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Authors

Kim-Mozeleski, Jin E

Tsoh, Janice Y

Ramirez-Forcier, Joseph

et al.

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Smoking Predicts Food Insecurity Severity among Persons Living with HIV

Jin E. Kim-Mozeleski[1], Janice Y. Tsoh[2], Joseph Ramirez-Forcier[3], Brett Andrews[3], Sheri D. Weiser[4], & Adam W. Carrico*[5]

[1] Department of Health Promotion and Policy, University of Massachusetts Amherst, Amherst, MA, USA

[2] Department of Psychiatry, University of California, San Francisco, San Francisco, CA, USA

[3] Positive Resource Center, San Francisco, CA, USA

[4] Division of HIV, ID and Global Medicine, University of California, San Francisco, San Francisco, CA, USA

[5] Department of Public Health Sciences, University of Miami, Miami, FL, USA

* Corresponding author: Adam W. Carrico, PhD. Department of Public Health Sciences, Division of Prevention Science and Community Health, University of Miami. 1120 NW 14th St. Miami, FL 33136. Tel: +1-305-243-6947. Email: a.carrico@miami.edu

Abstract

Food insecurity is a key social and health issue among persons living with HIV (PLHIV). Food insecurity oftentimes co-occurs with substance use, but little is known about the relationship between tobacco use and food insecurity particularly among PLHIV. In this study, we prospectively examined the association of cigarette smoking with food insecurity in a cohort of 108 individuals seeking vocational rehabilitation services. Over the 12-month study period, smokers at baseline reported consistently higher levels of food insecurity compared to non-smokers. Smoking remained an independent risk factor for greater food insecurity, controlling for sociodemographic characteristics and known confounders (e.g., substance use, depression). Food insecurity is a key structural and socioeconomic barrier that may partially explain HIV-related health disparities observed among smokers. Further research is needed to characterize the bio-behavioral mechanisms linking smoking and food insecurity as well as test whether smoking cessation can reduce food insecurity in PLHIV who smoke.

Keywords: HIV, food insecurity, smoking, substance use

INTRODUCTION

Food insecurity is a key social and health issue among persons living with HIV (PLHIV) worldwide, as an independent risk factor for HIV morbidity [1] and mortality [2]. As HIV is becoming increasingly concentrated among socioeconomically disadvantaged segments of the population, approximately one in two PLHIV in resource-rich settings reported experiencing food insecurity [3,4]. Through pathways involving nutrition (e.g., macro- and micronutrient deficiencies), mental health (e.g., depression, anxiety, substance use), and health behaviors (e.g., medication non-adherence, risky sex), food insecurity is bi-directionally linked with HIV disease progression [5]. Given the well-documented detrimental effects of food insecurity on the health sequelae of PLHIV, there is a need to examine further possible risk factors for food insecurity in order to inform the development of comprehensive interventions to address this structural and social determinant of health.

Factors influencing food insecurity occur on multiple levels, with key structural and social factors including poverty, issues of access, and housing instability [5–8]. Interacting with these structural and social factors, substance use oftentimes co-occurs with the experience of food insecurity [9–12]. For example, in a study of 250 PLHIV who were experiencing homelessness and unstable housing, recent crack cocaine use was independently associated with two-fold greater odds of food insecurity [13]. The intersection of food insecurity and substance use is an important area for further research, as the two are likely to be bi-directionally associated. Substance use places competing demands on limited resources which could thereby exacerbate food insecurity [14,15], yet the experience of food insecurity has also been found to be associated with increased prevalence of substance use [12]. In a study of 503 PLHIV using substances, those experiencing food and housing insecurity were more likely to engage in poor

coping strategies, such as diversion of their medications, in part to manage the immediate stressors of daily living in impoverished conditions [10].

