



Cross-sectional associations of food insecurity with smoking cigarettes and heavy alcohol use in a population-based sample of adults

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ABSTRACT

Background: Smoking, alcohol abuse and dual substance use represent significant public health problems and are thought to contribute to significant disparities in morbidity and mortality in the United States. Associations of food insecurity with these substances are poorly characterized, particularly concerning heavy alcohol consumption and dual substance use. Additionally, demographic factors may moderate these associations.

Methods: In a cross-sectional, representative sample of Wisconsin adults ($n = 1616$), logistic regression was used to examine whether food insecurity was associated with cigarette smoking, heavy alcohol use and dual substance use. Interactions of food insecurity with gender, marital status and age group tested moderation by demographic factors.

Principal Findings: Food insecurity was associated with cigarette smoking in men and women (odds ratio (OR) = 3.0, 95% confidence interval (CI) = 2.1–4.4); however, only among men was food insecurity associated with heavy alcohol use (OR = 1.5; 95% CI = 1.0–2.2) and dual substance use (OR = 5.2; 95% CI = 1.5–18.6). Marital status and age group did not moderate associations of food insecurity with substance use.

Conclusions: Food insecurity and substance use are highly correlated. Heavy alcohol consumption and dual use were positively correlated with food insecurity among men, but not among women. Longitudinal analyses are needed to disentangle temporality and underlying pathways of observed associations. Additionally, future work should determine whether interventions and policies targeting food insecurity can simultaneously reduce cigarette and alcohol use.

1. Introduction

Smoking cigarettes and heavy alcohol use are a significant public health concern in the United States. Tobacco contributes to over \$300 billion a year in U.S. economic costs, and to a litany of medical morbidities as the leading cause of preventable death (Federal Trade Commission (FTC), 2019; Department of Health and Human Services (DHHS), 2014; Xu et al., 2015). Heavy and excessive alcohol use is also economically costly and implicated in greater morbidity and mortality among U.S. adults (Rehm et al., 2014; Sacks et al., 2015). Dual use of cigarettes and alcohol is particularly burdensome given an increased risk for several diseases (e.g. cirrhosis, aerodigestive tract cancers) beyond either substance alone (McKee and Weinberger, 2013; Hashibe et al., 2007), and; both smoking cessation and alcohol disorder remission are more difficult among dual users (Weinberger et al., 2015, 2017). Smoking cigarettes and alcohol disorders are disproportionately prevalent among those who are socially or economically disadvantaged,

and subsequently represent considerable health disparities in life expectancy and mortality (Östergren et al., 2019).

Targeting food insecurity to reduce tobacco- and alcohol-related health disparities could be particularly effective. Food insecurity refers to both the physical pain of hunger as well as worrying about having enough nutritious food to eat. As a social determinant of health, food insecurity has a complex relationship with other social and economic factors at the individual- and macro-level to influence health and health behavior—including substance use (Adler et al., 2016). Physical and economic access to adequate food by all individuals at all times is declared a human right by the United Nations, emphasizing the public health obligation to address food insecurity (Committee on Economic, Social and Cultural Rights, 1999). Despite having the largest economy in the world, roughly 12% of the U.S. population is food insecure, with rates particularly high among persons of color (20%) and single mothers (30%) (Coleman-Jensen et al., 2018; International Monetary Fund, 2019). Food insecurity is associated with a number of negative

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health outcomes, including depression, poor diet quality and disordered eating—even after accounting for other indicators of socioeconomic status (Bergmans et al., 2019; Bergmans et al., 2018b; Rasmusson et al., 2019). Prior work demonstrates that food insecurity and its health impacts can be ameliorated using food assistance programs (Nord, 2010; Frongillo and Wolfe, 2010; Bergmans et al., 2018a). Thus, if food insecurity is linked with cigarette and heavy alcohol use, such programs could offer a unique opportunity to concurrently address substance use.

