HHS Public Access

Author manuscript

AIDS Behav. Author manuscript; available in PMC 2016 August 01.

Published in final edited form as:

AIDS Behav. 2015 August ; 19(8): 1527–1534. doi:10.1007/s10461-014-0922-9.

Food insecurity is longitudinally associated with depressive symptoms among homeless and marginally-housed individuals living with HIV

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Abstract

Introduction—Depression and food insecurity are prevalent among people with HIV (PLHIV) and contribute to poor HIV outcomes. Longitudinal data can help clarify the effect of food insecurity on depression among PLHIV in the United States.

Methods—We assessed the longitudinal association of food insecurity with symptoms of depression using validated measures among participants living with HIV from the Research on Access to Care in the Homeless cohort in San Francisco.

Results—We followed 346 participants for a median of 28 months. Over half of participants (55.0%) were food insecure and 35.8% had symptoms of depression. In adjusted models, severe food insecurity in the previous period was associated with increased depressive symptom severity ($b=1.22$; $p<0.001$). The association remained statistically significant in models including participant fixed effects.

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Conclusions—Severe food insecurity was longitudinally associated with symptoms of depression. Efforts to increase access to and participation in food security safety net programs for PLHIV could improve depression.

Keywords

food insecurity; depression; HIV/AIDS; United States; longitudinal

Introduction

Up to one-third of people living with HIV (PLHIV) receiving care or treatment in the US have symptoms of major depression (1, 2). A large body of evidence links mental illness – particularly depression – to poor HIV outcomes (3), including, disease progression (4, 5), non-adherence to antiretroviral therapy (ART) (6), and mortality (7). Depressive episodes are also linked to higher acute health care utilization (8). Evidence that treating depression leads to improved HIV outcomes further suggests a causal relationship (9, 10). The World Health Organization recommends attending to the mental health and psychosocial needs of PLHIV as an integral part of HIV care (11). Consequently, identifying modifiable determinants of depression among PLHIV may help identify targets for intervention.

Food insecurity, defined as the limited or uncertain availability of nutritionally adequate foods or the inability to acquire them in socially acceptable ways (12), affects up to half of all urban low-income PLHIV in resource-rich settings (13, 14). Food insecurity is independently associated with poor HIV clinical outcomes, including increased morbidity (15), poor ART adherence (13, 16), lower CD4 counts (16, 17), incomplete viral suppression (16, 18, 19) and mortality (20). Studies from the general population in the United States (US) and Canada have repeatedly found food insecurity to be associated with depression and poor mental health status, independent of other indicators of low socioeconomic status (21–24), particularly among women (24–27).

It has been hypothesized that depression is one of the critical pathways through which food insecurity may affect HIV outcomes (28), as uncertainty about food supply, coping with food deprivation or poor diet quality, and needing to obtain food in socially unacceptable ways may provoke emotional distress (29). In addition, micronutrient deficiencies – one potential consequence of food insecurity (30–32) – have been linked to depression via their detrimental impact on normal brain function (33, 34). The relationship of food insecurity with depression, however, is still being established among PLHIV in North America.

Cross-sectional studies have found food insufficiency to be significantly associated with depression among PLHIV using crack cocaine in Atlanta and Miami (35) and recipients of antiretroviral therapy in British Columbia (36). Yet, the relationship between food insecurity and depression is likely to be bidirectional: it is possible that functional decline associated with clinical depression (37) may worsen food security and account for observed associations between food insecurity and depression in cross-sectional data. Understanding time-ordered links between food insecurity and depression through longitudinal data will help delineate this potential pathway and help identify the directionality of association.

We assessed the magnitude of association between food insecurity and subsequent depressive symptoms in a cohort of urban homeless and marginally housed individuals living with HIV in the US. We hypothesized that higher food insecurity is associated with subsequent greater symptoms of depression.

