female	1108	63.1	Residence	Urban	179	75.8
Residence	Urban	1171	66.6		Rural	57	24.2
	Rural	586	33.4	Child lives with	Parents	195	82.6
Marital status	Never married	265	15.1		Gurdian	15	6.4
	Married (In. defacto)	722	41.1		Grand parents	2	0.8
	Separated	164	9.3		In orphanage	14	5.9
	Divorced	381	21.7		Sibilings	10	4.2
	Widow/Widower	225	12.8	Marital status of parents, n=195	Mother and father live together	100	51.3
	No education	535	30.4		Divorced	16	8.2

Education status	Primary	637	36.3		Widowed	5	2.7
	Secondary	459	26.1		Single father parent	18	9.2
	Tertiary	126	7.2		Single mother parent	54	27.7
Religion	Orthodox and other Christian	1659	94.4	Mother alive, n=208	Yes	175	84.1
	Muslim	98	5.6		No	33	15.9
Employment	Working	871	50.8	Employment status of mother if alive. n=147	Employed	55	37.4
	Employed but not working due to ill health	111	6.5		Unemployed	92	62.6
	Unemployed	732	42.7	Father alive, n=202	Yes	146	72.3
Household family size	≤5	1543	87.8		No	56	27.7
	>5	207	11.8	Employment status of father if alive. n=126	Employed	90	71.4
Have children	Yes	1346	76.6		Unemployed	36	28.6
	No	411	23.4	Child's birth order	First	32	13.6
Membership of HIV related community support group	Yes	333	19.0		Second	42	17.8
	No	1424	81.0		Third	32	13.6
	Yes	1366	77.7		Fourth and above	28	11.9

Disclosure to at least someone	No	391	22.3	Child atted school	Yes	170	72.0
Name of hospital	Mekelle	1045	59.5		No	66	28.0
	Lemlem Karl	378	21.5		Too young	60	90.1
	Shul Hospital	334	19.0	Reason for not atteding school, n=66	Lack of fund	6	9.1
				Name of hospital	Mekelle	189	80.1
					Lemlem Karl	24	10.2
					Shul	23	9.7

242

243 **Clinical and immunological characteristics of adults and children living with**
244 **HIV**

245 The functional status of the majority of adult participants was ‘working’ (83.8%), while 50.5%
246 of adults and 56% of children were in WHO clinical stage I. Furthermore, 94% of adults and
247 88% of children were on ART at baseline or at the time of enrolment in the nutritional program.
248 In addition, 45.7% of adults were anaemic at enrolment. 64% of adults and 72% of children
249 had been on ART for 24 months at enrolment to the nutritional program. A quarter (25%) of
250 adults and 22% of children had opportunistic infections, with TB being the major opportunistic
251 infection in both groups (**Table 3**).

252 **Table 3:** Clinical and immunological characteristics of adults and children enrolled in the nutritional program.

Adults (N=236)				Children (N=236)			
Variables		Number	Percent	Variables			
Functional status	Working	1473	83.8	WHO clinical stage	Stage I	132	55.9
	Ambulatory	207	11.8		Stage II	42	17.8
	Bedridden*	77	4.4		Stage III	50	21.2
WHO clinical stage	Stage I	888	50.5		Stage IV	12	5.1
	Stage II	225	12.8	ART status at enrolment	On pre-ART	29	12.3
	Stage III	518	29.5		On ART	207	87.7
	Stage IV*	126	7.2	Duration on ART	<12 months	27	13.0
Baseline CD4 count	<200	675	39.0		13-24 months	31	15.0
	200-349	488	28.2		>24 months	149	72.0
	350-500	294	17.0	Contrimoxzole prophylaxis	Yes	209	88.6
	>500	274	15.8		No	27	11.1
Presence of anaemia	Anaemic	687	45.7	Presence of opportunistic infection	Yes	52	22.0
	Not Anaemic	815	54.3		No	184	78.0

ART status	Pre-ART	100	5.7	Type of opportunistic infection	TB	14	26.9
	ART	1657	94.3		TB and other	10	19.2
Duration on ART	<6 months	324	19.6		Other	28	53.8
	6-12 months	99	6.0	Eligibility criteria to ART	WHO clinical stage only	28	11.9
	12-24 months	175	10.6		CD4 or TLC only	15	58.5
	>24 months	1059	63.9		CD4% only	47	19.9
Presence of opportunistic infection	Yes	436	24.8				
	No	1321	75.2				
Type of opportunistic infection	TB	152	37.3				
	TB and others	47	11.5				
	Others	208	51.1				

