Food Insecurity Is Associated with Greater Acute Care Utilization among HIV-Infected Homeless and Marginally Housed Individuals in San Francisco

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BACKGROUND: Food insecurity, or the uncertain availability of nutritionally adequate, safe foods, has been associated with poor HIV outcomes. There are few data on the extent to which food insecurity impacts patterns of health-care utilization among HIV-infected individuals.

OBJECTIVE: We examined whether food insecurity was associated with hospitalizations, Emergency Department (ED) visits, and non-ED outpatient visits.

METHODS: HIV-infected, homeless and marginally housed individuals participating in the San Francisco Research on Access to Care in the Homeless (REACH) cohort underwent quarterly structured interviews and blood draws. We measured food insecurity with the validated Household Food Insecurity Access Scale, and categorized participants as food secure, mild/moderately food insecure, and severely food insecure. Primary outcomes were: (1) any hospitalizations, (2) any ED visits, and (3) any non-ED outpatient visits. Generalized estimating equations were used to estimate model parameters, adjusting for socio-demographic (age, sex, ethnicity, education, income, housing status, health insurance) and clinical variables (CD4 nadir, time on antiretroviral therapy, depression, and illicit drug use).

RESULTS: Beginning in November 2007, 347 persons were followed for a median of 2 years. Fifty-six percent of participants were food insecure at enrollment. Compared with food-secure persons, those with severe food insecurity had increased odds of hospitalizations [adjusted odds ratio (AOR)=2.16, 95 % confidence interval (CI)=1.50–3.09] and ED visits (AOR=1.71, 95 % CI=1.06–2.30). While the odds of an outpatient visit were 41 % higher for severely food insecure individuals, the effect was not statistically significant (AOR=1.41, 95 % CI=0.99–2.01). Mild/moderate food insecurity was also associated with increased hospitalizations (AOR=1.56, 95 % CI=1.06–2.30), ED visits (AOR=1.57, 95 % CI=1.22–2.03), and outpatient visits (AOR=1.68, 95 % CI=1.20–2.17).

CONCLUSIONS: Food insecurity is associated with increased health services utilization among homeless and marginally housed HIV-infected individuals in San Francisco. Increased ED visits and hospitalizations are not related to fewer ambulatory care visits among food-insecure individuals. Addressing food insecurity should be a critical component of HIV treatment programs and may reduce reliance on acute care utilization.

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Received March 27, 2012
Revised June 22, 2012
Accepted June 28, 2012
Published online August 18, 2012

KEY WORDS: food security; HIV/AIDS; acute care utilization.
J Gen Intern Med 28(1):91–8
DOI: 10.1007/s11606-012-2176-4

INTRODUCTION

The introduction of antiretroviral therapy (ART) has led to substantial decreases in morbidity and mortality among HIV-infected individuals[1,2] with a concomitant decline in the use of acute health-care services. Longitudinal studies have shown downward trends in both hospitalizations and emergency department (ED) visits after initiation of ART.[3–5] Gains in health, longevity, and reductions in acute care usage, however, have not been uniform across all population groups in the US. Among HIV-infected individuals, women,[6–9] injection drug users,[7,8,10] and racial/ethnic minorities[8,11,12] account disproportionately for morbidity and suboptimal health-care utilization patterns. Socioeconomic marginalization, in the form of unmet subsistence needs, may drive the acute care usage seen in these subpopulations.[13,14]

Food insecurity, the limited availability of nutritionally adequate or safe food, or the inability to procure food in socially acceptable ways,[15] is an important form of socioeconomic marginalization. In the general population, food insecurity has been associated with many adverse health impacts, including poor nutritional status,[16–21] depression,[22–26] suicidal ideation,[26] obesity,[27] and increased

cardiovascular risk.[28,29] Cross-sectional studies among non-HIV infected individuals in the US found that food insecurity is associated with postponing needed medications and care, increased emergency department use, and increased hospitalizations.[30,31] In cross-sectional studies among HIV-infected individuals in the US and Canada, food insecurity has been associated with decreased immunologic and virologic responses,[32–35] and worse mental health, even when controlling for other markers of socioeconomic status such as income, education, and employment.[35–37] Qualitative and cross-sectional quantitative studies in resource-rich and resource-poor countries have found food insecurity is an important cause of ART non-adherence and treatment interruptions.[32,34,38] A few longitudinal studies have reported negative health impacts of food insecurity among HIV-infected individuals, including worse physical health status and increased opportunistic infections in Uganda, lower CD4 counts in a study in the Boston area, and higher risk of mortality in British Columbia.[39–41]