Methods

We conducted quarterly assessments with participants in the Research on Access to Care in the Homeless (REACH) study from May 2007 to March 2010. REACH is a cohort of homeless and marginally housed individuals living with HIV systematically recruited from homeless shelters, free meal programs, and single-room occupancy hotels in San Francisco, as previously described (38, 39). Participants provided written consent to participate in the study and received $15 compensation per interview. The University of California San Francisco (UCSF) Committee on Human Research approved all study procedures.

Measures

Primary outcome variable—Symptoms of depression were assessed using the Beck Depression Inventory – Second Edition (BDI-II), a 21-item self-report instrument indicating the existence and severity of symptoms of depression based on the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV) (40, 41). Although the DSM-V has replaced the DSM-IV, the core criterion symptoms for depression and the requirement that these symptoms last for at least 2 weeks have not changed from the DSM-IV (42). Because of problems with including somatic symptoms in measurement of depressive symptoms among PLHIV, (43–46) we excluded items capturing "lack of energy", "trouble sleeping", "change in appetite", and "tiredness", and determined depression cut-offs for binary variables using a similar approach as Kalichman et al (44). Scale reliability (Cronbach α) was 0.91. Scores above 10 indicate symptoms consistent with a diagnosis of depression (referred to hereafter as "probable depression").

Primary independent variable—We measured food insecurity using the validated Household Food Insecurity Access Scale (HFIAS) (47, 48), previously adapted for use among marginally housed individuals in the US (49). The HFIAS consists of nine questions covering three key dimensions of food insecurity: anxiety and uncertainty about household food supply, insufficient food quality, and insufficient food intake and its consequences. Overall scores ranging from 0 to 27, with higher scores reflecting greater food insecurity, were used to categorize individuals into one of four possible levels of food insecurity: 1 = none (food secure), 2 = mild, 3 = moderate or 4 = severe (50). Scale reliability (Cronbach α) was 0.94.

Possible confounders—Based on previous studies regarding sociodemographic and clinical factors that may confound the relationship between depressive symptoms and food insecurity, we selected as covariates: biological sex (male vs. female), age (per 10 years), race/ethnicity (black, white, Latino or other), educational attainment (less than high school education vs. high school or higher), income (continuous per 100 dollars), having a dependent child (yes vs. no), CD4 count (continuous per 100 units), ART status (prescribed

antiretroviral medications in the past 30 days, yes vs. no), physical health status (continuous physical component summary (PCS) score of the SF-36), self-reported emergency department (ED) use in the last 90 days (yes vs. no), recent homelessness (spent the night in the street or in a homeless shelter at least once in the last 90 days, yes vs. no), heavy drinking over the past 30 days based on definitions by the National Institute of Alcohol Abuse and Alcoholism (>14 drinks/week for men and >7 drinks/week for women, yes vs. no) (51, 52), and illicit drug use (crack, cocaine, or methamphetamine, yes vs. no) in the past 90 days.

Analysis—We used generalized estimating equations (GEE) to model the population-level association between depressive symptoms and food insecurity. Using GEE, we first modeled the bivariate association between levels of food insecurity and concurrent depressive symptom severity measured as a continuous variable; in a second concurrent model, we adjusted for covariates. In a third model, we used a 3-month lag between the independent variables and the outcome to rule out reverse directionality as an explanation for observed associations. As a robustness check, we estimated a lagged regression with participant fixed effects to rule out potential confounding by unobserved time-invariant characteristics (e.g., temperament or innate coping ability). Finally, we used GEE to model the population-level association between a binary indicator for probable depression and food insecurity, adjusting for covariates. To assess possible effect modification by sex, we first tested the association between depressive symptoms and an interaction of sex and food insecurity. As this interaction was not statistically significant, we present results for our study population as a whole.

Covariates from the selected set were included in adjusted models if they were statistically significant at $p \leq 0.20$ in bivariate analysis using concurrent models: time-invariant covariates were sex, race/ethnicity, education, income, and CD4 count at enrollment, and time-varying covariates were receiving ART, SF36 physical component summary score, ED use, recent homelessness, heavy drinking and illicit drug use. In addition, we controlled for baseline depression score at enrollment to take into account how initial levels of depressive symptoms could affect associations with food insecurity over time. We considered effects to be statistically significant at $\alpha < 0.05$. All analyses utilized semi-robust or robust standard errors, as appropriate, and were conducted in Stata/IC 11.2 (StataCorp: College Station, Texas).

