The Journal of Nutrition
Nutrition and Disease

Food insecurity is associated with anxiety, stress, and symptoms of posttraumatic stress disorder in a cohort of women with or at risk of HIV in the United States

Henry J Whittle,[1] Lila A Sheira,[2] William R Wolfe,[3] Edward A Frongillo,[4] Kartika Palar,[2] Daniel Merenstein,[5] Tracey E Wilson,[6] Adebola Adedimeji,[7] Kathleen M Weber,[8] Adaora A Adimora,[9] Ighovwerha Ofotokun,[10] Lisa Metsch,[11] Janet M Turan,[12] Eryka L Wentz,[13] Phyllis C Tien,[14] and Sheri D Weiser[2,15]

[1]Centre for Psychiatry, Wolfson Institute of Preventive Medicine, Barts and the London School of Medicine and Dentistry, Queen Mary University of London, London, UK; [2]Division of HIV, ID and Global Medicine, [3]Department of Psychiatry, and [4]Department of Health Promotion, Education, and Behavior, University of South Carolina, Columbia, SC; [5]Department of Family Medicine, Georgetown University Medical Center, Washington, DC; [6]Department of Community Health Sciences, State University of New York Downstate Medical Center, School of Public Health, Brooklyn, NY; [7]Department of Epidemiology and Population Health, Albert Einstein College of Medicine, Bronx, NY; [8]Cook County Health and Hospitals System and Hektoen Institute of Medicine, Chicago, IL; [9]School of Medicine and UNC Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC; [10]School of Medicine, Emory University, Atlanta, GA, and Grady Healthcare System, Atlanta, GA; [11]Department of Sociomedical Sciences, Mailman School of Public Health, Columbia University, New York, NY; [12]Department of Health Care Organization and Policy, School of Public Health, University of Alabama at Birmingham, Birmingham, AL; [13]Bloomberg School of Public Health, Department of Epidemiology, Johns Hopkins University, Baltimore, MD; [14]Department of Medicine, UCSF and Medical Service, Department of Veteran Affairs Medical Center, San Francisco, CA; and [15]Center for AIDS Prevention Studies, UCSF, San Francisco, CA

ABSTRACT

Background: Food insecurity, which disproportionately affects marginalized women in the United States, is associated with depressive symptoms. Few studies have examined relations of food insecurity with other mental health outcomes.

Objective: The aim of this study was to investigate the associations of food insecurity with symptoms of generalized anxiety disorder (GAD), stress, and posttraumatic stress disorder (PTSD) in the Women's Interagency HIV Study (WIHS), a prospective cohort study of women with or at risk of HIV in the United States.

Methods: Participants were 2553 women with or at risk of HIV, predominantly African American/black (71.6%). Structured questionnaires were conducted during April 2013–March 2016 every 6 mo. Food security (FS) was the primary predictor, measured using the Household Food Security Survey Module. We measured longitudinal outcomes for GAD (GAD-7 score and a binary GAD-7 screener for moderate-to-severe GAD). Only cross-sectional data were available for outcomes measuring perceived stress (PSS-10 score) and PTSD (PCL-C score and a binary PCL-C screener for PTSD). We examined associations of FS with the outcomes through use of multivariable linear and logistic regression, including lagged associations with GAD outcomes.

Results: After adjusting for sociodemographic and health-related factors including HIV serostatus, current marginal, low, and very low FS were associated with increasingly higher GAD-7 scores, and with 1.41 (95% CI: 1.10, 1.80; $P < 0.01$), 2.03 (95% CI: 1.59, 2.61; $P < 0.001$), and 3.23 (95% CI: 2.43, 4.29; $P < 0.001$) times higher odds of screening positive for moderate-to-severe GAD, respectively. Low and very low FS at the previous visit (6 mo earlier) were independently associated with GAD outcomes at current visit. Associations of FS with PSS-10 and PCL-C scores exhibited similar dose-response relations. Very low FS was associated with 1.93 (95% CI: 1.15, 3.24; $P < 0.05$) times higher odds of screening positive for PTSD.

Conclusions: Food insecurity may be associated with a range of poor mental health outcomes among women in the United States with or at risk of HIV. *J Nutr* 2019;149:1393–1403.

Keywords: food insecurity, anxiety, stress, PTSD, HIV

Manuscript received January 13, 2019. Initial review completed February 19, 2019. Revision accepted April 10, 2019.
First published online May 25, 2019; doi: https://doi.org/10.1093/jn/nxz093.

Introduction

Food insecurity is the limited or uncertain availability of nutritionally adequate, safe foods, or the inability to acquire personally acceptable foods in socially acceptable ways (1). Food insecurity includes *1*) insufficient quantity, quality, or diversity of available foods; *2*) feelings of deprivation, anxiety, or restricted choice about the amount or type of available foods; and *3*) having to engage in procurement strategies such as begging, dependence on charity, stealing, or exchanging sex to obtain food (1–3). In the United States in 2016, 41 million individuals (12.9% of the US population) experienced food insecurity (4). Women are disproportionately affected (5). In 2016, households with children headed by a single woman and those with single women living alone had higher food insecurity rates than the national average (4). Women also face unique challenges associated with food insecurity (6), which increases the risk of intimate partner violence (7–9) and high-risk sexual activity (10).

Previous research has demonstrated strong associations between food insecurity and poor clinical outcomes in several chronic physical health conditions (1). Fewer quantitative studies, meanwhile, have examined associations between food insecurity and mental illness. Of those that have, the majority have focused on mood: food insecurity has been consistently associated with depressive symptoms across diverse settings in a bidirectional relation (11–17). Other studies have demonstrated associations between food insecurity and suicidality (18–20). Few studies in resource-rich settings have examined relations between food insecurity and other psychiatric symptoms and disorders using validated scales.

In qualitative studies, anxiety, stress, and the recollection of trauma consistently arise from the experience of food insecurity (21–24). The associations between food insecurity and *1*) anxiety disorders and *2*) trauma-/stressor-related disorders are therefore pertinent targets for research. Generalized anxiety disorder (GAD) and posttraumatic stress disorder (PTSD) are the archetypal anxiety disorder and trauma-/stressor-related disorder, respectively. In the United States, both disorders are more prevalent among women than men (25, 26). Both are also more prevalent among people living with HIV (PLHIV) than in the general population (27, 28), particularly PTSD among women living with HIV (29). Like food insecurity, which similarly has a high prevalence among low-income PLHIV in the United States (30–32), both GAD and PTSD have been hypothesized to increase HIV transmission risk and worsen HIV clinical outcomes (1, 33). Few studies, however, have examined associations of food insecurity with GAD and PTSD, particularly in resource-rich settings and among PLHIV.

To start to address these research gaps, we aimed to investigate the relations of food insecurity with GAD, perceived stress, and PTSD among women with or at risk of HIV in the United States. We hypothesized that food insecurity would be associated with GAD, perceived stress, and PTSD, such that increasing severity of food insecurity would be associated with both increasing severity of symptoms and higher odds of screening positive for GAD and PTSD.

Methods

Study design and population

Our analysis used data from the Women's Interagency HIV Study (WIHS), an ongoing multicenter prospective cohort study of HIV-seropositive women and demographically similar HIV-seronegative controls in the United States. Cohort recruitment, demographics, and retention have previously been described in detail (34, 35). WIHS data are collected every 6 mo. Participants undergo structured interviews, physical examinations, and have blood and other biological samples taken at each visit. Since baseline recruitment in 1993, the study has undergone 3 additional waves of recruitment, with the latest occurring during 2013–2015 at several newly added study sites in the southern United States.

The data for our study were collected as part of a WIHS Food Insecurity Sub-Study that began in 2013. As part of the Food Insecurity Sub-Study, we collected data every 6 mo on comprehensive measures of food security, nutrition, and key socioeconomic variables among all individual WIHS women at visits 38–43 during April 2013–March 2016. In the WIHS, 1 woman is enrolled per household. The data were collected across all 9 WIHS sites: Birmingham, AL/Jackson, MS; Atlanta, GA; Miami, FL; Chapel Hill, NC; San Francisco, CA; Chicago, IL; Washington, DC; Bronx, NY; and Brooklyn, NY. This study combines data collected as part of the observational Food Insecurity Sub-Study with data collected in 2 other observational WIHS sub-studies: the Neurocognition Sub-Study (which started at visit 21) and the Engagement in Care Sub-Study (which started at visit 39) (**Figure 1**), as well as core WIHS data for covariates.

