Published in final edited form as:

AIDS. 2013 November 28; 27(18): 2953–2958. doi:10.1097/01.aids.0000432538.70088.a3.

Food insecurity and HIV clinical outcomes in a longitudinal study of urban homeless and marginally housed HIV-infected individuals

Sheri D. Weiser[a,b], **Caterina Yuan**[c], **David Guzman**[d], **Edward A. Frongillo**[e], **Elise D. Riley**[a], **David R. Bangsberg**[f], and **Margot B. Kushel**[d]

[a]Division of HIV/AIDS, San Francisco General Hospital

[b]Center for AIDS Prevention Studies, University of California, San Francisco

[c]University of California, San Francisco, School of Medicine

[d]Division of General Internal Medicine, San Francisco General Hospital, University of California, San Francisco, California

[e]Department of Health Promotion, Education, and Behavior, Arnold School of Public Health, University of South Carolina, Columbia, South Carolina

[f]Massachusetts General Hospital Center for Global Health, Ragon Institute of MGH, MIT and Harvard, Harvard Medical School, Boston, Massachusetts, USA

Abstract

Background—Food insecurity is common among HIV-infected individuals and has been associated with poor health. Little longitudinal research has examined the association of food insecurity with HIV clinical outcomes, or the extent to which adherence mediates these associations.

Design—Observational cohort study

Methods—HIV-infected homeless and marginally housed individuals in the San Francisco Research on Access to Care in the Homeless cohort completed quarterly structured interviews and blood draws. We measured food insecurity using the validated Household Food Insecurity Access Scale. Primary outcomes were: antiretroviral therapy (ART) nonadherence (<90% adherence), incomplete HIV viral load suppression more than 100 copies/ml, and $CD4^+$ cell counts less than 200 cells/μl. We estimated model parameters using generalized estimating equations, adjusting for sociodemographic and clinical variables.

Results—From May 2007 to March 2010, we followed 284 participants for a median of 22 months. At baseline 54.6% of participants were food-insecure. Food insecurity was associated with increased odds of ART nonadherence [adjusted odds ratio (AOR) = 1.48; 95% confidence interval (CI), 1.19–1.85], incomplete viral load suppression (AOR = 1.29, 95% CI 1.04–1.61), and

Correspondence to Sheri Weiser, MD, MPH, Division of HIV/AIDS, San Francisco General Hospital, POB 0874, UCSF, San Francisco, CA 94143, USA., Tel: +1 415 314 0665; fax: +1 415 869 5395; Sheri.Weiser@ucsf.edu.

There are no conflicts of interest.

$CD4^+$ cell counts less than 200 cells/μl (AOR = 1.26, 95% CI 1.01–1.56). When we included ART adherence in adjusted models for incomplete viral suppression and $CD4^+$ cell counts less than 200 cells/μl, the magnitude of the effect decreased slightly.

Conclusion—Food insecurity was associated with poor HIV outcomes, including nonadherence, in a longitudinal study of US-based HIV-infected unstably housed individuals. Efforts to address food insecurity should be included in HIV-treatment programs, and may help improve health outcomes.

Keywords

adherence; antiretroviral therapy; food security; HIV/AIDS

Introduction

Food insecurity (the limited or uncertain availability of nutritionally adequate, safe foods or the inability to acquire personally acceptable foods in socially acceptable ways) [1,2] affects up to 50% of HIV-infected urban poor populations in the United States [3,4]. Food insecurity is associated with worse health outcomes including obesity [5], diabetes [6], hypertension [7], self-reported hyperlipidemia [7], and depression [8].

Food insecurity and HIV/AIDS are reciprocally linked. Among HIV-infected individuals, food insecurity is associated with worse health-related quality of life [9], increased opportunistic infections [9], increased hospitalizations [9,10], and increased mortality [11]. Furthermore, cross-sectional and qualitative data suggest that food insecurity may lead to worse HIV outcomes including antiretroviral therapy (ART) nonadherence, viral rebound and worse immune status [3,4,12–16]. Yet there are limited longitudinal data examining these associations or the mechanisms through which food insecurity may impact HIV-clinical outcomes. Such data are critical for developing interventions to ameliorate food insecurity and mitigate its adverse effects.

