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ORIGINAL PAPER

Food Insecurity Among Homeless and Marginally Housed Individuals Living with HIV/AIDS in San Francisco

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Abstract Food insecurity is a risk factor for both HIV transmission and worse HIV clinical outcomes. We examined the prevalence of and factors associated with food insecurity among homeless and marginally housed HIV-infected individuals in San Francisco recruited from the Research on Access to Care in the Homeless Cohort. We used multiple logistic regression to determine socio-demographic and behavioral factors associated with food insecurity, which was measured using the Household Food Insecurity Access Scale. Among 250 participants, over half (53.6%) were food insecure. Higher odds of food insecurity was associated with being white, low CD4 counts, recent crack use, lack of health insurance, and worse physical and mental health. Food insecurity is highly prevalent among HIV-infected marginally housed individuals in San Francisco, and is associated with poor physical and mental health and poor social functioning. Screening for and addressing food insecurity should be a critical component of HIV prevention and treatment programs.

Keywords Food insecurity · HIV/AIDS · San Francisco · Homeless

Introduction

Food insecurity, a leading cause of morbidity and mortality worldwide [1, 2], occurs "when there is uncertainty about future food availability and access, insufficiency in the amount and kind of food required for a healthy lifestyle, or the need to use socially unacceptable ways to acquire food" because of resource or physical constraint [3]. In 2006, 11% of all households in the United States (US) were estimated to be food insecure [4]. Food insecurity is associated with having dependent children, drug abuse, poor social support, poor functional status and with markers of low socioeconomic status such as low education, low income, lack of health insurance, unemployment and homelessness [5–9]. In addition to interfering with quality of life and social functioning, food insecurity is associated with poor nutritional status, higher rates of heart disease, hypertension, diabetes, obesity, and depression, as well as worse health outcomes across a number of diseases [7, 8, 10–14]. Food insecurity is also associated with increased hospitalizations and emergency department use, and postponing needed medical care and medications

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above and beyond the effects attributable to low socio-economic status [15, 16].

Recently, food insecurity has become recognized as a key contributor to the HIV pandemic worldwide and as an important cause of worse health outcomes among people living with HIV/AIDS [1, 17]. Food insecurity is strongly linked with HIV wasting and malnutrition [1, 18], which have been associated with increased progression to AIDS and death among untreated individuals [19–28], as well as worse virologic responses and increased mortality among people on antiretroviral therapy [18, 29]. Recent studies from both the United States and France have shown that food insecurity can compromise adherence to antiretroviral therapy [30, 31]. We have previously reported that food insecurity was independently associated with incomplete HIV RNA suppression and mortality in urban poor populations in North America [31, 32], and that food insufficiency is a strong contributor to HIV transmission risk behavior in sub-Saharan Africa [33].

Food insecurity is highly prevalent among HIV-infected individuals in North America [9, 31]. Understanding the correlates of food insecurity is important in identifying HIV-infected individuals at risk for malnutrition, wasting, poor adherence, virologic failure, and other negative health outcomes. Such data are critical for planning interventions to address food insecurity and hunger among HIV-infected individuals, particularly among urban poor and marginally housed individuals who are at significant risk for food insecurity and its negative health sequelae. We therefore examined the prevalence of and factors associated with food insecurity among a sample of urban poor HIV-infected individuals living in San Francisco.

Methods

Participants were recruited from The Research on Access to Care in the Homeless (REACH) Cohort, a cohort of HIV-infected homeless and marginally housed adults recruited from San Francisco homeless shelters, free-meal programs, and single room-occupancy hotels charging less than $600/month, as previously described [34, 35]. Structured questionnaires were administered to participants at baseline and at 3-month intervals. In quarterly interviews information was collected on socio-demographics, overall health status and functional status, health service utilization, symptoms of depression, alcohol and drug use, sexual risk behaviors, use of antiretroviral therapy, and use of medications for opportunistic infections. Participants provided written consent to participate at the onset of the study and were reimbursed $15 for each interview.

In the first quarter of 2006, an assessment of food insecurity was introduced at REACH for a one-time cross-sectional study. Staff administered the additional questionnaire to all REACH participants who presented for their quarterly interviews between mid January and the end of March in 2006, and all participants who received the food insecurity questionnaire were included in this study. The UCSF Human Subjects Committee approved all study procedures.