Extant literature on food insecurity and substance use among PLHIV has largely focused on illicit substances, such as use of injection drugs, heroin, and crack cocaine. The role of tobacco has received less attention with regards to associations with food insecurity in the HIV literature, but an independent association has been reported in the general population [16]. Tobacco use is known to be disproportionately high among PLHIV [17,18], such that advancements in anti-retroviral therapy have unfortunately been met with smoking as a significant contributor to early mortality [19] and non-AIDS-defining cancer mortality [20]. In a study of over 14,000 PLHIV in New York City, smokers were more likely to have unsuppressed viral load and low CD4 cell counts (<200 cells/mm) compared to non-smokers [21].

There is a small but growing body of literature on food insecurity and tobacco use among PLHIV. For example, a study of 183 PLHIV who were of Hispanic ethnicity reported that smoking prevalence was significantly higher among those with food insecurity (63%) versus without food insecurity (32%) [22]. In another study, 671 participants with HIV were provided with $30 grocery gift cards as study participation incentives, and 74% (n = 498) returned receipts that reflected how the gift cards were spent. Those who experienced any food insecurity (compared to those without food insecurity) were more likely to spend the gift cards towards the purchase of tobacco products [14]. The findings suggested that the addictive nature of tobacco presented a competing survival demand amidst the struggle of living with limited resources [14]. Given these trends, better understanding how tobacco use contributes to experiences of food insecurity is needed to inform the development of interventions and policies that aim to address the disproportionate burden of smoking, food insecurity, and their related health problems.

The current study examined predictors of food insecurity severity over a 12-month study period in a cohort of PLHIV who were engaged in vocational rehabilitation services. We hypothesized that cigarette use would independently predict food insecurity severity after adjusting for key confounders such as depressive symptoms, substance use, and quality of life [12,13,23].

METHODS

Procedures and Setting

Data for this study were drawn from a prior investigation examining outcomes of a vocational rehabilitation program for PLHIV. The original purpose of the study and the procedures are outlined in greater detail in Gómez et al [24]. To summarize, from January 2011 through January 2012, 108 participants were enrolled in the study within 30 days of initiating vocational rehabilitation services through the Positive Resource Center's Employment Services Program in San Francisco, California. After obtaining informed consent, participants completed a baseline assessment, which was re-administered at a 6-month and a 12-month follow-up assessment. At each study visit, participants were remunerated with a $50 pre-loaded debit card for their time and travel expenses. All study procedures were approved by the University of California San Francisco Institutional Review Board. The current study utilized data from the baseline and 12-month follow-up assessments. Of the 108 participants initially enrolled, 82% (*n* = 89) completed assessments at the 12-month follow-up.

Measures

The primary outcome variable was food insecurity severity, measured via the Household Food Insecurity Access Scale (HFIAS) [25]. HFIAS is a nine-item self-report measure of food insecurity, assessing issues related to access to food (e.g., worrying about not enough food,

limitations in variety of foods) and frequency of access-related issues in reference to the past month. HFIAS may be used as a categorical or continuous measure of food insecurity. We selected to use the continuous measure in the analyses, as the continuous measure is better able to capture changes over time [25]. Scores range from 0 to 27, with higher scores indicating greater severity of food insecurity. We used the categorical measure for sample description.

The main independent variable was current smoking, assessed by asking participants how often they smoked cigarettes during the past 3 months. Those who reported current smoking were further categorized into daily smoking (responses of "more than once a day") and nondaily smoking (responses ranging from "once a month" to "2 to 3 times a week").

Covariates included demographic characteristics and known confounders of food insecurity, including depressive symptoms, substance use, and quality of life related to mental health and physical health [12,13,23]. Depressive symptoms were measured using the Beck Depression Inventory-II [26], a 21-item self-report measure assessing the severity of depressive symptoms in reference to the past two weeks. Scores range from 0 to 63, with higher scores indicating greater depressive symptom severity. Substance use severity was measured by the Drug Abuse Screening Test-10 item version [27], which measures consequences resulting from substance use over the past 12 months (e.g., withdrawal symptoms from substance use). Scores range from 0 to 10, with higher summed scores indicating greater substance use severity. We also included an item measuring hazardous drinking over the past 3 months, defined as having 6 or more alcoholic drinks on one occasion (yes or no). Overall mental health quality of life and physical health quality of life were assessed using the Medical Outcome Study HIV Health Survey. Scores range from 0 to 100 with higher scores indicating better mental health- and physical health-related quality of life [28].