We examined the associations between food insecurity and HIV outcomes in a longitudinal study of homeless and marginally housed HIV-infected individuals. We hypothesized that food insecurity would be associated with worse ART adherence, and worse immunologic and virologic outcomes. We further hypothesized that ART nonadherence would be an important mechanism by which food insecurity negatively impacts immunologic and virologic outcomes.

Methods

Participants were from the Research on Access to Care in the Homeless (REACH) study, a cohort of HIV-infected homeless and marginally housed individuals systemically recruited from homeless shelters, free meal programs, and single-room occupancy hotels in San Francisco, as previously described [17,18]. Participants were followed from May 2007 until March 2010. All REACH participants on ART at any time during follow-up were included beginning at the point they initiated or resumed ART. Treatment interruption and discontinuation were coded as 0% adherence. We administered blood draws and structured

questionnaires at baseline and at each quarterly follow-up. We processed and stored plasma for viral load and $CD4^+$ cell counts at −40°C within 6 h of collection. Participants provided written consent and received $15 reimbursement per interview. The UCSF Committee on Human Research approved all study procedures.

Measures

Primary independent variable

Food insecurity was measured by the Household Food Insecurity Access Scale, which was previously validated in eight countries [19,20] and adapted for use in marginally housed individuals [3]. The internal consistency of this measure was high in our sample, with a Cronbach's alpha of 0.94 [3]. Individuals were categorized as food secure or food insecure (including mild, moderate, or severe food insecurity) based on a standard algorithm [21].

Primary outcomes

ART nonadherence (average adherence for all ART drugs), was measured by the visual analog scale (VAS), a previously validated self-reported ART adherence measure [22,23]. The VAS has been closely correlated with unannounced pill count ($r = 0.76$) [24] and inversely correlated with viral load ($r = -0.49$) [24] in this population. Nonadherence was defined as less than 90% adherence, based on previous literature that adherence less than 90% is associated with increased progression to AIDS and death [25,26]. Incomplete viral load suppression was defined as an HIV-1 viral load more than 100 copies/ml (HIV-1 Amplicor Monitor Version 1.5 ultrasensitive assay), with a lower limit of quantification of 10 copies/ml. $CD4^+$ cell counts (done by Quest Diagnostics) were categorized as less than 200 cells/μl (low $CD4^+$ cell counts) versus at least 200 cells/μl to indicate severe immunosuppression consistent with a diagnosis of AIDS [27,28].

Covariates

We selected covariates based on previous literature and a conceptual framework on the linkages between food insecurity and HIV/AIDS [3,10,29,30]. We included these baseline covariates: sex (male versus female), age (continuous +10 years), ethnicity (African–American versus Latino versus Mixed/Other), income (≥versus < population monthly median $918), education (≥versus < high school diploma), months on ART at baseline (continuous +12 months), and $CD4^+$ cell count nadir (continuous per 100 cells). We also included these time-varying covariates: recent homelessness (sleeping on the street or in a shelter in the past 90 days), health insurance status (uninsured versus insured) illicit drug use in the last 90 days (yes versus no), and problem drinking over previous 30 days (>14 drinks per week for men and >7 drinks per week for women based on National Institute of Alcohol Abuse and Alcoholism's definitions) [31,32].

Analysis

We used generalized estimating equations to determine factors associated with time-varying ART nonadherence, incomplete viral load suppression, and low $CD4^+$ cell counts controlling for time-varying food insecurity and other sociodemographic and clinical covariates. For each outcome, all covariates with a $P \leq 0.20$ in bivariate analysis were included in adjusted

models, which were reduced using stepwise elimination, retaining covariates with $P \leq 0.05$. To evaluate the hypothesis that adherence is a potential mechanism through which food insecurity adversely affects virologic and immunologic outcomes, we added ART adherence to adjusted models for incomplete viral load suppression and both ART adherence and viral load suppression to models with incomplete $CD4^+$ cell response, and then reassessed the magnitude of the estimates for the relationship of food insecurity with these two outcomes.