A number of underlying pathways could link food insecurity with substance use. Smoking cigarettes and heavy alcohol consumption may be a strategy used by individuals who are food insecure to cope with the unique psychological strain of not having reliable access to food, and the stigma associated with social assistance dependence. Evidence suggests that while there is a strong desire to quit smoking among those with low-income due to health concerns, disapproval by significant others and financial burden; smoking cessation is perceived to be extremely challenging (Wiltshire et al., 2003). Individuals who have low-income express that smoking cigarettes is one of the few luxuries they can still afford (Peretti-Watel and Constance, 2009). Prior work has suggested that smoking may provide a strategy for appetite suppression during times of significant food scarcity (Jo et al., 2002). Additionally, cigarette and alcohol purchases may deplete financial resources that would otherwise be used to purchase food, thus exacerbating food insecurity (Hernandez et al., 2017).

While food insecurity is correlated with greater severity of tobacco use, less is known when considering alcohol disorders or the dual use of tobacco and alcohol with food insecurity (Hobkirk et al., 2018; Carim-Todd et al., 2016). Additionally, evidence is limited concerning whether associations of food insecurity with cigarette and alcohol use differ across population subgroups—specifically age, gender and marital status. Overall substance use is more common among younger age groups and men (Jamal, 2016; Drope et al., 2018; Linden-Carmichael et al., 2017), which may be due to greater impulsivity and higher rates of externalizing behaviors, particularly when younger persons and men in general are exposed to social stressors (Ayer et al., 2011; Corbin et al., 2013). Additionally, in post hoc analyses, Bergmans (2019) observed that becoming food insecure was associated with an increase in daily cigarette consumption among older women who smoke, whereas this was not the case for men. Marriage is another factor that may moderate the association of food insecurity with substance use. Marriage as a source of social support is considered to have protective health effects, especially for men (Reczek and Umberson, 2012; Umberson et al., 2010). For both men and women, those who are married are less likely to smoke tobacco or abuse alcohol than those who are not currently married.

This study aimed to determine associations of food insecurity with smoking cigarettes, heavy alcohol use and dual use. Additionally, we examined whether associations were moderated by age group, gender or marital status. We hypothesized that food insecurity would be associated with greater odds of smoking, heavy alcohol use and dual use—independent of other socioeconomic factors. Additionally, we hypothesized that associations of food insecurity and substance use would be stronger for younger age groups, males and unmarried persons.

2. Methods

2.1. Sample

Cross-sectional data from the Survey of the Health of Wisconsin (SHOW) collected between 2014–2016 was used. SHOW includes a randomly selected household-based sample of Wisconsin adults (aged ≥ 18 years) (Nieto et al., 2010). A three-stage probability-based stratified cluster sampling approach was used to select participants. County serves as the primary sampling unit stratified by mortality. The secondary sampling unit was census block groups stratified by poverty and

randomly selected with probability proportional to size. The tertiary sampling unit includes all persons residing in randomly selected households (Survey of the Health of Wisconsin (SHOW), 2019). Since 2008, SHOW has collected information on a broad range of demographics, socioeconomic status, health history and health behaviors among Wisconsin residents. Informed consent was obtained prior to data collection via in-home interview, questionnaire and physical exam, and collection of biological samples (Nieto et al., 2010).

All SHOW protocols were approved and regulated by the University of Wisconsin, Madison Health Sciences Institutional Review Board (IRB). The University of Michigan Medical School IRB determined that secondary analysis of SHOW data for this study did not require IRB approval. Among the 1758 adults who participated in SHOW 2014–2016, 1616 (92%) had complete case data for all variables of interest.

2.2. Measures

Smoking—To identify current smokers, two self-report survey items were used. Respondents were asked ‘Have you smoked 100 or more cigarettes in your entire life?’ and ‘Do you smoke cigarettes now?’. Those who responded ‘yes’ to both of these items were considered current smokers, those who did not respond ‘yes’ were considered either former or never smokers and served as the reference group.

Heavy Alcohol Use—Men who reported consuming > 14 drinks/week and women who reported consuming > 7 drinks/week were considered to meet criteria for heavy alcohol use, which is consistent with gender-specific risk of developing alcohol use disorder as defined by the National Institute for Alcohol Abuse and Alcoholism (Drinking Levels Defined | National Institute on Alcohol Abuse and Alcoholism (NIAAA) (2019)). Those who drank less than these cut points were not considered to meet criteria for heavy alcohol use and served as the reference group.

Dual Substance Use—Those who were both current smokers and met criteria for heavy alcohol use were considered to meet criteria for dual substance use. All others were considered to have none or single substance use and served as the reference group.