Primary predictor

The primary predictor was food security (FS), measured using the 18-item USDA Household Food Security Survey Module (HFSSM) (36). The HFSSM was developed using in-depth qualitative and survey data among women and low-income families in the United States (37, 38) to capture the experience of anxiety around household food supplies, inadequate quality of food, and/or reduced food intake (39). It has been validated across diverse settings and multiple countries (39), including in the United States (40). Respondents completed the HFSSM at each of visits 38–43 (April 2013–March 2016), reporting FS over the

Funded by a Women's Interagency HIV Study (WIHS) sub-study grant from the National Institute of Mental Health, R01MH095683 and 5U01AI103401, as well as the National Institute of Allergy and Infectious Diseases (K24AI134326) (Weiser). Additional salary support was provided by K01DK107335 (Palar). Data in this manuscript were collected by the Women's Interagency HIV Study (WIHS). The contents of this publication are solely the responsibility of the authors and do not represent the official views of the National Institutes of Health (NIH). WIHS (Principal Investigators): UAB-MS WIHS (Mirjam-Colette Kempf and Deborah Konkle-Parker), U01-AI-103401; Atlanta WIHS (Ighovwerha Ofotokun and Gina Wingood), U01-AI-103408; Bronx WIHS (Kathryn Anastos and Anjali Sharma), U01-AI-035004; Brooklyn WIHS (Howard Minkoff and Deborah Gustafson), U01-AI-031834; Chicago WIHS (Mardge Cohen and Audrey French), U01-AI-034993; Metropolitan Washington WIHS (Seble Kassaye), U01-AI-034994; Miami WIHS (Margaret Fischl and Lisa Metsch), U01-AI-103397; UNC WIHS (Adaora Adimora), U01-AI-103390; Connie Wofsy Women's HIV Study, Northern California (Ruth Greenblatt, Bradley Aouizerat, and Phyllis Tien), U01-AI-034989; WIHS Data Management and Analysis Center (Stephen Gange and Elizabeth Golub), U01-AI-042590; Southern California WIHS (Joel Milam), U01-HD-032632 (WIHS I – WIHS IV). The WIHS is funded primarily by the National Institute of Allergy and Infectious Diseases (NIAID), with additional co-funding from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), the National Cancer Institute (NCI), the National Institute on Drug Abuse (NIDA), and the National Institute on Mental Health (NIMH). Targeted supplemental funding for specific projects is also provided by the National Institute of Dental and Craniofacial Research (NIDCR), the National Institute on Alcohol Abuse and Alcoholism (NIAAA), the National Institute on Deafness and other Communication Disorders (NIDCD), and the NIH Office of Research on Women's Health. WIHS data collection is also supported by UL1-TR000004 (UCSF CTSA), UL1-TR000454 (Atlanta CTSA), and P30-AI-050410 (UNC CFAR).

Author disclosures: HJW, LAS, WRW, EAF, KP, DM, TEW, AA, KMW, AAA, IO, LM, JMT, ELW, PCT and SDW, no conflicts of interest.

Address correspondence to HJW (e-mail: h.whittle@qmul.ac.uk).

Abbreviations used: FS, food security; GAD, generalized anxiety disorder; GAD-7, Generalized Anxiety Disorder-7 scale; HFSSM, Household Food Security Survey Module; PCL-C, Posttraumatic Stress Disorder Checklist-Civilian Version; PLHIV, people living with HIV; PSS-10, Perceived Stress Scale 10; PTSD, posttraumatic stress disorder; WIHS, Women's Interagency HIV Study.

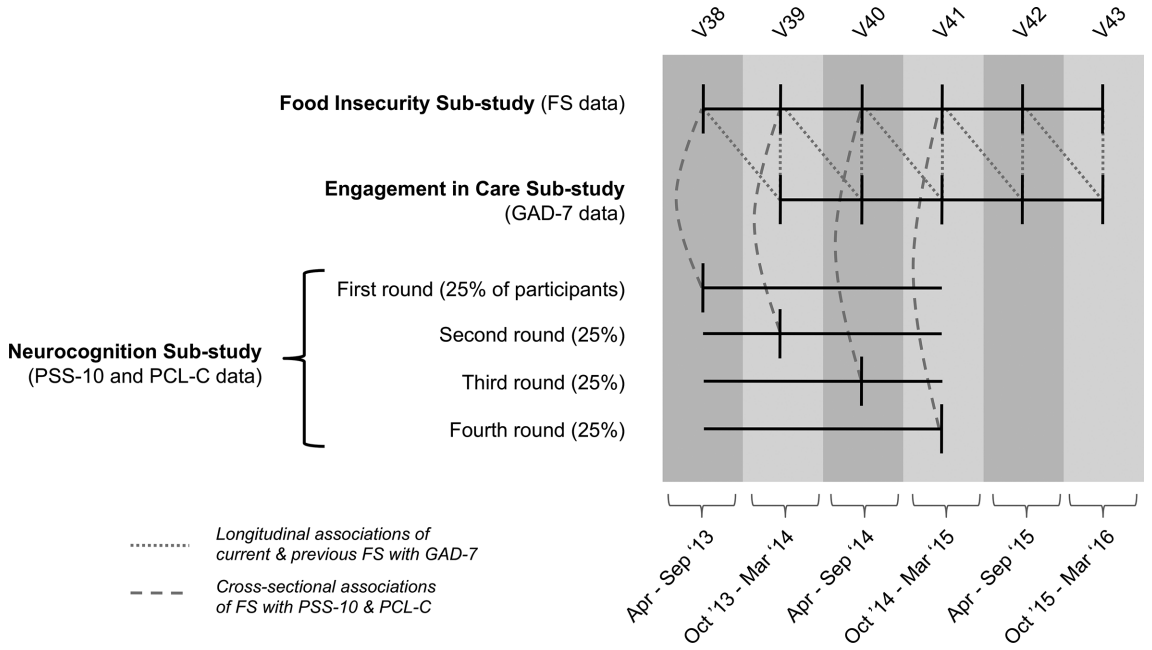

FIGURE 1 Timeline showing sub-studies, visits, data collection, and analytic plan.

previous 6 mo since their last visit. They were classified as having high, marginal, low, or very low FS per guidelines (36). The HFSSM's internal consistency was high in this sample: Cronbach's $\alpha = 0.91$.

During the Food Insecurity Sub-Study period, there were 12,464 person-visits in total in the WIHS, among 2613 unique women. Of these person-visits, 608 were abbreviated visits at which the women only contributed lab specimens, meaning that the HFSSM could not be offered. Further, 164 person-visits were missing data on our primary predictor, leaving 11,692 person-visits among 2553 women during the Food Insecurity Sub-Study period for which we had food security data.

Outcomes

Generalized anxiety was measured using the GAD-7 scale. The GAD-7 was developed and validated in the United States as a brief self-report tool to screen for and categorize severity of GAD in primary care (41). It has since been validated in multiple diverse contexts. Respondents are queried about how often they have experienced symptoms of generalized anxiety over the past 2 wk via 7 survey items. A total score out of 21 is obtained: 5, 10, and 15 points correspond to mild, moderate, and severe GAD, respectively, per standard categorization.

GAD-7 data were longitudinal, collected among all WIHS participants at visits 39–43 (October 2013–March 2016). GAD-7 data were collected as part of the Engagement in Care Sub-Study, which was only offered to women at follow-up visits. Women recruited into the WIHS during visits 39–42 at 1 of the new southern study sites were therefore not offered this measure until their second visit (i.e., visits 40–43). Of the 9439 person-visits (among 2477 unique women) that were WIHS follow-up visits during visits 39–43, 9358 (among 2472 unique women) had available GAD-7 data. Of these, 9274 (among 2470 unique women) also had food security data available. The internal consistency for the GAD-7 in the sample was high: Cronbach's $\alpha = 0.92$.

Perceived stress was measured using the perceived stress scale (PSS-10), a widely used self-report instrument that asks respondents how often they have found the situations in their lives unpredictable, uncontrollable, or overwhelming over the past month. Also developed and validated in the United States (42, 43), the PSS-10 consists of 10 survey items with a total score of 40; higher scores indicate greater perceived stress.