Results

Description of study population

Among the 284 participants who took ART during the study period, 15 died, five dropped out, and 23 were lost to follow-up. Participants were followed for a median of 22 months ([interquartile range (IQR) 11, 25]. The sample was predominately male (74.4%), with a median age of 48 years (Supplemental Table 1, http://links.lww.com/QAD/A387). Over half of the participants were food-insecure at baseline (54.6%); of these, 51.6% were severely food-insecure. The majority of participants had been on ART for over 4 years at baseline. In total, 25.8% were nonadherent to ART during follow-up, 37.2% of individuals had unsuppressed viral loads, and 21.9% had $CD4^+$ cell counts less than 200 cells/μl.

Associations between food insecurity, ART nonadherence, incomplete viral load suppression, and $CD4^+$ cell counts less than 200 cells/μl

In adjusted analyses, the odds of ART nonadherence were 48% higher [adjusted odds ratio (AOR) = 1.48; 95% CI, 1.19–1.85; $P < 0.001$; Table 1] while the odds of incomplete viral suppression were 29% higher (AOR = 1.29, 95% CI 1.04–1.61; $P = 0.021$; Table 2) on average among food-insecure persons. ART non-adherence was associated with 55% greater odds of unsuppressed viral load (Table 2, column 3). When ART adherence was included in the models for viral load suppression, the AOR for food insecurity decreased slightly (AOR = 1.24, 95% CI 0.99–1.55; $P = 0.06$; Table 2, column 3).

Food insecurity was associated with 26% greater odds of having $CD4^+$ cell counts <200 cells/μl in adjusted models (AOR = 1.26, 95% CI 1.01–1.56; $P = 0.039$; Supplemental Table 2, http://links.lww.com/QAD/A387). When adherence was included in the adjusted models for low $CD4^+$ cell counts, the magnitude of association for food insecurity decreased slightly (AOR = 1.24, 95% CI 1.00–1.54; $P = 0.055$). When ART adherence and viral load suppression were added in combination to models with low $CD4^+$ cell count as the outcome, the adjusted odds ratio for food insecurity was further attenuated. (AOR = 1.16, 95% CI = 0.83–1.61).

Discussion

Food insecurity was significantly associated with low ART adherence, incomplete viral load suppression, and low $CD4^+$ cell counts among homeless and marginally housed individuals in longitudinal analyses after controlling for potential confounders. These findings highlight the importance of addressing food insecurity as part of comprehensive HIV care in order to improve both food security and HIV-related treatment outcomes.

Food insecurity was highly prevalent in this population: over half of participants were food insecure (54.6%), consistent with previous studies among urban poor HIV-infected populations in North America [14,15]. Previous cross-sectional studies from the United States and Canada have similarly found that food insecurity is associated with ART nonadherence, incomplete viral load suppression, and lower $CD4^+$ cell counts [3,4,15,16,33]. One previous longitudinal study in New England also reported that food insecurity blunted immunologic recovery on ART [34]. Our longitudinal study design coupled with the consistency of findings across several measures of HIV-treatment outcomes strengthens the evidence on the potential detrimental impacts of food insecurity on the health of HIV-infected individuals. Additionally, our finding that food insecurity is associated with unsuppressed viral loads, coupled with prior studies showing that food insecurity contributes to risky sexual practices [35–39], suggests that improving food insecurity among HIV-infected individuals may also reduce secondary HIV/AIDS transmission.

In this study, adherence was a weak mediator of negative health impacts of food insecurity. After adding ART adherence, the magnitude of the odds ratio for food insecurity was only slightly attenuated in models for virologic and immunologic outcomes, and no longer statistically significant. Based on a previously published conceptual framework, impacts of food insecurity on clinical outcomes may also be explained by other behavioral pathways (delayed entry into care, poor clinic attendance, interruptions in care), mental health pathways (such as depression and anxiety), and nutritional pathways (macronutrient and micronutrient deficiencies, worse absorption of drugs in the absence of food) [29]. Further investigation of these pathways is needed in larger studies including detailed measures of macronutrient and micronutrient deficiencies.