There is little understanding of how food insecurity impacts patterns of health-care utilization among HIV-infected individuals, particularly in resource-rich countries without universal health care such as the US. Such understanding is critical because use of health services reflects both population-level morbidity and overall costs to the health-care system. We undertook a longitudinal study in an urban area in the US to examine the association of food insecurity and health-care utilization patterns among homeless and marginally housed, HIV-infected individuals. We hypothesized that food insecurity would be associated with hospitalizations and ED visits. Given that use of outpatient services is both a product of need for services (which food insecurity could theoretically increase) and the ability to get services when needed (which food insecurity could theoretically decrease), we also set out to understand whether and how food insecurity was associated with utilization of non-ED outpatient care services.

METHODS

Participants were from the Research on Access to Care in the Homeless (REACH) study, a cohort of HIV-infected homeless and marginally housed adults in San Francisco recruited using probability sampling from homeless shelters, free meal programs, and single room occupancy hotels charging less than $600/month, as previously described.[42,43] REACH participants received quarterly blood draws and structured interviews. All participants signed a written consent form at the onset of the study and were reimbursed $15 per interview. Between August 2007 and March 2010, we administered the Household Food Insecurity Access Scale (HFIAS) as part of the REACH study. The UCSF Human Subjects Committee approved all study procedures.

Measures

Primary Independent Variable. To measure recent food security, we used the Household Food Insecurity Access Scale (HFIAS), version 1, January 2006, previously adapted for use in homeless and marginally housed individuals.[35] The HFIAS was initially developed by Food and Nutrition Technical Assistance (FANTA) project based on validation studies in eight countries including the US.[44,45] Validation studies have demonstrated that the HFIAS distinguishes food-secure from -insecure individuals or households across different cultural contexts. The questions cover three domains of the experience of food insecurity: (1) anxiety and uncertainty about food supply, (2) insufficient quality and variety of food, and (3) insufficient food intake and its physical consequences.[46] Possible responses for each question were never, rarely, sometimes, and often; these were coded as 0, 1, 2, and 3, respectively. Scores range from 0 to 27; higher scores reflect more severe food insecurity. The internal consistency of this measure was high in our sample, with a Cronbach's alpha of 0.94.[35]

Primary Outcomes. Health-care utilization in the previous 3 months was measured by participant self-report and included the following outcomes: (1) any hospitalizations, (2) any ED visits, and (3) any outpatient or non-ED ambulatory visits (defined as any visit with a nurse, doctor, or other health-care provider for a physical health problem or preventative health care). We selected covariates for the study based on prior literature and theory,[35,47–50] and included age (continuous), sex (male/female), race/ethnicity (African American versus Latino versus other), income (≥ versus < sample median), education (≥ versus < high school diploma), health insurance status (insured/uninsured), recent homelessness (sleeping on the street or shelter in past 3 months), illicit drug use (including cocaine, heroin, and methamphetamine) over the past 3 months (yes versus no), nadir CD4 count (continuous -100 cells/μl), and months on ART at baseline of analysis (continuous). We defined risky drinking as greater than an average of 14 drinks/week for men and 7 drinks/week for women in accordance with definitions by the National Institute of Alcohol Abuse and Alcoholism.[51] Depression was assessed using the Beck's Depression Inventory (BDI) version II as a continuous variable, which has been shown to be a reliable and valid measurement of depression in different populations.[52–55]