253 *stage IV and bedridden indicate severe clinical condition

Nutritional and anthropometric characteristics of adult and child participants

Before enrolment into the nutritional program, 62.5% of adults and 80% of children participants had moderate undernutrition, while 23% of adults and 8% of children had severe acute undernutrition. Almost 78% of adults received less than three sachets per day during their engagement with the program. Having good appetite was one of the criteria for enrolment into the nutritional program and almost all of the adults reported having good appetite. Those with poor appetite were treated for the cause before enrolment into the nutritional program. Usually, the causes of poor appetite were opportunistic infections (Table 4).

After enrolment in the nutritional program, 55% of adults and 71% of children recovered or achieved the graduation criteria of a target BMI. Non-response (not meeting target BMI) was identified in 21% of adults and 14% of children. Amongst the study cohort, 18% of adults and 14% of children failed to complete the program. Among those who achieved nutritional recovery, 18% of adults and 7% of children later relapsed (Table 4).

268 **Table 4:** Nutritional characteristics of adults and children enrolled in the nutritional program

Adults (N=1757)				Children (N=236)			
Variables		Number	Percent	Variables		Number	Percent
Nutritional status at enrolment	Mild acute undernutrition	253	14.4	Nutritional status at enrolment	Mild acute undernutrition	29	12.3
	Moderate acute undernutrition	1098	62.5		Moderate acute undernutrition	188	79.7
	Severe acute undernutrition	406	23.1		Severe acute undernutrition	19	8.1
Number of sachets/ day	≤ 3	1362	77.6	Duration on nutritional program	<3 months	28	11.9
	≥4	394	22.4		3 months	193	81.8
Appetite test done	Yes	1731	98.5		>3 months	15	6.4
	No	26	1.5	Nutritional outcome	Graduated	167	70.8
Appetite test results	Good*	1150	65.5		Non-respondent	33	14.0
	Poor	580	33.0		Defaulted	33	13.9

Subsequent weight gain	Good*	1650	93.9		Died	2	0.8
	Poor	70	4.0		Transferred out	1	0.4
Nutritional outcome	Graduated/recovered	971	55.3	Relapse of malnutrition	Yes	12	7.2
	Non-respondent	379	21.0		No	154	92.8
	In completed(Defaulted)	329	18.7				
	Death	35	2.0				
	Transferred out	43	2.4				
Relapse after nutritional recovery (n=968)	Yes	170	17.6				
	No	801	82.4				

Determinants of relapses of undernutrition

The total time to relapse after nutritional recovery in the nutritional program was 68.5 months (95% CI 67.0-69.9). We conducted bivariate and multivariate Cox regression to identify the independent predictors of relapses of undernutrition after nutritional recovery.

In multivariate Cox regression, statistical significance was declared at $P < 0.05$. Accordingly, educational status, membership of an HIV community support group, duration on ART, ambulatory and bedridden functional status, presence of opportunistic infections, moderate and severe acute undernutrition were significantly associated with relapse of undernutrition after nutritional recovery. Adults who attended primary and secondary education were 2.8 and 3.7 times more likely to relapse than those who attended tertiary and above, but there was no difference for those who had no education. Non-membership of HIV community support group was associated with a 1.7 times higher chance of relapse than those who were members of community HIV support group. In addition, those who had been on ART for longer periods were more likely to relapse than those who had been less than 24 months on ART. Adults who had opportunistic infections at baseline were 1.7 times the risk of relapse of undernutrition after nutritional recovery (**Table 5**).

