Food insecurity at HIV diagnosis associated with subsequent viremia amongst adults living with HIV in an urban township of South Africa

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Abstract

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We assessed the impact of food insecurity on antiretroviral adherence, retention in care, hospitalization, mortality, and HIV viremia in an urban township of Kwazulu-Natal, South Africa. At the time of HIV testing, food security status was assessed using the Household Food Insecurity Access Scale (HFIAS), and people living with HIV were followed for at least twelve months. Among 2,383 HIV-positive participants, 253 (10.6%) experienced food insecurity. Food insecurity was associated with higher adjusted odds of having HIV viremia (>1,000 copies/mL) at 12 months after HIV testing (aPOR 1.2, P=0.001). At HIV testing, persons with WHO Stage 2 (aPOR 1.5, P=0.016) or Stage 3 (aPOR 1.7, P=0.001) disease were more likely to have experienced food insecurity.

BACKGROUND

Food security, or access to safe and nutritious foods, is recognized as a critical component of optimal health and has been affirmed as a fundamental human right [1]. Adequate nutrition, including micronutrition, is essential in maintaining the health of people living with HIV/AIDS (PLHIV) [2–10]. Food insecurity has been linked to sub-optimal antiretroviral therapy (ART) concentration [5], decreased co-stimulation of CD4+ and CD8+ T-cells [7], and lower odds of reaching viral suppression [4,9,11]. These impacts of poor nutrition are further compounded by the increased nutritional intake demanded in infectious states and the increase in resting energy expenditure that results from the use of ARTs [5,7,12]. Poor nutrition also leads to weight loss, a known risk factor for HIV-associated wasting and AIDS-related mortality [13].

In addition to the effects that inadequate nutrition has on the immune system, food insecurity has been associated with higher ART non-adherence, loss to follow-up, and virologic failure [14–17]. South Africa has the largest HIV epidemic where an estimated 19% of adults aged 15-49 are living with HIV [18]. The relationship between food insecurity and its impact on the HIV care and treatment outcomes of PLHIV in resource-limited settings has not been well characterized.

OBJECTIVES

We sought to estimate the prevalence of food insecurity and determine whether food security status has an impact on hospitalization, viral load, anti-retroviral treatment (ART) adherence, and retention in care in this cohort of PLHIV in Umlazi, South Africa. Additionally, we sought to identify sociodemographic characteristics that were associated with food insecurity in this population.

METHODS

Study Design

We conducted a longitudinal cohort study of adults aged 18 or older who voluntarily presented for HIV testing at the iThembalabantu clinic in the Umlazi township of KwaZulu-Natal, South Africa from September 2013 to April 2017. The primary goal of the study was to validate clinic-based rapid cryptococcal antigen lateral flow assay (CrAg LFA) [19]. All participants self-reported being ART naïve prior to enrollment. Females who were pregnant at time of presentation for HIV testing and patients who had received anti-fungal treatment within the past three months were excluded from the study. Participants were English or Zulu speaking and were able to provide written informed consent in their language. This study was authorized by the University of Kwazulu-Natal's Medical Ethics Committee (Protocol #BF052/13) and the University of Washington's Institutional Review Board (IRB #49563).

Data Collection

Research assistants fluent in English and Zulu determined patient eligibility, obtained consent, and collected basic sociodemographic information and baseline health data using structured questionnaires. Following enrollment and collection of baseline survey data, HIV testing was conducted by non-research clinic staff using serial rapid tests according to South African guidelines [20]. Following testing, HIV-positive participants were escorted to a research nurse who collected blood, urine, and sputum samples. All participants found to have HIV proceeded with standard of care HIV treatment and monitoring in accordance with South African guidelines including CD4 testing and ART initiation [20]. Participation in this study did not impede on enrollees' HIV or other primary healthcare. HIV-positive participants were then assessed for health outcomes at regular intervals for at least 12 months following enrollment via phone surveys and data obtained from medical and National Health Laboratory Services (NHLS) records. Participants who were HIV-negative did not proceed to a research nurse for biological sample collection and received no follow-up. Data was not collected in a manner that identified participants who may be from the same household.