ANALYSIS

We categorized individuals as food secure, mildly/moderately food insecure, or severely food insecure, based on a standardized algorithm of the HFIAS scale within the FANTA guide that is dependent upon the specific questions that are answered affirmatively. We used generalized

estimating equations to determine factors associated with hospitalizations, ED visits, and outpatient visits controlling for possible socio-demographic and clinical confounders. For each outcome, all factors associated with our outcomes of interest with a $p \leq 0.2$ in bivariate analysis were included in multivariate models, which then were reduced using backward elimination with a p-value of 0.05 for retention of covariates. These models included both time-invariant covariates (e.g., age at baseline, ethnicity, high school education) and time-varying variables (e.g., food insecurity, substance use, depression). Because we were interested in the association between *recent* food insecurity in relation to *recent* patterns of health care utilization, we examined associations over time between food insecurity and health-care utilization patterns reported at the same study visit. Regression diagnostic procedures yielded no evidence of multi-collinearity or overly influential outliers in any model. We conducted two additional sensitivity analyses where we excluded those who (1) were currently homeless or (2) had ever been homeless from our models to better understand whether housing status modifies associations between food insecurity and hospitalization and ED visits.

RESULTS

A total of 347 participants were included in our analysis. The sample was predominately male (71.3 %), with a median age of 48 years (Table 1). More than half of participants were food insecure, and 31.4 % were severely food insecure. The median monthly income was $918, 70.0 % of participants had completed high school, and most (93.4 %) had some form of health insurance (only 1.4 % with private insurance and the remainder having Medicaid/Medicare or Veterans Administration insurance). Only a small proportion of the sample had experienced recent homelessness, with 9.2 % having slept on the street or having been in a homeless shelter in the prior 3 months. While 72.0 % of participants had received some form of food aid at baseline [food aid from a church, clinic, soup kitchen, food bank, Supplemental Nutrition Assistance Programs (SNAP), or other sources], only 17.6 % had received SNAP over the previous year, and only 9.8 % had received SNAP over the previous month.

Nearly one-quarter of participants (23.3 %) reported an ED visit in the 3 months prior to the baseline interview for this analysis, and 10.7 % reported a hospitalization. Only 5.2 % of participants reported risky drinking, and more than one third of the sample (34.0 %) reported recent illicit drug use. The median CD4 nadir was 180 [interquartile range (IQR)=75–312], and a majority of participants had been on ART for over 3 years (median length of ART=44 months; IQR=17–89). The median BDI score was 11 (IQR=4–19); depression, as measured by a standard BDI cutoff of >13, was prevalent (29.6 %).

Table 1. Descriptive Characteristics

Variable	Total (*N*=347) n (%) unless noted
Food security (HFIAS)	
Food secure	154 (44.4)
Mild/moderately food insecure	84 (24.2)
Severely food insecure	109 (31.4)
ED visit, past 3 months	81 (23.3)
Hospitalization, past 3 months	37 (10.7)
Male sex (vs. female)	246 (71.3)
Race/ethnicity	
White	128 (37.4)
Black	147 (43.0)
Latino	25 (7.3)
Mixed/other	42 (12.3)
Age	
Mean ± SD	48.26 ± 7.73
Minimum, maximum	26, 80
Median (IQR)	48 (43, 53)
Education ≥ high school	238 (70.0)
Homeless, past 3 months*	32 (9.2)
Heavy alcohol consumption†	18 (5.2)
Income, per month (median, IQR)	918 (859, 980)
Insured (vs. uninsured)	324 (93.4)
Any illicit drug use, past 3 months‡	118 (34.0)
Months ARV, cumulative	
Mean ± SD	54.95±46.54
Minimum, maximum	0, 228
Median (IQR)	44 (17, 89)
CD4 nadir	
Mean ± SD	215.76±175.89
Minimum, maximum	3, 1,107
Median (IQR)	180 (75, 312)
BDI score	
Mean ± SD	12.84±11.29
Minimum, maximum	0.00, 53.00
Median (IQR)	11.00 (4.00, 19.00)

** Defined as self-report of sleeping on street or shelter*
† Defined as greater than an average of 14 drinks/week for men and 7 drinks/week for women
‡ Defined as self-reported use of cocaine, heroin, or methamphetamine
ED emergency department; HFIAS Household Food Insecurity Access Scale; IQR inter-quartile range; STD standard deviation; ARV antiretrovirals; BDI Beck's Depression Inventory

