HHS Public Access

Author manuscript

Ecol Food Nutr. Author manuscript; available in PMC 2018 May 15.

Published in final edited form as:

Ecol Food Nutr. 2017 ; 56(3): 256–276. doi:10.1080/03670244.2017.1311256.

Prevalence and Predictors of Food Insecurity among People Living with HIV Enrolled in Antiretroviral Therapy and Livelihood Programs in Two Rural Zambian Hospitals

Rainier Masa[a,b,iD], **Gina Chowa**[a,b], and **Victor Nyirenda**[a]

[a]Global Social Development Innovations, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

[b]School of Social Work, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Abstract

The objective of this study was to examine the prevalence and predictors of food insecurity among people living with HIV (PLHIV) in two rural communities in Zambia. A cross-sectional sample of 101 PLHIV was surveyed using the Household Food Insecurity Access Scale. In multivariable linear regression models, income, household possessions, and perceived coping strategies were significantly associated with decreased food insecurity. Debt and perceived mental distress were significantly associated with increased food insecurity. Programs that tackle economic disadvantage and its adverse effect on stress may be an appropriate strategy to improve food security of PLHIV in low-resource communities.

Keywords

Food security; HIV; socioeconomic factors; stress (psychological); Zambia

Food insecurity, defined in this study as lack of access to adequate and nutritious food at all times (Food and Agriculture Organization 1996), remains a critical social and public health issue that gravely affects the health and well-being of people living with HIV (PLHIV). In many resource-limited communities in sub-Saharan Africa (SSA), including Zambia, the prevalence of food insecurity among PLHIV is well above general population estimates (Hong et al. 2014; Mamlin et al. 2009; Musumari et al. 2014; Samuels and Rutenberg 2011; Tsai et al. 2011). The high prevalence of food insecurity among PLHIV undermines the fight against HIV/AIDS. At the very least, food insecurity is highly predictive of severe malnutrition and wasting (Kadiyala and Rawat 2013). At its worst, food insecurity increases risk of morbidity and mortality (Aibibula et al. 2016; Koethe et al. 2013; Rawat, McCoy, and Kadiyala 2013; Weiser et al. 2012). In addition, food insecurity is a significant barrier to treatment adherence (Hong et al. 2014; Singer, Weiser, and McCoy 2015; Young et al.

CONTACT Rainier Masa; rmasa@email.unc.edu 325 Pittsboro Street, Campus Box 3550, Chapel Hill, North Carolina 27599, USA.

iD**ORCID**

Rainier Masa http://orcid.org/0000-0002-0484-3107

2014). Nonadherence to treatment, in turn, decreases efficacy of HIV medications and heightens risk of harmful outcomes, including immunologic failure (Abrogoua et al. 2012; Chi et al. 2009; Wood et al. 2004), incomplete viral suppression (Bangsberg et al. 2000; Spacek et al. 2006), and rapid progression to AIDS (Bangsberg et al. 2001; Chi et al. 2009; Stringer et al. 2006).

Most of what we know about the prevalence and predictors of food insecurity among PLHIV and their households comes from studies in Eastern Africa (Bukusuba, Kikafunda, and Whitehead 2007; McCoy et al. 2014; Nagata et al. 2012; Tiyou et al. 2012; Tsai et al. 2011) and urban areas in Zambia (Cantrell et al. 2008; Samuels and Rutenberg 2011; Tirivayi, Koethe, and Groot 2012). Little is known about the extent and predictors of food insecurity among PLHIV in rural areas, although more HIV-positive individuals live in rural than in urban Zambia (National AIDS Council 2014). Consistent with limited evidence on prevalence of food insecurity in rural Zambia, little is known about predictors of food insecurity among PLHIV who are receiving treatment. Given current gaps in knowledge, this study aims to examine the prevalence and predictors of food insecurity among PLHIV in two rural communities in Zambia. Our study may help identify potential underlying factors that can be targeted by food security interventions for PLHIV in rural Zambia and similar communities in Southern Africa. To our knowledge, this study is one of the first to examine prevalence and predictors of food insecurity among PLHIV in rural areas of Eastern Province, Zambia.

Methods

Study design and sample

This study used a cross-sectional design. We analyzed baseline data that were collected from 101 treatment-experienced PLHIV who were participating in a livelihood intervention. The sample size was determined by the requirements of the main intervention outcome, treatment adherence. Thus, the aim was to recruit 100 treatment-experienced PLHIV.

At the time of data collection, all participants were receiving outpatient HIV care either at Lundazi District Hospital (LDH) or Lumezi Mission Hospital (LMH). In addition, all study participants were between 18 and 50 years old, economically poor (defined as living below the Zambian national poverty threshold of approximately $90 USD per month [Central Statistical Office of Zambia 2012a]), not pregnant, and not experiencing rapid weight loss at the time of recruitment. Informed consent was obtained from all study participants. The study protocol was approved by the University of Zambia Biomedical Research Ethics Committee and the University of North Carolina at Chapel Hill Institutional Review Board.

Study Setting

The study was conducted in Lundazi District, Eastern Province. In 2010, 78% of the population in Eastern Province were considered poor, which was consistent with the national trend of poverty being more concentrated in rural than in urban areas (Central Statistical Office, 2012a). Lundazi District is predominantly rural, with more than 90% of the population living in rural areas (Central Statistical Office, 2012b). In 2010, Lundazi District

had a population of 314,281, the third largest in Eastern Province (Central Statistical Office 2011). Lundazi District has an HIV prevalence rate of 15%, the second highest in Eastern Province (National AIDS Council of Zambia 2014). Agriculture is the most common occupation, and the district is one of the highest producers of maize, cotton, groundnuts, and tobacco.

Data collection and sources

Data were collected using an interviewer-administered survey. The survey was conducted between December 2014 and January 2015 and gathered data on participants' demographics and social and economic characteristics. Demographic information included age, gender, marital status, occupation, and education level. Social and economic characteristics included household size, income, asset ownership, financial status, and access to food. The survey also included questions on psychosocial functioning, accessibility of health facilities, and barriers to HIV treatment adherence.

Variables and measures

Food insecurity—The outcome variable was food insecurity, defined in this study as inadequate access to food. Food insecurity was measured using the Household Food Insecurity Access Scale (HFIAS) (Coates, Swindale, and Bilinsky 2007). HFIAS had been validated with various populations in SSA (Frongillo and Nanama 2006; Knueppel, Demment, and Kaiser 2010). HFIAS consists of nine items that ask respondents the frequency of experiencing different conditions and degrees of food insecurity within the past 30 days. Response options for the nine items range from 0 (*never*) to 3 (*often*). HFIAS score was calculated by summing the score for all nine items. Scores ranged from a minimum of 0 to a maximum of 27. A higher HFIAS score indicated poor access to food and greater household food insecurity. For descriptive purposes, we created a categorical measure of the different degrees of food insecurity. This categorical variable, or the prevalence of food insecurity, was based on the definition and categorization recommended by the scale developers (Coates, Swindale, and Bilinsky 2007). These prevalence levels, which classified households as food secure and mild, moderately, and severely food insecure, referred to the frequency and severity of coping strategies that households use when experiencing inadequate access to food. Households were categorized as increasingly food insecure if they responded affirmatively to more severe conditions and/or experienced those conditions more frequently.

