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Food Insecurity is Associated with Poor HIV Outcomes Among Women in the United States

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Compliance with Ethical Standards

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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Abstract

Women in the general population experience more food insecurity than men. Few studies have examined food insecurity's impact on HIV treatment outcomes among women. We examined the association between food insecurity and HIV outcomes in a multi-site sample of HIV-infected women in the United States (n = 1154). Two-fifths (40%) of participants reported food insecurity. In an adjusted multivariable Tobit regression model, food insecurity was associated with 2.08 times higher viral load (95% confidence interval (CI): 1.04, 4.15) and lower CD4+ counts (− 42.10, CI: − 81.16, − 3.03). Integration of food insecurity alleviation into HIV programs may improve HIV outcomes in women.

Keywords

Food insecurity; Women; HIV; Viral load

Introduction

Food insecurity is defined as the limited or uncertain availability of nutritionally adequate, safe foods, or the inability to acquire personally acceptable food in socially acceptable ways [1]. Food insecurity affects about a quarter to half of HIV-infected adults in the United States (U.S.) compared to 14% of the general population [2, 3]. Food insecurity is associated with lower physical health status, incomplete viral load suppression, and lower CD4+ counts [2, 4, 5].

HIV-infected women may be particularly susceptible to food insecurity [1]. Women in the general population are more susceptible to food insecurity than men, in part due to unequal household resource allocation, and also because women may prioritize feeding children and other family members over themselves [1]. Furthermore, HIV-infected women may experience additional consequences of food insecurity compared to HIV-infected men. For example, food-insecure women are more likely to enter risky sexual relationships, experience depression, and develop obesity compared to men [1, 6]. Most studies of the impact of food insecurity on HIV outcomes have been among men, due to the characteristics of the HIV epidemic in North America and the composition of populations in HIV-infected cohorts [2, 3, 5]. Women have represented from one-quarter to almost none of the participants in prior large studies of food insecurity and HIV outcomes in North America [2, 3, 5]. Thus, little is known about the impact of food insecurity on HIV outcomes among HIV-infected women.

We aimed to examine the relationship between food insecurity and HIV clinical outcomes in a multi-site U.S. sample of women. We hypothesized that food insecurity would be associated with higher HIV-1 viral load and lower CD4+ count in HIV-infected women from the Women's Interagency HIV Study (WIHS).

Methods

The WIHS is a multi-site prospective, longitudinal, cohort study of HIV-infected women and women at risk for HIV established in 1994 [7]. HIV-infected women complete interviews and laboratory assessments every 6 months. The cross-sectional sample from this cohort includes 1154 HIV-infected women interviewed from April 2013 to September 2013 recruited from 8 WIHS sites across the United States: San Francisco/Bay Area, CA, Bronx, NY, Brooklyn, NY, Washington, DC, Chicago, IL, Chapel Hill, NC, Miami, FL and Birmingham, AL. Details of cohort recruitment, demographics, and retention have been published previously [7]. Participants provide written informed consent and are compensated for participation. This study was approved by the Institutional Review Board at each study site's institution and by the WIHS Executive Committee.

Primary Independent Variable

Food insecurity in the previous 6 months was measured using the Household Food Security Survey Module, which has been validated previously in the U.S. [8]. The internal consistency of this measure in our sample was high, with Cronbach's alpha of 0.91. We considered marginal, low, and very low food security to be indicative of food insecurity.

Primary Outcomes

The primary outcome in this study was continuous HIV-viral load with a lower limit of detection of < 20 copies/ml using the Taqman© assay. Continuous CD4+ count/mm^3 was assessed as a secondary outcome.

Covariates

We selected covariates based on previous research and a conceptual framework for understanding the impact of food insecurity on HIV clinical outcomes [2, 4]. Variables selected were age (continuous per 10 years), race/ethnicity (non-Hispanic African-American, Hispanic, and other compared to non-Hispanic white), income (≥ $30,000/year vs. not), current savings (< vs. ≥ $500), child dependents (any vs. none), education (< vs. ≥ high school diploma or equivalency), receipt of food aid (any vs. no governmental or nongovernmental food aid), and being homeless or marginally housed (living in someone else's house/apartment, rooming house, shelter/welfare hotel, street, residential drug/alcohol treatment facility vs. living in own house/apartment or parent's house). Interviewers asked participants about their substance use (marijuana, either medical or recreational, cocaine, crack, heroin, methamphetamine, hallucinogens, club drugs, or any other illicit or recreational drugs) since the last visit and if they had consumed on average more than 7 drinks per week since the last visit, which we classified as heavy drinking. Nutritional covariates included low, normal, and high body mass index categories (BMI < 18.5; BMI 18.5–24; BMI ≥ 25). Clinical covariates included CD4+ nadir per 100 cells and cumulative years on antiretroviral therapy (ART). We did not adjust for ART adherence in our regression models given that ART adherence has been shown to be on the causal pathway between food insecurity and HIV clinical outcomes [1, 3].

