Food insecurity transitions and smoking behavior among older adults who smoke

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A B S T R A C T

Cross-sectional data reveal that smoking cigarettes is highly prevalent among those who are food insecure. However, there is limited and conflicting evidence concerning whether causal factors may influence associations of food insecurity with smoking behavior. Additionally, temporality is a core feature of food insecurity that should be considered when examining linkages between food insecurity and health behaviors like smoking cessation. In 2019, data were extracted from waves 2012 and 2014 of the Health and Retirement Study—a representative sample of U.S. adults ≥ 50. Analyses were limited to those who smoked cigarettes in 2012 ($n = 2197$). Food insecurity was assessed in 2012 and 2014 to indicate food insecurity transitions: (1) initially food insecure (food insecure in 2012 only); (2) became food insecure (food insecure in 2014 only); (3) remained food insecure (food insecure in 2012 and 2014), and; (4) not food insecure (reference group). Multivariable logistic regression examined odds of smoking cessation in 2014 due to food insecurity transition. Becoming food insecure was associated with a 2.0 (95% confidence interval = 1.1–3.4) higher odds of smoking cessation. Employment loss or retirement ($p < 0.020$) and diagnosis of a new chronic condition ($p = 0.026$) were also associated with higher odds of smoking cessation. In older U.S. adults, smoking cessation was associated with decreased spending power and new health problems. Future studies should examine whether findings of this study may be similar among younger adults and; whether those who quit smoking due to food insecurity are more susceptible to relapse than those who quit due to other factors.

1. Introduction

Smoking cigarettes is one of the most widely recognized public health problems, associated with numerous chronic conditions from cancer (Alberg et al., 2013) to cardiovascular disease (Campbell et al., 2008)—not to mention the risks due to passive exposure among non-smokers (Vardavas and Panagiotakos, 2009). Campaigns funded by the government and nonprofits in the United States dedicate hundreds of millions dollars annually with the aim of reducing smoking and associated health care costs (Holtgrave et al., 2009; King et al., 2014). Smoking cessation has health benefits across the life course (Girard et al., 2015), reducing excess risk of mortality even into old age (Mons et al., 2015).

Smoking cessation is particularly difficult for those with lower socioeconomic standing (Flint and Novotny, 1997; Gilman et al., 2003)—contributing to pervasive health disparities (Vidrine et al., 2009a; Vidrine et al., 2009b). Evidence suggests community norms, stressful environments and isolation from mainstream smoking perceptions may play a role in lower smoking cessation rates among these

populations (Stead et al., 2001). Food insecurity, which refers to the physical pain of hunger as well as the more common experience of worrying about having enough healthy food to eat (Coleman-Jensen et al., 2018), could be a contributing factor to poorer smoking cessation among low-income communities.

Cross-sectional data reveal that smoking is highly prevalent among those who are food insecure. For example, among low-income Americans, smoking is 38% more prevalent among households that are food insecure (Armour et al., 2008). However, there is limited and conflicting evidence concerning the causal nature of this relationship. Longitudinal analysis indicates that those who smoke cigarettes are more likely to become food insecure following economic disruptions, and recovery from food insecurity takes longer among persons who smoke (Farrelly and Shafer, 2017)—likely because the added expense further strains financial resources (Hernandez et al., 2017). Additionally, data reveal people use cigarettes to ease psychological distress associated with poor socioeconomic conditions such as food insecurity (Peretti-Watel and Constance, 2009; Twyman et al., 2014). Smoking cigarettes may also provide a coping strategy to aid with

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appetite suppression during times of austerity (Jo et al., 2002). In particular, the influence of food insecurity on smoking cessation is poorly understood.

A core feature of food insecurity is that severity can vary over time—whether over the course of a month, as time passes since receiving a pay check or social assistance (Seligman et al., 2014), or; over longer periods, as broader financial circumstances change (e.g. job loss) (Loopstra et al., 2016). Simply considering the influence of static food insecurity on health and health behaviors overlooks the potential unique role of food insecurity transitions—such as persistent food insecurity or transitioning out of food insecurity. Evidence suggests that prolonged exposure to stressors, such as food insecurity, may diminish the ability to control cravings (Carim-Todd et al., 2016), and; greater stress is associated with higher nicotine dependence (Hobkirk et al., 2018). Therefore, it is hypothesized that remaining food insecure and becoming food insecure will be associated with smoking more cigarettes and a decreased ability to stop smoking cigarettes than those who do not experience food insecurity. Using longitudinal data from a representative sample of U.S. adults over 50 years, this study examined the association of food insecurity transitions with smoking cessation and change in smoking consumption over two years among older adults.