Relationship Between Food Insecurity and Recent Hospitalizations. Both mild/moderate and severe food insecurity were significantly associated with hospitalizations in the prior 3 months in both unadjusted and adjusted analyses (Table 2). Compared to individuals who were food secure, the odds of recent hospitalization were one and a half times higher among individuals who were mildly or moderately food insecure [adjusted odds ratio (AOR)=1.56, 95 % confidence interval (CI)=1.06–2.30] and twice as high among individuals who were severely food insecure (AOR=2.16, 95 % CI=1.50–3.09) in

Table 2. Factors Associated with Recent Acute Health-Care Utilization among HIV-infected, Marginally Housed Individuals, *N*=347

Characteristic	Any hospitalization		Any ED visit	
	OR (95 % CI)	AOR (95 % CI)§	OR (95 % CI)	AOR (95 % CI)
Food security (HFIAS)				
Food secure	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Mild/moderately food insecure	1.69 (1.16, 2.48)†	1.56 (1.06, 2.30)*	1.73 (1.34, 2.22)‡	1.57 (1.22, 2.03)‡
Severely food insecure	2.52 (1.78, 3.55)‡	2.16 (1.50, 3.09)‡	2.20 (1.69, 2.86)‡	1.71 (1.30, 2.25)‡
Male (vs. female)	0.76 (0.51, 1.15)	–	0.96 (0.68, 1.34)	–
Age	1.15 (0.91, 1.46)	–	0.90 (0.73, 1.10)	–
Ethnicity				
Mixed/other	1.29 (0.66, 2.50)	–	1.30 (0.81, 2.09)	–
Latino	1.06 (0.46, 2.45)	–	1.27 (0.68, 2.37)	–
Black	1.51 (0.99, 2.31)	–	1.21 (0.84, 1.75)	–
More than high school education	0.66 (0.44, 0.98)*	–	0.89 (0.64, 1.25)	–
Homeless (past 3 months) ‖	1.87 (1.16, 3.01)*	–	1.87 (1.28, 2.74)†	1.53 (1.03, 2.27)*
Heavy drinking¶	1.41 (0.81, 2.47)	–	1.65 (1.10, 2.46)*	–
Income above median (vs. below)	1.05 (0.71, 1.54)	–	1.10 (0.80, 1.51)	–
Uninsured (vs. insured)	0.91 (0.40, 2.04)	–	0.64 (0.33, 1.24)	–
Illicit drug use (past 3 months) #	1.60 (1.17, 2.19)†	–	1.77 (1.34, 2.34)‡	1.56 (1.18, 2.07)†
Months on ARV	1.00 (0.99, 1.00)	–	1.00 (0.99, 1.00)	–
CD4 nadir (in 100 cells/μl)	1.24 (1.41, 1.09)‡	1.22 (1.38, 1.07)†	1.14 (1.24, 1.04)‡	1.11 (1.22, 1.01)†
Depression (BDI score)	1.03 (1.02, 1.04)‡	1.02 (1.01, 1.04)†	1.03 (1.02, 1.04)‡	1.02 (1.01, 1.03)†

**p< 0.05, †p< 0.01, ‡p< 0.001*
§ All factors associated with our outcomes of interest with a p≤0.2 in bivariate analysis were included in multivariate models
‖ Defined as sleeping in the street or shelter
¶ Defined as greater than an average of 14 drinks/week for men and 7 drinks/week for women
 # Defined as self-report of cocaine, methamphetamine, or heroin use
OR odds ratio; AOR adjusted odds ratio; ED emergency department; HFIAS Household Food Insecurity Access Scale; ARV anti-retrovirals; BDI Beck's Depression Inventory

adjusted analyses. In addition to food insecurity, individuals who had higher BDI scores or lower CD4 nadirs had significantly higher odds of hospitalizations in adjusted analysis.