Lastly, we used the PTSD Checklist-Civilian Version (PCL-C) to measure symptoms of PTSD. The PCL-C was adapted from the PCL-Military Version (44) and first validated in the United States (45). It comprises 17 items assessing symptoms of PTSD, asking participants to report how often in the past month they have been bothered by different symptoms relating to "a stressful experience from the past." Responses are tallied to score symptom severity, and the scale can also be used as a screening tool via a standardized algorithm that weighs certain core symptoms more strongly than others.

Data for the PSS-10 and PCL-C were collected as part of the concurrent Neurocognition Sub-Study. The Neurocognition Sub-Study collected data such that 25% of women at participating study sites completed the relevant measures at each visit, aiming for completion among 100% of women, once each, over 4 visits (2 y) collectively. Each 4-visit wave therefore amounts to 1 time point for these data. The 4-visit wave analyzed in this study encompasses visits 38–41 (April 2013–March 2015), creating a cross-sectional sample for PSS-10 and PCL-C data collected over 2 y (Figure 1). For this reason, our analyses involving PSS-10 and PCL-C outcomes are cross-sectional.

The Neurocognition Sub-Study was not extended to the new southern study sites until visit 42. Those women recruited into the WIHS as part of the southern recruitment wave occurring during visits 39–42 were therefore excluded from this part of the analysis. Of the 1346 women who were administered the Neurocognition Sub-Study measures during visits 38–41 at non-southern sites, 1324 and 1323 had PSS-10 and PCL-C data available, respectively. Of these, 1303 and 1301 unique women also had FS data available, respectively, with Cronbach's $\alpha = 0.88$ for the PSS-10 and $=0.94$ for the PCL-C, indicating high internal consistency for both.

Covariates

We selected as covariates multiple sociodemographic and health-related factors that may confound the relation between food insecurity and poor mental health, based on previous literature (46). We conducted extensive preliminary analyses of the socioeconomic measures available in the WIHS dataset to select those that most fully capture socioeconomic status. Sociodemographic factors were age at visit, race/ethnicity (non-Hispanic white, Hispanic, African American/black, or other), annual income ($\leq$\$12,000, \$12,001–24,000, or $\geq$\$24,001), education (less than high school education compared with at least high school education), and having child dependents (yes or no). Health-related factors were HIV serostatus (HIV-seropositive or seronegative), baseline physical health status [measured using the validated MOS-HIV physical health summary score (47) at first visit in the WIHS; higher scores indicate better physical health], having health insurance (yes or no), heavy drinking ($\geq$7 compared with <7 alcoholic drinks/wk), and illicit

substance use (use of any illicit substances not including cannabis since the last visit compared with none).

Ethics statement

All participants provided written informed consent for participation in the WIHS and received compensation for their participation at each visit. The institutional review board of each study site's institution and the WIHS Executive Committee approved this study.

Statistical analysis

We obtained baseline summary characteristics for the primary predictor, outcome variables, and covariates with use of data from the first visit per WIHS participant for the Food Insecurity Sub-Study period (i.e., visit 38 for most of the sample, and the next available visit for those not present at visit 38). The only exception was the physical health summary score, which was taken from the first WIHS visit per participant to capture a historical physical health assessment and to reduce likelihood of highly correlated terms in the model given that mental health and physical health share many dimensions (48).

To examine longitudinal associations between food insecurity and GAD, we ran repeated-measures, longitudinal, bivariate and adjusted linear and logistic regressions with individuals as random effects (i.e., random intercepts) and time-varying and time-invariant predictors and covariates as fixed effects. We examined both current FS (as measured at the current visit) and previous FS (as measured at the previous visit, 6 mo earlier) simultaneously in the same models to explore the temporal relations between FS and GAD (Figure 1). Outcomes were GAD-7 score and a binary screener for GAD using a GAD-7 score ≥10 (i.e., moderate-to-severe GAD) as positive. We performed a complete-case analysis. In the concurrent GAD-7 models, covariates were missing from 272 person-visits (2.9% of total person-visits), mostly because of missing annual household income data. These person-visits were therefore excluded from multivariable analyses. We additionally calculated the association of persistent food insecurity (i.e., current and previous food insecurity combined, encompassing 1 y of FS status) with GAD, by summing the adjusted β-coefficients from each GAD model for current and previous FS status.

To examine cross-sectional associations of FS with perceived stress and PTSD, we ran bivariate and adjusted linear and logistic regressions. Outcomes were PSS-10 score, PCL-C score, and a binary screener for PTSD using the standardized PCL-C screening algorithm. Covariates were missing from 59 women in both analyses, mostly because of missing annual household income data. All analyses were completed using Stata 14 (StataCorp LP).

Results

The total sample comprised 2553 participants with a median age of 47 y, mostly self-identifying as African American/black (71.6%) (Table 1). Over two-thirds of participants (70.6%) were HIV-seropositive. Two-thirds (67.4%) had at least a high school education, and just over half (51.9%) had an income <$12,000/y. At baseline, 13.0% and 15.2% reported using illicit substances and heavy drinking, respectively. Prevalence of food insecurity in the sample was high: 44.4% of participants reported some form of food insecurity (i.e., marginal, low, or very low FS) at baseline.

Generalized anxiety

At baseline, 20.2% screened positive for moderate-to-severe GAD (Table 1). Average number of visits for women completing the GAD-7 was 4.1 (of a possible 5). In bivariate analyses, marginal, low, and very low FS were significantly associated with increasing severity of concurrent generalized anxiety and increasingly higher odds of screening positive for moderate-to-severe GAD (Table 2). In adjusted analyses, these associations

TABLE 1 Background demographic characteristics of women with or at risk of HIV in the WIHS ($n = 2553$)[1]

Variable	Value
Age	47.0 ± 9.3
Race/ethnicity	
White	255 (10.0)
Hispanic	377 (14.8)
African American/black	1829 (71.6)
Other	92 (3.6)
Income	
≤$12,000	1262 (51.9)
$12,001–$24,000	541 (22.2)
≥$24,001	629 (25.9)
Education	
<High school	832 (32.6)
≥High school	1719 (67.4)
HIV serostatus	
Seronegative	750 (29.4)
Seropositive	1803 (70.6)
Food security categories[2]	
High	1419 (55.6)
Marginal	405 (15.9)
Low	372 (14.6)
Very low	357 (14.0)
Insurance status	
Uninsured	318 (12.5)
Insured	2235 (87.5)
Illicit substance use since last visit[3]	
No	2221 (87.0)
Yes	331 (13.0)
Heavy drinking[4]	
No	2161 (84.8)
Yes	388 (15.2)
Child dependents in household	
No	1567 (61.4)
Yes	986 (38.6)
WIHS baseline physical health score[5]	71.3 ± 21.1
GAD-7 score	5.1 ± 6.1
GAD-7 categories[6]	
None	104 (63.8)
Mild	26 (16.0)
Moderate	17 (10.4)
Severe	16 (9.8)
PSS-10 score	23.4 ± 8.0
PCL-C score	31.6 ± 14.1
Screen positive for PTSD	
No	323 (87.5)
Yes	46 (12.5)

[1]At first visit in the Food Insecurity Sub-Study period (V38–V43) unless stated otherwise. Values are frequencies (percentages) or means ± SDs. GAD-7, Generalized Anxiety Disorder-7 scale; HFSSM, Household Food Security Survey Module; MOS-HIV, Medical Outcomes Study HIV Health Survey; PCL-C, Posttraumatic Stress Disorder Checklist-Civilian Version; PSS-10, Perceived Stress Scale 10; PTSD, posttraumatic stress disorder; WIHS, Women's Interagency HIV Study.

[2]Food security categories derived from standard HFSSM coding algorithm; see reference (36).

[3]Participants were asked if they used cocaine, crack, heroin, methamphetamine, hallucinogens, club drugs, or any other illicit or recreational drugs not including cannabis since the last visit.

[4]Heavy drinking defined as ≥7 drinks/wk (1 drink defined as 1 can, bottle, or glass of beer; 1 glass of wine; 1 shot of liquor on its own or in a mixed drink; or any other kind of alcoholic beverage).

[5]MOS-HIV physical health summary score at first visit in the WIHS; higher scores indicate better physical health.