2. Methods

2.1. Sample

Data came from the Health and Retirement Study (HRS)—a nationally representative sample of > 37,000 individuals over age 50 in 23,000 households in the United States (Sonnega et al., 2014). The HRS sample has been built overtime, starting with recruitment of the initial cohort in 1992 of persons born 1931–41. Starting in 1998, HRS made its sample fully representative of the U.S. population over age 50 by enrolling additional age cohorts of persons born 1924–30 and 1942–47. Additionally, HRS uses a steady-state design; meaning, every six years the HRS sample is replenished by recruiting younger age cohorts not previously represented in order to maintain a nationally representative sample. Core questionnaires are mailed every two years to collect information on demographics, socioeconomic status, health and aging-related topics (response rate in 2010 was 88.6%). HRS was approved by the University of Michigan Health Sciences/Behavioral Science Institutional Review Board, and; informed consent is obtained from participants prior to questionnaire administration. HRS is funded by the National Institute on Aging and the Social Security Administration.

Analyses were limited to waves 2012 and 2014—the most recent years of data available so that findings would be most applicable to current economic circumstances and health behavior trends. Those who were not current smokers in 2012 were excluded from the study, no other exclusion criteria were applied. Among the 2650 current smokers who participated in HRS wave 2012, 2296 also participated in HRS wave 2014. The analysis sample was limited to 2197 persons with complete-case data for variables of interest (96% of the eligible sample). All analyses of this study occurred in 2019.

2.2. Measures

2.2.1. Food insecurity

In the United States, the standard for assessing household food insecurity is the U.S. Department of Agriculture (USDA) 18-Item Food Security Tool (Radimer and Kathy, 2002). Additionally, there is a 2-item screen that can identify household food insecurity with a sensitivity of 97% and specificity of 83% compared to the USDA 18-Item Food Security Tool, given an affirmative answer to (1) "*Within the past 12 months we worried whether our food would run out before we got money to buy more*", or; (2) "*Within the past 12 months the food we bought just didn't last and we didn't have money to get more*". In HRS, two survey items comparable to the 2-item food insecurity screen, and, previously used to test associations of food insecurity with diabetic morbidity and depression symptomology within HRS (Bergmans et al., 2019), were used to identify food insecurity in 2012 and 2014.

HRS participants were asked "*Do you have enough money to buy the food you need at all times?*" since their last interview, recorded as yes or no. Those who did not respond "no", were then asked "*Do you eat less than you feel you should because of a lack of money?*". Those who did not have enough money to buy food or ate less due to a lack of money were considered food insecure. Binary food insecurity variables in 2012 and 2014 were used to create a 4-category food insecurity transition variable: (1) Not food insecure—not food insecure in 2012 or 2014, which served as the reference group; (2) Initially food insecure—food insecure only in 2012; (3) Became food insecure—food insecure only in 2014, and; (4) Remained food insecure—food insecure in 2012 and 2014.

2.2.2. Smoking behavior

Both smoking cessation and change in smoking consumption were used as outcome measures for smoking behavior. In 2014, participants were asked "*Do you smoke cigarettes now?*". This was used to create a binary variable for smoking cessation, no longer current smokers vs. current smokers (reference group).

Participants were also asked, "*About how many cigarettes or packs do you usually smoke in a day now?*" in 2012 and 2014. Packs were considered to have 20 cigarettes. This was used to determine change in cigarette smoking consumption (more, fewer or the same amount [reference]). Those who no longer smoked in 2014 were considered to have smoked fewer cigarettes.

2.2.3. Covariates

A number of demographic and socioeconomic covariates were included in analyses. Demographic covariates included age (continuous measure), gender (male [reference] vs. female), race/ethnicity (non-Hispanic White [reference] vs. non-Hispanic Black, other) and marital status in 2012 (married [reference] vs. divorced or separated, widowed, single or never married). Socioeconomic covariates included educational attainment at HRS enrollment (≥ high school degree [reference] vs. < high school degree), work status in 2012 (work for pay [reference] vs. do not work for pay), retirement status in 2012 (partially or fully retired [reference] vs. not retired) and household income-to-poverty ratio in 2012 (continuous). Household income sources included earnings, unemployment, workers' compensation, Social Security, public assistance (e.g. welfare/TANF), veterans' benefits, pension and retirement income, interest, dividends, rents, royalties, income from estates and trusts, educational assistance, alimony, child support and other sources except noncash benefits (i.e. food stamps/Supplemental Nutrition Assistance Program benefits) from all resident family members.