Addressing food insecurity should become an integral part of HIV care, consistent with the National HIV/AIDS Strategy goal to support HIV-infected individuals in meeting basic needs, such as food and housing. Currently, food security programs and HIV-related care are separate systems, funded by separate entities, contributing to access barriers for those who require both food assistance and medical care. Co-location of food pantries within HIV care facilities, and having case managers assist eligible patients sign up for the Supplemental Nutrition Assistance Program may help improve food security and health in this population. Such strategies may also contribute to long-term cost savings, as previous work showed that food insecurity contributes to the use of costly emergency healthcare services [9,10,40]. Potential solutions to address food insecurity will also need to consider that a large proportion of marginally housed populations may not have access to cooking facilities or refrigeration [39,41], and creative interventions will be needed to address these additional barriers.

There were several limitations to this study. The initial sampling frame for REACH included those recruited from free meal programs and soup kitchens, which may have led to an oversampling of those with food insecurity; this would not necessarily change the associations reported between food insecurity and poor HIV outcomes. We did not have pretreatment $CD4^+$ cell count on all participants, but did adjust for nadir $CD4^+$ cell counts. ART nonadherence was measured by self-report, which can lead to an underestimation of its

prevalence, and also makes it more difficult to assess its role as a potential mediator; yet VAS adherence has been extensively validated against objective adherence measures and clinical HIV treatment outcomes [22–24] including in the current study. We could not distinguish between patient-initiated and physician-initiated treatment interruptions, but physicians are unlikely to have initiated cessation unless there was poor adherence.

In conclusion, food insecurity was associated with multiple measures of poor HIV outcomes including ART nonadherence, low $CD4^+$ cell counts, and unsuppressed viral load in longitudinal study of homeless and marginally housed HIV-infected individuals in San Francisco. Results do not support the hypothesis that effects of food insecurity on clinical outcomes are mainly due to nonadherence. Intervention studies are needed to understand causal connections and further research is needed to tease apart the mechanisms by which food insecurity may negatively impact treatment outcomes. Efforts to address food insecurity should be included in HIV treatment programs, and may help improve health outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We thank 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. We also thank Dr Kartika Palar for critical feedback on the article.

This publication was supported by NIH/NCRRUCSF-CTSI Grant Number UL1 RR024131. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NIH.

Financial disclosure: NIMH 54907 (PI Bangsberg), CHRP ID08-SF-054 (PI Weiser); UCSF Academic Senate; Hurlbut-Johnson funds from AIDS Research Institute award, UCSF, # 557858–8–148 (PI Weiser). The authors acknowledge the following additional sources of salary support: K23 MH079713 and the Burke Family Foundation (to S.D.W.), and K24 MH-87227 (to D.R.B.). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the article.

References

1. Anderson SA. Core indicators of nutritional state for difficult-to-sample populations. J Nutr. 1990; 120(Suppl 11):1559–1600. [PubMed: 2243305]
2. Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht JP. Understanding hunger and developing indicators to assess it in women and children. J Nutr Educ. 1992; 24:36S–45S.
3. Weiser SD, Bangsberg DR, Kegeles S, Ragland K, Kushel MB, Frongillo EA. Food insecurity among homeless and marginally housed individuals living with HIV/AIDS in San Francisco. AIDS Behav. 2009; 13:841–848. [PubMed: 19644748]
4. Kalichman SC, Cherry C, Amaral C, White D, Kalichman MO, Pope H, et al. Health and treatment implications of food insufficiency among people living with HIV/AIDS, Atlanta, Georgia. J Urban Health. 2010; 87:631–641. [PubMed: 20419478]
5. Franklin B, Jones A, Love D, Puckett S, Macklin J, White-Means S. Exploring mediators of food insecurity and obesity: a review of recent literature. J Commun Health. 2012:1–12.
6. Seligman HK, Bindman AB, Vittinghoff E, Kanaya AM, Kushel MB. Food insecurity is associated with diabetes mellitus: results from the National Health Examination and Nutrition Examination Survey (NHANES) 1999–2002. J Gen Intern Med. 2007; 22:1018–1023. [PubMed: 17436030]

