**Introduction**

Food insecurity, or the state of having insufficient dietary resources to maintain a healthy, active lifestyle, affects approximately 10 to 15% of United States households (~14.3 million) annually (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2018). Minority households and those that are headed by a single parent are more likely to experience food insecurity, although these associations may be partially confounded by household income and education (Gundersen & Ziliak, 2018). Food insecurity can include a variety of behaviors such as skipping meals or repeatedly eating the same foods due to lack of dietary resources, but the most common experiences of food insecurity reported in the U.S. are worry over ability to afford food and not being able to make food purchases last (Coleman-Jensen et al., 2018). Consistent with these experiences, dietary intake within food insecure households often follows a cyclical pattern mirroring availability of Supplemental Nutrition Assistance Program (SNAP) benefits, with larger purchases and consumption early in the month followed by a decline in purchases and intake until funds are again available (Castellari, Cotti, Gordanier, & Ozturk, 2017; Wilde & Ranney, 2000). This cycle may contribute to increased odds of overweight and obesity among individuals with food insecurity, potentially through physiological and metabolic changes (Dinour, Bergen, & Yeh, 2007) or increased compensatory eating, especially in combination with consumption of lower cost, energy dense foods (Drewnowski, 2004). However, there appears to be effect modification by sex, as several studies have observed an association between food insecurity and overweight/obesity in adult women only (Franklin et al., 2012; Gooding, Walls, & Richmond, 2012; Hernandez, Reesor, & Murillo, 2017; Martin & Lippert, 2012).

At the same time, a growing body of literature suggests that food insecurity may be associated with eating disorders (EDs) such as bulimia nervosa (BN), binge eating disorder (BED) and disordered eating behaviors. Whereas the lifetime prevalences of BN and BED in the general U.S. population are estimated to be approximately 1% and 3%, respectively (Hudson, Hiripi, Pope, & Kessler, 2007), internet and community-based samples drawn from food-insecure populations have found prevalences of clinically significant ED ranging from 6 – 17% (Becker, Middlemass, Gomez, & Martinez-Abrego, 2019; Becker, Middlemass, Taylor, Johnson, & Gomez, 2017; Lydecker & Grilo, 2019; Rasmusson, Lydecker, Coffino, White, & Grilo, 2019). The mechanism underlying the association between food insecurity and EDs is not well understood, but may be partially confounded by traumatic event exposure and associated comorbid psychopathology (e.g. depression) (Becker et al., 2018; Leung, Epel, Willett, Rimm, & Laraia, 2015), or a physiological response to hunger, deprivation, and food scarcity (Carr, 2011).

Alternatively, high levels of weight stigmatization and overvaluation of weight and shape among food insecure populations may underpin disordered eating behaviors (Becker et al., 2017). In general, individuals with overweight and obesity face significant amounts of psychological distress associated with weight gain and lack of perceived control over eating and food choices, particularly in conjunction with experiences of weight discrimination (Tomiyama, 2014). Weight discrimination is more pernicious when combined with other forms of discrimination, such as sexism, racism, and classism (Ciciurkaite & Perry, 2018), and given the associations between food insecurity, sex, minority status, and income, individuals with food insecurity may be especially vulnerable to this type of multiplicative discrimination. Given that associations between discriminatory experiences, psychological distress, disordered eating, and weight gain appear to be mediated by internalization of weight stigma and negative weight self-labelling (Mensinger, Calogero, & Tylka, 2016; O’Brien et al., 2016), it is also possible that self-perceptions of weight differ by food insecurity status and contribute to the high rates of disordered eating and obesity in this population. However, other research suggests that the perception of being overweight is more common among White individuals and those with higher incomes compared to minority and lower income individuals, respectively, irrespective of actual weight (Dorsey, Eberhardt, & Ogden, 2009; Paeratakul, White, Williamson, Ryan, & Bray, 2002), which suggests that those experiencing food insecurity would be similarly less likely to perceive themselves as overweight and internalize negative weight messages. Given these contradictory observations, a better understanding of how weight perception varies by food insecurity might provide functional insights into the high prevalence of disordered eating among those who are food insecure. The objective of the current study was to investigate whether beliefs about weight, weight perception, and current weight control behaviors vary as a function of food insecurity in a representative sample of the U.S. population.