Additionally, analyses adjusted for life transitions that could confound associations of food insecurity transitions with smoking cessation. Indicators for life transitions included change in marital status, change in income and employment transition. Those who no longer work for pay may lose access to social networks that are important for influencing or reinforcing certain health behaviors (Cornwell and Waite, 2009). Those who indicated that they were widowed or divorced in 2014 but were not widowed or divorced in 2012, were considered to have experienced a change in marital status (no change in marital status or unmarried in 2012 [reference]). Among those who worked for pay in 2012, those who indicated that they did not work for pay in 2014 were considered to have experienced an employment transition. Additionally, among those who were not retired in 2012 but did indicate that they were partially or fully retired in 2014 were considered to have experienced an employment transition. Those who did not experience a loss of work for pay or who did not become retired in 2014 served as the reference group for employment transition. Change in income was a continuous measure calculated by the difference in income-to-poverty-

Table 1

Characteristics by food insecurity (FI) transition among older adults who smoked in 2012, 2012 to 2014[a,b].

Characteristics	FI transition 2012 to 2014				P[c]
	Not FI n = 1559	Initially FI in 2012 $n = 185$	Became FI in 2014 $n = 174$	Remained FI in 2014 $n = 279$	
Age, mean (95% *CI*)	62.1 (61.5, 62.8)	60.0 (59.1, 60.9)	59.4 (58.1, 60.7)	59.5 (58.6, 60.5)	< 0.001
Gender					0.002
Male	733 (76.5)	95 (9.1)	72 (6.6)	99 (7.8)	
Female	826 (71.2)	90 (7.7)	102 (7.3)	180 (13.7)	
Race/ethnicity					< 0.001
Non-Hispanic White	965 (78.8)	77 (7.4)	66 (5.4)	107 (8.4)	
Non-Hispanic Black	377 (60.5)	75 (12.1)	65 (9.9)	125 (17.5)	
Other	217 (61.8)	33 (9.2)	43 (12.7)	47 (16.4)	
Marital status					< 0.001
Married	747 (81.3)	58 (6.5)	23 (7.4)	71 (5.8)	
Separated or divorced	347 (66.2)	51 (9.6)	51 (8.4)	93 (15.8)	
Widowed	205 (70.3)	21 (7.6)	69 (6.4)	40 (14.7)	
Single or never married	260 (68.4)	55 (11.5)	31 (6.1)	75 (14.0)	
Educational attainment[d]					0.003
< High school	1719 (77.0)	187 (7.1)	160 (6.8)	195 (9.1)	
High school degree or above	10,000 (90.7)	449 (3.6)	370 (2.8)	386 (3.0)	
Income-to-poverty ratio (IPR), mean (95% *CI*)	4.6 (4.2, 5.1)	2.1 (1.6, 2.7)	1.9 (1.5, 2.3)	1.5 (1.3, 1.7)	< 0.001
Work status					< 0.001
Do not work for income	892 (68.9)	125 (9.3)	118 (7.9)	205 (13.8)	
Work for income	667 (80.0)	60 (7.2)	56 (5.8)	74 (7.0)	
Retirement status					0.42
Not retired	703 (75.2)	84 (8.7)	77 (6.3)	128 (9.7)	
Partially or fully retired	856 (72.5)	101 (8.1)	97 (7.6)	151 (11.9)	
Divorced or widowed in 2014					0.002
No	74 (67.2)	11 (10.1)	15 (16.9)	10 (5.8)	
Yes	1485 (74.2)	174 (8.3)	159 (6.4)	269 (11.1)	
IPR change in 2014, mean (95% *CI*)	−0.5 (−0.8, −0.1)	0.1 (−0.1, 0.4)	0.0 (−0.2, 0.3)	0.1 (−0.1, 0.3)	0.041
Employment transition in 2014					0.22
No	1320 (74.8)	152 (7.8)	140 (6.8)	222 (10.5)	
Yes	239 (68.6)	33 (11.2)	34 (7.8)	57 (12.4)	
New health diagnosis in 2014[e]					0.24
No	1204 (75.0)	138 (8.4)	125 (6.4)	200 (10.1)	
Yes	355 (70.0)	47 (8.2)	49 (8.7)	79 (13.1)	
Smoking cessation in 2014					0.023
No	1297 (74.4)	156 (8.7)	133 (6.0)	227 (10.9)	
Yes	262 (71.0)	29 (7.0)	41 (11.7)	52 (10.3)	
Change in smoking consumption[f]					0.22
Same	541 (77.4)	65 (8.9)	49 (4.9)	76 (8.8)	
More	333 (72.5)	32 (6.9)	35 (7.5)	66 (13.2)	
Fewer	685 (71.6)	88 (8.7)	90 (8.4)	137 (11.3)	