Food Insecurity—Three survey items were used to create a binary indicator of food insecurity, (1) “(I/We) worried whether (my/our) food would run out before (I/We) got money to buy more”, (2) “The food that (I/we) bought just didn’t last, and (I/we) didn’t have money to get more” and (3) “(I/We) could not afford to eat balanced meals”. Those who responded that any of these statements was “often true” or “sometimes true” over the previous 12 months were considered food insecure. Those who responded that all three statements were “never true” over the previous 12 months were considered not food insecure and served as the reference group. This criterion was based on the United States Department of Agriculture 6-item Short Form Food Security Module (“U.S. Household Food Security Survey Module: Six-Item Short Form”, 2012), which is an international standard for identifying food insecurity.

Covariates—A number of demographic and socioeconomic covariates were included in analyses due to their potential to confound associations between food insecurity and substance use. Demographic covariates included age group (18 to < 35 [reference group], 35 to < 50 , 50 to < 65 , ≥ 65), race/ethnicity (non-Hispanic White [reference group], non-Hispanic Black, other race/ethnicity or multi-racial), marital status (married [reference group], single or living with partner, divorced or separated or widowed) and gender (male [reference group], female). Socioeconomic covariates included income-to-poverty ratio (continuous measure) estimated based on total household income and number of individuals in the home compared to federal poverty estimates provided by the Wisconsin Department of Health Services (Levy, 2008), educational attainment (treated as a continuous measure across 5 categories: $<$ high school degree, high school degree or equivalent, some college, associate’s degree, bachelor’s degree or

above), and employment status (employed [reference group], unemployed, other).

2.3. Statistical analysis

All analyses were conducted using SAS version 9.4 (SAS Institute Inc., 2013). Survey procedures were employed to account for SHOW's complex sampling design. First, χ^2 and F tests compared sample characteristics by food insecurity status. Next three separate logistic regression models were used to examine associations of food insecurity with current smoking status, heavy alcohol consumption and dual use. Fully adjusted models accounted for age category, gender, race, marital status, education attainment, household income-to-poverty ratio and employment status. Finally, moderation by demographic factors (i.e. marital status, age group and gender) with food insecurity were tested separately as interactions in fully adjusted models.

3. Results

There were 1616 adults age 18 and over in the analytic sample. Of these, 24% were food insecure ($n=382$), 13% currently smoked cigarettes ($n=216$), 14% reported heavy consumption of alcohol ($n=220$), and 3% reported dual substance use ($n=45$). Table 1 shows sample characteristics by food insecurity status. A larger proportion of self-identified non-Hispanic Blacks were food insecure compared to non-Hispanic Whites (14% vs 4%). People who were food insecure were

Table 1
Characteristics of Wisconsin adults, SHOW^a 2014–2016^b.

Characteristics	Food Insecure		P^c value
	No	Yes	
	$n = 1,234$	$n = 382$	
Age Category			< 0.001
18 to < 35 years	188 (19.5)	136 (42.1)	
35 to < 50	251 (24.2)	109 (28.8)	
50 to < 65	394 (33.1)	89 (21.5)	
≥ 65	401 (23.3)	48 (7.6)	
Female	665 (48.4)	235 (55.9)	0.082
Race/Ethnicity			< 0.001
Non-Hispanic White	1,103 (89.3)	273 (72.9)	
Non-Hispanic Black	37 (2.9)	59 (13.8)	
Other Race or Multiracial	94 (7.8)	50 (13.3)	
Marital Status			< 0.001
Married	863 (68.2)	158 (40.8)	
Divorced, Separated or Widowed	205 (14.3)	85 (19.3)	
Single or Living with Partner	166 (17.4)	139 (39.9)	
Educational Attainment			< 0.001
< High School Degree	50 (4.1)	38 (9.1)	
High School Degree or Equivalent	202 (16.5)	98 (27.2)	
Some College	212 (17.3)	92 (26.2)	
Associates Degree	202 (16.9)	77 (18.2)	
Bachelor's Degree or Above	568 (45.2)	77 (19.4)	
Household income-to-poverty ratio, mean (95% CI)	4.4 (4.0, 4.7)	2.0 (1.7, 2.3)	< 0.001
Employment Status			< 0.001
Employed	712 (63.7)	221 (61.5)	
Unemployed	28 (3.0)	37 (10.0)	
Not Working and Not Seeking Employment	494 (33.3)	124 (28.5)	
Currently Smoke Cigarettes	94 (8.4)	122 (33.6)	< 0.001
Heavy Alcohol Consumption ^d	161 (12.9)	59 (16.8)	0.133
Dual Substance Use ^e	19 (1.6)	26 (8.0)	0.007

^a Survey of the Health of Wisconsin.