Results

We followed 346 participants for a median of 28 months. At enrollment, 71.4% of participants were male, 43.0% were African American, 67.4% had less than a high school education, and 9.2% had been recently homeless (Table I). Mean age was 48.3 years (SD =7.7; range 26–80) and 10% of participants supported child dependents. The majority of participants (76%) received ART at some point during the study. While average length of time receiving ART for these participants was 66.6 months (or 5.6 years), participants who reported having been prescribed ART at some point during the study reported these prescriptions in 64.8% of study visits.

Over half of participants had some degree of food insecurity at enrollment as assessed by the HFIAS (Table I): 6.1% were mildly food insecure (n=21), 18.2% were moderately food insecure (n=63), and 31.2% were severely food insecure (n=108). Over one-third of participants (35.3 %; n=122) had symptoms consistent with a diagnosis of depression according to the cognitive-affective sub-scale of the Beck Depression Inventory-II. The average score on the BDI-II C-A sub-scale was 9.25 [SD=9.30; range 0–42].

In bivariate analyses, mild [b=0.59; $p<0.05$], moderate [b=1.25; $p<0.001$], and severe food insecurity [b=2.75; $p<0.001$] were associated with higher severity of concurrent symptoms of depression (Table II). Adjusting for potential confounders in concurrent models attenuated but did not eliminate the associations between moderate [b=0.77; $p<0.01$] and severe [b=1.97; $p<0.001$] food insecurity and depressive symptom severity. When we lagged the independent variables in the adjusted models by 3 months to address potential reverse causality, only the association between severe food insecurity and depressive symptom severity was retained [b=1.22; $p<0.001$]; the association between moderate food insecurity and depressive symptoms was no longer significant. Specifying the model to include participant fixed effects further attenuated, but did not eliminate, the association between severe food insecurity and depressive symptoms [b=0.74; $p<0.05$].

In adjusted, lagged analyses using binary outcomes for symptoms consistent with a diagnosis of depression (Table III), moderate and severe food insecurity in the previous period were associated with 34% [$p<0.05$] and 60% [$p<0.001$] higher odds of probable depression, respectively.

Examining model covariates, having a higher physical health summary score and receiving ART were associated lower depressive symptom severity in concurrent models (Table II). In lagged and fixed effects models, receiving ART but not the physical health summary score was still associated with lower depressive symptom severity. Higher baseline depressive symptoms were associated with higher overall depressive symptom severity in all models including this covariate (Tables 2 and 3).

Discussion

In this longitudinal study of homeless and marginally housed adults living with HIV, severe food insecurity was associated with increased depressive symptom severity and greater odds of probable depression. This study is among the first to estimate food insecurity as a risk factor for depressive symptoms among PLHIV in a resource-rich setting. Given the detrimental impact depression has on HIV outcomes, our findings underscore the importance of addressing food insecurity among vulnerable PLHIV in the US.

Our results are consistent with prior cross-sectional studies conducted in Atlanta and Miami (35) and British Columbia (36), and one longitudinal study conducted in Uganda (53). Taken together, these studies consistently show that the odds of depression are significantly higher among individuals who are food insecure; the current study confirms the effect even after adjusting for baseline depression.

It was notable that only severe – and not moderate or mild – food insecurity was statistically significant in the lagged regression and increased the risk for depressive symptoms in our study. Severe food insecurity is characterized by having to make significant reductions in food intake. Given the availability of food safety nets in the US, it may be that only those most vulnerable, and therefore the most severely food insecure, experience measurable impacts on depressive symptoms. Furthermore, a recent nationally representative study in Canada found that the prevalence of a mental health diagnosis was highest among those reporting food insufficiency (hunger) compared to those reporting poor diet quality (24). Future studies using robust indicators of food insufficiency can help confirm the association between severe food insecurity and symptoms of depression among PLHIV(54).