The primary dependent variable, food insecurity, was measured using the household food insecurity access scale (HFIAS). This measure was developed by the food and nutrition technical assistance (FANTA) project based on validation studies in eight countries including the United States [36–39]. The nine questions from the HFIAS 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 consequences. 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 [37]. Reliability was high, with a Cronbach's alpha of 0.94. Based on HFIAS scores, participants were dichotomized as being food insecure versus food secure based on the recommended categorization in the FANTA guide [36], and this dichotomous variable was used as our primary outcome. Individuals classified as food insecure either worried about insufficient food access, were not able to eat preferred foods, cut back on quantity of food consumed, or experienced frank hunger. This dichotomous variable is based on a carefully validated indicator that separates those that have no difficulty accessing food or only occasional worry from those that are mildly, moderately or severely food insecure.

All covariates used in analyses were part of REACH quarterly interviews. Selection of variables was based on prior literature [5, 6, 9, 33, 40]. Variables used were: age (a continuous variable); sex (male/female); race (white versus non-white); income (≥versus <population median); education (≥versus <high school diploma); recent homelessness (sleeping on the street or shelter in past 90 days); current employment; any health insurance; recent cocaine, crack, heroin and methamphetamine use over the past 30 days; problem drinking (greater than an average of 14 drinks/week for men and seven drinks/week for women) [41]; sex exchange (defined as having sold sex for money over the previous 30 days); and any incarceration in the previous 30 days. In addition, as a proxy for social support, we used number of friends in the participant's social network. Having a representative payee was defined as having payments such as supplemental security income (SSI) made to a third party or agency on behalf of the client in order to help the client manage their finances and meet their basic needs of daily living, and was included to

capture participants with particularly low social functioning. Most of the above variables were expected to be causes of food insecurity with the exception of sex exchange, which was more likely considered a consequence of food insecurity.

Based on prior literature, we also included a number of variables to examine associations between food insecurity and physical and mental health status [9, 10, 31, 42]. These included CD4 cell counts ($\geq$200 versus <200 to capture individuals who are severely immunocompromised); current highly active antiretroviral therapy (HAART) use (defined as using at least three antiretroviral medications); depression as measured by the beck depression inventory (BDI) Version II; and self-reported health status as assessed by the SF-36. The BDI version II is comprised of 21 items, and has proven to be a reliable and valid measurement of depression in different populations including homeless populations [43–46]. BDI version II scores range from 0 to 63 and provide an estimate of depression severity. BDI scores of 0–13 correspond to minimal depression, scores of 14–28 correspond to mild to moderate depression, and scores of 29 or greater indicate severe depression. Participants in this study were categorized as having symptoms of depression if their BDI scores were $\geq$14. The SF-36 has been proven to be a reliable and valid measure of health status in HIV-infected homeless and marginally housed individuals [44]. The SF-36 is comprised of 36 items and measures eight scales including: general health perception, physical functioning, role limitations because of physical health, role limitations due to emotional health, bodily pain, vitality and mental health. From these eight scales, a physical health composite score (PCS) and mental health composite score (MCS) were constructed [47], and were analyzed in this study as continuous variables. Many of these variables related to health status can be viewed as either antecedents or consequences of food insecurity; because of the cross-sectional study design, we are unable to tease out directionality of effect.

Analysis

We used multiple logistic regression to assess factors associated with being food insecure. Data were analyzed using SAS statistical analysis software (SAS Institute, Cary, North Carolina, Version 8). We constructed regression models for factors associated with food insecurity, and all variables with a $P < 0.25$ were included in the final analysis [48]. Depression as measured by the BDI was excluded from the final models due to collinearity with the mental health composite score of the SF-36.

We also used classification and regression trees (CART) implemented in SPSS Answer Tree 3.1 to identify groups of participants with different prevalence of food insecurity and the factors that defined those groups [49, 50]. CART is particularly useful when it is expected that there are statistical interactions involving multiple factors related to a condition (i.e., food insecurity); these are difficult to model well using traditional regression techniques. CART is a recursive partitioning technique that builds a tree one level at a time. At each level, all predictors are examined for all possible binary splits. The predictor and split chosen from each node at that level minimizes misclassification. The tree is grown until no more splits can be made, and is then pruned to be parsimonious while minimizing misclassification. Cross-validation was used to evaluate the resultant tree.