Analysis

Baseline differences between smokers and non-smokers were examined using *t*-tests and chi-square tests. Cohen's *d* was used to compare the magnitude of the difference between means, in which 0.20 indicates a "small" effect, 0.50 indicates a "medium" effect, and 0.80 indicates a "large" effect [29]. We conducted a two-step hierarchical multiple regression analysis to examine predictors of food insecurity severity at the 12-month follow-up, controlling for food insecurity severity at baseline. We used data from the baseline and 12-month assessments, as not all study variables were captured at the 6-month assessment. Prior to the regression analysis, we examined correlations amongst study variables to identify potential issues of multicollinearity.

Predictors in Model 1 included sociodemographics (age, gender, race, years since HIV diagnosis, disability status, and employment status) and covariates measured at baseline (substance use severity, depressive symptoms, hazardous drinking, mental health quality of life, and physical health quality of life). In Model 2, we included smoking status (smoking or non-smoking) measured at baseline to examine whether there was a significant change in the model's adjusted R^2. As a sensitivity analysis, and to examine whether food insecurity was associated with patterns of smoking, we repeated Step 2 with daily smoking (versus all others who did not indicate daily smoking) in the model.

RESULTS

Participant Characteristics

The majority of participants were men (90%), identified as being predominantly or exclusively gay (82%), and had a mean age of 46.7 years (*SD* = 9.3). For race/ethnicity, 16% identified as African American, 18% as Hispanic/Latino, 51% as non-Hispanic White, and 16% identified as other or multiracial. For educational level, 47% reported a college degree or higher,

40% reported some college, and 13% reported high school or less. On average, participants reported having been diagnosed with HIV for 14.7 years (*SD* = 8.4). Because the original study was conducted in the context of a vocational rehabilitation program, nearly two-thirds of participants (63%) were receiving disability benefits, either receiving Supplemental Security Income (SSI) or Social Security Disability Insurance (SSDI).

At baseline, 28% (*n* = 30) were considered current smokers, and among them, 70% (*n* = 21) reported smoking daily. About half, or 55% (*n* = 59), reported any food insecurity at baseline. Table 1 displays participant characteristics collected at study baseline by smoking status and the corresponding *p*-values of comparisons. Current smokers, compared to non-smokers, were significantly younger in age ($t(106) = 2.62$, $p = 0.01$, Cohen's $d = 0.54$) and had been more recently diagnosed with HIV ($t(104) = 2.16$, $p = 0.03$, Cohen's $d = 0.47$). Moreover, smokers reported significantly greater food insecurity severity ($t(106) = 2.45$, $p = 0.02$, Cohen's $d = 0.48$), depressive symptoms ($t(105) = 1.99$, $p = 0.05$, Cohen's $d = 0.40$), and substance use severity ($t(105) = 2.85$, $p = 0.01$, Cohen's $d = 0.58$) compared to non-smokers. Among the 30 smokers at baseline with available data at the 12-month follow-up (*n* = 19), 90% reported that they continued to smoke.

Predictors of Food Insecurity Severity

In Model 1 of the hierarchical multiple regression analysis predicting food insecurity severity at the 12-month follow-up (Table 2), significant baseline predictors were greater food insecurity severity at baseline (B (SE) = 0.34 (0.14), $\beta = 0.39$, $p = 0.016$) and younger age (B (SE) = -0.35 (0.14), $\beta = -0.46$, $p = 0.015$). No other variables, including sociodemographics and baseline covariates (substance use, depressive symptoms, mental health quality of life, and physical health quality of life), were significant. The adjusted R^2 of Model 1 was 0.36. In Model

2, smoking status at baseline was a significant predictor of food insecurity severity at the 12-month follow-up (B (SE) = 0.59 (0.22), β = 0.31, $p = 0.010$), controlling for confounders as shown in Table 2. The only other significant variable in Model 2 was food insecurity severity at baseline (B (SE) = 0.37 (0.13), β = 0.41, $p = 0.006$). The adjusted R^2 of Model 2 was 0.45, showing that the addition of baseline smoking in Model 2 explained significantly more variance in food insecurity at 12 months compared to Model 1 ($\Delta R^2 = 0.09$, $p = 0.010$). A sensitivity analysis using baseline daily smoking (versus others) did not change the results.