Food security status was determined at time of enrollment prior to HIV testing using the Household Food Insecurity Access Scale (HFIAS). The HFIAS is an experience-based scale with a recall period of one month that has been previously validated and used in the Sub-Saharan African context. [21–24] The questionnaire consists of nine questions, answers to which are correlated with a point value and weighted according to a scale [25]. Based on this weighted value, each participant is classified into one of four food insecurity categories: 1-food secure, 2-mildly food insecure, 3-moderately food insecure, and 4-severely food insecure [25]

Description of Outcomes

The outcomes of interest in this analysis are hospitalization, viremia (HIV viral load >1,000 copies/mL), ART adherence, and retention in care. These outcomes were selected due to a robust body of literature indicating an association between these measurements and food security in PLHIV in both the U.S. and Sub-Saharan Africa [11,15,17,26–30]. All outcomes were assessed by research assistants at the previously described follow-up intervals.

Hospitalization was defined as any admission to a hospital for any purpose and was ascertained by accessing medical records and by patient self-report. Participants were most likely to be admitted to Prince Mshiyeni Memorial Hospital in Umlazi or King Edward VIII Hospital at the University of KwaZulu-Natal, both of which work in partnership with iThembalabantu.

Viremia was measured as per South African guidelines of viral load measurement at baseline prior to starting ART at 6 and 12 months following commencement of ART [20]. Viral load testing was conducted as part of participants' standard non-research related HIV care at iThembalabantu, and the results were extracted from NHLS records.

Adherence to ART was assessed through clinic medical records. Research assistants tracked whether patients missed re-filling ARVs (anti-retrovirals) at the pharmacy or stopped taking them all together. This data could be found in the adherence counselor's reports in participant clinic records as part their standard non-research related HIV care at iThembalabantu. Participants were considered to have defaulted on ART if they missed more than 3 refills of ARVs or indicated that they had stopped taking them. Participants who defaulted and later resumed treatment were analyzed as having defaulted.

Retention in care was assessed through clinic medical records. Participants were considered retained in care at iThembalabantu if they had been seen in or in contact with the clinic within the previous 3 months. Medical records were also used to determine if participants had transferred their care to another clinic or died. Participants who had not been retained at iThembalabantu, had not transferred their care, and had no record of death were considered lost to follow-up.

Statistical Analysis

Descriptive statistics were performed for sociodemographic enrollment characteristics of all HIV-positive participants in this study. Chi-square analysis was used to compare sociodemographic enrollment characteristics of HIV-positive participants based on food security status. Participants were divided into two groups: "Food Secure", and "Food Insecure" based on HFIAS survey results. Those who were identified by HFIAS as category 1 were labeled "Food Secure" whereas those identified as category 2-4 were labeled "Food Insecure." Chi-square analysis was used to compare HIV-positive participant initial viral load measurements and the one-year outcomes of hospitalization occurrence, ART adherence, and retention in care.

Outcomes of interest were converted into categorical variables for logistic regression. Univariate and multivariate logistic regression analysis were used to produce unadjusted and adjusted prevalence odd ratios (POR and aPOR) of viremia by food security status in addition to POR and aPOR of any food insecurity by enrollment sociodemographic characteristics. Variables used in the univariate models were enrollment sociodemographic characteristics found to be significantly different between the food secure and food insecure groups in chi square analysis. Following this, enrollment sociodemographic characteristics found to be significant in univariate analysis were included in multivariate models. P values of <0.05 were considered significant. We analyzed data using STATA IC 15.1.

RESULTS

Among 2,383 PLHIV, 57.5% were female, the median age was 31.3 (IQR 26.3,38.3), and 253 (10.6%) experienced food insecurity (Table I). Demographic data collected reflects participant status at time of enrollment and were self-reported except for HIV clinical staging. HIV clinical staging was determined by non-research affiliated HIV nurses at the clinic using the World Health Organization guidelines and was collected by research assistants from medical records [31]. Transportation method to clinic refers to how the participant arrived to iThembalabantu the day of their enrollment to the study and education level obtained refers to level of education fully completed.

Enrollment characteristics of food insecure participants differed significantly from food secure participants in their means of transportation to the clinic, education level, monthly income, and HIV clinical stage (Table II). In these cases, those who were HIV-positive and food insecure were more likely to walk to the clinic for their care as opposed to using motorized transportation ($p=0.005$), had lower levels of education ($p<0.001$), lower incomes ($P=0.001$), and were overall diagnosed with HIV at later stages ($P<0.001$).

Food insecure participants again differed from those who were food secure in viremia and one year ART adherence, retention in care, and occurrence of hospitalization (Table III). Food insecure participants experienced viremia significantly more than their food secure counterparts ($p<0.001$). At 12 months, 55.3% of the food insecure had met the threshold of viremia compared to 43.4% of the food secure. There were no significant differences in the one-year retention in care, treatment adherence, and occurrence of hospitalization between food secure and food insecure participants.