Relationship Between Food Insecurity and ED Visits. Individuals with mild/moderate or severe food insecurity had higher odds of recent ED visits (Table 2) in both unadjusted and adjusted models. In adjusted models, individuals who were mildly moderately food insecure had more than 50 % higher odds of ED use (AOR=1.57, 95 % CI=1.22–2.03) and individuals who were severely food insecure had 71 % higher odds of ED use (AOR=1.71, 95 % CI=1.30–2.25). Additional factors associated with ED visits in adjusted analyses included recent homelessness, illicit drug use, higher BDI scores, and lower CD4 nadir cell counts.

The results of our sensitivity analyses, where we excluded homeless individuals, were similar for both ED use and hospitalizations. For both outcomes, excluding subjects who were ever homeless or those who were currently homelessness led to a slight reduction in the adjusted odds ratios for food insecurity. The odds ratios for food insecurity remained statistically significant for both outcomes, however, and were not qualitatively different from those in the original multivariate models.

Relationship Between Food Insecurity and Outpatient Visits. Individuals who were mildly or moderately food insecure had higher odds of having had a recent outpatient visit (AOR=1.64, 95 % CI=1.17–2.29). The increased odds of outpatient visits among individuals who were severely food insecure were similar, but smaller (AOR=1.41, 95 % CI=0.99–2.01) and not statistically significant (Table 3). Men and those who were uninsured had lower odds of outpatient visits, and people with more education and more years on ARVs had higher odds of outpatient visits.

DISCUSSION

This was the first study to our knowledge using a longitudinal design to examine associations between food insecurity and patterns of health-care utilization in a resource-rich country, the first among HIV-infected individuals, and the first among homeless and marginally housed individuals. We found that food insecurity was associated with utilization of both acute and non-ED ambulatory health-care services. These results add to the growing body of literature documenting negative health impacts of food insecurity, particularly for groups that are already socioeconomically marginalized. These findings may be helpful to guide development of interventions to improve HIV-related health outcomes and reduce acute care utilization.

Food insecurity was experienced by more than half of individuals within this cohort of homeless and marginally housed HIV-infected persons, consistent with estimates from other North American studies with similar populations.[15,34,56] Many of the same factors that predispose individuals to food insecurity—including poverty, mental

Table 3. Factors Associated with Recent Outpatient Visits among HIV-Infected, Marginally Housed Individuals, *N*=347

Characteristic	Any outpatient visit	
	OR (95 % CI)	AOR (95 % CI)
Food security (HFIAS)		
Food secure	1.00 (Ref.)	1.00 (Ref.)
Mild/moderately food insecure	1.51 (1.13, 2.02)†	1.64 (1.17, 2.29)†
Severely food insecure	1.34 (0.97, 1.83)	1.41 (0.99, 2.01)
Male (vs. Female)	0.69 (0.48, 0.98)*	0.60 (0.40, 0.91)*
Age	1.05 (0.82, 1.33)	–
Ethnicity		
Mixed/other	0.72 (0.42, 1.25)	–
Latino	0.73 (0.42, 1.27)	–
Black	1.39 (0.96, 2.00)	–
More than high school education	1.35 (0.96, 1.91)	1.52 (1.04, 2.22)*
Homeless (past 3 months) ‡	0.63 (0.42, 0.93)*	–
Heavy drinking §	0.93 (0.64, 1.36)	–
Income above median (vs. below)	1.00 (0.72, 1.38)	–
Uninsured (vs. insured)	0.61 (0.41, 0.91)*	0.51 (0.31, 0.84)†
Illicit drug use (past 3 months) ‖	1.12 (0.85, 1.47)	–
Months on ARV	1.00 (1.00, 1.01)*	1.00 (1.00, 1.01)*
CD4 nadir (in 100 cells/μl)	1.01 (1.10, 0.93)	–
Depression (BDI score)	0.99 (0.98, 1.01)	–

** $p < 0.05$, † $p < 0.01$*
‡ Defined as sleeping in street or shelter
§ Defined as greater than an average of 14 drinks/week for men and 7 drinks/week for women
‖ Defined as self-report of cocaine, methamphetamine, or heroin use
OR odds ratio; AOR adjusted odds ratio; HFIAS Household Food Insecurity Access Scale; ARV anti-retrovirals; BDI Beck's Depression Inventory

illness, and substance use—also put them at risk for HIV infection[50] and predict poor overall health among HIV-infected adults.[57] The prevalence of food insecurity among HIV-infected homeless and marginally housed individuals is higher than that seen in a nationally representative sample of non-HIV-infected homeless persons, where the prevalence is estimated at 25 %–32 %,[30] and higher than the prevalence of food insecurity in the general US population, which is estimated to be 15 %.[58]

