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Permalink

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Journal

Journal of Psychoactive Drugs, 53(2)

ISSN

0279-1072

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Publication Date

2021-03-15

DOI

10.1080/02791072.2020.1845419

Peer reviewed



Published in final edited form as:

J Psychoactive Drugs. 2021 ; 53(2): 177–184. doi:10.1080/02791072.2020.1845419.

Examining Reciprocal Effects of Cigarette Smoking, Food Insecurity, and Psychological Distress in the U.S.

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Abstract

In the U.S., cigarette smoking is increasingly concentrated in disadvantaged and vulnerable populations, such as populations with lower income and with mental health needs. Food insecurity is linked with psychological distress and is an independent risk factor for smoking. We prospectively examined how cigarette smoking, food insecurity, and psychological distress operate as risk factors for one another in a 2-year longitudinal analysis of U.S. adults from the 2015 and 2017 Panel Study of Income Dynamics, a nationally representative household survey (N=7946). Using cross-lagged panel analysis, cross-lagged regression coefficients were estimated simultaneously with direct-effect paths, controlling for covariates. Results showed significant bidirectional associations between smoking and food insecurity: 2015 smoking predicted 2017 food insecurity, and 2015 food insecurity predicted 2017 smoking. Food insecurity and psychological distress also had significant bidirectional associations. However, the association between smoking and psychological distress was unidirectional: 2015 psychological distress predicted 2017 smoking, but not vice versa. The findings suggest a cyclical possibility that smoking exacerbates food insecurity, food insecurity exacerbates psychological distress, and psychological distress exacerbates smoking. There is a need to replicate with more timepoints, but our results highlight the importance of examining the overlapping health burdens of smoking, food insecurity, and psychological distress.

Keywords

cigarette smoking; food insecurity; psychological distress; Panel Study of Income Dynamics

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DISCLOSURE STATEMENT

The authors have no conflicts of interests to declare.

INTRODUCTION

Over the past few decades, tobacco use—particularly cigarette smoking—has become increasingly concentrated in disadvantaged and vulnerable populations, such as populations with lower income and with mental health needs (U.S. Department of Health and Human Services 2014). Cigarette smoking prevalence for the general U.S. population was 14% in 2017, yet remained disproportionately higher at 21% for those whose annual household incomes were below \$35,000, and at 35% for those experiencing serious psychological distress (Wang et al. 2018). Given these disparities, it is becoming increasingly important to understand cigarette smoking behavior within the context of socioeconomic and health-related disadvantages, as smoking prevalence has been found to increase sequentially with the number of risk factors experienced (Leventhal et al. 2019; Higgins et al. 2016). In addition to the cumulative effects that these disadvantages have on the likelihood of smoking, it is also the case that different aspects of disadvantage influence smoking and one another in complex reciprocal cycles (Leventhal et al. 2019). This investigation examines reciprocal effects of cigarette smoking, food insecurity, and psychological distress, to understand how these variables influence one another over time, towards contributing to our understanding of how tobacco use may be perpetuated in disadvantaged populations.

Food insecurity is a key aspect of socioeconomic disadvantage that has high relevance to health and health behaviors. Food insecurity occurs when access to adequate food to live an active and healthy life is limited by a lack of money or other resources (Coleman-Jensen et al. 2019). Food insecurity often exists within a context of several unmet needs such as housing needs and unemployment concerns (Bisgaier and Rhodes 2011); however, there is a robust literature on the adverse health consequences of food insecurity specifically (Gundersen and Ziliak 2015). For instance, it has independent links to health outcomes such as cardiovascular disease risk (Vercammen et al. 2019), mental health conditions (Arenas et al. 2019), and HIV-related outcomes (Weiser et al. 2011). Although the pathways by which food insecurity impacts health are varied, there are several health risk behaviors that tend to co-occur with food insecurity and are important for understanding and mitigating health disparities, including tobacco-related health disparities. The relevance of examining food insecurity is that it offers a potential direction for interventions in considering how to address socioeconomic disparities.