288 **Table 5:** Determinants of relapse of undernutrition after nutritional recovery

Variables		Relapse of malnutrition		Crude Hazard ratio (95% CI)	Adjusted Hazard ratio (95% CI)	P-value
		No	Yes			
		No (%)	No (%)			
Sex	Male	289(83.5)	57(16.5)	0.92(0.67-1.27)	0.91(0.64-1.29)	0.591
	Female	509(81.8)	113(18.2)	1.0	1.0	
Residence	Urban	533(81.5)	121(18.5)	1.16(0.83-1.62)	0.94(0.65-1.34)	0.740
	Rural	265(84.4)	49(15.6)	1.0	1.0	
Marital status	Single	131(86.8)	21(13.2)	1.0	1.0	
	Married	342(83.2)	69(16.8)	1.33(0.81-2.19)	1.27(0.76-2.13)	0.363
	Divorced	228(80.9)	54(19.1)	1.49(0.89-2.49)	1.50(0.88-2.56)	0.132
	Widowed	97(78.2)	27(21.8)	1.57(0.88-2.82)	1.36(0.74-	0.331
Educational status	No education	231(84.9)	41(15.1)	1.055(0.75-1.49)	2.84 (0.87-9.26)	0.080
	Primary	276(79.8)	70(20.2)	1.48(1.07-2.03)	3.68(1.15- 11.77)	0.033
	Secondary	276(79.8)	70(20.2)	1.39(1.0-1.93)	3.25(1.01-10.48) *	0.049
	Tertiary	291(83.1)	59(16.9)	1.0	1.0	

Employment	Working	425(84.7)	77(15.30)	1.0	1.00	
	Not working	353(79.3)	92(20.7)	1.36(1.00-1.84)	1.32(0.97-1.81)	0.08
Membership of community support	Yes	127(73.0)	47(27.0)	1.0	1.0	
	No	671(84.50)	123(15.5)	1.87(1.33-2.63)	1.78(1.25-2.54) *	0.001
Functional status	Working	694(81.9)	153(18.1)	1.0	1.0	
	Ambulatory and bedridden	104(86.0)	17(14.0)	0.76(0.46-1.26)	5.2(1.63-16.67)	0.005
Duration on ART	≤6 months	133(88.1)	18(11.9)	1.0	1.0	
	6-12 months	52(91.2)	5(8.8)	0.70(0.26-1.89)	0.83(0.3-2.25)	0.71
	13-24 months	80(87.0)	12(13.0)	1.0(0.48-2.07)	1.28(0.61-2.70)	0.52
	>24 months	495(79.6)	127(20.4)	1.78(1.08-2.91)	2.15(1.27-3.63) *	0.004
Opportunistic infection	Yes	182(77.8)	52(22.2)	1.38(1.0-1.91)	1.68(1.18-2.39) *	0.004
	No	616(83.9)	118(16.1)	1.0	1.0	
Baseline nutritional status	Mild	186(80.9)	44(19.1)	1.0	1.0	
	Moderate	543(83.3)	109(16.7)	0.85(0.60-1.21)	0.93(0.65-1.33)	0.008
	Severe	68(80.2)	17(17.8)	1.09(0.62-1.90)	1.34(0.62-2.08)	0.003

Frequency of relapses of undernutrition

Data related to the frequency of relapses of undernutrition were only available from September 2012 to July 2016. Data analysis revealed that 170 (17.6%) of adults had relapsed after recovery with 124 (72.9%) relapsing once and 31 (18.3%) relapsing twice. The remaining, 10 (5.9%) and 5 (2.9%) relapsed three and four times respectively after nutritional recovery.

In multivariate logistic regression, statistical significance was declared at $P < 0.05$ and place of residence, education, employment status, functional status, presence of anaemia, and baseline nutritional status were statistically significantly associated with frequency of relapse of undernutrition. Individuals who were from rural areas were three times more likely to relapse more than once than those from urban areas. Those who had not attended formal education were more likely to relapse more than once, compared to those who attended secondary education. There was no difference between those attending primary, secondary education and above. Regarding employment, those who were employed were more likely to relapse more than once than those who were unemployed. Individuals who were bedridden were five times more likely to relapse more than once than those who were healthy. Individuals who were anaemic at enrolment were nine times more likely to relapse more than once than those who were not. Those who were severely and moderately undernourished at baseline were four and nine times respectively more likely to relapse more than once than those who had mild undernutrition (**Table 5**).