DISCUSSION

This is among the first longitudinal studies to highlight that cigarette use is an independent risk factor for food insecurity among PLHIV, after adjusting for known confounders such as comorbid substance use. In this sample of PLHIV engaged in vocational rehabilitation services, we found that smoking status at baseline predicted significantly greater levels of food insecurity severity at the 12-month follow-up, above and beyond other correlates of food insecurity. In fact, smoking explained 9% of the variance in food insecurity at 12 months; these results held regardless of whether one was a daily smoker, suggesting that either pattern of smoking (daily or non-daily) was associated with more severe food insecurity outcomes in this case.

Smoking may contribute to the experience of food insecurity in a number of ways. Depending on levels of cigarette consumption, the money spent on buying cigarettes may be directly competing with money needed for subsistence needs, such as food [30]. This may be particularly the case for persons living in impoverished conditions, as with many PLHIV in urban settings [6]. In a multi-national study using data from the International Tobacco Control Policy Evaluation Survey, 28% of U.S. respondents who were smokers reported smoking-

induced deprivation, which was defined as spending money on cigarettes that could be better spent on household essentials like food [31]. Importantly, lower income, racial minority status, and perceived stress were associated with increased odds of reporting smoking-related deprivation. Food insecurity may be a byproduct of smoking-induced deprivation, and these previous findings suggest a disproportionate burden of smoking-induced deprivation for disadvantaged or marginalized groups.

The association between smoking and food insecurity is likely more complex than spending patterns alone. Other possibilities are that smoking indirectly contributes to food insecurity through factors associated with declining health (e.g., limit one's workforce participation and earning potential), which could subsequently create higher health care costs and increase financial burden. Potential health declines are already a salient issue in HIV. Although the exact pathophysiological effects of tobacco smoke and nicotine on HIV is not yet well understood, there is evidence that smoking has more negative physical health effects, such as immunosuppression, for smokers with HIV compared to smokers without HIV [32]. This investigation furthers our understanding of smoking-related harms for PLHIV, particularly highlighting that smoking has prospective and exacerbation effects on food insecurity. Further research should examine the mechanisms linking smoking and food insecurity, which are likely to be complex and multifaceted.

Although the present study focused on a unidirectional association between smoking and food insecurity, the potential reciprocal association between the two should be acknowledged and further examined. For example, a study of women experiencing homelessness or unstable housing (half of whom were living with HIV) reported a bidirectional relationship between food insecurity and cigarette smoking [33]. One of the characteristics of food insecurity, particularly

when food insecurity is more severe, is the experience of feeling hungry but not eating due to not having enough money for food [34]. In addition to nicotine being the primary psychoactive substance in cigarettes that creates pleasurable feelings for the smoker, nicotine also has the effect of suppressing appetite and regulating eating behaviors [35]. Thus, the effects of nicotine on appetite suppression has been raised as a possibility for food insecurity's association with smoking, as individuals may be using cigarettes to curb feelings of hunger [33]. Furthermore, whether this is part of an intentional behavioral process that those with greater food insecurity are smoking cigarettes when feeling hungry, or food insecurity is attributable to limited economic resources due to the financial burdens of nicotine addiction is an area that remains to be examined.