7. Seligman HK, Laraia BA, Kushel MB. Food insecurity is associated with chronic disease among low-income NHANES participants. J Nutr. 2010; 140:304–310. [PubMed: 20032485]
8. Vozoris NT, Tarasuk VS. Household food insufficiency is associated with poorer health. J Nutr. 2003; 133:120–126. [PubMed: 12514278]
9. Weiser SD, Tsai AC, Gupta R, Frongillo EA, Kawuma A, Senkungu J, et al. Food insecurity is associated with morbidity and patterns of healthcare utilization among HIV-infected individuals in a resource-poor setting. AIDS. 2012; 26:67–75. [PubMed: 21904186]
10. Weiser SD, Hatcher A, Frongillo EA, Guzman D. Food insecurity is associated with greater acute care utilization among HIV-infected homeless and marginally housed individuals in San Francisco. J Gen Intern Med. 2012; 28:91–98. [PubMed: 22903407]
11. Weiser SD, Fernandes KA, Brandson EK, Lima VD, Anema A, Bangsberg DR, et al. The association between food insecurity and mortality among HIV-infected individuals on HAART. J Acquir Immune Defic Syndr. 2009; 52:342–349. [PubMed: 19675463]
12. Nagata JM, Magerenge RO, Young SL, Oguta JO, Weiser SD, Cohen CR. Social determinants, lived experiences, and consequences of household food insecurity among persons living with HIV/AIDS on the shore of Lake Victoria, Kenya. AIDS Care. 2011
13. Weiser SD, Tuller DM, Frongillo EA, Senkungu J, Mukiibi N, Bangsberg DR. Food insecurity as a barrier to sustained antiretroviral therapy adherence in Uganda. PLoS One. 2010; 5:e10340. [PubMed: 20442769]
14. Normen L, Chan K, Braitstein P, Anema A, Bondy G, Montaner JS, et al. Food insecurity and hunger are prevalent among HIV-positive individuals in British Columbia, Canada. J Nutr. 2005; 135:820–825. [PubMed: 15795441]
15. Anema A, Weiser SD, Fernandes KA, Ding E, Brandson EK, Palmer A, et al. High prevalence of food insecurity among HIV-infected individuals receiving HAART in a resource-rich setting. AIDS Care. 2011; 23:221–230. [PubMed: 21259135]
16. Weiser SD, Frongillo EA, Ragland K, Hogg RS, Riley ED, Bangsberg DR. Food insecurity is associated with incomplete HIV RNA suppression among homeless and marginally housed HIV-infected individuals in San Francisco. J Gen Intern Med. 2009; 24:14–20. [PubMed: 18953617]
17. Robertson MJ, Clark RA, Charlebois ED, Tulsky J, Long HL, Bangsberg DR, et al. HIV seroprevalence among homeless and marginally housed adults in San Francisco. Am J Public Health. 2004; 94:1207–1217. [PubMed: 15226145]
18. Zolopa AR, Hahn JA, Gorter R, Miranda J, Wlodarczyk D, Peterson J, et al. HIV and tuberculosis infection in San Francisco's homeless adults. Prevalence and risk factors in a representative sample. JAMA. 1994; 272:455–461. [PubMed: 8040981]
19. Swindale A, Bilinsky P. Development of a universally applicable household food insecurity measurement tool: process, current status, and outstanding issues. J Nutr. 2006; 136:1449S–1452S. [PubMed: 16614442]
20. Frongillo EA, Nanama S. Development and validation of an experience-based measure of household food insecurity within and across seasons in Northern Burkina Faso. J Nutr. 2006; 136:1409S–1419S. [PubMed: 16614438]
21. Coates, J., Swindale, A., Bilinsky, P. Household Food Insecurity Access Scale (HFIAS) for measurement of food access: indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development; 2006.
22. Walsh JC, Mandalia S, Gazzard BG. Responses to a 1 month self-report on adherence to antiretroviral therapy are consistent with electronic data and virological treatment outcome. AIDS. 2002; 16:269–277. [PubMed: 11807312]
23. Oyugi JH, Byakika-Tusiime J, Charlebois ED, Kityo C, Mugerwa R, Mugyenyi P, et al. Multiple validated measures of adherence indicate high levels of adherence to generic HIV antiretroviral therapy in a resource-limited setting. J Acquir Immune Defic Syndr. 2004; 36:1100–1102. [PubMed: 15247564]
24. Giordano TP, Guzman D, Clark R, Charlebois ED, Bangsberg DR. Measuring adherence to antiretroviral therapy in a diverse population using a visual analogue scale. HIV Clin Trials. 2004; 5:74–79. [PubMed: 15116282]