Specific to tobacco use, the literature has demonstrated that there is a significant association between food insecurity and tobacco use (primarily cigarette smoking) that is independent of related indicators of socioeconomic status such as income and education. A review article examined findings from 19 quantitative studies published between 2008–2018, in which each of the studies measured food insecurity and tobacco use (Kim-Mozeleski and Pandey 2020). Although the review was specific to study samples in the U.S. and Canada, there was a range of population-based, community-based, and clinical samples represented. In six studies, food insecurity independently increased the odds of tobacco use, and in 13 studies, tobacco use increased the odds of food insecurity. Most studies were cross-sectional, and of the small number of longitudinal studies ($n=3$), only unidirectional associations were examined; for instance, baseline smoking status significantly predicted severity of food insecurity at 12-months (Kim-Mozeleski et al. 2018).

A conceptual framework by Davison et al. (2018) specifically describes how food insecurity co-occurs with substance use and poor mental health. In this framework, there are contextual factors (such as socioeconomic factors related to income and education) that underlie food insecurity, substance use, and poor mental health. There are also explanatory pathways which emphasize the role of stress as a contributor to food insecurity, to poor mental health, and/or to substance use, and stress can also be an outcome of food insecurity, poor mental health, and/or substance use. For socioeconomically disadvantaged populations who desire and attempt to quit (Kotz and West 2009) but also report smoking to cope with life stressors (Krueger and Chang 2008), smoking behavior and smoking cessation can become especially complicated. It is well known that psychological distress is an established correlate of smoking (Sung et al. 2011), and psychological distress is also a significant correlate with food insecurity (Allen, Becerra, and Becerra 2017). In a prior study that estimated the quit ratio in a representative sample of low-income adults who have ever smoked, it was specifically reporting food insecurity *and* psychological distress that showed significantly lower odds of having quit smoking, whereas food insecurity alone (without distress) and psychological distress alone (without food insecurity) were not significantly associated with quitting status (Kim-Mozeleski and Tsoh 2019). These cross-sectional findings support the cumulative effects of disadvantages on smoking status, and longitudinal studies are needed to examine reciprocal effects of these risk factors that are often co-occurring.

The purpose of the current investigation was to examine reciprocal associations between smoking and other risk factors that are linked with disadvantage, focusing here on food insecurity and poor mental health (psychological distress). Building on Davison et al.'s conceptual framework, as well as findings from cross-sectional studies (Hernandez et al. 2017), this investigation is among the first studies to longitudinally examine reciprocal associations of smoking, food insecurity, and psychological distress in a national sample. This is important for understanding how smoking is perpetuated in disadvantaged populations, with implications for social and health policy.

METHODS

Dataset and Sampling

The Panel Study of Income Dynamics (PSID) is a nationally representative household survey of the general U.S. population (Panel Study of Income Dynamics, Public Use Data Set. Produced and Distributed by the Survey Research Center, Institute for Social Research, University of Michigan 2017). The PSID, which began in 1968, is currently the longest running longitudinal household survey worldwide, following individuals and their household units. It was conducted annually through 1997 and is now conducted biennially. The PSID captures information on socioeconomic factors and health of the general U.S. household population and oversamples for lower income households. Detailed information regarding the study and methodology is available at <https://psidonline.isr.umich.edu>.

We analyzed publicly available and de-identified data of head-of-household respondents who participated in both the 2015 and 2017 waves of the PSID Main Interview, with individuals linked by unique identification numbers generated according to a formula provided by the study's developers. At the time of this study's analysis, these survey years

were the most recent waves available that included supplementary questions on food insecurity, which were not included in immediately preceding survey years (e.g., the 2013 wave did not include the Food Security Survey Module). For each sampled household, the PSID designates a head-of-household respondent who responds on behalf of the household, and provides more detailed information about oneself than for other household members. For example, psychological distress is assessed for only the head-of-household respondent. In 2015, there were 9,048 head-of-household respondents (i.e., those who could presumably be followed in 2017), and the current study sample examined 7,946 respondents who had follow-up data in 2017 (88% of eligible respondents). Institutional Review Board exemption approval was received to analyze the data.