Predictors of food insecurity—We reviewed the literature to identify predictors of food insecurity and to guide inclusion of independent variables. Demographic factors included age (measured in years), gender (female or male), marital status (not married or married), occupation (farming or nonfarming), education level (primary or secondary/higher), and head of household status (yes or no). Social and economic characteristics included household size (total number of household members regardless of age), financial situation status (worse or stayed the same/better), household monthly income (measured in four categories: Zambian kwacha (ZK) 0–20, ZK 21–50, ZK 51–500, or ≥ ZK 501), frequency of saving (never saved or saved sometimes/more frequently), debt (owed money or did not owe money), and asset ownership. Asset ownership included four different types of assets: land,

transport, livestock, and household possessions. Land was measured in acreage. For transportation assets, livestock, and household possessions, we created three distinct asset indices using methods recommended in the literature (e.g., Filmer and Pritchett 2001; Filmer and Scott 2012). A high index value indicated high level of asset ownership. Transport-related assets included motor vehicle, canoe or boat, motorcycle, bicycle, and ox cart. Livestock comprised ownership of cattle, goats, sheep, donkey, pig, and chicken. Household possessions included ownership of radio, electric or gas stove, charcoal brazier, electric iron, charcoal iron, refrigerator, television, cellular phone, and land phone. Last, health characteristics included treatment duration (length of time on antiretroviral therapy [ART], measured in months), self-perceived health, (poor/fair or good/very good), and perceived stress. Perceived stress was measured using the 10-item perceived stress scale (PSS) (Cohen, Kamarck, and Mermelstein 1983). Consistent with prior research (Cohen and Williamson 1988; Lavoie and Douglas 2011; Leung, Lam, and Chan 2010), we used the two-factor PSS in our analysis. The first factor was a four-item measure of perceived coping strategies. The second factor was a six-item measure of perceived mental distress. A higher score on the perceived coping factor indicated ability to cope with stressful events; a higher score on the perceived distress factor implied inability to deal with stressful situations.

Data analysis

The analysis plan comprised several components. Bivariable analyses were conducted to identify differences in food insecurity scores on the basis of key independent variables. For binary predictors, comparison of mean food insecurity scores was conducted using independent *t*-test and Wilcoxon rank-sum test. For predictors with more than two response categories, one-way ANOVA and Kruskal Wallis tests were used to compare mean scores. Simple linear regression method using ordinary least squares (OLS) was used to examine bivariable associations between food insecurity and continuous predictor variables. Linear regression method using OLS was extended to multivariable models to simultaneously examine multiple predictors of food insecurity. Diagnostic tests and residual analyses were conducted to determine whether multivariable statistical assumptions were met and to use suitable remedial procedures to address data violations. Results indicated absence of heteroscedastic, highly collinear, and influential data. However, we used robust regression to address nonnormality of predictor variables. We estimated four multivariable linear regression models. Model 1 estimated HFIAS score by controlling for demographic characteristics. Model 2 took into account social and economic characteristics in addition to the variables introduced in model 1. Model 2 results indicated the extent to which food insecurity could be explained by household socioeconomic characteristics. Model 3 added health predictors, after demographic, social, and economic characteristics. Model 4 used backward elimination (BE) to determine the final multivariable model.

After our review of the literature defined an initial list of predictors, we used BE to determine the final multivariable model. We used BE to avoid model overparameterization and to ensure parsimony and consistency of findings given the relatively small sample size. Prior research suggests that BE procedures with a mild significance level criterion of $\alpha = .20$ are superior to other variable selection approaches (Maldonado and Greenland 1993; Sun, Shook, and Kay 1996). In addition, predictor variables that changed coefficient size by more

than 20% when eliminated were kept in the final model as these variables may provide necessary adjustment of the effect of the remaining variables in the model (Hosmer, Lemeshow, and Sturdivant 2013). Purposeful variable selection may be a more efficient method when the focus is on risk factor modeling and not solely on prediction. All analyses were conducted using Stata 14 (StataCorp 2015).

Results

Sample characteristics and prevalence of food insecurity

From the original sample of 101 treatment-experienced PLHIV, three (3%) had missing values on one or more independent variables. Table 1 shows the demographic, socioeconomic, and health characteristics of the remaining 98 respondents, as well as their HFIAS scores. Overall, 93% of the sample experienced food insecurity during the last 30 days prior to data collection. A high percentage (74%) of respondents reported severe food insecurity. Mean HFIAS score was 14.42, which was slightly higher than the midpoint of the range of possible scores. Food insecurity scores were not significantly different between respondents from LDH and those from LMH. The average age of respondents was 38. More women than men were represented in the study. More than 70% of respondents were married, and 64% had some primary education. Most respondents were income poor, with 69% reporting a household monthly income of ZK50 or less (or less than $10 USD). Seventy-six percent reported farming as their primary occupation. Mean (ART) treatment duration was 26 months, and the median was 19 months. Despite being HIV positive, most respondents (81%) perceived their overall health as good or better.

Predictors of food insecurity

Table 1 presents bivariable associations between HFIAS scores and characteristics of the study sample. Results indicate significant association between food insecurity and the following variables: gender, education level, financial situation, household income, asset ownership (land, mode of transport, livestock, and household possessions), saving frequency, self-perceived health, and perceived mental distress. Women were more food insecure than men. PLHIV with lower (primary) education level were more food insecure than PLHIV with secondary education or higher. PLHIV who were economically insecure (e.g., less income, fewer assets, and worse financial situation) were more food insecure than their peers who had higher income, more assets, and better financial situation. PLHIV who reported higher levels of perceived mental distress were less food secure than PLHIV who reported lower levels of perceived mental distress.

Multivariable results were consistent with bivariable findings. Table 2 presents results of the four multivariable linear regression models. In model 1, education level was a significant predictor. In model 2, indicators of household economic instability (such as worse financial situation, lower income, fewer assets, and having debts) were significant predictors of food insecurity. Frequency of saving was also significantly associated with food insecurity, albeit in the opposite direction. In this sample of treatment-experienced PLHIV in Lundazi District, the ability to save money sometimes or more frequently was significantly associated with food insecurity. In model 3, indicators of household economic instability (i.e., fewer

assets and lower income) remained significant predictors of food insecurity. In addition, higher levels of perceived mental distress and lower levels of perceived coping strategies were significantly associated with food insecurity. The final multivariable model (after BE) included nine predictors: six financial and economic-related factors, two health characteristics, and one demographic variable.