25. Garcia de Olalla P, Knobel H, Carmona A, Guelar A, Lopez-Colomes JL, Cayla JA. Impact of adherence and highly active antiretroviral therapy on survival in HIV-infected patients. J Acquir Immune Defic Syndr. 2002; 30:105–110. [PubMed: 12048370]
26. Bangsberg DR, Perry S, Charlebois ED, Clark RA, Roberston M, Zolopa AR, et al. Nonadherence to highly active antiretroviral therapy predicts progression to AIDS. AIDS. 2001; 15:1181–1183. [PubMed: 11416722]
27. World Health Organization. WHO case definitions of HIV for surveillance and revised clinical staging and immunological classification of HIV-related disease in adults and children. Geneva, Switzerland: World Health Organization;
28. Revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. MMWR. 1992; 41:1–18.
29. Weiser SD, Young SL, Cohen CR, Kushel MB, Tsai AC, Tien PC, et al. Conceptual framework for understanding the bidirectional links between food insecurity and HIV/AIDS. Am J Clin Nutr. 2011; 94:1729S–1739S. [PubMed: 22089434]
30. Anema A, Vogenthaler N, Frongillo EA, Kadiyala S, Weiser SD. Food insecurity and HIV/AIDS: current knowledge, gaps, and research priorities. Curr HIV/AIDS Rep. 2009; 6:224–231. [PubMed: 19849966]
31. Enoch M, Goldman D. Problem drinking and alcoholism: diagnosis and treatment. Am Fam Physician. 2002; 65:441–449. [PubMed: 11858627]
32. Friedmann PD, Saitz R, Gogineni A, Zhang JX, Stein MD. Validation of the screening strategy in the NIAAA 'Physicians' Guide to Helping Patients with Alcohol Problems'. J Stud Alcohol Drugs. 2001; 62:234.
33. Wang EA, McGinnis KA, Fiellin DA, Goulet JL, Bryant K, Gibert CL, et al. Food insecurity is associated with poor virologic response among HIV-infected patients receiving antiretroviral medications. J Gen Intern Med. 2011; 26:1012–1018. [PubMed: 21573882]
34. McMahon JH, Wanke CA, Elliott JH, Skinner S, Tang AM. Repeated assessments of food security predict CD4 change in the setting of antiretroviral therapy. J Acquir Immune Defic Syndr. 2011; 58:60–63. [PubMed: 21694604]
35. Miller CL, Bangsberg DR, Tuller DM, Senkungu J, Kawuma A, Frongillo EA, et al. Food insecurity and sexual risk in an HIV endemic community in Uganda. AIDS Behav. 2011; 15:1512–1519. [PubMed: 20405316]
36. Shannon K, Kerr T, Milloy MJ, Anema A, Zhang R, Montaner JSG, et al. Severe food insecurity is associated with elevated unprotected sex among HIV-seropositive injection drug users independent of HAART use. AIDS. 2011; 25:2037. [PubMed: 21811140]
37. Weiser SD, Leiter K, Bangsberg DR, Butler LM, Percy-de Korte F, Hlanze Z, et al. Food insufficiency is associated with high-risk sexual behavior among women in Botswana and Swaziland. PLoS Med. 2007; 4:1589–1597. [PubMed: 17958460]
38. Tsai AC, Hung KJ, Weiser SD. Is food insecurity associated with HIV risk? cross-sectional evidence from sexually active women in Brazil. PLoS Med. 2012; 9:e1001203. [PubMed: 22505852]
39. Vogenthaler NS, Kushel MB, Hadley C, Frongillo EA Jr, Riley ED, Bangsberg DR, et al. Food insecurity and risky sexual behaviors among homeless and marginally housed HIV-infected individuals in San Francisco. AIDS Behav. 2013; 17:1688–1693. [PubMed: 23086429]
40. Kushel MB, Gupta R, Gee L, Haas JS. Housing instability and food insecurity as barriers to healthcare among low-income Americans. J Gen Intern Med. 2006; 21:71–77. [PubMed: 16423128]
41. Anema A, Vogenthaler N, Frongillo EA, Kadiyala S, Weiser SD. Food insecurity and HIV/AIDS: current knowledge, gaps, and research priorities. Curr HIV/AIDS Rep. 2009; 6:224–231. [PubMed: 19849966]