The prevalence of smoking in the current study (28%) was lower than other published studies of population groups with HIV, with large epidemiological studies reporting smoking prevalence at about 40% [17,36] and smaller studies reporting even higher [37,38]. The relatively lower smoking prevalence in our study may be partially due to a geographic effect, given that smoking prevalence in California is lower than the national average [39]. It also serves to highlight the unique characteristics of this particular sample of PLHIV who were actively seeking vocational rehabilitation services. Most notably, the sample was well educated with the majority (87%) reporting that they completed at least some college. Smoking prevalence tends to decline with greater education in the general population and among PLHIV [17]. The lower smoking rate may also reflect quitting among former smokers. About 20% of PLHIV are former smokers [17], and although we did not assess former smoking in the current study, we did find that non-smokers (which would include former smokers) were older than current smokers, and this might reflect individuals who were once smokers but have since quit. Furthermore, because

our sample was drawn from individuals engaged in vocational rehabilitation services, individuals who smoke may be more motivated to quit prior to enrollment in preparation to enter or re-enter the workforce.

It is also noteworthy that current smokers in this study reported higher levels of depressive symptoms and substance use severity, which underscores the potential benefits of comprehensive approaches for smoking cessation. Clinical research has documented the efficacy of cognitive-behavioral interventions targeting depression and substance use to optimize HIV/AIDS prevention [40,41]. However, the efficacy of smoking cessation interventions for PLHIV have been modest at best [42,43], and many have not been tailored to address the unique barriers to smoking cessation. For example, one study of 57 smokers living with HIV reported that HIV symptom distress was associated with smoking outcome expectancies, such as relief from emotional distress and enhancement of positive mood [44]. There is a need to promote smoking cessation through interventions that are tailored to address the unique barriers for smokers who are living with HIV. A research question to be investigated in the future is whether smoking cessation can reduce food insecurity among PLHIV. Given that our study sample was drawn from individuals seeking vocational rehabilitation services, our findings also have implications for providing evidence-based smoking cessation resources in such settings.

We acknowledge that our findings must be interpreted in light of some limitations. The current study sample included individuals who were seeking vocational rehabilitation services and had relatively higher levels of education. The extent to which these findings may be generalizable to other samples in both urban and non-urban settings and with different educational backgrounds is not yet known. Our assessment of smoking status was based on self-reported cigarette smoking frequency in the past three months, and we were unable to include

biochemical verification or assess other smoking-related characteristics, such as lifetime and former smoking, as well as use of other tobacco or nicotine delivering products. It is also important to note that we cannot conclude causality from our findings, and these limitations highlight areas to be examined in future investigations.

This investigation found that smoking was significantly predictive of food insecurity severity in this sample of PLHIV. An important implication is that expanded smoking cessation services for this population may have the potential to extend beyond physical health benefits by also impacting key social and health determinants, such as food insecurity. Both cigarette use and food insecurity disproportionately impact the health and wellbeing of individuals who are living with HIV. Better understanding their association, including the potential reciprocal nature and mechanisms, is needed to inform efforts to improve health outcomes.

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Table 1. Demographic and Other Characteristics of Study Participants by Smoking Status