In model 4, income, assets, and debts remained significantly associated with food insecurity. Respondents with monthly incomes between ZK 51 and 500 scored 4.92 points lower on the food insecurity scale compared with participants that had monthly incomes between ZK 0 and 20 (95% confidence interval [CI]: −9.51 to −0.32). Owning more assets predicted less food insecurity. For every one-unit increase in the household possession index, HFIAS scores decreased by 2.93 points (95% CI: −4.80 to −1.06). Similarly, for every one-unit increase in the transportation asset index, HFIAS scores decreased by 2.65 points (95% CI: −5.90 to 0.60). On the contrary, owing money was positively associated with food insecurity. Respondents with monetary debts scored 3.32 points higher on the food insecurity scale compared with their peers without monetary debts (95% CI: 0.29 to 6.34). With the exception of transportation assets, all these associations were statistically significant at the . 05 level. The relationship between ownership of transportation assets and food insecurity demonstrated statistical trend ($p \leq .10$). The associations between household size, financial situation, and having a monthly income of at least ZK 501 and food insecurity also showed statistical trend ($p \leq .10$). Further, the two dimensions of perceived stress (coping strategies and mental distress) remained significantly associated with food insecurity. Respondents with higher levels of perceived coping mechanisms remained less likely to experience food insecurity ($\beta = -0.55$, 95% CI: −0.89 to −0.20). By contrast, respondents with higher levels of perceived mental distress were more likely to be food insecure ($\beta = 0.56$, 95% CI: 0.19 to 0.93). In the final model, five variables were statistically significant predictors of food insecurity. As expected, all but one variable in model 4 showed consistency (i.e., numerical stability and same direction of relationship) across models. Finally, 58% of the variability of food insecurity scores in this sample of rural ART patients was explained by the nine predictors included in model 4, as illustrated in table 2 by the model $R2$.

Discussion

This study examined the prevalence and predictors of food insecurity among ART patients living in two rural communities in Eastern Province, Zambia. Three overarching themes emerged from the findings. First, food insecurity was highly prevalent. More than 70% of respondents experienced severe food insecurity or hunger. Our findings are consistent with prior research in SSA that found a substantial proportion of food-insecure ART patients (Hong et al. 2014; Mamlin et al. 2009; Musumari et al. 2014; Tsai et al. 2011). This growing body of evidence suggests that there is a substantial overlap of food-insecure households and treatment-experienced PLHIV.

Second, our findings support the hypothesis that food insecurity appears strongly to be a problem of poor financial situation and lack of economic security in the household. Bivariable and multivariable results indicate that earning less income, owning fewer assets, owing money, and having a poor financial situation increases the risk of food insecurity. Our

results highlight the importance of household economic characteristics in identifying which ART patients are more likely to experience food insecurity. Obviously, less income deprives ART patients and their households of financial resources that they can use to buy food or purchase raw materials that can be used to produce food. Owning fewer assets may deny ART patients and their households additional sources of income that can be used to meet food consumption and other needs. Owing money increases the risk of food insecurity as households are obligated to pay back money owed to creditors, which in turn diminishes the amount of financial resources that households can use to buy or produce food.

Asset ownership, in particular, plays an important role in decreasing risk of food insecurity. In many communities in SSA, assets are used to generate income, which in turn allows households to obtain or produce food (Barrett, Reardon, and Webb 2001; Chowa, Masa, and Sherraden 2012). In many instances, these income-generating assets form livelihood strategies that buffer against various household shocks. Evidence suggests that HIV-afflicted households in SSA often sell their assets to cope with food insecurity (Bukusuba, Kikafunda, and Whitehead 2007; Samuels and Rutenberg 2011). Alternatively, low-asset households tend to experience severe and more frequent food insecurity compared with high-asset households (Nagata et al. 2015; Tsai et al. 2011). Some types of assets also have a direct effect on food security. For example, livestock and agricultural crops provide immediate sources of food. In addition to selling livestock or agricultural produce for cash returns, ART patients and their households might rely on some of these assets to feed and nourish them.

Third, our multivariable findings are consistent with prior research that has shown consistent predictors of food insecurity between HIV-positive and HIV-negative populations in SSA (Leyna et al. 2007; McCoy et al. 2014; Misselhorn 2005; Nagata et al. 2012; Tiyou et al. 2012). These predictors include demographic factors such as gender, age, marital status, and household size (Bukusuba, Kikafunda, and Whitehead 2007; Tsai et al. 2011) and indicators of poverty such as low educational attainment, limited assets, poor housing conditions, and unemployment (Leyna et al. 2007; Nagata et al. 2015, 2012; Lukmanji et al. 2013; Tsai et al. 2011; Walsh and Van Rooyen 2015). Although predictors of food insecurity are consistent between HIV-positive and HIV-negative populations, there are distinct factors that elevate risk of food insecurity among PLHIV. These factors may increase the severity and frequency of food insecurity in HIV-affected households relative to non-HIV-affected households (Akrofi, Price, and Struik 2012). One plausible reason for more severe and chronic forms of food insecurity among HIV-affected households is the compounded effects of higher health care expenses, reduced labor productivity, and HIV stigma and discrimination. Compared with HIV-negative populations, PLHIV are more likely to miss work and earn less income (Donovan and Massingue 2007; Larson et al. 2013). At the same time, they are more likely to incur additional and higher health care expenses, particularly if they are receiving treatment (Gregson, Mushati, and Nyamukapa 2007; Ngalula et al. 2002). They are also more likely to experience dissolution of social support and persistent discrimination because of their chronic health condition (Dawson 2013; Kaschula 2011). In the context of household and community-level economic insecurity, these distinct factors intersect with each other, which in turn exacerbates the risk of food insecurity among PLHIV.

Furthermore, our results suggest other significant predictors of food insecurity, including gender, education level, household size, and perceived stress. In our bivariable analysis, women were more food insecure than men. This finding is consistent with prior research in SSA that found women, regardless of HIV status, are at a higher risk of food insecurity compared to men (Belachew et al. 2012; McCoy et al. 2014; Tiyou et al. 2012). Within-household bias against women increases their risk of food insecurity as women (including young girls) are not generally prioritized in the allocation of food (Haddad et al. 1996; Hadley et al. 2008). Women also tend to have limited control over income-generating activities (Gibbs et al. 2012; Gladwin et al. 2001). Women's inability to control or earn income means a lack of or limited financial resources to buy or produce food. In addition to gender, low education level was associated with increased food insecurity. In this sample of rural ART patients, those with primary education were more food insecure compared to those who attended secondary education or higher. In SSA, education influences the ability to earn income and diversify income sources by providing tangible skills and facilitating attitude changes that can be used to create or take advantage of livelihood opportunities (Smith et al. 2001). Individuals with higher education levels may be more likely to earn income from various livelihood activities or adopt technology that can contribute to better food production because of their relevant and tangible skills. In turn, higher income and better agricultural yields reduce risk of food insecurity. Although mean food insecurity scores differed by gender and education level, the significant differences disappeared in multivariable analysis.