Univariate modeling demonstrated that experiencing food insecurity was statistically significantly associated with higher prevalence odds of viremia within 12 months of HIV diagnosis (aPOR 1.2, $p=0.001$) (Table IV). In univariate and multivariate analysis of these same baseline characteristics, having a clinical HIV WHO stage of 2 (aPOR 1.5, $p=0.016$) or stage 3 (aPOR 1.7, $p=0.001$) at time of diagnosis were both statistically significantly associated with greater prevalence odds of being food insecure (Table V). Conversely, driving a private car (aPOR 0.0, $P<0.001$), obtaining greater than a primary school education, and having a monthly income greater than 2,000 ZAR were all statistically significantly associated with decreased prevalence odds of being food insecure (Table V).

DISCUSSION

The results of this prospective study on the impact of food security status on HIV care and treatment in Umlazi, South Africa reveals two important findings. First, persons who are food insecure are more likely to walk to access their healthcare, to have not received any formal education, to have a lower income, and to be diagnosed with HIV at a later stage of disease. Moreover, these factors are predictive of whether a person in this population is experiencing food insecurity. Second, the presence of food insecurity is predictive of a person in this population experiencing HIV viremia within 12 months of their diagnosis. This particular finding could have implications for potential transmission to partners and maternal transmission to children.

The association between food insecurity with educational level obtained and transportation method to the clinic may be related to monthly income, which was also found to be associated with food insecurity in this study. Increased income affords people the ability to own or rent a private vehicle or to pay for the fees required for mini-buses and taxis. A previous investigation of a cohort from Durban outpatient clinics found that that low income was a barrier to accessing care due to inability to afford transportation or medications [32]. Other studies have similarly concluded that lower income acts as a barrier to health because people are forced to choose what needs are most critical to fund [33,34].

In our cohort, food insecurity at time of HIV diagnosis was predictive of viremia within one year despite food insecurity having no significant impact on treatment adherence and retention in care suggests that the food insecure are a uniquely vulnerable population in this setting. This finding is widely supported in the literature showing that inadequate access to food impairs immune function and leads to poor health outcomes [2–5,7–11,14,32–36]

A study of HIV-TB co-infected adults in Senegal found that food supplementation was economically feasible and bettered health outcomes in addition to treatment adherence [37]. Additionally, previous investigations have shown that providing nutritional supplementation to HIV positive food insecure people could lead to lower weight loss, and greater treatment adherence [38,38–43]. Such investigations suggest that screening for food insecurity at time of diagnosis and providing food supplementation could be a feasible and beneficial to our population of interest. Food supplementation also could increase overall quality of life in other ways, like decreasing stress levels, that should not be underrated [44].

The overall burden of food insecurity as measured by the HFIAS in our cohort was low, accounting for 10.6% of the study population. This prevalence was lower than prior South African government sponsored HFIAS survey of households in KwaZulu-Natal, which showed that 23.4% of households in the province experienced food insecurity [45]. A study of the nutrition situations of free-living elders in Umlazi found that food shortages were frequent, with 54% of participants regularly experiencing them [46]. Though this study was of the elder population of Umlazi and utilized a seven-day food frequency questionnaire to survey food security as opposed to the HFIAS, it provides greater insight into what is highly a high food insecurity prevalence in the township. Additionally, a study of depression rates in caregivers of AIDS-orphaned children in Umlazi found that 61.7% of participant households experienced food insecurity when measured using the HFIAS; again indicating that food insecurity prevalence is likely higher than what was captured in our investigation [47].

The low prevalence of food insecurity in this population was a study limitation. The low prevalence of food insecurity may be a true reflection or an under estimation of the problem, but this is uncertain without having conducted detailed food questionnaires and home visits. It's possible that rapid HIV testing prior to collecting HFIAS survey data may have made participants more comfortable disclosing food insecurity. However, there were ethical considerations guiding the timing of the surveys; primarily to avoid the passive implication that taking the survey after testing positive for HIV would result in participants being provided with food supplementation by study staff. Additionally, we recognize that participants in this study presented for HIV testing presumable due to a recent exposure. It's possible that they were hesitant to disclose further sensitive information such as food security status at time of testing. Finally, food insecurity was only assessed once for each participant in the study. Because of this, we could not measure whether food security status changed throughout the course of the yearlong follow-ups. It’s possible that some participants experienced a change in food security status due to a variety of factors like changes in agricultural availability or income. Whether these factors are the true cause of our lower reports of food insecurity are unknown but worthy of consideration in future study designs.