	Total (N = 108)	Non-smokers (n = 78)	Current smokers (n = 30)	p value
Age, M (*SD*)	46.6 (9.3)	48.0 (8.7)	42.9 (10.0)	0.01
Male, *n* (%)	97 (89.8)	70 (89.7)	27 (90.0)	0.97
Race/ethnicity, *n* (%)				0.24
Black / African American	17 (15.7)	12 (15.4)	5 (16.7)	
Hispanic / Latino	19 (17.6)	17 (21.8)	2 (6.7)	
White, non-Hispanic	55 (50.9)	36 (46.2)	19 (63.3)	
Other or multiracial	17 (15.7)	13 (16.7)	4 (13.3)	
Sexual orientation, *n* (%)				0.10
Predominantly or exclusively heterosexual	16 (14.8)	8 (10.4)	8 (26.7)	
Equally heterosexual and homosexual	3 (2.8)	2 (2.6)	1 (3.3)	
Predominantly or exclusively homosexual	88 (81.5)	67 (87.0)	21 (70.0)	
Disability status- on SSI or SSDI, *n* (%)	67 (62.6)	47 (60.3)	20 (69.0)	0.35
Years since HIV diagnosis, M (*SD*)	14.0 (8.4)	15.6 (8.2)	11.7 (8.5)	0.03
Education level, *n* (%)				0.07
High school or less	14 (13.0)	7 (9.0)	7 (23.3)	
Some college or trade school	43 (39.8)	30 (38.5)	13 (43.3)	
College or more	51 (47.2)	41 (52.6)	10 (33.3)	
Personal annual income, *n* (%)				0.34
< $5,000	16 (14.8)	13 (16.7)	3 (10.0)	
$5,000 - $11,999	31 (28.7)	22 (28.2)	9 (30.0)	
$12,000 - $15,999	23 (21.3)	13 (16.7)	10 (33.3)	
$16,000 - $24,999	24 (22.2)	18 (23.1)	6 (20.0)	
$25,000 - $34,999	9 (8.3)	7 (9.0)	2 (6.7)	
> $35,000	5 (4.6)	5 (6.4)	0 (0.0)	
Hazardous drinking, *n* (%)	33 (30.6)	21 (26.9)	12 (40.0)	0.43
Depressive symptoms, M (*SD*)	15.8 (11.3)	14.4 (10.2)	19.3 (13.5)	0.05
Substance use severity, M (*SD*)	1.8 (2.5)	1.4 (2.2)	2.9 (3.0)	0.01
Mental health-related quality of life, M (*SD*)	46.7 (9.8)	46.7 (9.2)	43.9 (11.6)	0.20
Physical health-related quality of life, M (*SD*)	45.9 (9.9)	46.9 (9.8)	46.1 (9.9)	0.71
Food insecurity at baseline, M (*SD*)	4.6 (6.1)	3.7 (5.2)	6.8 (7.6)	0.02
Food insecurity at follow-up, M (*SD*)	(n = 89) 3.9 (6.0)	(n = 70) 3.1 (5.6)	(n = 19) 6.8 (1.6)	0.03

Notes. Not all categories match overall sample size due to individuals who did not provide answers. All characteristics are measured at baseline, unless otherwise noted. SSI = Supplemental Security income; SSDI = Social Security Disability Insurance

Table 2. Results from Hierarchical Multiple Regression Analysis Predicting Severity of Food Insecurity at 12-Month Study Follow-Up (N = 89)

	Model 1 (Adjusted R^2 = 0.36)			Model 2 (Adjusted R^2 = 0.45)		
Variable	B (SE)	Beta	p- value	B (SE)	Beta	p-value
Food insecurity severity at baseline	0.34 (0.14)	0.39	0.02	0.37 (0.13)	0.41	0.01
Age	-0.35 (0.14)	-0.46	0.02	-0.25 (0.13)	-0.33	0.07
Male (vs. female)	0.52 (0.47)	0.14	0.28	0.52 (0.43)	0.15	0.24
White (vs. non-White)	0.14 (0.22)	0.08	0.52	0.13 (0.20)	0.08	0.52
Years since HIV diagnosis	-0.06 (0.13)	-0.07	0.67	-0.06 (0.12)	-0.07	0.65
Disability status	-0.19 (0.30)	-0.11	0.52	-0.25 (0.27)	-0.15	0.36
Unemployed	-0.03 (0.33)	-0.02	0.92	-0.08 (0.31)	-0.04	0.79
Substance use severity	-0.17 (0.12)	-0.17	0.17	-0.18 (0.11)	-0.18	0.12
Depressive symptoms	-0.05 (0.17)	-0.05	0.79	-0.07 (0.16)	-0.08	0.67
Hazardous drinking	-0.31 (0.28)	-0.18	0.28	-0.25 (0.26)	-0.15	0.35
Mental health quality of life	-0.15 (0.16)	-0.18	0.36	-0.12 (0.12)	-0.14	0.33
Physical health quality of life	-0.14 (0.13)	-0.18	0.29	-0.17 (0.15)	-0.21	0.26
Current smoking at baseline	Not included in Model 1			0.59 (0.22)	0.31	0.01