Household size was negatively (and minimally) associated with food insecurity. In this study, larger-sized households were less food insecure than smaller-sized households. This finding may seem counterintuitive. However, larger households may comprise other working-age members who can earn additional income and provide adequate food for all household members. The presence of other income-earning household members in an HIV-afflicted household is essential, particularly when the HIV-positive household member, who may or may not be the primary income earner, is sick and cannot work. Therefore, income from other household members becomes an important buffer against economic shocks due to HIV/AIDS. In addition, larger household size may not necessarily worsen food insecurity if the household dependency ratio (i.e., number of nonworking members versus number of working members) is low. Although household dependency ratio was not measured in this study, it is possible that, on average, households in the study had low dependency ratio. This low dependency ratio may explain why household size was inversely related to food insecurity in this study.

Further, in the multivariable analysis, perceived stress was a significant predictor of food insecurity. Higher levels of perceived coping strategies were negatively associated with food insecurity. Higher levels of perceived mental distress were positively associated with food insecurity. In general, stress is regarded as an adverse effect of food insecurity among PLHIV (Addo et al. 2011; Garcia et al. 2013). Although prior research has indicated that perceived stress is an effect of food insecurity, our findings suggest that perceived stress is also a predictor of food insecurity. The link between perceived stress and food insecurity may be explained through two pathways: behavioral and instrumental. For ART patients, perceived stress may be a result of living amidst multiple adverse conditions such as poverty,

HIV/AIDS, discrimination, and stigma. These adverse living conditions may affect the motivation and ability of ART patients to work and earn income, which in turn diminishes access to food. The association between stress and food insecurity may also be due to limited or lack of instrumental support that provides food assistance to ART patients and their households. ART patients with higher perceived coping strategies may signify presence of a reliable social network—formal or informal—that they can depend on when access to food is limited. On the contrary, ART patients with higher perceived mental distress may indicate a weak social support system to rely on when access to food is inadequate. In summary, these noneconomic factors should be considered when targeting PLHIV who are at a higher risk of being food insecure.

Findings have important program and policy implications. Although food insecurity can be triggered by a combination of factors, our study findings provide evidence of potential underlying predictors of inadequate access to food in rural Zambia. Food insecurity in this sample of ART patients in Lundazi District was closely associated with social and economic standing and determined by social and economic resources. Poor financial and economic situations characterized by having low income, fewer assets, and monetary debts increased the risk of food insecurity. These economic indicators, albeit not the only known predictors, are potentially alterable factors. Identification of alterable protective and risk factors that are supported by empirical evidence is valuable to development and testing of food security interventions for poor PLHIV and their households. In other words, improving household economic security through income generation, asset accumulation, and livelihood diversification may be an appropriate intervention.

One type of intervention that offers a feasible and potentially effective strategy that targets malleable economic predictors of food insecurity among PLHIV is livelihood programs. A *livelihood* is defined as a set of capabilities, assets, and activities required for means of living (Chambers and Conway 1992). In general, livelihood programs are multifaceted household-economic-strengthening interventions that cover a broad set of activities, including direct transfer of cash or assets, technical skills training related to a specific livelihood, life or soft skills training such as financial literacy, and access to financial services such as savings and credit products. Consistent with livelihood programs for HIV-negative populations, livelihood programs for PLHIV should be designed to increase household income and assets, provide employment, manage different household shocks, and maintain consumption patterns. On the other hand, livelihood programs for PLHIV are generally linked with HIV treatment. In addition to promoting household economic security, livelihood programs for PLHIV are designed to improve HIV-treatment-related behaviors, for example, adherence to antiretroviral therapy.

Although livelihood programs for PLHIV have been implemented and evaluated with promising effects on food access (Wagner et al. 2012; Weiser et al. 2015), psychosocial functioning (Tsai et al. 2017; Wagner et al. 2012), and HIV treatment outcomes (Weiser et al. 2015), they remain beyond the reach of many treatment-experienced PLHIV in resource-limited settings. Although there are numerous factors that impede adoption of livelihood programs as a component of HIV care in low-resource settings, one barrier is limited evidence on malleable predictors of adequate access to food among treatment-experienced

PLHIV. Our findings may guide further development of food security interventions for PLHIV through identification of malleable predictors of inadequate access to food. To date, our study is one of the first quantitative studies to examine predictors of inadequate access to food in rural Zambia and similar rural communities in southern Africa. Although there are similarities between livelihood programs for HIV-positive and HIV-negative populations, the design of economic-strengthening programs for PLHIV needs to carefully consider the health status of PLHIV. Livelihood activities that require strenuous work may not be optimal for some PLHIV. Similarly, livelihood programs may not be the most appropriate intervention for undernourished PLHIV who may require therapeutic feeding or immediate nutrition supplementation to gain weight and improve their physical conditions before engaging in various livelihood activities.

Cautious interpretation of findings is recommended because of study limitations. First, the study sample is not representative of people living with HIV receiving ART in rural Eastern Province and the catchment population of the two hospitals included in the study. Findings should be interpreted taking into account the limited representativeness of the current study sample. Second, the use of cross-sectional data provides weak evidence of causal relationship. Lack of temporal order in cross-sectional data does not eliminate reverse causality and may alter the true direction of relationship. For example, food insecurity may be predicted by and a predictor of perceived stress. Third, other important and distinct predictors of food insecurity may have been omitted. For example, contrasted with food insecurity in the general population, food insecurity among PLHIV may be due to factors such as dissolution of social support, HIV stigma, and discrimination. Fourth, the small sample size might affect statistical power. Low statistical power may result in overestimation of coefficient sizes. Small sample size also limited the number of predictors that could be included in multivariable models. In the final model, the number of predictors was proportional to the sample size. Fifth, our dependent variable only measured the access component of food insecurity. Results do not tell us about actual food intake or access to food over time. Actual food intake is equally crucial for PLHIV given the importance of adequate nutrition for HIV-therapy efficacy and overall health conditions.