Analysis

Tobit regression models were used to estimate bivariate associations between independent variables and the primary dependent variable, HIV-1 viral load. Bivariate results with a *p* value < 0.15 were then included in multivariable models. A Tobit model was used given that a large proportion of the viral load distribution is left-censored due to values in the undetectable range. HIV-1 viral load was transformed using the natural logarithm so that the non-censored values satisfied the assumption of a normal distribution. Results are then presented as the natural exponent of the regression coefficient, which is interpreted as a relative difference (i.e., multiplicative factor) for viral load. To examine the impact of food insecurity on continuous CD4+ count, linear regression was used to calculate the bivariate association between the same independent variables and continuous CD4+ count.

Results

Participants had a mean age of 49 (standard deviation (SD): 8.6). The sample was predominantly non-Hispanic African-American (67%); 18% were Hispanic, 11% were non-Hispanic white, and 3.7% identified as other (Supplementary Table I). Two-fifths (40%) reported food insecurity: 15% marginal food security, 13% low, and 12% very low. Nearly a fifth (18%) were currently receiving food aid. Of participants with very low food security, 31% were receiving governmental food aid, and 20% were receiving non-governmental food aid. More than half (58%) had an undetectable viral load, and few had CD4+ counts below 200 (9%).

In the multivariable Tobit regression model, food insecurity was associated with 2.08 times higher HIV-1 viral load (95% confidence interval (CI) 1.04, 4.15, p = 0.04) (Table 1). In a multivariable linear regression model, food insecurity was associated with an average 42.10 cells/mm^3 lower mean CD4+ count (CI − 81.16, − 3.03; p = 0.03) after adjusting for covariates (Table 1).

Discussion

In a multi-site study of 1154 HIV-infected women in the U.S., food insecurity was associated with higher HIV-1 viral load and lower CD4+ count [9]. Using a large multi-site, national, diverse sample, our findings extend prior research on food insecurity and HIV outcomes by showing that food insecurity is associated with worse HIV clinical outcomes in a less-studied population, HIV-infected U.S. women.

Food insecurity was common in our sample, with 40% of participants experiencing some degree of food insecurity. The prevalence of WIHS participants with very low food security (12%) is more than twice as high as the prevalence of households in the U.S. general population with very low food security (5%) [10]. Furthermore, the prevalence of WIHS participants with any food insecurity (40%) is higher than a large, multi-site, predominantly male sample of HIV-infected veterans in the Veterans Aging Cohort Study in which 24% were food insecure [5]. For participants with very low food security, only 31% were receiving governmental food assistance compared to 55% of households with very low food security in the general population [10].

The limited receipt of food assistance in our sample highlights the need to improve access to food assistance for HIV-infected women on both a clinical and policy level. It is unclear based on the data available if poor access to food assistance was related to a lack of integration of food insecurity assessment into routine HIV clinical care, or a lack of resources available for addressing food insecurity. Although collection of food insecurity data is required for food and nutrition providers for Ryan White Part A beneficiaries in some regions, it is not collected routinely throughout other aspects of the Ryan White Program [2]. Integration of food insecurity assessments into comprehensive HIV care, particularly for vulnerable patients such as Ryan White beneficiaries, could facilitate referrals to food assistance.

Until recently, there have been few trials of food insecurity interventions integrated into comprehensive HIV care. Studies in international settings have found that monthly food baskets given to participants as part of clinical management of HIV improved ART adherence and retention in care [11]. While few studies have evaluated food support interventions in North America, one recent pilot trial from the Bay Area found that a meal and snack intervention designed to meet 100% of caloric needs in a population of patients with HIV not only significantly decreased food insecurity, but also decreased substance use and resulted in improved antiretroviral therapy adherence [12]. Furthermore, participants reported a significant reduction in their need to forgo essential medical care as a result of inadequate food [12]. Given the high prevalence of food insecurity in women and the association of food insecurity with poor HIV outcomes in our study, interventions designed to address food insecurity in HIV-infected women may have a significant impact on the HIV care continuum, particularly in bolstering retention in care and adherence to HIV therapy.

There were a few limitations of this study. Our results may not be generalizable to all HIV-infected women in the U.S., particularly if there are differences between women who enroll in WIHS and women who do not or could not have enrolled in WIHS because they live in a geographic area without a WIHS site. The cross-sectional and observational nature of the data preclude causal inference. Longitudinal studies, however, have also found significant associations between food insecurity and poor HIV outcomes [4]. Future research should evaluate the mechanisms through which food insecurity impacts HIV outcomes using longitudinal data. Furthermore, randomized trials of food insecurity interventions could quantify the impact of addressing food insecurity as a part of comprehensive HIV care.

Conclusions

Food insecurity was associated with higher viral load and lower CD4+ cell count in a sample of HIV-infected U.S. women. Comprehensive HIV care that integrates food insecurity interventions may have a significant impact on the health of HIV-infected women.