Table 1

Factors associated with ART adherence less than 90% in a homeless and marginally housed population in San Francisco ($N = 284$).

Characteristic	Bivariate analyses odds ratio (0.95 CI)	Adjusted odds ratio*
Any food insecurity	1.60 (1.29–1.99) ***	1.48 (1.19–1.85) ***
Man (versus woman)	1.17 (0.81–1.68)	–
Age (per 10 years)	0.86 (0.69–1.07)	–
African–American ethnicity	1.20 (0.82–1.77)	–
Latino ethnicity	0.77 (0.38–1.56)	–
Mixed/other ethnicity	1.38 (0.80–2.38)	–
Education less than high school	1.05 (0.73–1.52)	–
Living in shelter or on street, past 90 days	1.75 (1.16–2.64) **	1.55 (1.04–2.32) *
Problem drinking, past 30 days	1.73 (1.12–2.68) *	1.76 (1.15–2.69) **
Income less than median ($916)	1.21 (0.86–1.72)	–
Uninsured	1.35 (0.77–2.35)	–
Illicit drugs use in last 90 days	2.33 (1.79–3.03) ***	2.17 (1.66–2.82) ***
Cumulative months on ART at baseline (per 12 months)	0.97 (0.93–1.01)	–
Nadir $CD4^+$ cell count (per 100 cells)	0.85 (0.76–0.96) **	0.88 (0.79–0.99) *

*** $P < 0.001$.

** $P < 0.01$.

* $P < 0.05$.

Table 2

Factors associated with HIV viral load more than 100 copies/ml in a homeless and marginally housed population in San Francisco ($N = 284$).

Characteristic	Bivariate analyses odds ratio (0.95 CI)	Adjusted odds ratio (0.95 CI)	AOR with adherence (0.95 CI)
Any food insecurity	1.36 (1.10–1.68) **	1.29 (1.04–1.61) *	1.24 (0.99–1.55)
Man (versus woman)	0.88 (0.58–1.33)	–	–
Age (per 10 years)	0.69 (0.53–0.91) **	–	–
African–American ethnicity	1.77 (1.16–2.70) **	1.98 (1.29–3.02) **	1.96 (1.29–2.99) **
Latino ethnicity	1.31 (0.61–2.80)	1.43 (0.63–3.22)	1.44 (0.63–3.26)
Mixed/other ethnicity	2.57 (1.41–4.68) **	2.47 (1.32–4.63) **	2.48 (1.34–4.62) **
Education less than high school	1.14 (0.74–1.76)	–	–
Living in shelter or on street in past 90 days	1.98 (1.25–3.14) **	1.89 (1.16–3.07) *	1.86 (1.15–3.02) *
Problem drinking, past 30 days	1.49 (0.96–2.32)	–	–
Income less than median ($916)	0.99 (0.68–1.46)	–	–
Uninsured	1.21 (0.46–3.18)	–	–
Illicit drugs use in last 90 days	1.45 (1.12–1.88) **	1.37 (1.04–1.81) *	1.30 (0.98–1.72)
Cumulative months on ART at baseline (per 12 months)	0.94 (0.89–0.99) *	–	–
Nadir $CD4^+$ cell count (per 100 cells)	0.76 (0.67–0.87) ***	0.76 (0.67–0.87) ***	0.77 (0.67–0.88) ***
Adherence <90%	1.63 (1.30–2.04) ***	–	1.55 (1.20–2.00) ***

*** $P < 0.001$.

** $P < 0.01$.

* $P < 0.05$.