[a] Data come from the U.S. Health and Retirement Study (HRS) and cell values represent row percentages unless otherwise indicated.

[b] All variables assessed in 2012 unless otherwise indicated.

[c] X^2 or F test.

[d] Assessed during initial HRS enrollment wave.

[e] Additional number of chronic conditions in 2014 vs. 2012.

[f] Number of cigarettes per day in 2014 vs. 2012.

ratio between 2012 and 2014. Lastly, analyses accounted for being diagnosed with a new chronic condition, since individuals may be more likely to change their behavior following disease onset (Keenan, 2009), and; costs associated with hospitalization could increase risk of food insecurity. In 2012 and 2014, number of chronic conditions was determined based on which of the following 8 diagnoses a respondent reported a history of: psychiatric problems, arthritis, high blood pressure, heart disease, stroke, diabetes, lung disease and cancer. Those with a greater number of chronic conditions in 2014, than in 2012, were considered to have received a new diagnosis. Those without a new diagnosis served as the reference group.

Depressive disorder has been associated with poorer smoking cessation (Agrawal et al., 2008) and has a bidirectional relationship with food insecurity (Huddleston-Casas et al., 2009), therefore sensitivity analyses accounted for depression status. In 2012, HRS assessed depression over the previous year using the World Health Organization Composite International Diagnostic Interview Short Form (CIDI-SF). The CIDI-SF is designed to identify Major Depression based on the Diagnostic and Statistical Manual of Mental Disorders criteria (American Psychiatric Association, 2013). To be considered depressed,

respondents must report symptoms of anhedonia or depressed mood most of the day for over half of a 2-week period or longer to be considered depressed. Those that meet this screening requirement complete an additional seven items which assess symptoms of lost interest, fatigue, weight change, trouble with sleep, trouble concentrating, feeling down and thoughts of death. HRS respondents who scored ≥ 3 depression symptoms on the 0 to 7 symptom scale were considered to have experienced a major depressive episode in 2012 (*Documentation of Affective Functioning Measures in the Health and Retirement Study*, 2000).

2.3. Statistical approach

All analyses were conducted using SAS 9.4 (SAS Institute Inc, 2013) and used survey procedures to account for HRS survey design. First, x^2 tests compared the distribution of demographic factors; socioeconomic status; change in marital status, income and employment; diagnosis of new chronic conditions and; smoking cessation across levels of food insecurity transitions. Given that analysis of longitudinal data may be sensitive to attrition bias (Weir et al., 2011), demographic and socioeconomic characteristics for those who participated in the HRS 2012

Table 2
Food insecurity (FI) transition and smoking cessation among older adults, HRS[a] 2012 and 2014[b].