[6]None = GAD-7 score of 0–4; mild = 5–9; moderate = 10–14; severe = ≥15 (maximum = 21).

TABLE 2 Longitudinal bivariate and adjusted associations of food security status with GAD outcomes among women with or at risk of HIV in the WIHS[1]

	GAD-7 score		GAD-7 screener for moderate-to-severe GAD[2]	
	Bivariate[3]	Adjusted[3]	Bivariate[4]	Adjusted[4]
Current food security[5] (reference = high)				
Marginal	1.04*** ± 0.15	0.84*** ± 0.15	1.59*** (1.26, 2.01)	1.41** (1.10, 1.80)
Low	1.75*** ± 0.16	1.33*** ± 0.16	2.79*** (2.22, 3.52)	2.03*** (1.59, 2.61)
Very low	2.98*** ± 0.19	2.24*** ± 0.20	5.35*** (4.11, 6.97)	3.23*** (2.43, 4.29)
Previous food security[5] (reference = high)				
Marginal	0.32* ± 0.15	0.07 ± 0.15	1.22 (0.96, 1.55)	0.95 (0.74, 1.22)
Low	1.15*** ± 0.16	0.62*** ± 0.16	2.12*** (1.67, 2.69)	1.37* (1.07, 1.75)
Very low	1.72*** ± 0.19	0.80*** ± 0.19	3.00*** (2.30, 3.91)	1.46** (1.11, 1.93)
HIV serostatus (reference = seronegative)	−0.50* ± 0.21	0.41* ± 0.19	0.81 (0.62, 1.05)	0.79 (0.61, 1.02)
Age at visit	−0.0066 ± 0.010	0.03** ± 0.01	1.00 (0.99, 1.01)	0.99* (0.97, 1.00)
Race/ethnicity (reference = non-Hispanic white)				
Hispanic	−1.13** ± 0.39	0.95* ± 0.37	0.66 (0.40, 1.07)	0.73 (0.45, 1.17)
African American/black	−1.44*** ± 0.32	1.39*** ± 0.31	0.54** (0.36, 0.82)	0.57** (0.38, 0.85)
Other	−0.51 ± 0.58	0.70 ± 0.54	0.93 (0.45, 1.92)	0.95 (0.48, 1.88)
Annual household income (reference = <$12,000)				
$12,001–$24,000	−0.47** ± 0.14	0.27 ± 0.14	0.59*** (0.47, 0.74)	0.69** (0.55, 0.87)
>$24,001	−1.24*** ± 0.17	0.69*** ± 0.16	0.28*** (0.21, 0.36)	0.45*** (0.34, 0.60)
High school or greater education (reference = less than high school)	−0.89*** ± 0.20	0.57** ± 0.19	0.51*** (0.39, 0.66)	0.65*** (0.51, 0.83)
Insurance status (reference = uninsured)	−0.79*** ± 0.22	0.25 ± 0.23	0.62** (0.44, 0.88)	0.94 (0.66, 1.34)
Illicit substance use since last visit[6] (reference = none)	1.53*** ± 0.21	0.83*** ± 0.21	2.34*** (1.75, 3.13)	1.37* (1.01, 1.84)
Heavy drinking[7] (reference = 'No')	1.09*** ± 0.16	0.90*** ± 0.17	1.79*** (1.40, 2.29)	1.58*** (1.23, 2.03)
Child dependents in household (reference = none)	−0.094 ± 0.14	0.16 ± 0.14	0.78* (0.63, 0.97)	0.77* (0.61, 0.96)
WIHS baseline physical health score[8]	−1.95*** ± 0.10	1.61*** ± 0.10	0.35*** (0.30, 0.40)	0.44*** (0.38, 0.51)
Person-visits (*n*)		8550		8550
Unique women (*n*)		2343		2343

[1] GAD, generalized anxiety disorder; GAD-7, Generalized Anxiety Disorder-7 scale; HFSSM, Household Food Security Survey Module; MOS-HIV, Medical Outcomes Study HIV Health Survey; WIHS, Women's Interagency HIV Study.
[2] Moderate-to-severe GAD = GAD-7 score ≥10.
[3] Values are $\beta \pm$ SE.
[4] Values are OR (95% CI).
[5] Food security categories derived from standard HFSSM coding algorithm; see reference (36).
[6] Participants were asked if they used cocaine, crack, heroin, methamphetamine, hallucinogens, club drugs, or any other illicit or recreational drugs not including cannabis since the last visit.
[7] Heavy drinking defined as ≥7 drinks/wk (1 drink defined as 1 can, bottle, or glass of beer; 1 glass of wine; 1 shot of liquor on its own or in a mixed drink; or any other kind of alcoholic beverage).
[8] MOS-HIV physical health summary score at first visit in the WIHS; higher scores indicate better physical health.
*** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$.

remained significant in a dose-response relation. Compared to high FS, marginal, low, and very low FS were associated with increasingly higher GAD-7 scores: $\beta = 0.84$ (SE = 0.15; $P < 0.001$), $\beta = 1.33$ (SE = 0.16; $P < 0.001$), and $\beta = 2.24$ (SE = 0.20; $P < 0.001$), respectively, indicating more severe generalized anxiety. Marginal, low, and very low FS were also associated with 1.41 (95% CI: 1.10, 1.80; $P < 0.01$), 2.03 (95% CI: 1.59, 2.61; $P < 0.001$), and 3.23 (95% CI: 2.43, 4.29; $P < 0.001$) times higher odds of screening positive for moderate-to-severe GAD, respectively.

Previous FS similarly had independent associations with GAD-7 scores. Low and very low FS at the previous visit were associated with increasingly higher current GAD-7 scores: $\beta = 0.62$ (SE = 0.16; $P < 0.001$) and $\beta = 0.80$ (SE = 0.18; $P < 0.001$), respectively, again indicating more severe current generalized anxiety. Low and very low FS at the previous visit were associated with 1.37 (95% CI: 1.07, 1.75; $P < 0.05$) and 1.46 (95% CI: 1.11, 1.93; $P < 0.05$) times higher odds of screening positive for current moderate-to-severe GAD, respectively. HIV serostatus was not significantly associated with GAD outcomes in bivariate or adjusted analyses.

Finally, combining previous and current FS from the above model (in Table 2) showed that, holding all other variables constant, women with persistent very low FS had higher GAD-7 scores ($\beta = 3.04$; SE = 0.26; $P < 0.001$) and 4.72 (95% CI: 3.34, 6.66; $P < 0.001$) times higher odds of screening positive for moderate-to-severe GAD than women with high FS at both visits (**Table 3**).

Perceived stress

In bivariate analyses, marginal, low, and very low FS were significantly associated with perceived stress in a dose-response relation (**Table 4**). In adjusted analyses, marginal, low, and very low FS were associated with increasingly higher PSS-10 scores compared to high FS: $\beta = 2.42$ (SE = 0.63; $P < 0.001$), $\beta = 4.55$ (SE = 0.69; $P < 0.001$), and $\beta = 5.21$ (SE = 0.78; $P < 0.001$), respectively. Again, HIV serostatus was not significantly associated with PSS-10 score in bivariate or adjusted analyses.

TABLE 3 Associations of persistent food security over the previous year with GAD outcomes among women with or at risk of HIV in the WIHS[1]

	GAD-7 score[2]	GAD-7 screener for moderate-to-severe GAD[3]
Current + previous food security[4] (reference = high)		
Marginal	0.91*** ± 0.22	1.33 (0.95, 1.89)
Low	1.95*** ± 0.23	2.79*** (2.00, 3.89)
Very low	3.04*** ± 0.26	4.72*** (3.34, 6.66)

[1]Results are the linear combinations of the β-coefficients for current and past food security within each level (i.e., marginal, low, and very low) from Table 2. Estimates, standard errors, and *P* values were obtained through postestimation commands for linear combinations in Stata. GAD, generalized anxiety disorder; GAD-7, Generalized Anxiety Disorder-7 scale; HFSSM, Household Food Security Survey Module; WIHS, Women's Interagency HIV Study.
[2]Values are $\beta \pm$ SE.
[3]Values are adjusted OR (95% CI). Moderate-to-severe GAD = GAD-7 score ≥10.
[4]Food security categories derived from standard HFSSM coding algorithm; see reference (36).
*** $P < 0.001$.