Conclusion

Food insecurity undermines the fight against HIV/AIDS in rural and resource-limited settings. Development of appropriate and relevant food security programs for rural PLHIV relies on identifying and understanding the extent and underlying malleable predictors of food insecurity. Our study sought to address gaps in knowledge by examining prevalence and predictors of food insecurity among treatment-experienced PLHIV in rural Zambia. The prevalence of food insecurity in Lundazi District was high. The substantial overlap between food-insecure and treatment-experienced PLHIV will only increase as more economically poor and food-insecure PLHIV obtain access to life-saving HIV medications. This alarming pattern requires effective interventions and indicates relevance of such interventions for a large segment of the population. Our study provides empirical findings of alterable household economic characteristics that are predictive of food insecurity and that can be targeted by carefully designed programs. Improving a household's economic standing and its ability to accumulate resources (through income generation, asset accumulation, and

diversification of livelihood activities) can increase food security. In addition, noneconomic factors (i.e., gender, education, household size, and perceived stress) that heighten vulnerability to food insecurity should be considered when developing programs and targeting higher risk PLHIV.

References

Abrogoua DP, Kablan BJ, Kamenan BA, Aulagner G, N'guessan K, Zohore C. Assessment of the impact of adherence and other predictors during HAART on various CD4 cell responses in resource-limited settings. Patient Preference and Adherence. 2012; 6:227–37. DOI: 10.2147/PPA.S26507 [PubMed: 22536059]

Addo AA, Marquis GS, Lartey AA, Perez-Escamilla R, Mazur RE, Harding KB. Food insecurity and perceived stress but not HIV infection are independently associated with lower energy intakes among lactating Ghanaian women. Maternal & Child Nutrition. 2011; 7(1):80–91. DOI: 10.1111/j.1740-8709.2009.00229.x

Aibibula W, Cox J, Hamelin AM, Mamiya H, Klein MB, Brassard P. Food insecurity and low CD4 count among HIV-infected people: A systematic review and meta-analysis. AIDS Care. 2016; 28(12):1577–85. DOI: 10.1080/09540121.2016.1191613 [PubMed: 27306865]

Akrofi S, Price LL, Struik PC. HIV and severity of seasonal household food-related coping behaviors in rural Ghana. Ecology of Food and Nutrition. 2012; 51(2):148–75. DOI: 10.1080/03670244.2012.661347 [PubMed: 22455863]

Bangsberg DR, Hecht FM, Charlebois ED, Zolopa AR, Holodniy M, Sheiner L, Bamberger JD, Chesney MA, Moss A. Adherence to protease inhibitors, HIV-1 viral load, and development of drug resistance in an indigent population. Aids. 2000; 14(4):357–66. DOI: 10.1097/00002030-200003100-00008 [PubMed: 10770537]

Bangsberg DR, Perry S, Charlebois ED, Clark RA, Roberston M, Zolopa AR, Moss A. Non-adherence to highly active antiretroviral therapy predicts progression to AIDS. Aids. 2001; 15(9):1181–83. DOI: 10.1097/00002030-200106150-00015 [PubMed: 11416722]

Barrett CB, Reardon T, Webb P. Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. Food Policy. 2001; 26(4):315–31. DOI: 10.1016/S0306-9192(01)00014-8

Belachew T, Lindstrom D, Gebremariam A, Jira C, Hattori MK, Lachat C, Huybregts L, Kolsteren P. Predictors of chronic food insecurity among adolescents in Southwest Ethiopia: A longitudinal study. BMC Public Health. 2012; 12:604.doi: 10.1186/1471-2458-12-604 [PubMed: 22863140]

Bukusuba J, Kikafunda JK, Whitehead RG. Food security status in households of people living with HIV/AIDS (PLWHA) in a Ugandan urban setting. The British Journal of Nutrition. 2007; 98(1):211–17. DOI: 10.1017/S0007114507691806 [PubMed: 17381879]

Cantrell RA, Sinkala M, Megazinni K, Lawson-Marriott S, Washington S, Chi BH, Tambatamba-Chapula B, et al. A pilot study of food supplementation to improve adherence to antiretroviral therapy among food-insecure adults in Lusaka, Zambia. Journal of Acquired Immune Deficiency Syndromes. 2008; 49(2):190–95. DOI: 10.1097/QAI.0b013e31818455d2 [PubMed: 18769349]

Central Statistical Office of Zambia. Zambia 2010 census of population and housing: Preliminary population figures. Lusaka, Zambia: Central Statistical Office; 2011.

Central Statistical Office of Zambia. Living conditions and monitoring survey report 2006 and 2010. Lusaka, Zambia: Central Statistical office; 2012a.

Central Statistical Office of Zambia. 2010 census of population and housing (volume 11 national descriptive tables). Lusaka, Zambia: Central Statistical Office; 2012b.

Chambers, R., Conway, G. Sustainable rural livelihoods: Practical concepts for the 21st century. Brighton, UK: Institute of Development Studies; 1992.

Chi BH, Cantrell RA, Zulu I, Mulenga LB, Levy JW, Tambatamba BC, Reid S, et al. Adherence to first-line antiretroviral therapy affects non-virologic outcomes among patients on treatment for more than 12 months in Lusaka, Zambia. International Journal of Epidemiology. 2009; 38(3):746–56. DOI: 10.1093/ije/dyp004 [PubMed: 19223334]

Chowa GA, Masa RD, Sherraden M. Wealth effects of an asset-building intervention among rural households in sub-Saharan Africa. Journal of the Society for Social Work and Research. 2012; 3(4):329–45. DOI: 10.5243/jsswr.2012.20

Coates, J., Swindale, A., Bilinsky, P. Household food insecurity access scale (HFIAS) for measurement of food access: Indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2007.

Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. Journal of Health and Social Behavior. 1983; 24(4):385–96. DOI: 10.2307/2136404 [PubMed: 6668417]

Cohen, S., Williamson, GM. Perceived stress in a probability sample of the US. In: Spacapam, S., Oskamp, S., editors. The social psychology of health: Claremont symposium on applied social psychology. Thousand Oaks, CA: Sage; 1988. p. 31-67.

Dawson H. HIV/AIDS, the erosion of social capital and the collapse of rural livelihoods in the Nkomazi district of South Africa. African Journal of AIDS Research. 2013; 12(4):185–94. DOI: 10.2989/16085906.2013.863218 [PubMed: 25871480]

Donovan C, Massingue J. Illness, death, and macronutrients: Adequacy of rural Mozambican household production of macronutrients in the face of HIV/AIDS. Food and Nutrition Bulletin. 2007; 28(2 Suppl):S331–S338. DOI: 10.1177/15648265070282S212 [PubMed: 17658079]

Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—Or tears: An application to educational enrollments in states of India. Demography. 2001; 38(1):115–32. [PubMed: 11227840]

Filmer D, Scott K. Assessing asset indices. Demography. 2012; 49(1):359–92. DOI: 10.1007/s13524-011-0077-5 [PubMed: 22135117]

Food and Agriculture Organization. Rome declaration on world food security and world food summit plan of action. Rome, Italy: Food and Agriculture Organization; 1996.