	Crude		Model 1 demographics		Model 2 demographics and socioeconomic status		Model 3 demographics, socioeconomic status and life transitions	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
FI transition		0.033		0.024		0.032		0.048
Not FI	Ref.		Ref.		Ref.		Ref.	
Initially FI in 2012	0.8 (0.5, 1.4)		0.9 (0.5, 1.5)		0.9 (0.5, 1.4)		0.8 (0.5, 1.4)	
Became FI in 2014	2.0 (1.2, 3.4)		2.1 (1.3, 3.5)		2.1 (1.2, 3.5)		2.0 (1.1, 3.4)	
Remained FI in 2014	1.0 (0.6, 1.7)		1.0 (0.6, 1.8)		1.0 (0.6, 1.7)		1.0 (0.6, 1.6)	
Age, mean (95% CI)	–		1.0 (1.0, 1.0)	0.12	1.0 (1.0, 1.0)	0.14	1.0 (1.0, 1.0)	0.25
Gender				0.25		0.24		0.19
Male			Ref.		Ref.		Ref.	
Female	–		1.2 (0.9, 1.7)		1.2 (0.9, 1.7)		1.2 (0.9, 1.7)	
Race/ethnicity				0.45		0.28		0.23
Non-Hispanic white			Ref.		Ref.		Ref.	
Non-Hispanic black	–		1.0 (0.7, 1.6)		1.1 (0.7, 1.7)		1.0 (0.6, 1.7)	
Other	–		1.3 (0.8, 2.1)		1.4 (0.9, 2.3)		1.5 (0.9, 2.4)	
Marital status				0.18	0.9 (0.5, 1.5)	0.13		0.11
Married			Ref.		Ref.			
Separated or divorced	–		0.7 (0.4, 1.0)		0.6 (0.4, 1.0)		0.6 (0.4, 0.9)	
Widowed	–		0.7 (0.4, 1.2)		0.7 (0.4, 1.2)		0.7 (0.4, 1.2)	
Single or never married	–		0.9 (0.5, 1.5)		0.9 (0.5, 1.5)		0.9 (0.5, 1.5)	
Educational attainment[c]						0.09		0.07
< High school					Ref.		Ref.	
High school degree or above	–		–		1.4 (0.9, 2.1)		1.5 (1.0, 2.2)	
Income-to-poverty ratio (IPR)	–		–		1.0 (0.9, 1.0)	0.20	1.0 (0.9, 1.0)	0.18
Work status						0.62		0.76
Do not work for income					Ref.		Ref.	
Work for income	–		–		1.1 (0.8, 1.4)		1.0 (0.8, 1.4)	
Retirement status						0.92		0.46
Not retired					Ref.		Ref.	
Partially or fully retired	–		–		1.0 (0.7, 1.5)		1.2 (0.8, 1.7)	
Divorced or widowed in 2014								0.73
No							Ref.	
Yes	–		–		–		0.9 (0.5, 1.7)	
IPR change in 2014	–		–		–		1.0 (0.9, 1.0)	0.44
Employment transition in 2014								0.020
No							Ref.	
Yes	–		–		–		1.6 (1.1, 2.4)	
New health diagnosis in 2014								0.026
No							Ref.	
Yes	–		–		–		1.4 (1.0, 2.0)	

[a] U.S. Health and Retirement Study.
[b] $n = 2197$.
[c] Assessed during HRS enrollment wave.

wave to those who participated in the HRS 2012 *and* 2014 wave (i.e. the analysis sample) were compared.

Next, multivariable logistic regression examined the association of food insecurity transitions with smoking cessation. Model 1 accounted for demographic factors (age, gender, race/ethnicity and marital status). Model 2 accounted for demographic factors and socioeconomic status (all variables in Model 1, plus educational attainment, household income-to-poverty ratio, work and retirement status).

Model 3 accounted for demographic factors, socioeconomic status and life transitions (all variables in Model 2, plus becoming divorced or widowed, change in household income, employment transition and being diagnosed with a new chronic condition). Interaction terms of food insecurity with demographic (age, marital status, gender) and socioeconomic (work status, retirement status, educational attainment) factors were tested in Model 3 using separate models.

Multinomial logistic regression was used to determine the association of food insecurity transitions with change in smoking behavior, using no change in cigarette consumption as the reference. Analyses accounted for demographic factors, socioeconomic status and life transitions. Interaction terms of food insecurity by demographic and

socioeconomic factors were tested using separate models. Finally, sensitivity analyses included 2012 depression status as a covariate in fully adjusted models for both smoking cessation and change in smoking consumption.

3. Results

Table 1 describes the analysis sample ($n = 2197$). Among those who smoked cigarettes in 2012, 384 persons no longer smoked in 2014 (17%), 185 persons were initially food insecure (8%), 174 persons became food insecure in 2014 (8%), 279 persons remained food insecure (13%), while a majority did not report food insecurity ($n = 1559$; 71%). Overall, social and economic disadvantage were less common among those who were food secure. When looking across food insecurity transitions, those who remained food insecure represented the lowest income group (1.5 household income-to-poverty ratio (IPR); 95% confidence interval (CI) = 1.3, 1.7) compared to those who were initially food insecure or became food insecure (average IPR~ = 2.0). Not earning income; being separated, divorced or widowed; being female and; being non-Hispanic Black was also more common among those

Table 3

Multinomial logistic regression for the association of food insecurity (FI) transition with smoking more or fewer cigarettes[a], HRS[b] 2012–2014[c].