Posttraumatic stress

At baseline, 12.5% of participants screened positive for PTSD (Table 1). In bivariate analyses, low and very low FS were significantly associated with both increasing severity of concurrent PTSD symptoms and increasingly higher odds of screening positive for PTSD (Table 4). In adjusted analyses, low and very low FS were associated with increasingly higher PCL-C scores compared to high FS: $\beta = 4.70$ (SE = 1.18; $P < 0.01$) and $\beta = 6.46$ (SE = 1.31; $P < 0.001$), respectively, indicating more severe PTSD symptoms. Very low FS was associated with 1.93 (95% CI: 1.15, 3.24; $P < 0.05$) times higher odds of screening positive for PTSD. As with the other outcomes, HIV serostatus was not significantly associated with PTSD outcomes in bivariate or adjusted analyses.

Discussion

In this study of women with and at risk of HIV in the United States, increasing severity of food insecurity was associated with higher GAD-7, PSS-10, and PCL-C scores in a consistent dose-response relation, and with higher odds of screening positive for GAD and PTSD. Collectively, the findings expand the evidence base for associations between food insecurity and poor mental health outcomes.

Food insecurity is well established to cause higher stress levels in quantitative studies (17, 49–51). Our findings corroborate this research, and also support and extend the few quantitative studies that have specifically examined associations of food insecurity with anxiety and/or posttraumatic stress. Most of these previous studies took place in sub-Saharan African countries, where food insecurity was associated with high anxiety (12, 52, 53), posttraumatic stress or PTSD (52, 54), or any anxiety disorder or PTSD (55). To our knowledge, only 2 relevant studies using validated scales of psychiatric symptoms have been conducted in resource-rich settings, both in the United States. One demonstrated a cross-sectional association between food insecurity and GAD among mothers of 3-y-old children (56). Another showed that food insecurity was longitudinally associated with PTSD acquisition among women at risk of HIV (57). This latter study, however, used only a single-question assessment of food insecurity.

Our study extends this research in 4 ways. First, to our knowledge this is the first longitudinal study to associate food insecurity with GAD, and therefore also the first to demonstrate a lagged association between the 2. Second, we measured food insecurity using the validated HFSSM, which strengthens the evidence from the single previous study of food insecurity and PTSD. Third, we performed a fully disaggregated examination of the associations between food insecurity and these 2 psychiatric outcomes, classifying participants as having marginal, low, or very low FS. This allowed us to demonstrate dose-response relations, a key criterion for inferring causality. Lastly, we demonstrated these associations in a sample of women who were mostly HIV-seropositive, which has important considerations for the HIV epidemic (1, 33).

Contextualizing food insecurity and mental health

Relations between food insecurity and mental health outcomes must be understood in the complex context in which they are embedded. Food insecurity is both a harmful experience in its own right—with its own unique downstream effects and consequences—and a marker of sociopolitical, economic, and personal historical adversity. For example, adverse childhood experiences predict a range of social and health issues in adulthood [what has been termed "toxic stress" (58)], including adult and household food insecurity (59, 60) and poor mental health (61). Child hunger may therefore be linked to later adult food insecurity and mental health issues, propagating intergenerational cycles of adversity and food insecurity (24). Intimate partner violence (IPV) also heightens the risk of food insecurity among women (62) [who may then become more dependent and vulnerable to IPV (7–9)], while also driving stress, anxiety, and PTSD (63).

Furthermore, the unique sociopolitical and economic context of the United States is closely related to food insecurity. Inadequacy of the social safety net (64); economic policies driving disparities in access to jobs, housing, and other basic resources (3); and structural and institutional racism (65) all give rise to food insecurity among vulnerable populations in the United States. Many of these social-structural factors also contribute to mental health issues, and particularly predispose to the symptoms of anxiety, stress, and PTSD measured in this study (66, 67). Low-income women of color, who make up most of the WIHS cohort, are particularly vulnerable: both food security and mental health among such populations may be worsened by intersectional processes of discrimination attached to race, gender, and socioeconomic status identities (65), additionally aggravated by HIV stigma where present (68).

At the same time, food insecurity exerts negative effects on mental health over and above other correlates of poverty and disparity. Food insecurity consistently predicts poor mental health outcomes after adjusting for markers of socioeconomic status (11, 18, 69). Qualitative data also highlight how the particular experience of food insecurity fuels feelings of sadness, guilt, shame, powerlessness, and anxiety in societies such as the United States, where wealth and self-sufficiency are widespread and culturally celebrated (22–24, 70). The unique stresses and strains of food insecurity may also have distinctive physiological sequelae through a combined process of allostasis (cumulative physiological "wear and tear") (71) and malnutrition from low intake of vegetables, fruit, and dairy products (72), which may then predispose to particular patterns of psychological harm.

TABLE 4 Cross-sectional bivariate and adjusted associations of food security status with perceived stress and PTSD outcomes among women with or at risk of HIV in the WIHS[1]

	PSS-10 score		PCL-C score		PCL-C screener for PTSD[2]	
	Bivariate[3]	Adjusted[3]	Bivariate[3]	Adjusted[3]	Bivariate[4]	Adjusted[4]
Current food security[5] (reference = high)						
Marginal	3.18*** ± 0.63	2.42*** ± 0.63	2.66* ± 1.12	1.28 ± 1.07	0.88 (0.51, 1.52)	0.71 (0.40, 1.27)
Low	5.63*** ± 0.68	4.55*** ± 0.69	7.30*** ± 1.21	4.70*** ± 1.18	2.01** (1.26, 3.18)	1.35 (0.81, 2.25)
Very low	7.02*** ± 0.76	5.21*** ± 0.78	10.34*** ± 1.35	6.46*** ± 1.31	3.17*** (2.00, 5.04)	1.93* (1.15, 3.24)
HIV serostatus (reference = seronegative)	0.02 ± 0.49	−0.37 ± 0.48	−0.77 ± 0.85	−1.46 ± 0.81	0.90 (0.63, 1.27)	0.87 (0.59, 1.30)
Age at visit	−0.00 ± 0.03	−0.05 ± 0.03	0.05 ± 0.04	−0.07 ± 0.04	0.99 (0.98, 1.01)	0.97* (0.95, 0.99)
Race/ethnicity (reference = non-Hispanic white)						
Hispanic	−0.43 ± 0.90	−0.64 ± 0.87	1.14 ± 1.56	−0.20 ± 1.48	0.82 (0.45, 1.50)	0.64 (0.33, 1.26)
African American/black	−0.58 ± 0.76	−0.97 ± 0.74	−0.77 ± 1.31	−2.16 ± 1.25	0.69 (0.42, 1.14)	0.56* (0.31, 0.98)
Other	1.67 ± 1.29	0.32 ± 1.21	3.14 ± 2.25	0.56 ± 2.05	0.98 (0.42, 2.28)	0.67 (0.26, 1.70)
Annual household income (reference = <$12,000)						
$12,001–$24,000	−1.31∗ ± 0.60	−0.54 ± 0.57	−1.96 ± 1.04	−0.35 ± 0.97	1.01 (0.68, 1.51)	1.21 (0.79, 1.87)
>$24,001	−4.08*** ± 0.53	−1.85*** ± 0.54	−8.06*** ± 0.91	−3.86*** ± 0.92	0.33*** (0.21, 0.53)	0.51* (0.30, 0.87)
High school or greater education (reference = less than high school)	−1.99*** ± 0.49	−1.39** ± 0.48	−4.91*** ± 0.84	−3.63*** ± 0.82	0.53*** (0.38, 0.73)	0.58** (0.40, 0.85)
Insurance status (reference = uninsured)	−0.89 ± 1.07	0.22 ± 1.03	−1.39 ± 1.86	0.45 ± 1.75	0.59 (0.31, 1.13)	0.72 (0.34, 1.49)
Illicit substance use since last visit[6] (reference = none)	5.08*** ± 0.77	3.67*** ± 0.77	10.24*** ± 1.33	7.85*** ± 1.31	2.95*** (1.90, 4.57)	2.40*** (1.44, 4.00)
Heavy drinking[7] (reference = 'No')	0.32 ± 0.66	−0.30 ± 0.63	1.39 ± 1.14	0.36 ± 1.08	1.25 (0.80, 1.95)	1.14 (0.69, 1.88)
Child dependents in household (reference = none)	−1.16* ± 0.48	−1.06* ± 0.49	−1.16* ± 0.48	−2.59** ± 0.84	0.70 (0.49, 1.01)	0.65* (0.43, 0.99)
WIHS baseline physical health score[8]	−2.60 ± 0.26	−1.84*** ± 0.26	−5.62 ± 0.43	−4.45*** ± 0.44	0.50 (0.42, 0.60)	0.54*** (0.45, 0.67)
Unique women (*n*)		1232		1228		1228