Frongillo EA, Nanama S. Development and validation of an experience-based measure of household food insecurity within and across seasons in Northern Burkina Faso. The Journal of Nutrition. 2006; 136(5):1409S–1419S. [PubMed: 16614438]

Garcia J, Hromi-Fiedler A, Mazur RE, Marquis G, Sellen D, Lartey A, Perez-Escamilla R. Persistent household food insecurity, HIV, and maternal stress in peri-urban Ghana. BMC Public Health. 2013; 13:215.doi: 10.1186/1471-2458-13-215 [PubMed: 23497026]

Gibbs A, Willan S, Misselhorn A, Mangoma J. Combined structural interventions for gender equality and livelihood security: A critical review of the evidence from Southern and Eastern Africa and the implications for young people. Journal of the International AIDS Society. 2012; 15(Suppl 1):1–10. DOI: 10.7448/IAS.15.3.17362

Gladwin CH, Thomson AM, Peterson JS, Anderson AS. Addressing food security in Africa via multiple livelihood strategies of women farmers. Food Policy. 2001; 26(2):177–207. DOI: 10.1016/S0306-9192(00)00045-2

Gregson S, Mushati P, Nyamukapa C. Adult mortality and erosion of household viability in AIDS-afflicted towns, estates, and villages in Eastern Zimbabwe. Journal of Acquired Immune Deficiency Syndromes. 2007; 44(2):188–95. DOI: 10.1097/01.qai.0000247230.68246.13 [PubMed: 17075384]

Haddad, LJ., Peña, C., Nishida, C., Quisumbing, AR., Slack, AT. Food security and nutrition implications of intrahousehold bias. Washington, DC: International Food Policy Research Institute, Food Consumption and Nutrition Division; 1996.

Hadley C, Lindstrom D, Belachew T, Tessema F. Ethiopian adolescents' attitudes and expectations deviate from current infant and young child feeding recommendations. Journal of Adolescent Health. 2008; 43(3):253–59. DOI: 10.1016/j.jadohealth.2007.01.015 [PubMed: 18710680]

Hong SY, Fanelli TJ, Jonas A, Gweshe J, Tjituka F, Sheehan HM, Wanke C, Terrin N, Jordan MR, Tang AM. Household food insecurity associated with antiretroviral therapy adherence among HIV-infected patients in Windhoek, Namibia. Journal of Acquired Immune Deficiency Syndromes. 2014; 67(4):e115–e122. DOI: 10.1097/QAI.0000000000000308 [PubMed: 25356779]

Hosmer, DW., Lemeshow, S., Sturdivant, RX. Applied logistic regression. New York, NY: John Wiley & Sons; 2013.

Kadiyala S, Rawat R. Food access and diet quality independently predict nutritional status among people living with HIV in Uganda. Public Health Nutrition. 2013; 16(1):164–70. DOI: 10.1017/S136898001200050X [PubMed: 22348289]

Kaschula S. Using people to cope with the hunger: Social networks and food transfers amongst HIV/AIDS afflicted households in KwaZulu-Natal, South Africa. AIDS and Behavior. 2011; 15(7): 1490–502. DOI: 10.1007/s10461-011-0006-z [PubMed: 21822628]

Knueppel D, Demment M, Kaiser L. Validation of the household food insecurity access scale in rural Tanzania. Public Health Nutrition. 2010; 13(3):360–67. DOI: 10.1017/S1368980009991121 [PubMed: 19706211]

Koethe JR, Blevins M, Bosire C, Nyirenda C, Kabagambe EK, Mwango A, Kasongo W, Zulu I, Shepherd BE, Heimburger DC. Self-reported dietary intake and appetite predict early treatment outcome among low-BMI adults initiating HIV treatment in sub-Saharan Africa. Public Health Nutrition. 2013; 16(3):549–58. DOI: 10.1017/S1368980012002960 [PubMed: 22691872]

Larson BA, Fox MP, Bii M, Rosen S, Rohr J, Shaffer D, Sawe F, Wasunna M, Simon JL. Antiretroviral therapy, labor productivity, and sex: A longitudinal cohort study of tea pluckers in Kenya. Aids. 2013; 27(1):115–23. DOI: 10.1097/QAD.0b013e32835a5b12 [PubMed: 23014516]

Lavoie JAA, Douglas KS. The perceived stress scale: Evaluating configural, metric and scalar invariance across mental health status and gender. Journal of Psychopathology and Behavioral Assessment. 2011; 34(1):48–57. DOI: 10.1007/s10862-011-9266-1

Leung DYP, Lam TH, Chan SSC. Three versions of perceived stress scale: Validation in a sample of Chinese cardiac patients who smoke. BMC Public Health. 2010; 10(1):1–7. DOI: 10.1186/1471-2458-10-513 [PubMed: 20043862]

Leyna GH, Mnyika KS, Mmbaga EJ, Hussain A, Klouman E, Holm-Hansen C, Klepp KI. Food insufficiency in rural Kilimanjaro, Tanzania. East African Medical Journal. 2007; 84(4):163–71. [PubMed: 17894250]

Lukmanji Z, Hertzmark E, Spiegleman D, Fawzi WW. Dietary patterns, nutrient intake, and sociodemographic characteristics in HIV-infected Tanzanian pregnant women. Ecology of Food and Nutrition. 2013; 52(1):34–62. DOI: 10.1080/03670244.2012.705768 [PubMed: 23282190]

Maldonado G, Greenland S. Simulation study of confounder-selection strategies. American Journal of Epidemiology. 1993; 138(11):923–36. DOI: 10.1093/oxfordjournals.aje.a116813 [PubMed: 8256780]

Mamlin J, Kimaiyo S, Lewis S, Tadayo H, Jerop FK, Gichunge C, Petersen T, Yih Y, Braitstein P, Einterz R. Integrating nutrition support for food-insecure patients and their dependents into an HIV care and treatment program in Western Kenya. American Journal of Public Health. 2009; 99(2):215–21. DOI: 10.2105/AJPH.2008.137174 [PubMed: 19059851]

McCoy SI, Ralph LJ, Njau PF, Msolla MM, Padian NS. Food insecurity, socioeconomic status, and HIV-related risk behavior among women in farming households in Tanzania. AIDS and Behavior. 2014; 18(7):1224–36. DOI: 10.1007/s10461-013-0629-3 [PubMed: 24097335]

Misselhorn AA. What drives food insecurity in Southern Africa? A meta-analysis of household economy studies. Global Environmental Change. 2005; 15(1):33–43. DOI: 10.1016/j.gloenvcha.2004.11.003

Musumari PM, Wouters E, Kayembe PK, Nzita M Kiumbu, Mbikayi SM, Suguimoto SP, Techasrivichien T, et al. Food insecurity is associated with increased risk of non-adherence to antiretroviral therapy among HIV-infected adults in the Democratic Republic of Congo: A cross-sectional study. Plos One. 2014; 9(1):e85327.doi: 10.1371/journal.pone.0085327 [PubMed: 24454841]

Nagata JM, Fiorella KJ, Salmen CR, Hickey MD, Mattah B, Magerenge R, Milner EM, Weiser SD, Bukusi EA, Cohen CR. Around the table: Food insecurity, socioeconomic status, and instrumental social support among women living in a rural Kenyan island community. Ecology of Food and Nutrition. 2015; 54(4):358–69. DOI: 10.1080/03670244.2014.995790 [PubMed: 25680030]

Nagata JM, Magerenge RO, Young SL, Oguta JO, Weiser SD, Cohen CR. Social determinants, lived experiences, and consequences of household food insecurity among persons living with HIV/AIDS on the shore of Lake Victoria, Kenya. AIDS Care. 2012; 24(6):728–36. DOI: 10.1080/09540121.2011.630358 [PubMed: 22150119]

National AIDS Council of Zambia. Zambia country report: Monitoring the declaration of commitment on HIV and AIDS and the universal access. Lusaka, Zambia: Ministry of Health, National AIDS Council; 2014.