Pathways linking food insecurity and depression are likely both behavioral and biological. Research on poverty indicates that having insufficient food can undermine social relationships because of feelings of anxiety, deprivation, and alienation and can lead to feelings of low self-efficacy (29, 55, 56). Food insecurity may thus trigger a deep sense of helplessness, leading to mental and emotional distress (25, 27, 29). For people with HIV, this distress may be further heightened by worries about the ability to maintain physical health, including the ability to adhere to medications, triggered by the challenges of severe food insecurity. Meanwhile, studies from the US (30, 31) and Canada (32) link food insecurity with inadequate dietary intakes and serum nutrient levels, which can in turn inhibit normal brain function and contribute to depression (33, 34). In particular, deficiencies in essential fatty acids, folate, and vitamin B12 have been implicated in the pathogenesis of major depressive disorder (33).

Efforts to improve food security among PLHIV in the US may have a positive impact on mental health in this population. The National HIV/AIDS Strategy for the US recommends that government agencies should support and increase access to non-medical supportive services, including food, as critical elements of an effective HIV care system. While federal financing for HIV services in the US does provide some limited funds for food and nutrition services to PLHIV through the Ryan White program, the design and delivery of nutritional services for PLHIV can be improved to better address food insecurity and its multiple negative impacts, including those related to not only malnutrition and hunger but also overweight and obesity (57). One critical advance would be to include harmonized food security and nutrition indicators into HIV monitoring and evaluation in the US, as is being done internationally by the Joint United Nations Programme on HIV/AIDS and others, in order to comprehensively track progress addressing nutritional issues among PLHIV (58).

Improved funding for, and reach of, food and nutrition safety nets to PLHIV may be particularly important given the negative effects of both food insecurity and depression on HIV. Previous studies among older adults in the US found that participation in the Supplemental Nutrition Assistance Program (SNAP, or “food stamps”) modified the detrimental effect of food insecurity on depression, and appeared to be protective (59). Policies precluding recipients of Supplemental Security Income living with HIV from receiving SNAP benefits in some states (such as California), and rules in certain states excluding previously incarcerated individuals, who are at higher risk for HIV, from participating in SNAP (60) may negatively impact the food security and subsequent health

of PLHIV. Expanding coverage under the Medicare Part B for medical nutrition therapy to people with HIV (currently only offered to individuals with diabetes and renal disease), and expanding services beyond nutritional counseling to include the provision of food, may be another innovative policy solution (61).

Interventions in health-care settings are also important to help the most vulnerable PLHIV overcome access barriers to food and nutrition safety net services. Primary care medical homes (PCMH) represent the goal model for primary care in the US and seek to integrate standard primary care with mental health care, social work, and ancillary services needed to address health broadly along the patient's continuum of needs (62), including access to basic needs (e.g. food) for vulnerable populations. Our results suggest that within the PCMH model, interventions to address food insecurity, such as helping PLHIV understand SNAP eligibility requirements, assistance with signing up for food support or job programs, and addressing livelihood barriers, may have important mental health benefits. Overcoming barriers to identifying food insecurity during primary care visits – particularly misconceptions that food insecurity is only a problem for underweight individuals – will be an important precursor to any of these interventions (63–65). Few studies have specifically explored how primary health care settings can effectively implement integration of mental health care with support for contextual risk factors such as housing and food security (66) within the PCMH model, making such research a priority.

Our study has several limitations. First, our results may not be generalizable to the broader population of PLHIV in the US. While our results are in line with previous work among drug users in other urban settings, including Atlanta and Miami (35), it is possible that the relationship between food insecurity and depressive symptoms may be different in rural settings or among stably-housed PLHIV. In addition, the cognitive complexity of the BDI-II may result in limited measurement accuracy (67). In our study, it is likely that more severely food insecure individuals had characteristics, such as higher HIV morbidity (which can include cognitive difficulties) and lower education, which made them more sensitive to issues of cognitive complexity, leading to measurement error. There is no reason to believe, however, that cognitive complexity would result in systematically higher or lower measurement of depressive symptom. Thus, it is likely that the measurement error is random and does not bias our estimates. Finally, self-reported measures of depressive symptoms such as the BDI-II approximate but are not the same as clinical diagnoses of depression. Future studies using diagnostic measures such as the Structured Clinical Interview (SCID) should confirm these associations.