Measures

All PSID variables included in this analysis were asked uniformly in 2015 and 2017. Respondents provided a yes/no response to the question “Do you smoke cigarettes?” Those responding yes were further asked about the average number of cigarettes per day. Current smoking captures both daily and non-daily smoking, as respondents who reported that they smoke one or fewer cigarettes per day were coded as ‘1 cigarette’ based on the PSID methodology.

Food insecurity was assessed using the U.S. Department of Agriculture Food Security Survey Module (Bickel et al. 2000). This module assesses food insecurity experienced in the past 12 months; the items range in severity from how often a respondent worried about running out of food to whether a respondent did not eat for a whole day because of lack of money. The number of affirmative responses is used to determine the degree of food insecurity (categorized as full, marginal, low, or very low food security). Furthermore, raw scores correspond to a scaled continuous score as designed by the instrument developers (Bickel et al. 2000).

Psychological distress was assessed using the 6-item Kessler Psychological Distress Scale (K6) (Kessler et al. 2002). K6 assesses nonspecific psychological distress symptoms experienced in the past 30 days (such as how often one felt nervous, or how often one felt hopeless), with responses ranging from none (0) to all of the time (4), yielding a distress score ranging from zero to 24. Higher summed scores correspond to greater severity of psychological distress.

Several demographic variables as measured in 2015 were included as covariates, selected on the basis of reflecting socioeconomic disadvantages related to smoking as identified in prior research (Leventhal et al. 2019): education level (number of years of education), poverty status (at/below or above 100% of federal poverty level), and current unemployment which included being unable to work due to disability. We also included participant sex, age, and race/ethnicity, which are related to smoking status at the population level.

Data Analysis

Cross-lagged panel analysis (or cross-lagged path modeling) was used to examine reciprocal associations amongst smoking status (dichotomous variable), food insecurity (continuous variable), and psychological distress (continuous variable) over a two-year time period

covering the 2015 and 2017 waves of the PSID. This method is commonly used to model reciprocal effects (Usami, Todo, and Murayama 2019). In a saturated model (i.e., all possible paths are estimated), cross-lagged regression coefficients were estimated simultaneously with the autoregressive or direct-effect paths from 2015 to 2017. Analyses used a weighted least squares estimator, and included demographic covariates (sex, race, age, education level, poverty status, and unemployment). We allowed for residual correlations amongst the endogenous variables in 2017. Data were analyzed in Mplus version 8, using appropriate survey weights, and accounting for the complex survey design. There are relatively few missing data in the PSID; most variables in the current analysis had no missing data except for the psychological distress variables (n=67 missing in both years; n=31 missing in 2015 only, and n=49 missing in 2017 only). The weighted least squares estimator in Mplus handles missing data by assuming that data were missing at random or missing completely at random (Asparouhov and Muthen 2010).

RESULTS

There were 7,946 respondents who provided data in both the 2015 and 2017 PSID waves. Mean age of respondents in 2015 was 51.7 years (95% CI: 51.1–52.4). The majority of the sample were men (70%), with a mean of 13.7 years of education (95% CI: 13.5–13.8). Approximately 12% were below 100% of the federal poverty level in 2015. Table 1 depicts sample characteristics.

Table 2 provides path coefficients and corresponding 95% confidence intervals for direct and cross-lagged effects, and also displays the variance explained (R^2) for the endogenous variables. The results showed significant bidirectional associations between cigarette smoking and food insecurity. As shown in Table 2, smoking in 2015 independently predicted food insecurity in 2017 ($\beta=0.06$, $p<0.001$), and conversely, food insecurity in 2015 independently predicted cigarette smoking in 2017 ($\beta=0.05$, $p<0.001$). After accounting for the direct or autoregressive paths, the cross-lagged path coefficients were generally small but statistically significant. There was also a significant bidirectional association between food insecurity and psychological distress. Food insecurity in 2015 independently predicted psychological distress in 2017 ($\beta=0.08$, $p<0.001$), and psychological distress in 2015 independently predicted food insecurity in 2017 ($\beta=0.07$, $p<0.001$).