Results

In total, 250 REACH participants received quarterly interviews and hence the food insecurity questionnaire in early 2006. More than half (53.6%) were classified as food insecure, with 21.2% mildly or moderately food insecure and 32.4% severely food insecure. The median age of the sample was 46.2, 69.6% were male, and 68.8% had completed high school (Table 1). Thirty-two percent of participants were white, 42.8% were African American, 9.2% were Latino, and the other 16.0% were of other racial and ethnic backgrounds. Twenty-eight percent of participants reported crack use, 8.4% heroin use, and 14.4% methamphetamine use over the previous month. Eleven percent of participants reported multi-drug use. Sixty-two percent of participants were currently on HAART therapy, 39.2% met criteria for depression according to the BDI, and 40.8% had a representative payee. While 94.8% of participants had any form of health insurance including Medicare, Medical and AIDS drug assistance program (ADAP), only 6.0% were employed at the time of the study.

In unadjusted analyses, individuals who were white had over 80% higher odds of food insecurity compared to individuals of other racial backgrounds (Table 2). Participants who screened positive for depression according to the BDI had nearly two times the odds of food insecurity, and individuals with higher physical health and mental health composite scores on the SF-36 had $\sim$30% lower odds of food insecurity. Individuals who reported recent sex exchange had an over eightfold greater odds of food insecurity. Participants who had recently used crack or had CD4 cell counts below 200 had over two times the odds of being food insecure.

In adjusted analyses, individuals who were white had over two times the odds of food insecurity (AOR = 2.03, 95% CI = 1.11–3.71). Individuals with higher physical health composite scores on the SF-36 (AOR = 0.74 for each ten point increase, 95% CI = 0.58–0.94) as well as those with higher mental health composite scores (AOR = 0.68, 95% CI = 0.54–0.85) still both had $\sim$30% lower odds of being

Table 1 Participant characteristics

Characteristic	All participants $N = 250$	Food insecure $N = 134$ (53.6%)	Food secure $N = 116$ (46.4%)	X^2 (P)
White	80 (32.0%)	51 (38.1%)	29 (25.0%)	4.87 (0.027)
Male	174 (69.6%)	91 (67.9%)	83 (71.6%)	0.39 (0.533)
≥High school education	172 (68.8%)	92 (68.7%)	80 (69.0%)	0.003 (0.958)
Income (≥median of 855$/month)	125 (50.0%)	69 (51.5%)	56 (48.3%)	0.26 (0.612)
Recent incarceration	11 (4.4%)	8 (5.6%)	3 (2.6%)	1.69 (0.230)
Recent homelessness	23 (9.2%)	15 (11.2%)	8 (6.9%)	1.37 (0.278)
Recent crack	70 (28.0%)	48 (35.8%)	22 (19.0%)	8.76 (0.003)
Recent heroin	21 (8.4%)	15 (11.2%)	6 (5.2%)	2.93 (0.110)
Recent speed	36 (14.4%)	23 (17.2%)	13 (11.2%)	1.79 (0.181)
Problem drinking	24 (9.6%)	14 (10.5%)	10 (8.6%)	0.26 (0.671)
Delayed HAART initiation	129 (51.6%)	76 (56.7%)	53 (45.7%)	3.03 (0.082)
Representative payee	102 (40.8%)	60 (44.8%)	42 (36.2%)	1.89 (0.169)
Employed	15 (6.0%)	9 (6.7%)	6 (5.2%)	0.26 (0.791)
Lack of any health insurance	13 (5.2%)	10 (7.5%)	3 (2.6%)	3.00 (0.083)
Depression	98 (39.2%)	62 (46.3%)	36 (31.0%)	6.05 (0.014)
Sex exchange	10 (4.0%)	9 (6.7%)	1 (0.9%)	4.48 (0.040)
Living with children	7 (2.8%)	2 (1.5%)	5 (4.4%)	1.85 (0.254)
Receipt of food aid	148 (59.9%)	85 (64.4%)	63 (54.8%)	2.36 (0.032)
CD4 < 200	65 (26.2%)	44 (67.7%)	21 (32.3%)	6.62 (0.010)
	Mean (SD)	Mean (SD)	Mean (SD)	T test (P)
Age (mean, SD)	46.2 (±7.9)	46.0 (±7.6)	46.4 (±8.3)	0.41 (0.683)
Physical health composite (SF-36)	41.2 (±11.7)	39.2 (±11.2)	43.5 (±11.8)	2.96 (0.003)
Mental health composite (SF-36)	43.9 (±12.5)	41.5 (±12.5)	46.6 (±11.9)	3.30 (0.001)
Number of close friends in social network	1.9 (±2.1)	2.1 (±2.5)	1.6 (±1.5)	−1.57 (0.117)

P values compare any food insecure versus all other participants for each characteristic

food insecure. Participants without health insurance had an over fourfold higher odds of being food insecure (AOR = 4.38, 95% CI = 1.08–17.85). Crack use (AOR = 2.06, 95% CI = 1.09–3.91) and low CD4 cell counts (AOR = 2.08, 95% CI = 1.09–3.94) retained their strong association with food insecurity in adjusted analyses.