Our study also has two notable strengths. First, given that both food insecurity and depressive symptoms were assessed using self-report instruments, observed associations could be explained by unobserved characteristics, such as temperament. This could, for example, lead some individuals to self-report both higher levels of depressive symptoms and higher levels of food insecurity compared to other individuals with the same (unobserved) true levels of depressive symptoms and food insecurity but with different temperaments. The association between food insecurity and depression remained, however, even after controlling for unobserved time fixed individual characteristics using fixed-effects regression, helping to address this concern related to over reporting. In addition, while our

study is associational and does not conclusively establish a causal relationship, our results held in lagged analyses. This provides plausible evidence suggesting a direction of effect whereby food insecurity may lead to worsened symptoms of depression.

In conclusion, our study suggests that reducing food insecurity, a modifiable risk factor for depression among PLHIV in the US, may help improve HIV-related morbidity among vulnerable populations. In combination with other studies that have linked food insecurity with ART non-adherence, disease progression and acute health care among PLHIV, efforts to increase access to and participation in federal and local food-security safety net programs for PLHIV could improve their mental and physical health. While interventions to improve all levels of food insecurity are necessary, reducing severe food insecurity among the most vulnerable is essential and may be a more feasible initial policy target.

Acknowledgments

This study was funded by NIMH RO154907 (PI: Dr Bangsberg) CHRP ID08-SF-054; UCSF Academic Senate; Hurlbut-Johnson funds from AIDS Research Institute award, UCSF, # 557858-8-148. The authors acknowledge the following additional sources of salary support: AHRQ T32HS00046 (Dr. Palar), R01 MH095683 and the Burke Family Foundation (Dr. Weiser), and NIMH K24 87227 (Dr. Bangsberg).

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Table I

Baseline characteristics at enrollment (n=346)

Depression – BDI-II Cognitive affective sub-scale	**All**
Depressive symptom severity score, mean [SD]	9.25 [9.30]
Probable depression, % (BDI C-A score > 10)	35.3
Food insecurity, %	
1 = None (food secure)	44.5
2 = Mild	6.1
3 = Moderate	18.2
4 = Severe	31.2
Socio-demographics	
Male, %	71.4
Age, median [IQR]	48 [43, 53]
Race, %	
Black	43.0
Latino	7.2
White	37.6
Other	12.1
Monthly income, $ median [IQR]	916 [854, 980]
Less than HS education, %	67.4
Has child dependents, %	10.1
Current homelessness, %	9.2
Health	
Ever prescribed ART during study, %	76%
CD4 count, median [IQR]	403 [202, 570]
SF36 general health score, mean [SD]	52.0 [25.6]
Heavy drinking, %	5.2
Illicit drug use, past 90 days, %	33.8