[1]HFSSM, Household Food Security Survey Module; MOS-HIV, Medical Outcomes Study HIV Health Survey; PCL-C, Posttraumatic Stress Disorder Checklist-Civilian Version; PSS-10, Perceived Stress Scale 10; PTSD, posttraumatic stress disorder; WIHS, Women's Interagency HIV Study.
[2]Calculated using standardized PCL-C algorithm.
[3]Values are $\beta \pm$ SE.
[4]Values are OR (95% CI).
[5]Food security categories derived from standard HFSSM coding algorithm; see reference (36).
[6]Participants were asked if they used cocaine, crack, heroin, methamphetamine, hallucinogens, club drugs, or any other illicit or recreational drugs not including cannabis since the last visit.
[7]Heavy drinking defined as ≥7 drinks/wk (1 drink defined as 1 can, bottle, or glass of beer; 1 glass of wine; 1 shot of liquor on its own or in a mixed drink; or any other kind of alcoholic beverage).
[8]MOS-HIV physical health summary score at first visit in the WIHS; higher scores indicate better physical health.
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Mechanisms and implications

Although our results support the hypothesis that food insecurity may predict symptoms of GAD, stress, and PTSD, the nature of the data means that interpretation within the above context must be carefully considered. For the longitudinal GAD data, although we cannot demonstrate causality in an observational study, both the lagged associations and the dose-response relations support that food insecurity may plausibly contribute independently to clinically significant levels of generalized anxiety in this population. This proposition corroborates qualitative studies (21–24) and a previous study in the United States that used a validated measure of GAD symptoms (56). Given that women with HIV are already vulnerable to both food insecurity and clinically significant anxiety, this longitudinal association is an important finding. That women with persistently severe food insecurity (very low FS) were nearly 5 times more likely to screen positive for moderate-to-severe GAD than persistently food-secure women, also highlights the particularly pernicious effects of long-term food insecurity. This is consistent with associations between persistent food insecurity and depressive symptoms in the same population (69).

For the perceived stress and PTSD data, the cross-sectional nature of the data means that directionality cannot be assessed. Furthermore, numerous studies among vulnerable women in the United States indicate that food insecurity, violence, and trauma are so closely related that many who experience them perceive them as almost inseparable (24). At the more severe end of food insecurity, hunger and energy deprivation can have profound effects on emotion, cognition, and behavior (73), and also seem to be intimately linked to the recollection of violence and trauma (22, 24). This connection may be even stronger when violence, trauma, and hunger were co-experienced in early life (24).

When exposure to violence and trauma, as well as poor mental health, are added to this mix of social, cognitive, and emotional experiences produced by food insecurity, multidirectional causation and mutual reinforcement is likely. Traumatic experiences predispose to both food insecurity and PTSD, yet food insecurity may also both heighten the recollection of trauma and have social, psychological, and physiological effects that elevate the risk of developing symptoms of PTSD in response. Downstream physical and sexual violence driven by the vulnerability and lack of basic needs associated with food insecurity may also lead to PTSD. Although there may be disagreement over whether food insecurity in itself would be sufficient to meet criteria for a traumatic event in PTSD clinical guidelines (74), repeated, prolonged exposure to food insecurity has been conceptualized as a traumatic experience (75). The experience of food insecurity is so intimately linked to violence, trauma, and poor mental health outcomes that this possibility must be further explored, and the relations between these different components carefully disentangled and examined.

Collectively, our findings have important implications for addressing both components of the relation between food insecurity and poor mental health. The findings firmly strengthen, for example, calls to address food insecurity through "trauma-informed" policy and interventions (75). Trauma-informed approaches to policy design emphasize developing solutions in close collaboration with affected populations by empowering them and providing them with meaningful choice and a strong voice in steering the development of interventions. Interventions, in turn, need to prioritize physical and emotional safety, trust, and transparency. They should also acknowledge that policies are embedded in a system of historical and intersectional privilege and oppression that have traditionally marginalized vulnerable populations (75)—including, in particular, women of color in the United States (65). Researchers and public policymakers in Baltimore, for example, recently employed these principles to develop recommendations for strengthening the city's food system resilience by working in close collaboration with affected community members, community leaders, staff of food assistance organizations, and other parties on the ground (75), resulting in over 30 recommended strategies to comprehensively address food insecurity (76).

Meanwhile, our findings support calls, on the other side, for "structurally competent" clinical care, in which mental health professionals serving vulnerable populations enquire about food insecurity and its social-structural correlates, and address them where possible as part of the therapeutic package (77, 78). For example, referrals to social services or community groups providing food assistance and support can be made. Preliminary research indicates that providing dignified and medically appropriate food assistance to food-insecure PLHIV may reduce depressive symptoms (79, 80). Interventions such as this, which can be integrated into clinical services, may also impact other components of mental health. Formal evaluation is needed to this end. Frontline health professionals should also be encouraged to engage in and support broader efforts to address the causes of food insecurity in their locality, as well as related forms of deprivation, material need insecurity, chronic adversity, and violence.

Study limitations

The data are limited by the cross-sectional nature of the PSS-10 and PCL-C data, and the absence of data on violence and other traumatic experiences among participants. Another limitation is that there may be some conceptual overlap between the constructs of food insecurity and GAD, meaning that people who experience anxiety may be more likely to report more severe food insecurity. Finally, like most previous research on food insecurity in the United States, most WIHS participants were living in urban settings. It is unclear to what extent these findings are generalizable to different populations in the United States, including men, younger women, and those living in non-urban settings.

Conclusion

This study provides evidence that food insecurity may contribute to clinically significant levels of generalized anxiety, stress, and symptoms of PTSD among women with or at risk of HIV. Together with previous studies that have associated food insecurity with depressive symptoms (17) and suicidality (18–20), the study strengthens the evidence base for the harmful consequences of food insecurity for mental health. Future work should examine the specific paths and mechanisms linking food insecurity and poor mental health, and in particular the roles of violence, trauma, and intersectional experiences of discrimination and stigma among women living with HIV. Researchers and practitioners should consider the role of food insecurity and related social-structural factors in the development and propagation of mental illness among vulnerable individuals, and engage with collaborative, trauma-informed approaches to tackling food insecurity in the 21st century.

Acknowledgments

Data for this manuscript were provided by the Women's Interagency HIV Study (WIHS) as part of an Executive Committee (EC) approved concept sheet. These data cannot be provided to other investigators or used for additional projects without the written consent of the WIHS EC. Data are made available to investigators through a formal concept sheet submission and review process or the WIHS Public Use Data Set. Please visit www.wihshealth.org for more information on how to obtain WIHS data. The authors' responsibilities were as follows—SDW, EAF, HJW, LAS, and KP: designed the research; LAS: performed the statistical analysis; DM, TEW, AA, KMW, AAA, IO, LM, JMT, ELW, and PCT: provided essential materials by representing lead institutions for WIHS Study sites; HJW, LAS, SDW, EAF, and KP: wrote the paper; SDW: had primary responsibility for the final content; and all authors: read and approved the final manuscript.