**Methods**

*Study Sample*

For this secondary analysis, we used data from the publicly available National Health and Nutrition Examination Survey (NHANES). The methods and design of NHANES have been described in detail elsewhere (Curtin et al., 2013; Johnson, Dohrmann, Burt, & Mohadjer, 2014). Briefly, NHANES is a nationally representative multi-stage probability sample conducted every two years by the National Center for Health Statistics and Centers for Disease Control and Prevention. In order to ensure representativeness, NHANES oversamples minority, low-income, and older individuals, although individuals of all ages are eligible to participate. The cross-sectional survey assesses a wide variety of health topics, including weight control behaviors, mental health, drug and alcohol use, and functional limitations, although specific questions vary according to participant age and year of interview. Surveys are completed in-person at NHANES mobile examination centers using audio computer-assisted self-interview systems. Additionally, trained NHANES staff conduct physical examinations of respondents, obtaining in-person measurements of weight, height, and waist circumference, among other biometrics.

In the present study, we restricted our analyses to respondents age 18 and over in the 2005 (*n* = 3,285) , 2007 (*n* = 4,625), 2009 (*n* = 5,001), 2011 (*n* = 4,796), and 2013 (*n* = 5,057) waves of NHANES. Although data for later waves (2015 – 2016) are available, the structure of the questionnaire assessing weight perception changed somewhat between 2013 and 2015, such that respondents in later years were asked only about weight loss behaviors, rather than both weight loss behaviors and behaviors to not gain weight. Because we were interested in both types of weight control behaviors, we focused on earlier waves of data. Response rates for the selected years ranged from 72 – 79%.

**Measures**

*Food Insecurity*

Household food insecurity was assessed using the 18-item U.S. Food Security Survey Module (Bickel, Mark, Cristofer, William, & John, 2000). Participants were asked a series of questions regarding worry about affording and obtaining food, behaviors to stretch food supply (e.g. skipping meals and fasting), and consequences of not being able to afford food (e.g. hunger and weight loss). Depending on the question, responses were given as binary (yes = 1/no = 0) or ordinal (never = 0/sometimes = 1/often = 2) answers, and composite scores were derived by summing all scale items. Scores ranged from 0 to 18. We dichotomized food insecurity as completely food secure (a score of 0 at the household level) or food insecure (a score of 1 or greater at the household level).

*Weight Perception and Desired Weight*

After self-reporting their current weight, participants were asked two questions regarding weight perception: “Do you consider yourself now to be overweight, underweight, or about the right weight?” and “Would you like to weigh more, less, or about the same?” We operationalized two weight perception variables, weight consideration and desired weight, respectively, from responses to these questions.

Participants also self-reported their weight a year prior to the interview, and, if their previous weight was more than 10 pounds greater than their current weight, were asked if the change was intentional. Those who had not lost weight or had done so unintentionally were also asked if they had tried to lose weight or to not gain weight at any point in the past year and, if so, what methods they used to accomplish this (e.g. used laxatives, dieted, exercised). Due to a skip pattern in the survey, questions about weight control methods were not asked of participants who had lost weight unintentionally, had not tried to lose weight, or had not tried to not gain weight in the past year. We dummy coded a five-level weight action variable based on responses to weight control questions as lost weight intentionally, lost weight unintentionally, tried to lose weight (but did not), tried to not gain weight, and none of the above. Because no questions were asked about attempts to gain weight, individuals in the ‘none of the above’ category include individuals who did not try to control their weight and those who tried to gain weight.

*Covariates*

We used weight and height measured in the NHANES mobile clinics to calculate BMI using the formula weight in kilograms divided by height in meterssquared, and coded BMI category as follows: < 18.5kg/m2 as underweight, 18.5 – < 25 kg/m2 as normal weight, 25 – < 30 kg/m2 as overweight, 30 – < 35 kg/m2 as obesity, class I, 35 – 40 kg/m2 as obesity, class II, and ≥ 40 kg/m2 as obesity, class III. Race/ethnicity was coded according as a four-level dummy variable (Non-Hispanic White, Non-Hispanic Black, Hispanic/Latino, or other), and education was coded as high school degree or less, some college, and college degree or higher. Current depressive symptoms was assessed using the nine-item Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer, & Williams, 2001). PHQ-9 scores range from zero to 27, with higher scores representing greater depression severity. Per scoring guidelines, we operationalized depression as a score of 11 or greater, which roughly corresponds to moderate to severe depression (Kroenke et al., 2001). To accommodate potential nonlinearity in the associations between age and weight perception, we also categorized age as 18 – 29, 30 – 39, 40 – 49, and 50 – 59, and 60 years or older.