	Change in number of cigarettes smoked per day		
	More	Fewer	
	OR (95% CI)	OR (95% CI)	P
FI transition			0.65
Not FI	Ref.	Ref.	
Initially FI in 2012	0.8 (0.4, 1.5)	1.0 (0.6, 1.5)	
Became FI in 2014	1.4 (0.7, 2.8)	1.6 (0.9, 2.9)	
Remained FI in 2014	1.5 (0.8, 2.8)	1.2 (0.7, 2.0)	
Age, mean (95% CI)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	0.48
Gender	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	0.67
Male	Ref.	Ref.	
Female	1.0 (0.8, 1.3)	1.1 (0.9, 1.5)	
Race/ethnicity			0.023
Non-Hispanic White	Ref.	Ref.	
Non-Hispanic Black	1.4 (1.0, 2.0)	1.3 (0.9, 1.9)	
Other	2.1 (1.3, 3.5)	1.5 (1.0, 2.3)	
Marital status			0.39
Married	Ref.	Ref.	
Separated or divorced	0.8 (0.6, 1.1)	1.0 (0.7, 1.4)	
Widowed	0.8 (0.5, 1.4)	0.7 (0.5, 1.1)	
Single or never married	0.9 (0.6, 1.4)	1.1 (0.7, 1.6)	
Educational attainment[d]			0.39
< High school	Ref.	Ref.	
High school degree or above	1.1 (0.8, 1.5)	1.3 (0.9, 1.8)	
Income-to-poverty ratio (IPR)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	0.96
Work status			0.24
Do not work for income	Ref.	Ref.	
Work for income	0.9 (0.5, 1.4)	0.7 (0.5, 1.1)	
Retirement status			0.76
Not retired	Ref.	Ref.	
Partially or fully retired	1.2 (0.7, 1.8)	1.1 (0.8, 1.5)	
Divorced or widowed in 2014			0.39
No	Ref.	Ref.	
Yes	1.4 (0.6, 2.9)	1.4 (0.8, 2.3)	
IPR change in 2014	1.0 (1.0, 1.1)	1.1 (1.0, 1.1)	0.11
Employment transition in 2014			0.21
No	Ref.	Ref.	
Yes	0.9 (0.6, 1.4)	1.3 (0.9, 1.9)	
New health diagnosis in 2014			0.015
No	Ref.	Ref.	
Yes	1.0 (0.7, 1.4)	1.5 (1.1, 2.0)	

[a] Number of cigarettes per day in 2014 vs. 2012; reference = same number/no change.
[b] U.S. Health and Retirement Study.
[c] *n* = 2197.
[d] Assessed during HRS enrollment wave.

who remained food insecure in 2014 compared to initially being food insecure or becoming food insecure.

When considering smoking behavior, proportions of smoking cessation were similar across food insecurity transitions—except for those who became food insecure. Among those who quit smoking, 12% became food insecure, whereas only 6% of those who did not quit smoking became food insecure. For change in smoking consumption, proportions did not appear to vary by food insecurity transition.

Supplemental Table 1 compares the distribution of characteristics for HRS respondents who smoke among those who participated in 2012 wave to the analysis sample (i.e. those who participated in 2012 and 2014). Proportions across characteristics differed by no > 1%, and, age and household income-to-poverty ratio were comparable. This indicates that attrition bias was not a concern.

Table 2 shows the odds of smoking cessation by food insecurity transition. In fully adjusted models, those who became food insecure had a 2.0 (95% *CI* = 1.1, 3.4) times higher odds of smoking cessation than those who did not report food insecurity. However, other food

insecurity transitions were not associated with smoking cessation. Additionally, both employment transition and being diagnosed with a new chronic condition were associated with cessation. Those who stopped earning income or became retired had a 1.6 (95% CI = 1.1, 2.4) times higher odds of smoking cessation than those who did not experience a change in employment status. Those with a new health diagnosis had a 1.4 (95% CI = 1.0, 2.0) times higher odds of smoking cessation than those without a new health diagnosis. Findings were not moderated by demographic or socioeconomic factors (data not shown). Additionally, results remained unchanged when accounting for 2012 depression status in sensitivity analyses (*n* = 2167). Meeting criteria for major depression in 2012 was not associated with smoking cessation (odds ratio (*OR*) = 0.8; 95% CI = 0.5, 1.2).