The association between cigarette smoking and psychological distress was unidirectional. Psychological distress in 2015 predicted cigarette smoking in 2017 ($\beta=0.04$, $p=0.032$), but cigarette smoking in 2015 did not significantly predict psychological distress in 2017 ($p=0.078$). Rather, there was a concurrent association between cigarette smoking and psychological distress in 2017 (results not shown).

DISCUSSION

In the U.S., cigarette smoking has become increasingly concentrated in disadvantaged and vulnerable populations, such as population groups with lower income and with mental health needs. This investigation focused on food insecurity and psychological distress as specific aspects of socioeconomic and health-related disadvantage that often co-occur with cigarette

smoking, with the purpose of prospectively examining the reciprocal cycles of smoking and disadvantage. The results provided evidence for a significant reciprocal association between cigarette smoking and food insecurity, as well as for food insecurity and psychological distress over a two-year period from 2015 to 2017. In addition, the association between psychological distress and smoking was unidirectional, such that psychological distress predicted smoking status but not vice versa. Whereas conceptual frameworks have delineated that food insecurity, substance use, and poor mental health co-occur with one another (Davison et al. 2018), and cross-sectional studies have posited that the association between smoking and food insecurity is bidirectional (Hernandez et al. 2017), this study adds to the literature by prospectively examining the reinforcing relationships with population-based longitudinal data.

In explaining the finding that cigarette smoking predicted food insecurity, and that food insecurity predicted cigarette smoking, it may be relevant to consider the roles of financial strain and smoking-induced deprivation. In a study analyzing data from the International Tobacco Control Four-Country Survey of smokers in Australia, Canada, the U.K., and the U.S., it was not necessarily daily spending on cigarettes that increased levels of financial stress, but it was more specifically smoking-induced deprivation that was associated with financial stress (Siahpush et al. 2012). Smoking-induced deprivation, which occurs when spending towards tobacco directly competes with spending on food and other household essentials, is relatively common among low-income smokers, with studies reporting that it affects 28% among U.S. smokers in the International Tobacco Control Survey (Siahpush, Borland, and Yong 2007), and 32% among U.S. smokers with depression (E. S. Rogers 2019). The experience of food insecurity is important to consider alongside the overall financial burden of smoking and associations with quitting. In a study of low-income smokers in Minnesota, cigarettes per day was associated with increased odds of reporting concerns about affording food (Widome et al. 2015). However, financial hardship (including concerns about food) may not necessarily be a motivator for quitting since smoking may function as a coping strategy (Tucker-Seeley et al. 2015). Among smokers in New York City enrolled in a smoking cessation trial, participants with smoking-induced deprivation reported lower motivation to quit compared to counterparts without smoking-induced deprivation (E. Rogers et al. 2019). Although food insecurity represents one of many aspects of financial hardship, taken together, tobacco spending and smoking to cope may help to explain the current study's reciprocal relationship between smoking and food insecurity.

We also found that there was a reciprocal relationship between food insecurity and psychological distress, which is a finding that extends the largely cross-sectional body of research reporting that food insecurity is highly associated with poorer mental health (Jones 2017). In an analysis of the U.S. National Health Interview Survey, there was a dose-response relation between the number of financial stressors (including food insecurity, financial worries, and health care insecurity) and serious psychological distress (Tsuchiya et al. 2020). In a study analyzing the Canadian Community Health Survey, increases in the number of chronic conditions (which included mental and physical conditions) were associated with increased odds of food insecurity (Tarasuk et al. 2013). Our findings highlight the mutually reinforcing nature of food insecurity and psychological distress over time, showing that psychological distress was independently predictive of food insecurity.

Prior studies have discussed that poor mental health can increase vulnerability to food insecurity (Davison et al. 2018), particularly through pathways that involve substance use.