308 **Table 5:** Determinants of frequency of relapse of undernutrition after nutritional recovery

Variables		Relapsed only once	Relapsed more than once	COR (95% CI)	AOR(95%CI)	P-value
		No (%)	No (%)			
Place of residence	Urban	95(78.5)	26(21.5)	1.0	1.0	
	Rural	29(59.2)	20(40.8)	2.52(1.23-5.16)	3.14(1.30-7.57)*	0.011#
Marital status	Single	17(85.0)	3(15.0)	0.6(0.13-2.72)	0.49(0.076-3.19)	0.463
	Married	46(65.7)	24(34.3)	1.74(0.62-4.91)	1.50(0.40-5.62)	0.551
	Divorced	41(75.9)	13(24.1)	1.06(0.35-3.19)	0.6(0.15-2.35)	0.464
	Widowed	20(76.9)	6(23.1)	1.0	1.0	
Educational status	No education	25(61.0)	16(39.0)	5.65(1.98-16.19)	3.88(1.22-12.36)*	0.022
	Primary	46(65.7)	24(34.3)	4.61(1.73-12.25)	2.23(0.75-6.58)	0.150
	Secondary and above	53(89.8)	6(10.2)	1.0	1.0	
Employment status	Working	42(53.8)	36(46.2)	7.81(3.44-17.73)	3.86(1.15-12.94)*	0.029
	Not working	82(90.1)	9(9.9)	1.0	1.0	
Disclosure of HIV status	Yes	94(69.6)	41(30.40)	2.62(0.95-7.22)	2.44(0.79-7.53)	0.121
	No	30(85.7)	5(14.3)	1.0	1.0	
Functional status	Working	117(76.5)	36(23.0)	1.0	1.0	
	Ambulatory or bedridden	7(41.2)	10(58.8)	4.64(1.65-13.08)	5.21(1.63-16.67)*	0.005
WHO clinical stage	Stage I and II	89(78.1)	25(21.9)	1.0	1.0	
	Stage III and V	35(62.5)	21(37.5)	2.14(1.06-4.30)	1.26(0.45-3.55)	0.673
Duration on ART	<=6 months	9(50.0)	9(50.00)	3.38(1.24-9.17)	2.51(0.79-8.00)	0.121

	> 6 months	111(77.1)	33(22.9)	1.0	1.0	
Haemoglobin level	Anaemic	30(51.7)	28(48.3)	5.54(2.61-11.74)	9.28(3.39-25.33) *	0.0001
	Not anaemic	89(85.6)	15(14.4)	1.0	1.0	
Cotrimoxazole	Yes	81(69.2)	36(30.8)	1.91(0.86-4.22)	1.86(0.69-5.04))	0.223
	No	43(81.1)	10(18.9)	1.0	1.0	
Baseline nutritional status	Mild malnutrition	39(88.6)	5(11.4)	1.0	1.0	
	Moderate malnutrition	75(68.8)	34(31.2)	3.54(1.28-9.76)	4.30(1.37-13.54)) *	0.013
	Severe malnutrition	10(58.8)	7(41.2)	5.46(1.43-20.88)	9.90(2.04-48.14) *	0.004

309

Results of the qualitative findings

In the qualitative analysis, food insecurity emerged as one of the key factors that directly and indirectly influenced undernutrition, nutrition program participation and utilisation, and program outcomes – through its impact on weight loss, motivation to enrol in the program, driver of selling and sharing the nutritional support, as a disincentive to graduate from the program and final impact on relapse.

Food insecurity, poor livelihood, poverty and undernutrition

Adults cited household food insecurity as being a key cause of weight loss. For example;

“Yes, I made an effort to maintain my weight, but your economic status determines your nutritional status. You didn’t have enough, then from where can you get? I try [to get] by what I have but my economic status is very low. I know if you eat properly, I will have the energy to work and perform like others but if you are poor, you can do nothing”
(Adult female, age 48 #9).

Poverty and HIV are interwoven, both contributing to food insecurity and undernutrition among people living with HIV. This was particularly reported as an important challenge for people enrolled in the nutritional program. Many adults and caregivers of child participants reported the absence of adequate educational attainment, lack of regular and reliable employment as well as lack of sustainable and reliable income to support them and their family.

“If you are poor and don’t have good job, even if you try to create your own job, no one allows you to work for the reason of no education. I asked the kebele administration for job but they told me that you have no education. This makes you very angry. Otherwise, if you have a job, you will not lack adequate and balance food.” (Adult female, age 31 #1).