CONCLUSIONS

Experiencing food insecurity at time of HIV diagnosis is predictive of subsequent viremia within one year despite food insecurity having no significant impact on treatment adherence and retention in care. Among sociodemographic characteristics, having to walk to the clinic for care as opposed to using motorized transportation, lacking primary school education, and having later stage HIV at time of diagnosis were significantly associated with food insecurity. These findings suggest that screening for food insecurity at time of HIV diagnosis and providing food supplementation, if indicated, should be a standard part of HIV clinical care in this population.

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Table I

Sociodemographic characteristic of all HIV (+) participants at enrollment

	n (%)
Number of Participants	2,383
Age in years, median (IQR)	31.3 (12.0)
Female	1,371 (57.5)
Live in Umlazi	2,229 (93.5)
Distance from Household to Nearest Clinic	
<5km	1,953 (82.0)
5-10km	393 (16.5)
>10km	35 (1.5)
Transportation Method to Clinic	
Walk	1,518 (63.9)
Public Transportation	826 (34.8)
Private Car	31 (1.3)
Educational Level Obtained	
None[a]	464 (19.5)
Primary School	62 (2.6)
Some High School	776 (32.6)
Completed High School	1,005 (42.2)
Higher Degree	76 (3.2)
Monthly Income[b]	
<2,000 ZAR	1,785 (75.6)
2,000-10,000 ZAR	550 (23.3)
>10,000 ZAR	25 (1.1)
Household Characteristics	
Married	250 (6.3)
Never Married	2,211 (92.8)
Widowed/Divorced	22 (1.0)
HFIAS Food Security Category	
Food Secure	2,130 (89.4)
Mildly Food Insecure	86 (3.6)
Moderately Food Insecure	102 (4.3)
Severely Food Insecure	65 (2.7)
HIV Clinical Stage	
WHO Stage 1	936 (39.3)
WHO Stage 2	870 (36.6)
WHO Stage 3	546 (23.0)
WHO Stage 4	27 (1.1)

[a]Primary school not completed

[b]1 ZAR = 0.061 USD

Table II

Comparison of food insecure HIV (+) participants to food secure HIV (+) participants by sociodemographic characteristics at enrollment

	Food Insecure HIV(+) Participants n=253	**Food Secure HIV(+) Participants n=2,383**	**p-value**
Demographics	**n=253**	**n=2,130**	
Female	149 (58.9)	1,222 (57.4)	0.643
Age in years, median (IQR)	31 (11.5)	31 (12)	
Distance from Household to Nearest Clinic	**n=252**	**n=2,129**	0.680
<5km	201 (79.8)	1,752 (82.3)	
5-10km	48 (19.1)	345 (16.2)	
>10km	3 (1.2)	31 (1.51)	
Transportation Method to Clinic	**n=252**	**n=2,123**	**0.005**
Walk	182 (72.2)	1,226 (63.0)	
Public Transportation	70 (27.8)	756 (35.6)	
Private Car	-	31 (1.5)	
Educational Level Obtained	**n=253**	**n=2,130**	**<0.001**
None[a]	95 (37.6)	369 (17.3)	
Primary School	6 (2.4)	56 (2.6)	
Some High School	76 (30.0)	700 (32.9)	
Completed High School	74 (29.3)	931 (43.7)	
Higher Degree	7 (0.8)	74 (3.5)	
Monthly Income[b]	**n=238**	**n=2,122**	**0.001**
<2,000 ZAR	220 (92.4)	1,565 (73.8)	
2,000-10,000	18 (7.6)	532 (25.1)	
>10,000 ZAR	-	25 (1.2)	
Marital Status	**n=253**	**n=2,130**	0.337
Married	21 (8.3)	129 (6.1)	
Never Married	229 (90.5)	1,982 (93.1)	
Widowed/Divorced	3 (1.2)	19 (0.9)	
HIV Clinical Stage	**n=253**	**n=2,126**	**<0.001**
WHO Stage 1	67 (26.5)	869 (40.9)	
WHO Stage 2	102 (40.3)	768 (36.1)	
WHO Stage 3	82 (32.4)	464 (21.8)	
WHO Stage 4	2 (0.8)	25 (1.2)	