Ngalula J, Urassa M, Mwaluko G, Isingo R, Boerma J Ties. Health service use and household expenditure during terminal illness due to AIDS in rural Tanzania. Tropical Medicine & International Health. 2002; 7(10):873–77. DOI: 10.1046/j.1365-3156.2002.00922.x [PubMed: 12358623]

Rawat R, McCoy SI, Kadiyala S. Poor diet quality is associated with low CD4 count and anemia and predicts mortality among antiretroviral therapy-naive HIV-positive adults in Uganda. Journal of Acquired Immune Deficiency Syndromes. 2013; 62(2):246–53. DOI: 10.1097/QAI.0b013e3182797363 [PubMed: 23117502]

Samuels FA, Rutenberg N. "Health regains but livelihoods lag": Findings from a study with people on ART in Zambia and Kenya. AIDS Care. 2011; 23(6):748–54. DOI: 10.1080/09540121.2010.532535 [PubMed: 21574075]

Singer AW, Weiser SD, McCoy SI. Does food insecurity undermine adherence to antiretroviral therapy? A systematic review. AIDS and Behavior. 2015; 19(8):1510–26. DOI: 10.1007/s10461-014-0873-1 [PubMed: 25096896]

Smith DR, Gordon A, Meadows K, Zwick K. Livelihood diversification in Uganda: Patterns and determinants of change across two rural districts. Food Policy. 2001; 26(4):421–35. DOI: 10.1016/S0306-9192(01)00012-4

Spacek LA, Shihab HM, Kamya MR, Mwesigire D, Ronald A, Mayanja H, Moore RD, Bates M, Quinn TC. Response to antiretroviral therapy in HIV-infected patients attending a public, urban clinic in Kampala, Uganda. Clinical Infectious Diseases. 2006; 42(2):252–59. DOI: 10.1086/499044 [PubMed: 16355337]

StataCorp. Stata statistical software: Release 14. College Station, TX: Stata Corp LP; 2015.

Stringer JS, Zulu I, Levy J, Stringer EM, Mwango A, Chi BH, Mtonga V, et al. Rapid scale-up of antiretroviral therapy at primary care sites in Zambia: Feasibility and early outcomes. Jama. 2006; 296(7):782–93. DOI: 10.1001/jama.296.7.782 [PubMed: 16905784]

Sun GW, Shook TL, Kay GL. Inappropriate use of bivariable analysis to screen risk factors for use in multivariable analysis. Journal of Clinical Epidemiology. 1996; 49(8):907–16. DOI: 10.1016/0895-4356(96)00025-X [PubMed: 8699212]

Tirivayi N, Koethe JR, Groot W. Clinic-based food assistance is associated with increased medication adherence among HIV-infected adults on long-term antiretroviral therapy in Zambia. Journal of AIDS & Clinical Research. 2012; 3(7):171.doi: 10.4172/2155-6113.1000171 [PubMed: 23227443]

Tiyou A, Belachew T, Alemseged F, Biadgilign S. Food insecurity and associated factors among HIV-infected individuals receiving highly active antiretroviral therapy in jimma zone Southwest Ethiopia. Nutrition Journal. 2012; 11:51.doi: 10.1186/1475-2891-11-51 [PubMed: 22824145]

Tsai AC, Bangsberg DR, Emenyonu N, Senkungu JK, Martin JN, Weiser SD. The social context of food insecurity among persons living with HIV/AIDS in rural Uganda. Social Science & Medicine. 2011; 73(12):1717–24. DOI: 10.1016/j.socscimed.2011.09.026 [PubMed: 22019367]

Tsai AC, Hatcher AM, Bukusi EA, Weke E, Hufstedler LL, Dworkin SL, Kodish S, Cohen CR, Weiser SD. A livelihood intervention to reduce the stigma of HIV in rural Kenya: Longitudinal qualitative study. AIDS and Behavior. 2017; 21(1):248–60. DOI: 10.1007/s10461-015-1285-6 [PubMed: 26767535]

Wagner G, Rana Y, Linnemayr S, Balya J, Buzaalirwa L. A qualitative exploration of the economic and social effects of microcredit among people living with HIV/AIDS in Uganda. AIDS Research and Treatment. 2012; 2012:318957.doi: 10.1155/2012/318957 [PubMed: 22778923]

Walsh CM, Van Rooyen FC. Household food security and hunger in rural and urban communities in the Free State Province, South Africa. Ecology of Food and Nutrition. 2015; 54(2):118–37. DOI: 10.1080/03670244.2014.964230 [PubMed: 25551521]

Weiser SD, Bukusi EA, Steinfeld RL, Frongillo EA, Weke E, Dworkin SL, Pusateri K, et al. Shamba maisha: Randomized controlled trial of an agricultural and finance intervention to improve HIV health outcomes. Aids. 2015; 29(14):1889–994. DOI: 10.1097/QAD.0000000000000781 [PubMed: 26214684]

Weiser SD, Tsai AC, Gupta R, Frongillo EA, Kawuma A, Senkungu J, Hunt PW, et al. Food insecurity is associated with morbidity and patterns of healthcare utilization among HIV-infected individuals in a resource-poor setting. Aids. 2012; 26(1):67–75. DOI: 10.1097/QAD.0b013e32834cad37 [PubMed: 21904186]

Wood E, Hogg RS, Yip B, Harrigan PR, O'Shaughnessy MV, Montaner JS. The impact of adherence on CD4 cell count responses among HIV-infected patients. Journal of Acquired Immune Deficiency Syndromes. 2004; 35(3):261–68. DOI: 10.1097/00126334-200403010-00006 [PubMed: 15076240]

Young S, Wheeler AC, McCoy SI, Weiser SD. A review of the role of food insecurity in adherence to care and treatment among adult and pediatric populations living with HIV and AIDS. AIDS and Behavior. 2014; 18(Suppl 5):S505–S15. DOI: 10.1007/s10461-013-0547-4 [PubMed: 23842717]

Table 1

Sample Characteristics and Their Bivariable Associations with HFIAS Scores.