References

1. Weiser SD, Palar K, Hatcher AM, Young S, Frongillo EA, Laraia B. Food insecurity and health: a conceptual framework. In: Ivers LC , editor. Food insecurity and public health. Boca Raton (FL): CRC Press; 2015. pp. 23–50.
2. Whittle HJ, Palar K, Napoles T, Lemus Hufstedler L, Ching I, Hecht FM, Frongillo EA, Weiser SD. Experiences with food insecurity and risky sex among low-income people living with HIV/AIDS in a resource-rich setting. J Int AIDS Soc 2015;18:20293.
3. Whittle HJ, Palar K, Hufstedler LL, Seligman HK, Frongillo EA, Weiser SD. Food insecurity, chronic illness, and gentrification in the San Francisco Bay Area: an example of structural violence in United States public policy. Soc Sci Med 2015;143:154–61.
4. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A. Household food security in the United States in 2016. Washington (DC): USDA Economic Research Service; 2017.
5. Jung NM, de Bairros FS, Pattussi MP, Pauli S, Neutzling MB. Gender differences in the prevalence of household food insecurity: a systematic review and meta-analysis. Public Health Nutr 2017;20:902–16.
6. Ivers LC, Cullen KA. Food insecurity: special considerations for women. Am J Clin Nutr 2011;94:1744S.
7. Montgomery BE, Rompalo A, Hughes J, Wang J, Haley D, Soto-Torres L, Chege W, Justman J, Kuo I, Golin C, et al. Violence against women in selected areas of the United States. Am J Public Health 2015;105:2156–66.
8. Ricks JL, Cochran SD, Arah OA, Williams JK, Seeman TE. Food insecurity and intimate partner violence against women: results from the California Women's Health Survey. Public Health Nutr 2016;19:914–23.
9. Conroy AA, Cohen MH, Frongillo EA, Tsai AC, Wilson TE, Wentz EL, Adimora AA, Merenstein D, Ofotokun I, Metsch L, et al. Food insecurity and violence in a prospective cohort of women at risk for or living with HIV in the U.S., PLoS One 2019;14 (3):e0213365.
10. Chop E, Duggaraju A, Malley A, Burke V, Caldas S, Yeh PT, Narasimhan M, Amin A, Kennedy CE. Food insecurity, sexual risk behavior, and adherence to antiretroviral therapy among women living with HIV: a systematic review. Health Care Women Int 2017;38:927–44.
11. Palar K, Kushel M, Frongillo EA, Riley ED, Grede N, Bangsberg D, Weiser SD. Food insecurity is longitudinally associated with depressive symptoms among homeless and marginally-housed individuals living with HIV. AIDS Behav 2015;19:1527–34.
12. Hadley C, Patil CL. Seasonal changes in household food insecurity and symptoms of anxiety and depression. Am J Phys Anthropol 2008;135:225–32.
13. Vogenthaler NS, Hadley C, Rodriguez AE, Valverde EE, del Rio C, Metsch LR. Depressive symptoms and food insufficiency among HIV-infected crack users in Atlanta and Miami. AIDS Behav 2011;15:1520–6.
14. Tsai AC, Bangsberg DR, Frongillo EA, Hunt PW, Muzoora C, Martin JN, Weiser SD. Food insecurity, depression and the modifying role of social support among people living with HIV/AIDS in rural Uganda. Soc Sci Med 2012;74:2012–9.
15. Davey-Rothwell MA, Flamm LJ, Kassa HT, Latkin CA. Food insecurity and depressive symptoms: comparison of drug using and nondrug-using women at risk for HIV. J Community Psychol 2014;42:469–78.
16. Leung CW, Epel ES, Willett WC, Rimm EB, Laraia BA. Household food insecurity is positively associated with depression among low-income supplemental nutrition assistance program participants and income-eligible nonparticipants. J Nutr 2015;145:622–7.
17. Bruening M, Dinour LM, Chavez JBR. Food insecurity and emotional health in the USA: a systematic narrative review of longitudinal research. Public Health Nutr 2017;20:3200–8.
18. Alaimo K, Olson CM, Frongillo EA. Family food insufficiency, but not low family income, is positively associated with dysthymia and suicide symptoms in adolescents. J Nutr 2002;132:719–25.
19. Davison KM, Marshall-Fabien GL, Tecson A. Association of moderate and severe food insecurity with suicidal ideation in adults: national survey data from three Canadian provinces. Soc Psychiatry Psychiatr Epidemiol 2015;50:963–72.
20. Pryor L, Lioret S, van der Waerden J, Fombonne E, Falissard B, Melchior M. Food insecurity and mental health problems among a community sample of young adults. Soc Psychiatry Psychiatr Epidemiol 2016;51:1073–81.
21. Hamelin AM, Beaudry M, Habicht JP. Characterization of household food insecurity in Quebec: food and feelings. Soc Sci Med 2002;54:119–32.
22. Chilton M, Booth S. Hunger of the body and hunger of the mind: African American women's perceptions of food insecurity, health and violence. J Nutr Educ Behav 2007;39:116–25.
23. Whittle HJ, Palar K, Seligman HK, Napoles T, Frongillo EA, Weiser SD. How food insecurity contributes to poor HIV health outcomes: qualitative evidence from the San Francisco Bay Area. Soc Sci Med 2016;170:228–36.
24. Chilton M, Knowles M, Bloom SL. The intergenerational circumstances of household food insecurity and adversity. J Hunger Environ Nutr 2017;12:269–97.
25. McLean CP, Asnaani A, Litz BT, Hofmann SG. Gender differences in anxiety disorders: prevalence, course of illness, comorbidity and burden of illness. J Psychiatr Res 2011;45:1027–35.
26. Kilpatrick DG, Resnick HS, Milanak ME, Miller MW, Keyes KM, Friedman MJ. National estimates of exposure to traumatic events and PTSD prevalence using DSM-IV and DSM-5 criteria. J Trauma Stress 2013;26:537–47.
27. Dew MA, Becker JT, Sanchez J, Caldararo R, Lopez OL, Wess J, Dorst SK, Banks G. Prevalence and predictors of depressive, anxiety and substance use disorders in HIV-infected and uninfected men: a longitudinal evaluation. Psychol Med 1997;27:395–409.
28. Sherr L, Nagra N, Kulubya G, Catalan J, Clucas C, Harding R. HIV infection associated post-traumatic stress disorder and post-traumatic growth—a systematic review. Psychol Health Med 2011;16:612–29.
29. Machtinger EL, Wilson TC, Haberer JE, Weiss DS. Psychological trauma and PTSD in HIV-positive women: a meta-analysis. AIDS Behav 2012;16:2091–100.
30. Normen L, Chan K, Braitstein P, Anema A, Bondy G, Montaner JS, Hogg RS. Food insecurity and hunger are prevalent among HIV-positive individuals in British Columbia, Canada. J Nutr 2005;135:820–5.
31. 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;13:841–8.
32. Anema A, Weiser SD, Fernandes KA, Ding E, Brandson EK, Palmer A, Montaner JS, Hogg RS. High prevalence of food insecurity among HIV-infected individuals receiving HAART in a resource-rich setting. AIDS Care 2011;23:221–30.
33. Brief DJ, Bollinger AR, Vielhauer MJ, Berger-Greenstein JA, Morgan EE, Brady SM, Buondonno LM, Keane TM; HIV/AIDS Treatment Adherence, Health Outcomes and Cost Study Group. Understanding the interface of HIV, trauma, post-traumatic stress disorder, and substance use and its implications for health outcomes. AIDS Care 2004;16 (Suppl 1):97.