Notes: IQR = interquartile range; SD = standard deviation

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Table II

Associations between depressive symptom severity and food insecurity

			Adjusted Models					
	Bivariate associations, GEE		**Concurrent model, GEE**		**Lagged model, GEE**		**Model with participant fixed effects**	
	Coeff.	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**
Primary independent variable								
Food insecurity:								
1 = None (Food secure)	Ref		Ref		Ref		Ref	
2 = Mild	**0.59***	(0.36)	0.29	(0.36)	0.33	(0.37)	0.16	(0.38)
3 =-Moderate	**1.25*****	(0.29)	0.77**	(0.29)	0.06	(0.33)	−0.31	(0.34)
4 = Severe	**2.75*****	(0.34)	1.97***	(0.35)	1.22***	(0.35)	0.74*	(0.36)
Baseline covariates								
Male	**−2.19****	(0.89)	−0.79	(0.53)	−1.14	(0.64)		
Age (per 10 years)	0.05	−0.54						
Race/ethnicity:								
White	Ref		Ref		Ref			
Black	0.60	(0.84)	0.02	(0.46)	−0.08	(0.56)		
Latino	−1.72≠	(1.23)	−0.45	(0.79)	−0.85	(1.04)		
Other	2.05≠	(1.53)	0.34	(0.81)	0.46	(1.02)		
High school education or less	**1.37***	(0.81)	0.75	(0.47)	1.09	(0.58)		
Income, per $100	**−0.22****	(0.09)	−0.02	(0.04)	−0.03	(0.05)		
Baseline depression score	**0.65*****	(0.03)	0.60***	(0.03)	0.54***	(0.04)		
Has child dependents	−0.55	(1.34)						
CD4 count (per 100 cells)	**−0.30****	(0.12)	−0.06	(0.09)	−0.07	(0.11)		
Time-varying covariates								
Physical health summary score	**−0.09*****	(0.01)	−0.06***	(0.02)	−0.01	(0.02)	0.02	(0.02)
Receiving ART	**−1.00*****	(0.26)	−0.84**	(0.27)	−0.59*	(0.28)	−0.60*	(0.29)
Emergency room use, past 90 days	**1.10*****	(0.34)	0.59	(0.33)	−0.06	(0.39)	−0.07	(0.41)
Recent homelessness	**1.33****	(0.64)	0.06	(0.70)	0.20	(0.68)	0.52	(0.70)

	Bivariate associations, GEE		Adjusted Models					
			Concurrent model, GEE		Lagged model, GEE		Model with participant fixed effects	
	Coeff.	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**	**Coeff.**	**(SE)**
Heavy drinking	1.03≠	(0.74)	0.71	(0.70)	0.29	(0.66)	0.05	(0.72)
Illicit drug use, past 90 days	**1.22*****	(0.38)	0.52	(0.34)	0.46	(0.36)	0.64	(0.41)
Constant			5.34***	(1.14)	4.01**	(1.39)	6.84***	(0.99)
Observations			2,421		2,140		2,178	
Number of ID			339		319		325	

*** p<0.001;

** p<0.01;

* p<0.05;

≠ p<0.20

Notes: GEE = generalized estimating equations; SE = standard error; Ref = Reference category; Outcome variable for all regressions is the score on the cognitive-affective sub-scale of the BDI-II.

Table III

Factors associated with probable depression

	Any depression (BDI > 10)	
VARIABLES	**AOR**	**95% CI**
Primary independent variable		
Food insecurity:		
1 = None (Food secure)		
2 = Mild	1.41	(0.99 – 2.02)
3 = Moderate	1.34*	(1.01 – 1.78)
4 = Severe	1.64***	(1.26 – 2.13)
Baseline covariates		
Male	0.69	(0.45 – 1.08)
Race/ethnicity:		
White	Ref	
Black	1.06	(0.68 – 1.63)
Latino	0.80	(0.32 – 2.00)
Other	0.95	(0.51 – 1.78)
High school education or less	0.98	(0.93 – 1.03)
Baseline depression score	1.14***	(1.11 – 1.17)
CD4 count	0.94	(0.87 – 1.02)
Time-varying covariates		
Physical health summary score	0.99	(0.98 – 1.01)
Receiving ART	0.81	(0.64 – 1.02)
Emergency room use, past 90 days	1.02	(0.75 – 1.39)
Recent homelessness	0.92	(0.60 – 1.40)
Heavy drinking	0.90	(0.60 – 1.36)
Illicit drug use, past 90 days	1.14	(0.87 – 1.49)
Constant	0.21**	(0.07 – 0.62)
Observations	2,140	
Number of ID	319	

*** p<0.001;

** p<0.01;

* p<0.05

Notes: AOR = adjusted odds ratio. 95% CI = 95% confidence interval. Outcome variables are binary indicators of probable depression (BDI-II C-A score > 10). Results from logistic regression implemented with geneAral estimating equations (GEE), using a 3-month lag between predictors and outcomes