The odds of recent hospitalization increased with increasing severity of food insecurity, even when accounting for potential confounders including measures of socioeconomic status. Both severe and mild/moderate food insecurity were also associated with higher odds of ED visits, but the effect was most pronounced with severe food insecurity. Our findings that link food insecurity to acute care use are supported by previous literature. In previous cross-sectional studies among the general US population, food insecurity was independently associated with increased medical and psychiatric hospitalizations and ED use.[30,31] While the context and contributors to health-care utilization are quite different in resource-rich and resource-poor countries, in a recent study in rural Uganda, severe food insecurity (but not mild/moderate food insecurity) was associated with an increased number of hospitalizations among HIV-infected individuals on ART.[40] This is consistent with studies showing that impacts of food insecurity on HIV-related health outcomes, including immunologic and virologic outcomes, physical health status, and other measures of morbidity, are quite similar in resource-rich and resource-poor countries.[33,34,39–41,59] Such consistency across different settings suggests that food insecurity is a robust and seemingly universal predictor of worse outcomes, which may contribute to the increased need for acute care services.

Other studies have shown that competing subsistence needs are associated with acute health-care utilization among HIV-infected individuals in the US,[60] but did not focus specifically on food security. Previous studies consistently demonstrated a linear relationship between the degree of housing instability and increased acute care use.[61,62] Our study further supports this literature by showing that individuals who lived on the street or in a homeless shelter had higher odds of recent ED visits. The high prevalence of ED visits among homeless and marginally housed HIV-infected persons seen in this study is also consistent with previous research.[10,63] While most US cohorts have shown a steady decline in acute care usage as ART regimens improve and people initiate treatment with higher CD4 counts,[5] the ongoing high rate of acute care utilization in our study highlights that marginalized HIV-infected populations have not realized the same gains in overall health as the general HIV-infected population in the US.[8,64]

While we found that mild/moderate food insecurity was associated with increased outpatient care, severe food insecurity had a non-significant relationship with the same outcome. This finding is consistent with previous studies indicating mixed results. One study among low-income adults across the US found that food insecurity was associated with postponing needed medical care and medications, but was not associated with prior year outpatient care utilization.[31] In related literature, housing instability shows no consistent relationship with increased or reduced ambulatory visits.[61,65–67] These inconsistent findings may be explained by the fact that outpatient clinic visits are the product of the need for care (which is likely increased by food insecurity) and ability to obtain care when needed (which is likely decreased by food insecurity). While available data preclude a definitive conclusion, the predominant mechanism by which mild/moderate food insecurity impacted outpatient care in the current study may have been via worsening morbidity rather than a compromised ability to access to health care. Since our study defined outpatient care broadly (including scheduled and unscheduled primary care, non-ED urgent care, nurse visits, specialist visits), future studies should separate these out in order to help unpack these mechanisms and help us understand whether food insecurity differentially impacts access to scheduled and unscheduled visits.

Previous studies have also shown adverse impacts of food insecurity on morbidity, mortality, and quality of life among HIV-infected individuals.[14,32–34,39,41] Interventions are needed to address food insecurity and its negative impacts on the health and health-care utilization patterns of HIV-infected individuals. Related interventions that address other subsistence needs have shown promise in improving health-care use and treatment outcomes. For example, providing interim or supportive housing has been shown to strengthen engagement in HIV care, lead to fewer hospitalizations, and improve HIV treatment outcomes.[68–73] For non-HIV infected populations, federally funded food assistance programs (e.g., the Supplemental Nutrition Assistance Program and Special Supplemental Nutrition Program for Women, Infants, and Children) have been shown to have a protective effect on pregnancy outcomes among women,[74,75] birthweight outcomes for infants,[76] and nutritional outcomes for young children.[77,78] Limited research has examined health-care utilization among program participants.[79] Several studies in the general population have found equivocal[80,81] or detrimental[82] health outcomes associated with program participation; these studies are difficult to interpret because selection bias was probably not at all or only partially controlled.