333 **Food insecurity as a motivation to participate in the nutritional program**

334 Lack of access to adequate food was one of the key motivations for adults and caregivers to
335 enroll in the nutritional program. Those who lived in urban areas and did not have a reliable
336 source of income or were unemployed reported a lack of access to enough food in their
337 household and that lack of adequate food was a motivation to enroll in the nutritional program.
338 These motivations were shared by both male and female adult participants, reporting
339 circumstances of food shortage in the household.

340 *If you have something to eat, it should be fine but if you don't have anything to eat like*
341 *me this food support is very important (Adult male, age 40 #18).*

342 *Yes... many people suffer from lack of access to adequate food. The nutritional support*
343 *is very helpful to all HIV patients. I have benefited a lot from the nutritional support. So,*
344 *I suggest this nutritional support to all people with HIV (Adult female, age 45 #2).*

345 **Food insecurity as a driver of selling and sharing of the nutritional support**

346 Household economic problems was one of the main reasons encouraging people to sell and
347 share nutritional support. A health provider and program manager stated that people sell the
348 nutritional support because of their economic conditions and to exchange for other household
349 consumables such as oil or coffee beans:

350 *Instead of eating it [nutritional support] for himself only, they want to sell and exchange*
351 *it for other household needs such as sugar, salt or oil. Most of the time the reason is*
352 *this but the base is the poor livelihood condition. So, they are not doing it intentionally,*
353 *but it is because of their problems (Health provider #9).*

354 *Even though the patients were counseled well, one reason for selling could be the*
355 *existing economic problems. Poverty by itself would encourage individuals to sell it and*
356 *spend the money on something that matters to the family is there (Program manager*
357 *#1).*

Sharing practices were also reported by health providers as common in mothers in circumstances of food insecurity, and caregivers themselves indicated this as highlighted below:

Yes, there is sharing among household members. As far as there is an economic problem, it is not necessarily selling but also sharing. Because if it is given to him, it is likely that the mother will share it with his siblings. If given two sachets then the mother gives one to her other child and keeps one for the HIV positive child (Health provider #7).

Even though it is prescribed to the sick child if there is no adequate food to eat in the household the mother may share it to other children. So, the mother shares it to fulfill the dietary needs of the other children in the household because she has nothing to give to the other child (Caregiver, age 35 #9).

“Even now, I can’t get enough [food] and I am not taking adequate food. I give everything [including RTUF] I have to my children and my main effort is to feed and care for them. With all the problems I have, I can’t get enough food to support myself and my children” (Adult female, age 29 #15).

Food insecurity, dependence and disincentive to graduate from the program

Some health providers expressed concerns of dependence of adults and caregivers on the nutritional program due to poverty and food insecurity.

Some patients become very reliant on the supports (soaps, water treatment jerrycan and the nutritional support) given from the health facility because they believe they should get supported due to their HIV condition (Health provider #2).

There were also concerns voiced by health providers that there was reluctance to graduate among some participants enrolled in the nutritional program due to poor socioeconomic status. For this reason, participants preferred prolonged enrolment in the nutritional program to fulfill poor household socioeconomic status:

It is because of their poor economic status that most don't want to graduate. If he graduates, you will not give him Plumpynut in the next time because they don't have other sources of income. Most want their weight to stay as low as possible (Health provider, age 35 #7).

Food insecurity as a contributor to relapse

Despite the high magnitude of food insecurity among those enrolled in the nutritional program, health providers identified that there was no remedial strategy as part of the program to prevent relapses of undernutrition among those graduated.

The major issue that creates a problem in this regard is that when they (people living with HIV) graduate from the nutritional program. There is no local or international NGO which we can link people with after their graduation from the program. There is no more NGOs in our area and I don't know the reason. So, there are no efforts made to prevent relapse of malnutrition after nutritional recovery. Because they should be linked into other income-generating activities (Health provider, age 27 #2).

Things that needs improvement in the nutrition program, now after you treat him for malnutrition and he graduates, there is nobody who helps you prevention of relapse. At least you have to link the patients in order the problem not to come again. So, we have big problem in this regard and we don't have supportive organization to do this (Health provider, age 37 #6).

Some adults indicated the presence of support for participants of the program in rural areas such as provision and maintenance of land as well as initiatives prioritizing adults living with HIV in income-generating activities, but no such experience was reported in patients living in urban areas.