^b Cell values represent column percentages.

^c χ^2 or F test.

^d Men who reported consuming > 14 drinks/week and women who reported consuming > 7 drinks/week were considered to meet criteria for heavy alcohol use.

^e Currently Smoke Cigarettes and Heavy Alcohol Consumption.

also more likely to be single or living with a partner than married (40% vs. 17%). Those who were food insecure also had lower socioeconomic status. Household income-to-poverty ratio (PIR) was 2.0 (95% confidence interval (CI) = 1.7, 2.3) among those who were food insecure compared to 4.4 (95% CI = 4.0, 4.7) among those who were food secure. Additionally, food insecurity was more common among those with less than a high school degree (9% vs. 4% of those food secure) and those who were unemployed (10% vs. 3% of those food secure).

Table 2 shows odds ratios (OR's) and 95% CIs for the association of food insecurity with current smoking status. Smoking was more common among individuals who were food insecure. Those who were food insecure had a 5.5 (95% CI = 4.2, 7.3) times higher odds of currently smoking cigarettes. In fully adjusted models this association remained but was diminished (OR = 3.0; 95% CI = 2.1, 4.4). A number of covariates were also associated with current smoking status. Those who were ≥ 65 had a 0.4 (95% CI = 0.2, 0.9) times lower odds of currently smoking cigarettes than those 18 to < 35. Women had a 0.6 (95% CI = 0.5, 0.9) times lower odds of currently smoking cigarettes. The odds of current smoking was greater for those who were divorced, separated, or widowed (OR = 2.5; 95% CI = 1.8, 3.4) than those who were married. Greater educational attainment (OR = 0.6; 95% CI = 0.5, 0.7) and household income (OR = 0.8; 95% CI = 0.7, 0.9) were inversely associated with current smoking status.

Table 3 shows OR's and 95% CIs for the association of food insecurity with heavy alcohol use. In the adjusted model, food insecurity was not associated with heavy alcohol consumption (OR = 1.3; 95% CI = 0.9, 1.8). However, a number of covariates were associated with heavy alcohol consumption, including age, gender, marital status and employment. Those who were 35 to < 50 years of age had a 1.4 (95% CI = 1.0, 2.1) times higher odds of heavy alcohol consumption than those 18 to < 35. Women had a 1.5 (95% CI = 1.1, 2.1) times higher odds of heavy alcohol consumption compared to men. The odds of currently smoking was greater for those who were single or living with a partner (OR = 1.8; 95% CI = 1.3, 2.6) than those who were married.

Table 4 shows OR's and 95% CIs for the association of food insecurity with dual substance use. Dual substance use was more common among those who were food insecure. In adjusted analyses, food insecure individuals had a 5.4 (95% CI = 2.1, 13.7) times higher odds of dual substance use compared to those who were food secure. Significant associations remained in fully adjusted models but was attenuated (OR = 2.8; 95% CI = 1.3, 6.1). Age and educational attainment were also associated with dual substance use after adjusting for all other covariates. Those who were 35 to < 50 had a 3.6 (95% CI = 2.0, 6.4) times higher odds of dual substance use than those 18 to < 35 in adjusted models and dual substance use was lower among individuals with greater educational attainment (OR = 0.8; 95% CI = 0.7, 1.0).

When testing moderation of associations by demographic factors, interactions with food insecurity were not observed for marital status or age ($\alpha < 0.05$; data not shown). However, gender did moderate the relationship of food insecurity with heavy alcohol consumption (p -value = 0.012) and dual substance use (p -value = 0.001). Fig. 1 shows associations of food insecurity with heavy alcohol consumption and dual substance use, stratified by gender. Among men, food insecurity was associated with a 1.5 (95% CI = 1.0, 2.2) times higher odds of heavy alcohol consumption; however, food insecurity was not associated with heavy alcohol consumption among women (OR = 1.1; 95% CI = 0.7, 1.8). Similarly, food insecurity was associated with a higher odds of dual substance use among men (OR = 5.2; 95% CI = 1.5, 18.6); however, this was not the case for women (OR = 1.6; 95% CI = 0.5, 5.5).