Variable		HFIAS scores	
	% or *M (SD)*[a]	Mean score or *β*[b]	p
Outcome			
Household food insecurity (continuous)	14.21 (7.86)		
Food insecurity (prevalence)			
Food secure	7%		
Mildly food insecure	2%		
Moderately food insecure	17%		
Severely food insecure	74%		
Demographic			
Age (in years)	37.78 (7.35)	−0.13	.24
Gender			.03
Female	45%	15.74	
Male	55%	12.34	
Marital status			.15
Married	76%	13.55	
Not married	24%	16.25	
Education level			.00
Primary education	64%	15.98	
Secondary education or higher	36%	11.03	
Type of occupation			.04
Farming	76%	15.12	
Nonfarming	24%	11.42	
Head of household status			.26
Head of household	65%	13.56	
Non–head of household	35%	15.44	
Residence			.22
Lumezi	50%	15.18	
Lundazi	50%	13.24	
Social and economic			
Household size	5.94 (3.53)	−0.45	.01
Financial situation			.00
Worse than two years ago	82%	15.84	
The same or better than two years ago	18%	7.00	
Household income			.00
ZK0–20	44%	16.79	
ZK21–50	26%	16.04	
ZK51–500	15%	12.07	
≥ ZK501	15%	5.93	
Transportation asset index	0.19 (0.39)	−5.06	.00

Variable		HFIAS scores	
	% or *M (SD)*[a]	Mean score or β[b]	p
Household possessions index	0.65 (0.81)	−4.44	.00
Livestock ownership index	1.39 (3.03)	−0.63	.00
Landownership (in acreage)	3.84 (4.03)	−0.39	.01
Saving behavior			.37
Save sometimes or frequently	63%	14.76	
Do not save	37%	13.28	
Debt			.46
Owe money	24%	15.25	
Do not owe money	76%	13.88	
Health			
Perceived stress, mental distress	7.32 (4.60)	0.69	.00
Perceived stress, coping strategies	9.44 (4.28)	−0.13	.51
Health perception			.01
Good or better	81%	13.16	
Poor or fair	19%	18.58	
ART treatment duration (in months)	26.13 (20.39)	−0.01	.78

Note. ART = antiretroviral therapy; HFIAS = Household Food Insecurity Access Scale; *M* = mean, *SD* = standard deviation. Household income was measured in Zambian kwacha (ZK).

[a] *M* (*SD*) for continuous variables and percentage distribution (*%*) for categorical variables.

[b] Comparison of mean scores for categorical variables and β for continuous variables.

Table 2

Multivariable Linear Regression Results of HFIAS Scores and Sample Characteristics ($N = 98$).

	Household Food Insecurity Access Scale scores											
	Model 1			Model 2			Model 3			Model 4		
Variable	**β**	**p**	**95% CI**	**β**	**p**	**95% CI**	**β**	**p**	**95% CI**	**β**	**p**	**95% CI**
Demographic												
Age (in years)	−0.10	.38	−0.34, 0.13	−0.12	.28	−0.35, 0.10	−0.04	.68	−0.25, 0.16			
Gender (reference is female)	−1.93	.35	−6.03, 2.16	0.88	.67	−3.24, 4.99	0.20	.90	−3.10, 3.50			
Marital status (reference is not married)	−1.59	.43	−5.53, 2.35	−0.94	.61	−4.64, 2.75	−0.12	.94	−3.12, 2.88			
Education level (reference is primary education)	−4.44	.01	−7.84, −1.05	−0.57	.75	−4.07, 2.93	−0.70	.65	−3.74, 2.35			
Type of occupation (reference is farming)	−1.93	.43	−6.76, 2.90	1.86	.39	−2.40, 6.12	2.28	.30	−2.09, 6.65			
Head of household status (reference is non-head of household)	0.14	.95	−4.44, 4.71	−1.14	.62	−5.69, 3.40	−0.25	.89	−3.94, 3.44			
Residence (reference is Lundazi)	1.02	.60	−2.85, 4.89	0.44	.84	−3.82, 4.71	2.39	.28	−1.99, 6.78	2.01	.17	−0.86, 4.89
Social and economic												
Household size				−0.23	.39	−0.76, 0.30	−0.20	.36	−0.63, 0.23	−0.30	.12	−0.67, 0.07
Financial situation (reference is worse than two years ago)				−3.42	.04	−6.74, −0.11	−2.76	.13	−6.35, 0.83	−3.10	.06	−6.27, 0.06
Household income (reference is ZK0–20)												
ZK21–50				0.76	.62	−2.28, 3.81	−0.15	.91	−2.43, 2.73	0.47	.71	−2.01, 2.95
ZK51–500				−4.98	.07	−10.28, 0.31	−4.57	.09	−9.80, 0.65	−4.92	.04	−9.51, −0.32
≥ ZK501				−7.71	.01	−13.34, −2.07	−4.33	.18	−10.74, 2.09	−4.86	.08	−10.39, 0.67
Transportation asset index				−1.89	.39	−6.22, 2.44	−1.77	.41	−6.01, 2.47	−2.65	.10	−5.90, 0.60
Household possessions index				−2.25	.08	−4.74, 0.25	−3.53	.01	−5.95, −1.12	−2.93	.00	−4.80, −1.06
Livestock ownership index				−0.05	.86	−0.65, 0.55	−0.18	.51	−0.73, 0.36			
Landownership (in acreage)				0.04	.83	−0.33, 0.41	−0.00	.99	−0.35, 0.34			
Saving behavior (reference is do not save)				4.64	.03	0.37, 8.91	−0.82	.69	−4.89, 3.25			
Debt (reference is no debt)				3.65	.05	0.01, 7.29	3.32	.07	−0.30, 6.94	3.32	.03	0.29, 6.34
Health												
Perceived stress, mental distress							0.55	.01	0.12, 0.98	0.56	.00	0.19, 0.93
Perceived stress, coping strategies							−0.55	.01	−0.95, −0.14	−0.55	.00	−0.89, −0.20
Health perception (reference is poor/fair)							−2.03	.23	−5.40, 1.34			
ART treatment duration (in months)							0.02	.60	−0.05, 0.08			

	Household Food Insecurity Access Scale scores											
	Model 1			Model 2			Model 3			Model 4		
Variable	β	p	95% CI	β	p	95% CI	β	p	95% CI	β	p	95% CI
R^2		0.1624			0.4691			0.5986			0.5799	

Note. ART = antiretroviral therapy; HFIAS = Household Food Insecurity Access Scale; CI = confidence interval. Household income was measured in Zambian kwacha (ZK). Results are based on two-tailed tests.