I heard there are some support for people living in rural area. So they should do similar way in urban areas. Living in the city with HIV is very difficult and creates problem of house rent and others (Adult female, age 48 #9).

However, the above claim may be a perception as no other participant reported such an experience.

Discussion

This study highlights that household food insecurity coupled with underlying factors such as poverty and poor livelihood undermines the effectiveness of the nutritional programs in HIV care settings, particularly in relation to relapse of undernutrition. Food insecurity was explored in qualitative study and variables which may indirectly relate with food insecurity were also significantly associated with relapse in the quantitative findings. In addition, the link between food insecurity and the nutritional program emerged during the qualitative data analysis. Hence, this discussion will combine the qualitative and quantitative findings on how they relate with food insecurity and undermine the effectiveness of the nutritional program mainly relapse of undernutrition.

Studies in sub-Saharan Africa [\[37-39\]](#) have indicated that people living with HIV are more likely to be unemployed and less skilled. Consistent with the earlier studies, the current study demonstrated high rates of unemployment including from the quantitative sample, and many participants in the qualitative interviews also reporting no or unreliable sources of income related to lack of employment. The lack of employment seemed to place significant stress on household income and contributed to food insecurity, and were reported as key motivators for enrolment in the program in the qualitative study.

While both adults and children in the study regained weight and achieved nutritional recovery after enrolment in the nutritional program, sustaining nutritional wellbeing in the presence of household food insecurity was a challenge. In the current study, 18% of adults and 7% of children relapsed after nutritional recovery, and 27% of adults relapsed more than once. These findings are significant as they are an indication of the contribution of demographic, socioeconomic, clinical and nutritional factors to the relapse of undernutrition after nutritional recovery.

The quantitative analysis found that those with lower levels of education were more likely to relapse and that those who did not attend formal education were more likely to relapse more frequently. These are novel findings as we were unable to find previous studies that have examined the relationship between educational status and relapse of undernutrition. It is well acknowledged that a better education is related with better health more generally [40-42], and greater education could be related to enhanced understanding of the program, including the nutritional counseling, and strategies to prevent relapse. Those who were not employed were more likely to relapse. This may relate to poor clinical status making work difficult or could also reflect the impact of lower income on food security. Surprisingly, those who were employed were more likely to relapse more than once compared to those who were not employed.

Another study from Ethiopia and Uganda found that people from rural areas have limited access to basic services such as health, education and other social services than their urban counterparts [43]. In the current study being a rural dweller was associated with being more likely to relapse multiple times than their urban counterparts. This suggests the need to consider contextual factors in supporting positive program outcomes.

Another interesting finding is that adults involved in community HIV support groups were less likely to relapse, community HIV support group was not related with the frequency of relapse of undernutrition. This could be related to community HIV support groups' role in reducing food insecurity among people living with HIV and also through improved access to services, they could offer greater support in maintaining weight and reducing HIV related stigma [44, 45].

In addition, clinical and nutritional factors such as duration on ART, presence of opportunistic infections and anaemia were associated with relapse of undernutrition. For example, anaemia among people living with HIV is common due to the HIV illness and some ART medications [46, 47] and in the current study, those with anaemia and severe and moderate acute undernutrition at enrolment were more likely to relapse. Those with the worst clinical conditions (bedridden functional status) were also more likely to relapse more than once than those apparently healthy. These clinical and nutritional conditions may contribute to undernutrition directly because worst HIV infection contributes to undernutrition [48], and also indirectly by limiting the individual from contributing economically leading to poverty and food insecurity. This is consistent with literature which states that prolonged illnesses are one of the essential contributors of poverty and food insecurity among people living with HIV [11, 49]. However, there are no other studies demonstrating the role of these clinical and nutritional characteristics in contributing to relapse of undernutrition after nutritional recovery among those enrolled in the nutritional programs.

While undernutrition in people living with HIV is underpinned by underlying determinants of food insecurity such as poverty, poor livelihood, it seems that the nutritional program primarily focuses on short term treatment of undernutrition, dealing with "tip of the iceberg". As a result, the effectiveness of the nutritional program in improving nutritional status is hampered, including the reluctance of people to graduate from the program.