34. Hessol NA, Weber KM, Holman S, Robison E, Goparaju L, Alden CB, Kono N, Watts DH, Ameli N. Retention and attendance of women enrolled in a large prospective study of HIV-1 in the United States. J Womens Health (Larchmt) 2009;18:1627–37.
35. Adimora AA, Ramirez C, Benning L, Greenblatt RM, Kempf MC, Tien PC, Kassaye SG, Anastos K, Cohen M, Minkoff H, et al. Cohort Profile: The Women's Interagency HIV Study (WIHS). Int J Epidemiol 2018;47:394i.
36. US Department of Agriculture Economic Research Service. US Household Food Security Survey Module: three-stage design, with screeners. Washington (DC): United States Department of Agriculture; 2012.
37. Wehler CA, Scott RI, Anderson JJ. The community childhood hunger identification project: a model of domestic hunger—demonstration project in Seattle, Washington. J Nutr Educ 1992;24:35S.
38. 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;24:44S.
39. Jones AD, Ngure FM, Pelto G, Young SL. What are we assessing when we measure food security? A compendium and review of current metrics. Adv Nutr 2013;4:481–505.
40. Frongillo EA, Jr. Validation of measures of food insecurity and hunger. J Nutr 1999;129:509S.
41. Spitzer RL, Kroenke K, Williams JB, Lowe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med 2006;166:1092–7.
42. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385–96.
43. Cohen S, Williamson G. Perceived stress in a probability sample of the United States. In: Spacapan S, Oskamp S , editors. The Social Psychology of Health: Claremont symposium on applied social psychology. Newbury Park (CA): Sage; 1988.
44. Weathers FW, Litz BT, Herman JA, Keane TM. In: The PTSD checklist (PCL): reliability, validity, and diagnostic utility. 9th Annual Conference of the International Society for Traumatic Stress Studies; San Antonio (TX); 1993.
45. Freedy JR, Steenkamp MM, Magruder KM, Yeager DE, Zoller JS, Hueston WJ, Carek PJ. Post-traumatic stress disorder screening test performance in civilian primary care. Fam Pract 2010;27:615–24.
46. Allen J, Balfour R, Bell R, Marmot M. Social determinants of mental health. Int Rev Psychiatry 2014;26:392–407.
47. Wu AW, Revicki DA, Jacobson D, Malitz FE. Evidence for reliability, validity and usefulness of the Medical Outcomes Study HIV Health Survey (MOS-HIV). Qual Life Res 1997;6:481–93.
48. McHorney CA, Ware JE, Jr, Raczek AE. The MOS 36-Item Short-Form Health Survey (SF-36): II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. Med Care 1993;31:247–63.
49. Garcia J, Hromi-Fiedler A, Mazur RE, Marquis G, Sellen D, Lartey A, Perez-Escamilla R. Persistent household food insecurity, HIV, and maternal stress in peri-urban Ghana. BMC Public Health 2013;13:215.
50. Laraia B, Vinikoor-Imler LC, Siega-Riz AM. Food insecurity during pregnancy leads to stress, disordered eating, and greater postpartum weight among overweight women. Obesity (Silver Spring) 2015;23:1303–11.
51. Hjelm L, Handa S, de Hoop J, Palermo T; Zambia CGP and MCP Evaluation Teams. Poverty and perceived stress: evidence from two unconditional cash transfer programs in Zambia. Soc Sci Med 2017;177:110–7.
52. Hadley C, Tegegn A, Tessema F, Cowan JA, Asefa M, Galea S. Food insecurity, stressful life events and symptoms of anxiety and depression in east Africa: evidence from the Gilgel Gibe growth and development study. J Epidemiol Community Health 2008;62:980–6.
53. Decaro JA, Manyama M, Wilson W. Household-level predictors of maternal mental health and systemic inflammation among infants in Mwanza, Tanzania. Am J Hum Biol 2016;28:461–70.
54. Mugisha J, Muyinda H, Wandiembe P, Kinyanda E. Prevalence and factors associated with posttraumatic stress disorder seven years after the conflict in three districts in northern Uganda (The Wayo-Nero Study). BMC Psychiatry 2015;15:5.
55. van Heyningen T, Honikman S, Myer L, Onah MN, Field S, Tomlinson M. Prevalence and predictors of anxiety disorders amongst low-income pregnant women in urban South Africa: a cross-sectional study. Arch Womens Ment Health 2017;20:765–75.
56. Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. Pediatrics 2006;118:859.
57. Golin CE, Haley DF, Wang J, Hughes JP, Kuo I, Justman J, Adimora AA, Soto-Torres L, O'Leary A, Hodder S. Post-traumatic stress disorder symptoms and mental health over time among low-income women at increased risk of HIV in the U.S. J Health Care Poor Underserved 2016;27:891–910.
58. Shonkoff JP, Garner AS, Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, Section on Developmental and Behavioral Pediatrics. The lifelong effects of early childhood adversity and toxic stress. Pediatrics 2012;129:232.
59. Wehler C, Weinreb LF, Huntington N, Scott R, Hosmer D, Fletcher K, Goldberg R, Gundersen C. Risk and protective factors for adult and child hunger among low-income housed and homeless female-headed families. Am J Public Health 2004;94:109–15.
60. Sun J, Knowles M, Patel F, Frank DA, Heeren TC, Chilton M. Childhood adversity and adult reports of food insecurity among households with children. Am J Prev Med 2016;50:561–72.
61. Hughes K, Bellis MA, Hardcastle KA, Sethi D, Butchart A, Mikton C, Jones L, Dunne MP. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. Lancet Public Health 2017;2:e366.
62. Hernandez DC, Marshall A, Mineo C. Maternal depression mediates the association between intimate partner violence and food insecurity. J Womens Health (Larchmt) 2014;23:29–37.
63. Lagdon S, Armour C, Stringer M. Adult experience of mental health outcomes as a result of intimate partner violence victimisation: a systematic review. Eur J Psychotraumatol 2014;5:10.3402/ejpt.v5.24794. eCollection 2014.
64. Whittle HJ, Palar K, Ranadive NA, Turan JM, Kushel M, Weiser SD. "The land of the sick and the land of the healthy": disability, bureaucracy, and stigma among people living with poverty and chronic illness in the United States. Soc Sci Med 2017;190:181–9.
65. Odoms-Young A, Bruce MA. Examining the impact of structural racism on food insecurity: implications for addressing racial/ethnic disparities. Fam Community Health 2018;41 (Suppl 2. Suppl, Food Insecurity and Obesity):S3–S6.
66. Hansen H, Bourgois P, Drucker E. Pathologizing poverty: new forms of diagnosis, disability, and structural stigma under welfare reform. Soc Sci Med 2014;103:76–83.
67. Knight KR. addicted.pregnant.poor. Durham (NC): Duke University Press; 2015.
68. Turan B, Hatcher AM, Weiser SD, Johnson MO, Rice WS, Turan JM. Framing mechanisms linking HIV-related stigma, adherence to treatment, and health outcomes. Am J Public Health 2017;107:863–9.
69. Tuthill EL, Sheira LA, Palar K, Frongillo EA, Wilson TE, Adedimeji A, Merenstein D, Cohen MH, Wentz EL, Adimora AA, et al. Persistent food insecurity is associated with adverse mental health among women living with or at risk of HIV in the United States. J Nutr 2019;149(2):240–8.
70. Hamelin AM, Beaudry M, Habicht JP. Characterization of household food insecurity in Quebec: food and feelings. Soc Sci Med 2002;54:119–32.
71. McEwen BS. Allostasis and allostatic load: implications for neuropsychopharmacology. Neuropsychopharmacology 2000;22:108.
72. Hanson KL, Connor LM. Food insecurity and dietary quality in US adults and children: a systematic review. Am J Clin Nutr 2014;100:684–92.
73. Kalm LM, Semba RD. They starved so that others be better fed: remembering Ancel Keys and the Minnesota experiment. J Nutr 2005;135:1347–52.
74. World Health Organization. The ICD-10 Classification of Mental and Behavioural Disorders: clinical descriptions and diagnostic guidelines. Geneva: World Health Organization; 1992.
75. Hecht AA, Biehl E, Buzogany S, Neff RA. Using a trauma-informed policy approach to create a resilient urban food system. Public Health Nutr 2018;21:1961–70.
76. Biehl E, Buzogany S, Huang A, Chodur G, Neff R. Baltimore Food System Resilience Advisory Report; Baltimore (MD): Baltimore Office of Sustainability & Johns Hopkins Center for a Livable Future; 2017.

77. Metzl JM, Hansen H. Structural competency: theorizing a new medical engagement with stigma and inequality. Soc Sci Med 2014;103: 126–33.
78. Bourgois P, Holmes SM, Sue K, Quesada J. Structural vulnerability: operationalizing the concept to address health disparities in clinical care. Acad Med 2017;92:299–307.
79. Palar K, Napoles T, Hufstedler LL, Seligman H, Hecht FM, Madsen K, Ryle M, Pitchford S, Frongillo EA, Weiser SD. Comprehensive and medically appropriate food support is associated with improved HIV and diabetes health. J Urban Health 2017;94: 87–99.
80. Palar K, Frongillo EA, Riley ED, Ryle M, Madsen K, O'Donnell A, Napoles TM, Sheira LA, Phillips B, Weiser SD. Health impacts of medically-appropriate food support in the San Francisco Bay Area: results of the Changing Health through Food Support (CHEFS) randomized trial. 13th International Conference on HIV Treatment and Prevention Adherence; June 8–10, 2018; Miami (FL): International Association of Providers of AIDS Care (IAPAC); 2018.