4. Discussion

This study determined associations of food insecurity with smoking cigarettes and heavy alcohol use among Wisconsin adults, independent of other socioeconomic factors. Findings demonstrated that smoking

Table 2
Odds ratios (OR's) and 95% confidence intervals (CI's) for currently smoking cigarettes among Wisconsin adults, SHOW^a 2014–2016^b.

	Crude		Adjusted	
	OR (95% CI)	P value	OR (95% CI)	P value
Food Insecure (ref = no)	5.5 (4.2, 7.3)	< 0.001	3.0 (2.1, 4.4)	< 0.001
Age Category (ref = 18 to < 35)				< 0.001
35 to < 50	–		1.5 (1.0, 2.3)	
50 to < 65	–		1.9 (1.0, 3.6)	
≥ 65	–		0.4 (0.2, 0.9)	
Female (ref = male)	–		0.6 (0.5, 0.9)	0.016
Race/Ethnicity (ref = non-Hispanic White)				0.31
Non-Hispanic Black	–		1.0 (0.4, 2.3)	
Other Race or Multiracial	–		1.6 (0.9, 2.9)	
Marital Status (ref = married)				< 0.001
Divorced, Separated or Widowed	–		2.5 (1.8, 3.4)	
Single or Living with Partner	–		1.4 (0.7, 2.9)	
Educational Attainment	–		0.6 (0.5, 0.7)	< 0.001
Household income-to-poverty ratio, mean (95% CI)	–		0.8 (0.7, 0.9)	0.005
Employment Status (ref = employed)				0.12
Unemployed	–		1.2 (0.7, 2.1)	
Not Working and Not Seeking Employment	–		0.7 (0.5, 1.0)	

^a Survey of the Health of Wisconsin.

^b n = 1616.

cigarettes was more common among those who were food insecure. Additionally, food insecurity was associated with heavy alcohol use and dual substance use among men, but not among women. These findings, when taken into consideration with prior evidence, demonstrate that food insecurity and substance use are highly correlated. Observed differences in the associations by gender suggest another layer of complexity. More work is needed to disentangle the temporality of these associations and identify strategies that best address their co-occurrence.

Our observation that smoking cigarettes is more common among Wisconsin adults who are food insecure replicates previous findings in diverse cross-sectional data sources. This includes a nationally-representative sample of U.S. adults (Farrelly and Shafer, 2017) and within U.S. Latinos (Iglesias-Rios et al., 2015). Associations of food insecurity and smoking has also been observed in communities outside the U.S. (Semba et al., 2011).

Longitudinal analyses are necessary to test temporality of associations between food insecurity and cigarette smoking. Work thus far is

inconsistent but demonstrates a reciprocal relationship. One longitudinal study spanning the Great Recession observed that those who did not smoke in 2003 and became food insecure in 2015 were more likely to initiate cigarette use than those who did not become food insecure and; those who smoked at baseline were less likely to stop smoking if they became food insecure (Kim-Mozeleski et al., 2019). Conversely, longitudinal data following the Great Recession in a cohort of older Americans indicated that becoming food insecure was associated with greater smoking cessation—potentially as a coping strategy in response to financial constraint (Bergmans, 2019). When testing the influence of cigarette consumption on food insecurity, longitudinal analysis of U.S. data suggested that the added expense associated with smoking cigarettes may prolong recovery from food insecurity (Hernandez et al., 2017). In sum, future analyses testing associations of food insecurity with smoking behavior should consider potential moderation by macroeconomic factors. Additionally, the underlying pathways by which food insecurity would increase cigarette consumption are not well established and require further investigation.

Table 3
Odds ratios (OR's) and 95% confidence intervals (CI's) for heavy alcohol consumption^a among Wisconsin adults, SHOW^b 2014–2016^c.