Supplementary Material

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Table 1

Characteristics associated with HIV-1 viral load in Tobit regression models (N = 1023) and with CD4+ cells/mm^3 count in linear regression models (N = 944)

	Viral load model bivariate Factor[a] (95% CI; p-value)	Viral load model multivariable adjusted N = 1023) Factor[a] (95% CI; p-value)	CD4+ model bivariate β (95% CI; p-value)	CD4+ model multivariable adjusted (N = 944) β (95% CI; p-value)
Having food insecurity (marginal, low, or very low food security compared to high)	2.41 (1.20, 4.82; 0.01)	2.08 (1.04, 4.15; 0.04)	− 45.97 (− 84.23, − 7.72; 0.02)	− 42.10 (− 81.16, − 3.03; 0.03)
Age per 10 years	0.49 (0.33, 0.72; < 0.001)	0.70 (0.45, 1.08; 0.10)	10.42 (− 11.30, 32.14; 0.35)	–
Race/ethnicity (White ref. group)				
African-American	2.83 (0.91, 8.75; 0.07)	2.69 (0.86, 8.42; 0.09)	6.82 (− 54.64, 68.29; 0.83)	− 24.85 (− 87.77, 38.07; 0.44)
Hispanic	1.23 (0.32, 4.67; 0.76)	2.41 (0.64, 9.09; 0.19)	− 50.01 (− 121.76, 21.74; 0.17)	− 80.47 (− 153.99, − 6.95; 0.03)
Other	0.83 (0.10, 6.79; 0.86)	0.72 (0.09, 5.82; 0.76)	60.59 (− 52.34, 173.51; 0.29)	54.35 (− 55.51, 164.20; 0.33)
At least high school degree or equivalency	0.79 (0.39, 1.62; 0.52)	–	0.10 (− 39.08, 39.29; 0.99)	–
Less than $30,000 income	1.69 (0.71, 4.00; 0.23)	–	− 53.67 (− 100.07, − 7.28; 0.02)	− 48.20 (− 95.54, − 0.86; 0.05)
Less than $500 savings	1.85 (0.76, 4.48; 0.17)	–	1.04 (− 47.89, 49.98; 0.97)	–
Having child dependents	4.03 (1.99, 8.16; < 0.001)	2.95 (1.38, 6.32; 0.01)	− 23.20 (− 62.75, 16.34; 0.25)	–
Homeless/marginal housing	2.22 (0.65, 7.59; 0.21)	–	− 92.48 (− 161.14, − 23.81; 0.01)	− 89.76 (− 165.32, − 14.20; 0.02)
Any food aid	1.30 (0.54, 3.17; 0.56)	–	− 3.96 (− 52.72, 44.79; 0.87)	–
Any substance use since last visit[b]	3.98 (1.82, 8.69; < 0.001)	2.41 (1.06, 5.47; 0.04)	− 40.91 (− 84.78, 2.96; 0.07)	− 3.56 (− 50.28, 43.17; 0.88)
Heavy drinking[c]	9.38 (3.36–26.19; < 0.001)	4.49 (1.54, 13.06; 0.01)	− 47.04 (− 107.43, 13.35; 0.13)	− 39.57 (− 102.02, 22.88; 0.21)
CD4+ nadir (cells/mm^3 per 100 cells)	1.13 (0.96, 1.34; 0.15)	–	33.40 (24.72, 42.08; < 0.001)	34.57 (25.81, 43.33; < 0.001)
Time on ART (years)	0.94 (0.88, 0.99; 0.03)	0.97 (0.91, 1.03; 0.26)	− 2.38 (− 5.67, 0.92; 0.16)	–
BMI (normal ref. group)				
Underweight, BMI < 18.5	15.60 (2.32, 105.01; < 0.001)	16.68 (2.53, 109.8; 0.00)	− 132.84 (− 246.69, − 18.99; 0.02)	− 112.48 (− 225.55, 0.58; 0.05)
Overweight/obese, BMI ≥ 25	0.93 (0.42, 2.04; 0.85)	0.82 (0.38, 1.80; 0.63)	93.15 (50.46, 135.84; < 0.001)	74.39 (30.76, 118.03; < 0.001)

CI confidence interval, *ART* antiretroviral therapy, *BMI* body mass index

[a]The natural logarithm of viral load was used to satisfy the assumption of a normal distribution, and the factors above are natural exponential "e" of the Tobit regression coefficients and are interpreted as multiplicative factors; i.e. factor of 2.41 for food insecurity is interpreted as 2.41 times higher HIV-1 viral load

[b]Participants were asked if they used marijuana, either medical or recreational, cocaine, crack, heroin, methamphetamine, hallucinogens, club drugs, or any other illicit or recreational drugs since the last visit

[c]Heavy drinking defined as > 7 drinks per week