When using multinomial regression to examine changes in smoking consumption, testing main effects indicated that food insecurity transition was not associated with smoking more or fewer cigarettes (Table 3). However, interactions were present for gender (interaction *p*-value = 0.025) and marital status (interaction *p*-value < 0.001)—which were subsequently explored using stratified analyses. Among women, becoming food insecure was associated with a 2.9 (1.4, 6.2) times higher odds of smoking fewer cigarettes *and* a 3.0 (1.3, 6.8) times higher odds of smoking more cigarettes (Fig. 1). Food insecurity transition was not associated with change in smoking behavior among men (data not shown). Among those who were widowed; being initially food insecure in 2012 was associated with smoking more cigarettes in 2014 (*OR* = 8.0; 95% *CI* = 1.8, 35.9). Food insecurity transition was not associated with change in smoking consumption for those who were married; separated or divorced or; single or never married (data not shown). Adjusting for 2012 depression status in sensitivity analyses did not change findings for associations between food insecurity transition with change in smoking consumption.

4. Discussion

Findings of this study clarify the association of food insecurity with smoking behavior among older adults. In a representative sample of adults age 50 or older in the U.S., becoming food insecure was associated with a greater odds of smoking cessation. Additionally, employment loss or retirement and being diagnosed with a new chronic condition were associated with smoking cessation. Being diagnosed with a new chronic conditions was also associated with smoking fewer cigarettes. Findings suggest that decreased spending power and the onset of health problems is associated with smoking reduction among older Americans. Future studies should examine whether smoking cessation in response to food insecurity makes individuals more susceptible to relapse than if they had decided to quit smoking for other reasons.

While it was initially hypothesized that persistent food insecurity or onset of food insecurity would make smoking cessation less likely—evidence of this study indicated otherwise. Instead, smoking cessation appears to be a coping mechanism by which older adults deal with the onset of food insecurity. This task-oriented response to becoming food insecure is consistent with prior research on coping over the life course. Lazarus (1996) posits that once the reality of a situation has been accepted, people tend to respond to life stressors in constructive ways, regardless of age. Given that cigarette smoking increases risk of food insecurity (Farrelly and Shafer, 2017), no longer having the need to purchase cigarettes due to smoking cessation frees up financial resources that can be used to obtain food.

While not the main focus of this study, findings also indicate that leaving the work force and being diagnosed with a new chronic condition are associated with smoking cessation and smoking fewer cigarettes among older adults. Prior research has examined similar associations. In HRS waves 1992–2010, Quiñones et al. (2017) also observed that a new health diagnosis is associated with greater smoking cessation. However, analyses within the HRS 1994 wave revealed that
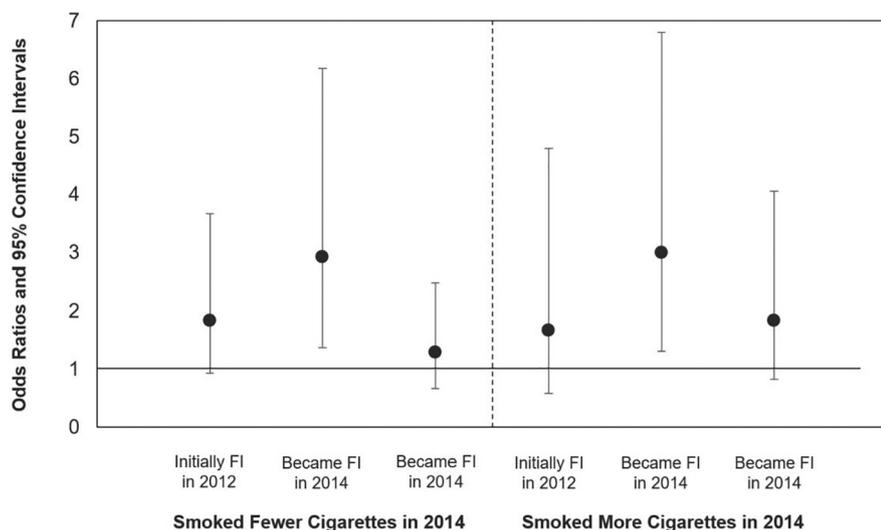
Fig. 1. Multinomial logistic regression for the association of food insecurity (FI) transition with change in smoking behavior[a] among women, HRS[b] 2012-2014[c–e].
[a]Number of cigarettes per day in 2014 vs. 2012; reference = same number/no change.
[b]U.S. Health and Retirement Study.
[c]n (men and women) = 2197; n (women subsample in stratified analyses) = 1197.
[d]Accounting for age, race/ethnicity, marital status, educational attainment, household income-to-poverty ratio, work status, retirement status, change in household income-to-poverty ratio, employment transition and being diagnosed with a new health condition.
[e]Food insecurity transition and gender interaction p-value = 0.025.