Similarly, sharing and selling of the nutritional support was a common practice and appeared to be driven by food insecurity and its underlying determinants. In the current study, adults and caregivers shared the nutritional support to fulfill dietary needs of their family due to lack of adequate food in the households. These findings support a study conducted in Ethiopia which reported RUTF sharing was more common in poor households indicating the negative impact of food insecurity on the nutritional program [29]. Although no program participants reported selling the nutritional support, health providers stated that this happened and did so for families to fulfill family nutritional needs. Selling and sharing undermine the effectiveness of the program through reducing and changing ration size.

While the study has provided important qualitative and quantitative evidence regarding the predictors of relapse and the role of food insecurity, there were a number of limitations. While the relationship between food insecurity and relapse emerged during the qualitative analysis, it was not directly measured in the quantitative study where it was not possible to directly measure the relationship between food insecurity and relapse of undernutrition. The other limitations include that it was not possible to validate the accuracy and precision of measurement of the demographic, socioeconomic, clinical and nutritional characteristics as only secondary data was used. It is also likely that the originality of information in the qualitative study may have been lost during the translation and transcription, even though efforts were made to maintain the original conversation as narrated by the participants.

Conclusions

In conclusion, a significant proportion of adults and children relapsed after nutritional recovery and qualitative findings highlighted that food insecurity, poverty, and poor livelihood were common among people living with HIV enrolled in the nutritional program. Food insecurity contributed to the problems of effectiveness of the nutritional program in three ways including: (i) many adults and caregivers were motivated to join the nutritional program because of the food insecurity, (ii) Individuals from food-insecure households shared and sold the nutritional support to fulfill family dietary needs, and (iii) a significant number of adults and

children relapsed because after graduation they were food insecure, leading to the loss of weight that was gained from the program. Various demographic characteristics such as low educational status, employment status, rural residence and involvement in a community support group; clinical characteristics such as poor clinical condition and presence of opportunistic infections; and nutritional characteristics such as moderate and severe acute undernutrition all were associated with relapse of undernutrition. The above factors likely contributed to a vicious cycle of complex poor nutritional outcomes. Thus, addressing poverty and poor livelihood is crucial to improve and sustain the nutritional wellbeing of people living with HIV enrolled in nutritional programs. Nutritional programs in HIV care should be poverty oriented and should consider household food security status in their program implementation. To improve the overall nutritional wellbeing and HIV treatment outcomes in these programs, they need to address the underlying social and economic determinants of undernutrition. Further research should be conducted on the relationship between food insecurity and relapse of undernutrition by quantitatively measuring food insecurity and its impact on the nutritional program particular relapse of undernutrition.

List of abbreviations

- **ART:** Antiretroviral Therapy
- **BMI:** Body Mass Index
- **CD4:** Cluster Differential T-lymphocytes
- **CI:** Confidence Interval
- **ERC** Ethical review committee
- **HIV/AIDS:** Human Immune Virus /Acquired Immune Deficiency
- **MAM:** Moderate Acute Undernutrition
- **MUAC:** Mid Upper Arm Circumference
- **P:** P-value

- **RUSF:** Ready to Use Supplementary Food
- **RUTF:** Ready to Use Therapeutic Food
- **SAM:** Severe Acute Malnutrition
- **SBRE:** Social and Behavioural Research Ethics
- **TB:** Tuberculosis
- **W/H%:** Weigh for Height z-scores
- **WHO:** World health organization
- **WHZ:** Weight for Height z-scores

Declarations

Ethical issues: There were no direct ethical concerns regarding the quantitative data, but issues of anonymity and confidentiality were sources of concern in the qualitative study. To address these concerns for the qualitative study participants, strategies such as reassurance, maintenance of confidentiality and anonymity was employed. In addition, qualitative study participants were provided with compensation for the time they spent during the interview. Ethical clearance was also secured from the Flinders University Social and Behavioural Research Ethics Committee (SBREC) (7118) in Australia and Mekelle University Ethical review committee (ERC 06211/2016), Ethiopia.

Consent to participant: Written informed consent was obtained from all study participants.

Consent for publication: Not applicable.

Availability of data and material: The datasets used and/or analysed during the current study are not possible to share with a third party because of the agreement between the first author and the study participants to only use it for the purpose of current study. However, the authors can share de-identified aggregate data.

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563 **Authors' contributions:** **FT** designed the study, collected, analysed and interpreted the
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566

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