CART analysis revealed four groups based on the interactions among three factors. Two of the groups had relatively low prevalence of food insecurity (38.7 and 42.7%) and were defined, respectively, by mental health composite scores on the SF-36 (MCS) > 48.9 and by MCS ≤ 48.9, physical health composite scores (PCS) > 36.6, and CD4 ≥ 200 (Table 3). Two of the groups had a high prevalence of food insecurity (73.9 and 84.5%) and were defined, respectively, by MCS ≤ 48.9, PCS > 36.6, and CD4 < 200 and by MCS ≤ 48.9 and PCS ≤ 36.6. That is most (85%) participants with low CD4 cell counts and low MCS and PCS scores were food insecure. The tree correctly classified 67% of participants and would be expected to correctly classify 54% of participants in a future similar sample.

Discussion

Over half of this sample of HIV-positive poor individuals had food insecurity, almost five times that of the general US population. The prevalence of food insecurity in this study was also twice as high as the rates reported in studies using similar validated measures of food insecurity from other low-income populations including homeless populations, individuals with income levels below 300% of the

Table 2 Factors associated with food insecurity among homeless and marginally housed HIV-infected participants in San Francisco ($n = 250$)

Characteristic	Odds ratio[a] (OR) (.95 CI)	Adjusted OR[a] (.95 CI)
Recent homelessness (past 30 days)	1.70 (0.69, 4.17)	–
Age (per year)	0.99 (0.96, 1.03)	–
White (versus nonwhite)	1.84 (1.07, 3.18)	2.03 (1.11, 3.71)
Male (versus female)	0.84 (0.49, 1.45)	–
≥High school education	0.99 (0.58, 1.69)	–
Employed	1.32 (0.46, 3.83)	–
Income ≥ mean	1.14 (0.69, 1.87)	–
Recent incarceration	2.39 (0.62, 9.23)	3.97 (0.95, 16.57)
Lack of health insurance	3.04 (0.82, 11.32)	4.38 (1.21, 19.75)
Has Payee	1.43 (0.86, 2.38)	–
Delayed HAART initiation	1.56 (0.94, 2.57)	–
Crack use past 30 days	2.38 (1.33, 4.27)	2.06 (1.09, 3.91)
Heroine use past 30 days	2.31 (0.87, 6.16)	–
Speed use past 30 days	1.64 (0.79, 3.41)	–
Problem drinking	1.25 (0.53, 2.93)	–
BDI score ≥ 14	1.91 (1.14, 3.22)	–
PCS for SF-36 (per 10 units)	0.72 (0.58–0.90)	0.74 (0.58–0.94)
MCS for SF-36 (per 10 units)	0.71 (0.58–0.88)	0.68 (0.54–0.85)
Sex exchange	8.28 (1.03, 66.37)	–
Number of friends in social network	1.11 (0.97, 1.27)	–
Living with children (past 30 days)	0.33 (0.06, 1.75)	–
Receipt of food aid (past 30 days)	1.49 (0.90, 2.49)	–
CD4 < 200	2.17 (1.19, 3.93)	2.08 (1.09, 3.94)

BDI beck depression inventory, *PCS* physical health composite score, *MCS* mental health composite score

[a] Logistic regression

Table 3 Groups resulting from analysis using classification and regression trees to predict food-insecure homeless and marginally housed HIV-infected participants

Group	Percentage of sample	Percent food insecure	Predictors		
			MCS	PCS	CD4
1	40.4	38.7	>48.9		
2	27.2	42.7	≤48.9	>36.6	≥200
3	9.2	73.9	≤48.9	>36.6	<200
4	23.2	84.5	≤48.9	≤36.6	

Estimate of misclassification in this sample: 33% (SE 3%)

Cross-validation estimate of misclassification for future similar sample: 46% (SE 3%)

federal poverty level, and individuals visiting urban county hospitals [5, 6, 40]. This high prevalence is similar to a previous study among HIV-infected individuals in Vancouver [9], and suggests that HIV-infected individuals are at particular risk for food insecurity.