**Statistical Analyses**

We first compared baseline covariates between individuals with and without food insecurity using Chi-square and t-tests for categorical and continuous variables, respectively. Then, to determine the strengths of association among weight consideration, desired weight, weight control, food insecurity, and BMI category, we constructed a matrix of pairwise polychoric correlations between the five variables. We then computed unadjusted associations between food insecurity and weight consideration, desired weight, and weight control using three individual multinomial logistic regressions with thinking ones’ weight was about right, wanting to weigh the same amount, and not doing anything about ones’ weight as the reference outcomes (Model 1). In Model 2, we adjusted for age category, education, race, and sex, then further adjusted for BMI category (Model 3) and depression (Model 4). We tested for interactions by race and sex to accommodate potential effect modification, and decomposed significant interactions using marginal effects at representative values (MERs). Specifically, holding all covariates not included in the interaction at their mean value, we calculated the response probability for each outcome for all possible combinations of food insecurity and sex or food insecurity and race. Given the complex sampling methodology of NHANES, all analyses were adjusted for survey design. Data were managed in R, version 3.6.1 (R Core Team, 2019) using the RNHANES (Susmann, 2016), dplyr (Wickham, Francois, Henry, & Müller, 2015), and survey packages (Lumley, 2004), and analyzed in Stata, version 15 (StataCorp, 2017).

**Results**

*Descriptive Statistics*

A total of 7,234 respondents (23.4%) had experienced food insecurity in the year prior to interview. Individuals with food insecurity were more likely to have BMIs in the obese or underweight ranges and were more likely to be young, female, and non-White than respondents with complete food security (Table 1). Irrespective of food security status, most individuals believed themselves to be overweight (56.5% of food secure and 54.6% of food insecure) and wanted to weigh less (67.6% of food secure and 62.3% of food insecure), and were either trying to lose weight or not taking action to change their weight. However, a greater percentage of those with food insecurity perceived themselves to be underweight, wanted to weigh more, or had lost weight unintentionally than those with complete food security. Food insecurity, BMI category, weight perception, desired weight, and weight action were all significantly correlated with one another (Table 2). In most cases, associations were weak, with the strongest association observed between weight perception and desired weight (ρ = 0.644, *p* < 0.001).

*Food Insecurity and Weight Perception*

In unadjusted models, food insecurity was significantly associated with individuals’ perception of their weight (Table 3). Those experiencing food insecurity had higher odds of perceiving themselves as underweight versus about right compared to those without food insecurity (OR = 1.93, 95% CI = 1.62 – 2.29), and this association persisted after adjustment for potential confounders including actual BMI category. In contrast, food insecurity was associated with significantly lower odds of overweight perception only after adjustment for all potential confounders (Table 3). As a whole, the interactions between race and weight perception were not significant (*p*interaction = 0.232), but there was effect modification by sex (*p*interaction < 0.001). In stratified fully adjusted models, food insecurity was associated with significantly lower odds of wanting to weigh less compared to weighing the same in women but not men (female OR = 0.82, 95% CI = 0.70 – 0.98; male OR = 0.99, 95% CI = 0.84 – 1.17). Food insecurity was associated with higher odds of wanting to weigh more in both women and men, although the association was stronger in women (female OR = 1.94, 95% CI = 1.43 – 2.67; male OR = 1.60, 95% CI = 1.34 – 1.91).

*Food Insecurity and Desired Weight*

Closely paralleling the results for weight consideration, food insecurity was associated with higher odds of wanting to weigh more compared to wanting to weigh the same amount both before (OR = 1.93, 95% CI =1.65 - 2.25) and after (OR = 1.58, 95% CI = 1.32 - 1.90; Table 3) adjustment. While wanting to weigh less was not significantly associated with food insecurity, the magnitudes of estimates were virtually identical to those for self-perception of overweight, reflecting the strong correlation between these variables. There was not strong evidence of effect modification by race (*p*interaction = 0.435) or sex (*p*interaction = 0.075) on the association between food insecurity and desired weight.

*Food Insecurity and Weight Action*

Individuals with food insecurity had 2.12 times higher odds of losing weight unintentionally versus doing nothing about their weight compared to those without food insecurity in unadjusted models (95% CI = 1.86 – 2.42; Table 3). Food insecurity was not associated with intentional weight loss, but was associated with lower odds of trying to lose weight unsuccessfully and of trying to not gain weight. Again, associations were generally robust against adjustment for confounders, although the association between food insecurity and trying not to gain weight was reduced to nonsignificance in the final model (Table 3).

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