involuntary job loss was associated with smoking relapse among those who previously quit smoking and, smoking more cigarettes among current smokers. This earlier study by Falba et al. (2005) is contradictory with current findings. Additional research is needed to determine whether associations of food insecurity and employment transitions with smoking cessation could be moderated by macro-level factors across time periods, such as the Great Recession or cigarette taxation.

Among European adults ≥50 years who smoked at baseline, becoming widowed or divorced was associated with a lower probability of smoking cessation, whereas; transitions to unemployment and retirement were not associated with smoking cessation (Trias-Llimós et al., 2017). Further research is needed to determine why trends among U.S. older adults concerning associations of marriage and employment transitions with smoking cessation appear to be incongruent with those in Europe. The finding that depression was not associated with smoking cessation or change is smoking consumption also contrasts with prior work, which observed that older adults with depressive disorders were less likely to have quit smoking in the 12-months prior (Agrawal et al., 2008).

Interestingly, when examining moderation of the association between food insecurity transition and change in smoking consumption, interactions were observed for gender and marital status. Future studies should seek to replicate these findings since they were not part of initial hypotheses. Among women, becoming food insecure was associated with a higher odds of smoking fewer cigarettes *and* a higher odds of smoking more cigarettes—as opposed to smoking the same amount. Future research is needed to examine what additional factors contribute to smoking consumption decisions among women who become food insecure. While the association of becoming food insecure with smoking more cigarettes is consistent with initial hypotheses, it is not clear why this was only observed for women and requires further study. Additionally, more work is needed to determine why transitioning out of food insecurity could be associated with smoking more cigarettes among those who are widowed.

5. Limitations

HRS provides a nationally representative sample of older adults who smoke in the United States from 2012 to 2014. The relatively high initial-response and re-interview rates within HRS, and, the use of survey weights in analyses, which account for differential non-response, help mitigate selection bias (Sonnega and Weir, 2014). Additionally, findings indicated that attrition bias was not a concern, given that the distribution of characteristics for HRS respondents in 2012 was similar

for those who also participated in 2014.

However, a number of limitations should be considered. Data collection in HRS prevents drawing causal conclusions since both food insecurity and smoking behavior are collected at the same time point every two years. When assessing smoking status, HRS asks study participants about cigarette use specifically. Therefore, this study could not examine tobacco use and smoking cessation from other sources (e.g. chew, pipe, cigar, e-cigarettes). Findings should not be generalized to younger adults. Trends in smoking cessation differ across age groups. For example, quit attempts tend to be more common among those in their early to mid-40's (Agrawal et al., 2008). By the time individuals reach 50 years or above, it may take greater pressure from external factors (e.g. financial strain from food insecurity or onset of a chronic illness) to motivate smoking cessation. Thus, further research is needed to determine whether findings of this study may be similar among younger age groups. While analyses adjust for a number of demographic and socioeconomic factors, health status and life transitions; it is possible that there is residual confounding due to other factors such as area-level socioeconomic status. For example, 'food deserts'—i.e. areas with poor access to a variety of healthy, affordable foods—have a higher density of 'convenience stores' (Alviola et al., 2013), where 69% of cigarette sales to current adult smokers occur in the U.S. (Kruger et al., 2017).

6. Conclusions

Among older adults in the U.S., smoking cessation and smoking fewer cigarettes were associated with decreased spending power and the onset of new health problems. Unexpectedly, becoming food insecure was associated with higher odds of smoking cessation. Future studies should examine whether smoking cessation due to food insecurity makes older adults more susceptible to relapse than if they had decided to quit smoking for other reasons. Determining whether associations of food insecurity with smoking behavior vary in response to macro-level factors across time periods (e.g. economic recession, cigarette taxation) could be of particular benefit to policy makers. Additionally, qualitative data could reveal decision making processes for smoking behavior in response to food insecurity transitions—which could help identify underlying pathways when considering moderation by gender and marital status.

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Declaration of Competing Interest

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