	Crude		Adjusted	
	OR (95% CI)	P value	OR (95% CI)	P value
Food Insecure (ref = no)	1.4 (1.0, 2.0)	0.09	1.3 (0.9, 1.8)	0.16
Age Category (ref = 18 to < 35)				0.024
35 to < 50	–		1.4 (1.0, 2.1)	
50 to < 65	–		1.3 (0.9, 2.0)	
≥ 65	–		0.9 (0.4, 1.8)	
Female (ref = male)	–		1.5 (1.1, 2.1)	0.014
Race/Ethnicity (ref = non-Hispanic White)				0.30
Non-Hispanic Black	–		0.7 (0.3, 1.3)	
Other Race or Multiracial	–		1.1 (0.4, 2.6)	
Marital Status (ref = married)				0.004
Divorced, Separated or Widowed	–		1.2 (0.6, 2.3)	
Single or Living with Partner	–		1.8 (1.3, 2.6)	
Educational Attainment	–		1.0 (1.0, 1.1)	0.35
Household income-to-poverty ratio, mean (95% CI)	–		1.0 (0.9, 1.1)	0.52
Employment Status (ref = employed)				0.047
Unemployed	–		1.5 (1.0, 2.3)	
Not Working and Not Seeking Employment	–		0.9 (0.5, 1.6)	

^a Men who reported consuming > 14 drinks/week and women who reported consuming > 7 drinks/week were considered to meet criteria for heavy alcohol use.

^b Survey of the Health of Wisconsin.

^c n = 1616.

Table 4
Odds ratios (OR's) and 95% confidence intervals (CIs) for dual substance use^a among Wisconsin adults, SHOW^b 2014–2016^c.

	Crude		Adjusted	
	OR (95% CI)	P value	OR (95% CI)	P value
Food Insecure (ref = no)	5.4 (2.1, 13.7)	0.001	2.8 (1.3, 6.1)	0.011
Age Category (ref = 18 to < 35)				< 0.001
35 to < 50	–		3.6 (2.0, 6.4)	
50 to < 65	–		1.2 (0.4, 4.0)	
≥ 65	–		1.3 (0.3, 5.6)	
Female (ref = male)	–		1.0 (0.6, 1.8)	0.99
Race/Ethnicity (ref = non-Hispanic White)				0.94
Non-Hispanic Black	–		1.1 (0.3, 4.0)	
Other Race or Multiracial	–		1.3 (0.3, 4.6)	
Marital Status (ref = married)				0.46
Divorced, Separated or Widowed	–		2.5 (0.5, 11.3)	
Single or Living with Partner	–		2.1 (0.4, 11.8)	
Educational Attainment	–		0.8 (0.7, 1.0)	0.018
Household income-to-poverty ratio, mean (95% CI)	–		0.9 (0.6, 1.1)	0.26
Employment Status (ref = employed)				0.13
Unemployed	–		1.2 (0.5, 3.1)	
Not Working and Not Seeking Employment	–		0.6 (0.3, 1.1)	

^a Those who reported that they currently smoked cigarettes and had heavy alcohol consumption (i.e. men who reported consuming > 14 drinks/week and women who reported consuming > 7 drinks/week were considered to meet criteria for heavy alcohol use).

^b Survey of the Health of Wisconsin.

^c n = 1616.

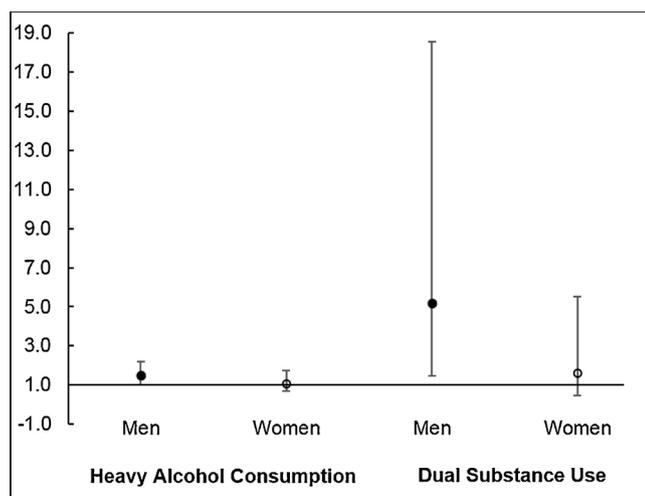


Fig. 1. Odds ratios and 95% confidence intervals for the association of food insecurity with heavy alcohol consumption^a and dual substance use^b, stratified by gender^{c–e}.