The overall pattern of results suggests the possibility of a chain of events: cigarette smoking exacerbates food insecurity, food insecurity exacerbates psychological distress, psychological distress exacerbates smoking, and so on. From the current set of findings, it is possible that smoking is associated with psychological distress via food insecurity. This is a potential interpretation to the results showing that smoking did not have a significant cross-lagged effect on psychological distress. This finding is of a similar pattern to an investigation that analyzed data from the Copenhagen General Population Study; using a Mendelian randomization design, it was reported that there was no significant causal relationship between tobacco use and psychological distress, although there was a strong correlation between the two (Skov-Ettrup et al. 2017). It is important to emphasize that the current analysis was not aimed to test for mediation effects, and such interpretations must be made cautiously as future longitudinal studies are needed to confirm the potential pathways.

There are several limitations to the current research. The estimated cross-lagged effects are specific to this 2-year time frame and without additional timepoints, it is not possible to examine alternative models to test reciprocal effects (Usami, Todo, and Murayama 2019). The current measure of cigarette smoking status could not distinguish between daily versus non-daily smoking. We note that smoking prevalence rates obtained here are generally consistent, although slightly higher compared to other population-based studies examining this time period, with the National Health Interview Survey reporting 15.1% cigarette smoking prevalence in 2015 (Phillips et al. 2017), and 14.0% smoking prevalence in 2017 (Wang et al. 2018). The higher prevalence in this study is likely due to the PSID's sampling methodology of following individuals who are designated as the heads of their households, of whom the majority were male respondents.

As the characteristics of cigarette smokers have shifted towards low-income and other vulnerable populations, it has been a growing public health challenge to address disparities in tobacco use and curb tobacco-related health problems. Given the overall pattern of reciprocal and unidirectional associations, the results imply that promoting smoking cessation may also promote food security, which may then promote improved mental health by reducing psychological distress. However, it is also important to consider that the smoking cessation process is likely to be complicated by food insecurity. There is a growing need to specifically design cessation programs with such barriers in mind. For instance, there is ongoing work in Germany that is examining the effect of a smoking cessation program on smoking status and food insecurity among individuals who use food pantries (Simmet et al. 2020). There could also be a need to specifically consider the management of negative mood and psychological distress that could be resulting from food insecurity. In addition to such approaches that recruit through community-based food assistance venues, another strategy may be to engage with social service providers. Beyond the more traditional approach of engaging healthcare providers for providing cessation counseling, engaging with social service providers who may frequently encounter smokers with food insecurity, to co-design cessation programs may be more effective for socioeconomically disadvantaged smokers. The implications of this research are that population-level strategies to reduce

smoking prevalence, particularly in priority populations, may require a concerted effort to understand and address key socioeconomic conditions and mental health factors that increase vulnerability to smoking while posing additional difficulties in quitting. To address the widening burden of tobacco use on disparity populations, there is a critical need to examine the intersection of multiple and co-occurring risk factors.

FUNDING

This work was supported by the National Institutes of Health, grant number K01DA043659 to JEKM. The collection of data used in this study (the Panel Study of Income Dynamics) was partly supported by the National Institutes of Health under grant number R01HD069609 and the National Science Foundation under award number 1157698. The funding agencies had no involvement in the design and conduct of the study, data analysis, interpretations of the data, and preparation and submission of the article.

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Table 1.

Sample Characteristics of Head-of-Household Respondents in the 2015 and 2017 Panel Study of Income Dynamics (PSID; N=7,946)