Despite the high prevalence of food insecurity found in this study, fewer than 10 % of participants were receiving SNAP benefits at baseline, which is consistent with UDSA findings that only a portion (72 %) of eligible persons[83] or food-insecure households (41 %)[84] access SNAP. This uptake gap among study participants may be partly due to income limits, since a single-person household is eligible for SNAP only if they earn less than $ 1,080 monthly, including social security. As the median monthly income in our cohort is $ 918 (IQR $ 859–980), it is likely that a number of our food-insecure participants were ineligible. This echoes findings that federal poverty levels are set too low as a measure of what it means to be poor in the US today,[85] particularly in metropolitan areas where the cost of living is high. It is also possible that participants in this cohort were unable to access a computer to complete the online application, which became necessary when SNAP moved program enrollment online in lieu of caseworkers.[86] Overall, our findings suggest that access to and use of SNAP benefits is inadequate among HIV-infected homeless and marginally housed individuals. It is crucial to better link vulnerable HIV-infected persons to SNAP and other food assistance programs. More work is also needed to understand the extent to which enrollment in available food aid programs alleviates food insecurity among HIV-infected populations.

Among HIV-infected individuals, small studies from Haiti and Uganda have shown significant improvements in food security, nutritional status, adherence, and engagement in care among individuals receiving food supplementation during the first 12 months after ART initiation,[59,87] but few studies to date have evaluated food-insecurity interventions among HIV-infected individuals in North America. Such studies using the best possible designs are critical to better understand the impacts that can be gained by addressing food insecurity, to determine which food insecurity interventions are most effective, and to inform the integration of food security and HIV care and treatment programs.

There were several limitations to our study. Several key variables, including food security and health-care utilization, were measured through self-report, which may introduce bias. While we controlled for demographic, socioeconomic, and clinical variables, it is possible that unobserved confounders may explain some of the associations reported. For example, factors related to food insecurity such as household size, household expenditures, and non-monetary resources may influence whether clients seek care in outpatient clinics vs. emergency departments. In addition, mental illnesses other than depression may confound associations between food insecurity and patterns of health-care utilization. Randomized intervention studies are needed to fully understand the causal relationships among food insecurity, HIV-related morbidity, and patterns of health-care utilization; such studies are difficult to carry out in practice because of ethical concerns about withholding food support for a group identified to be in need.

In summary, we found a longitudinal association between food insecurity and increased utilization of acute and ambulatory health services among impoverished HIV-infected individuals in the US. Addressing food insecurity may reduce morbidity among HIV-infected individuals and lead to a reduction in the high utilization of expensive health services over the long term.

Acknowledgements: *This publication was made possible by grant no. UL1 RR024131 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH) and NIH Roadmap for Medical Research. Its contents are solely the responsibility of the authors and do not necessarily represent the official view of the NCRR or the NIH. Information on NCRR is available at http:///www.ncrr.nih.gov.*

Contributors: *We thank the collaborating researchers including Kathleen McCartney, Richard Clark, Greg Barnell, John Day, Nelia Dela Cruz, Minoo Gorji, Scot Hammond, Jackie Haslam, Zizi Hawthorne, Jay Jankowski, Rhonda Johnson, Mac McMaster, Sandra Monk, Rebecca Packard, Joyce Powell, Kathleen Ragland, Mathew Reynolds, Paul Rueckhaus, Jacqueline So, John Weeks and Kelly Winslow.*

Funders: *NIMH 54907, 79713-01; CHRP ID08-SF-054; UCSF Academic Senate; Hurlbut-Johnson funds from AIDS Research Institute award, UCSF, no. 557858-8-148. The authors acknowledge the following additional sources of salary support: the Burke Family Foundation and the Hellman Family Foundation (to Dr. Weiser), and K24 MH-87227 (to Dr. Bangsberg).*

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

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