^aMen who reported consuming > 14 drinks/week and women who reported consuming > 7 drinks/week were considered to meet criteria for heavy alcohol use.

^bCurrently Smoke Cigarettes and Heavy Alcohol Consumption.

^cData come from the Survey of the Health of Wisconsin (SHOW), 2014–2015; n = 1616.

^dOdds ratios are adjusted for age group, race/ethnicity, marital status, educational attainment, household income-to-poverty ratio and employment status.

^ep-value for interaction of gender and food insecurity when modeling odds of heavy alcohol consumption = 0.012; p-value for interaction of gender and food insecurity when modeling odds of dual substance use = 0.001.

Our finding that the association of food insecurity with cigarette smoking was consistent, regardless of age, gender or marital status is a novel contribution. Moderation of associations between food insecurity and tobacco use is largely understudied. A study by Mayer et al. (2019) also observed a lack of moderation by age, gender or marital status using data from a nationally representative sample of U.S. adults. A lack of moderation by demographic factors would suggest that the pathways connecting food insecurity and cigarette use are similar across

demographic factors and could be leveraged to benefit multiple populations subgroups simultaneously. In contrast, post hoc analyses by Bergmans (2019) demonstrated that becoming food insecure was associated with an increase in daily cigarette consumption among women but not among men, which indicates more research using longitudinal data is needed.

The observation that food insecurity was associated with heavy alcohol consumption and dual use among men, but not women, is another novel contribution of this study. Perhaps the experience of food insecurity is unique among men such that it increases the risk of heavy alcohol consumption and dual substance use. For example, some evidence suggests that men are more sensitive to the broader social implications of food insecurity than women (Perkins et al., 2018). However, associations of food insecurity with alcohol use and dual use among men may be bidirectional, and reverse causation cannot be ruled out. For example, men have a greater shared genetic vulnerability to alcohol use disorder and disordered gambling than women, which was not accounted for in our analyses (Slutske et al., 2013). Therefore, it is possible that there are behaviors unique to men who excessively consume alcohol, such as disordered gambling, that also increase the risk of food insecurity. Overall associations of food insecurity with alcohol use are not well understood and require further study.

Findings demonstrated that food insecurity was associated with prevalence of smoking cigarettes among both men and women, and heavy alcohol use and dual use among men. Regardless of directionality, these associations could inform public health interventions. For example, it is possible that addressing both food insecurity and substance use concurrently is more effective than trying to ameliorate either alone. Additionally, failing to acknowledge food insecurity within the context of substance use interventions could render them less effective for participants who are food insecure, or vice versa.

4.1. Strengths and limitations

This study determined associations of food insecurity with smoking cigarettes, heavy alcohol consumption and dual use. Additionally, we tested moderation by age, gender and marital status. Data came from a large, statewide representative sample of adults living in Wisconsin—an upper Midwestern state with both urban and rural residents with diverse socioeconomic status. However, findings should be considered in

light of several limitations. First, the use of cross-sectional data prevents drawing causal conclusions or testing temporality of associations. Second, tobacco use was restricted to cigarette smoking, thus; future analyses should consider the changing landscape of nicotine use as e-cigarettes become increasingly common. Finally, future research should determine whether analyses concerning heavy alcohol use, dual use and moderation by gender can be replicated in other data sources.

5. Conclusions

This study extends current understanding regarding the relationship of food insecurity with substance use—particularly linkages of food insecurity with heavy alcohol use and dual use among men. Findings indicated that smoking cigarettes was more common among those who were food insecure than those who were not food insecure. Additionally, when testing moderation by gender, heavy alcohol consumption and dual use were positively correlated with food insecurity among men, but not among women. Longitudinal analyses are needed to disentangle temporality and underlying pathways of observed associations. Additionally, future work should determine whether interventions and policies targeting food insecurity can simultaneously reduce cigarette and alcohol use.

Role of funding source

Nothing declared.

Contributors

RSB and LC conceived of the study. RSB and LC designed the study. KM oversaw data collection. RSB analyzed the data. RSB, LC, TW and KM interpreted study findings. RSB, LC and TW drafted the initial manuscript draft. RSB, LC, TW and KM revised the manuscript and approved of the final version. All authors contributed to and approved of the final manuscript.

Declaration of Competing Interest

None declared.

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