No previous study to our knowledge has assessed factors associated with food insecurity in a population of HIV-infected individuals in the US. Some of the factors associated with food insecurity were similar to those reported in the general population. For example, we found that food insecurity was associated with worse physical and mental health according to the SF-36, a self-reported generic measure of health status. This has important implications as self-reported health status has been found to be predictive of the development of chronic disease and mortality [51, 52]. Others have previously reported that food insecurity was associated with poor self-ratings of physical and mental health, poor physical functioning, major depression, and suicidal symptoms [7, 10–12, 14, 53].

This study is one of the first to demonstrate a strong association between low CD4 cell counts and food insecurity in either domestic or international settings, suggesting that food insecurity may be an important marker of poor HIV clinical outcomes. These findings are consistent with our previous data showing that food insecurity is associated with incomplete viral load suppression in San Francisco [31] and with non-accidental mortality in Vancouver [32]. Another possible explanation of our findings is that individuals with more advanced disease and poor functional health status are less able to secure food. As demonstrated by the CART analysis, the vast majority of participants who had both low CD4 counts and low physical and mental health status scores on the SF-36 were food insecure, suggesting that food insecurity is highest among individuals with the worst health profiles. The combination of health indicators identified by the CART analysis

suggest that a multi-modal intervention strategy with these patients that addresses both food insecurity and other contributors to poor health status is warranted.

We found that a lack of health insurance was associated with higher odds of food insecurity even when controlling for income, social support, and stage of disease. This may be because individuals without health insurance had to spend some of their limited resources on health care costs rather than procuring food and as a result were more food insecure. Other studies have shown adverse health impacts of the need to make choices between buying food and buying medicines [15]. As this study was cross-sectional and health care is available largely free of charge through the AIDS Drug Assistance Program in San Francisco, another possible interpretation is that individuals who are food insecure have trouble focusing on other basic needs such as arranging for health insurance and health care. Recent crack use was also associated with food insecurity, potentially because individuals are spending their resources on drugs rather than food, or alternatively because drug abuse leads to a more chaotic lifestyle which in turn predisposes to food insecurity. Previous studies have also found that illicit drug use was associated with food insecurity among urban poor populations [6, 9]. The association of food insecurity with cocaine use also suggests that food insecurity may be related to poor social functioning in this population. Finally, while food insecurity was strongly associated with sex exchange in unadjusted analyses (as also reported in a recent study in sub-Saharan Africa) [33], this association was not seen in adjusted analyses and may be due to the lack of statistical power related to the small number of individuals that endorsed sex exchange.

There were also some important differences in the factors associated with food insecurity in this population compared to previous studies. As our study population was mainly composed of homeless and marginally housed individuals, and socioeconomic status was relatively homogenous, markers of socioeconomic status that have been found to be associated with food insecurity in other studies such as low education, homelessness and low income were not associated with food insecurity in this study [5, 7, 9, 54]. Also, we found that white homeless and marginally housed HIV-infected individuals were more likely to be food insecure, whereas studies in the general population have shown that racial and ethnic minorities typically have higher rates of food insecurity [4]. This may be related to the fact that racial inequalities seen in the general population do not always hold in homeless populations where there is extreme deprivation, but further studies will be needed to better understand these associations.

There were several important limitations to this study. First, this study was cross-sectional making it impossible to determine causality. Since several covariates (e.g., mental and physical health status) could be considered both causes and effects of food insecurity, longitudinal or randomized intervention studies will be critical to clarify the direction of causality underlying the relationships among these variables. Also, the unique social attitudes, risk behavior profiles and institutional resources among San Francisco's HIV-infected marginally housed individuals may limit generalizability to other populations. Finally, given that this population was homeless and marginally housed, the high prevalence of reported food insecurity can not necessarily be generalized to other HIV–infected groups or urban poor populations.

In summary, we found that food insecurity is highly prevalent among HIV-infected marginally housed individuals in San Francisco, and is associated with markers of poor physical and mental health and worse social functioning. Screening for and addressing food insecurity should be a critical component of HIV prevention and treatment programs domestically as well as internationally to improve quality of life and health outcomes. That food insecurity was associated with multiple factors suggests that there may be several ways to potentially intervene to reduce food insecurity. Further research is needed to better understand the causal relationships and ultimately how best to intervene in different populations.

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