Sample Demographic Characteristics (2015)	% or <i>M</i> (95% CI)	
Age in years, %		
18–34	19.7	(18.5, 20.8)
35–49	25.2	(23.9, 26.6)
50–64	30.9	(21.2, 32.2)
65+	24.3	(22.6, 26.0)
Sex, %		
Female	29.7	(27.9, 31.6)
Male	70.4	(68.4, 72.2)
Education level, %		
Less than 12 years	13.0	(11.5, 14.7)
12 years	26.8	(24.8, 28.9)
13 or more years	60.2	(57.5, 62.7)
Race/ethnicity		
Black/African American	13.5	(10.6, 16.5)
White	79.8	(76.4, 83.1)
Another race/ethnicity	6.7	(5.4, 8.0)
Poverty, %	11.6	(10.2, 20.9)
Unemployed, %	9.4	(8.1, 10.8)
Study Variables	% or <i>M</i> (95% CI) in 2015	% or <i>M</i> (95% CI) in 2017
Current smoking, %	17.2 (15.7, 18.6)	15.7 (14.4, 16.9)
Number of cigarettes per day, <i>M</i>	12.6 (11.8, 13.4)	12.7 (12.0, 13.4)
Food insecurity categories, %		
None (High food security)	78.6 (76.7, 80.6)	81.0 (79.4, 82.6)
Mild (Marginal food security)	9.1 (8.3, 9.9)	8.8 (7.9, 9.7)
Moderate (Low food security)	7.2 (6.2, 8.1)	5.5 (4.6, 6.3)
Severe (Very low food security)	5.2 (4.3, 6.0)	4.7 (3.9, 5.5)
Psychological distress categories, %		
No/mild distress	75.6 (73.9, 77.2)	75.0 (73.6, 76.3)
Moderate distress	20.9 (19.6, 22.1)	21.8 (20.5, 23.1)
Serious distress	3.6 (2.9, 4.2)	3.2 (2.8, 3.7)

Notes: For number of cigarettes per day, responses of less than 1 cigarette per day (non-daily smoking) were coded as 1 cigarette based on PSID methodology. In 2015, 5.1% (95% CI [3.8, 6.2], n=81) of smokers smoked '1 or fewer cigarettes per day' and similarly in 2017, 4.8% (95% CI [3.4, 6.1], n=66) of smokers smoked '1 or fewer cigarettes per day.'

Table 2.Unstandardized (B) and Standardized (β) Path Coefficients from Cross-Lagged Panel Model

	B (SE)	β	<i>p</i>	R²
Predicting 2017 smoking				0.579
2015 smoking	1.926 (0.061)	0.67	<0.001	
2015 food insecurity	0.036 (0.010)	0.05	0.001	
2015 psychological distress	0.012 (0.005)	0.04	0.032	
Age	-0.010 (0.001)	-0.12	<0.001	
Race (white vs. other)	-0.007 (0.039)	-0.01	0.865	
Education	-0.046 (0.009)	-0.12	<0.001	
Poverty	0.050 (0.049)	0.02	0.302	
Male sex (vs. female sex)	-0.015 (0.039)	-0.01	0.703	
Unemployment	0.068 (0.062)	0.02	0.273	
Predicting 2017 food insecurity				0.465
2015 smoking	0.221 (0.007)	0.06	<0.001	
2015 food insecurity	0.547 (0.007)	0.58	<0.001	
2015 psychological distress	0.026 (0.003)	0.07	<0.001	
Age	-0.005 (0.001)	-0.05	<0.001	
Race (white vs. other)	-0.034 (0.034)	-0.01	0.315	
Education	-0.026 (0.006)	-0.05	<0.001	
Poverty	0.262 (0.039)	0.06	<0.001	
Male sex (vs. female sex)	-0.055 (0.039)	-0.02	0.157	
Unemployment	0.198 (0.034)	0.04	<0.001	
Predicting 2017 psychological distress				0.423
2015 smoking	0.138 (0.083)	0.01	0.078	
2015 food insecurity	0.203 (0.018)	0.08	<0.001	
2015 psychological distress	0.566 (0.008)	0.57	<0.001	
Age	-0.017 (0.002)	-0.07	<0.001	
Race (white vs. other)	0.223 (0.092)	0.02	0.016	
Education	-0.045 (0.016)	-0.03	0.004	
Poverty	0.339 (0.128)	0.03	0.013	
Male sex (vs. female sex)	-0.311 (0.076)	-0.04	<0.001	
Unemployment	0.382 (0.110)	0.03	0.001	

Note: All pathways were estimated simultaneously in a saturated model.