[a]Primary school not completed

[b]1 ZAR = 0.061 USD

Table III

Comparison of hospitalizations, virological failure, retention in care, and treatment adherence of food insecure HIV (+) participants to food secure HIV(+) participants at 12 months

	Food Insecure HIV(+) Participants (n=253)	Food Secure HIV(+) Participants (n=2,130)	p-value
Hospitalizations	**n=253**	**n=2,126**	0.934
Ever Hospitalized	14 (5.53)	115 (5.41)	
Disease Progression	**n=253**	**n=2,130**	**<0.001**
Viremia (>1,000 copies/ml)	140 (55.3)	925 (43.4)	
Retention in care	**n=253**	**n=2,128**	0.980
Retained in care at iThembalabantu	167 (66.0)	1,410 (66.3)	
Transferred care to another HIV clinic	27 (10.7)	215 (10.1)	
Defaulted or lost to follow-up	49 (19.4)	426 (20.0	
Death	10 (4.0)	77 (3.6)	
Treatment Adherence	**n=253**	**n=2,130**	0.392
Defaulted on ARVs	16 (6.3)	167 (7.8)	

Table IV

Adjusted and unadjusted prevalance odds ratios of viremia(>1,000 copies/ml) in HIV (+) participants by food security status

		Unadjusted[a]		Adjusted[b] (n= 2,348)	
Demographic and Household Factors		**POR[c] (95% CI)**	**p-value**	**aPOR[c] (95% CI)**	**p-value**
Food Security Category	No Food Insecurity	REF	-	REF	-
	Any Food Insecurity	1.3 (1.1 , 1.4)	**<0.001**	1.2 (1.1 , 1.4)	**0.001**

[a]Additional univariate variables included sex, age, transportation method to clinic, educational level obtained, monthly income, food security category, and WHO HIV stage

[b]Regression additionally adjusted for factors found significant in univariate analysis (age, transportation method to clinic, educational level obtained, and monthly income)

[c]POR=prevalance odds; aPOR=adjusted prevalance adjusted odds

Table V

Adjusted and unadjusted prevalence odds ratios of any food insecurity in HIV (+) participants by significantly different sociodemographic characteristics at enrollment + age and sex

Demographic and Household Factors		Unadjusted		Adjusted (n= 2,348)	
		POR[a] (95% CI)	p-value	aPOR[a] (95% CI)	p-value
Sex	Female	REF	-	-	-
	Male	0.9 (0.7 , 1.2)	0.644	-	-
Age		1.0 (1.0 , 1.0)	0.484	-	-
Transportation Method to Clinic	Walk	REF	-	REF	-
	Public Transportation	0.7 (0.5 , 0.9)	**0.010**	0.9 (0.7 , 1.1)	0.262
	Private Car	0.0 (0.0 , 0.0)	**<0.001**	0.0 (0.0 , 0.0)	**<0.001**
Educational Level Obtained	None[b]	REF	-	REF	-
	Primary School	0.5 (0.2 , 1.0)	0.060	0.6 (0.3 , 1.3)	0.179
	Some High School	0.5 (0.4 , 0.6)	**<0.001**	0.7 (0.5 , 0.9)	**0.005**
	Completed High School	0.4 (0.3 , 0,5)	**<0.001**	0.5 (0.4 , 0.7)	**<0.001**
	Higher Degree	0.1 (0.0 , 0.5)	**0.004**	0.2 (0.1 , 0.8)	**0.028**
Monthly Income[c]	<2,000 ZAR	REF		REF	-
	2,000-10,000	0.3 (0.2 , 0.4)	**<0.001**	0.3 (0.2 , 0.6)	**<0.001**
	>10,000 ZAR	0.0 (0.0 , 0.0)	**<0.001**	0.0 (0.0 , 0.0)	**<0.001**
WHO HIV Stage	WHO Stage 1	REF	-	REF	-
	WHO Stage 2	1.6 (1.2 , 1.2)	**0.001**	1.5 (1.0, 2.0)	**0.016**
	WHO Stage 3	2.1 (1.5 , 2.8)	**<0.001**	1.7 (1.2 , 2.4)	**0.001**
	WHO Stage 4	1.0 (0.3 , 4.0)	**0.050**	0.9 (0.2 , 3.6)	0.912

[a]POR=prevalance odds; aPOR=adjusted prevalance adjusted odds (adjusted for factors found significant in univariate analysis)

[b]Primary school not completed

[c]1 ZAR = 0.061 USD