**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 purchased food 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 (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).

A growing body of literature suggests that food insecurity may also be associated with eating disorders (EDs) such as bulimia nervosa (BN) and 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 underpinned by high levels of weight stigma and overvaluation of weight and shape among food insecure populations (Becker et al., 2017), or confounding by traumatic event exposure and associated comorbid psychopathology (e.g. depression) (Becker et al., 2018; Leung, Epel, Willett, Rimm, & Laraia, 2015). Moreover, because previous research on food insecurity and disordered eating has largely been drawn from non-representative convenience samples, it is unknown whether results are generalizable to the U.S. population overall. The objective of the current study was to investigate whether beliefs about weight, current weight control behaviors, and depression 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 2007 (*N* = 4,625), 2009 (*N* = 5,001), and 2011 (*N* = 4,796) waves of NHANES. Although data for later waves (2013 - 2014 and 2015 – 2016) are available, the structure of the questionnaire assessing weight perception changed somewhat between 2011 and 2013, 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. In maintaining consistency with previous studies (Becker et al., 2017; Rasmusson et al., 2019), we operationalized food insecurity as a three level variable representing food secure (a score of 0 at the household level), marginally food insecure/food insecurity without hunger (one to two affirmative responses and no hunger), and highly food insecure/food insecurity with hunger (three or more affirmative responses or hunger reported).

*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 both those who did not try to control their weight and those who tried to gain weight.

*Specific Weight Control Behaviors*

*Depression*

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 10 or more, which roughly corresponds to moderate depression or greater (Kroenke et al., 2001).

*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). To accommodate potential nonlinearity in the associations between age and weight perception, we also categorized age into quartiles. Family income-to-poverty ratio was coded as less than or equal to 100% of the federal poverty line (FPL), 101 - 200% FPL, 201 – 300 % FPL, 301 – 400% FPL, and greater than 400% FPL. We also coded missing or ‘refused’ as a sixth income category, given that individuals missing income data often differ systematically from those providing income information (Kim, Egerter, Cubbin, Takahashi, & Braveman, 2007). We dummy coded education as high school degree or less, some college, and college degree or higher.

**Statistical Analyses**

To determine the strengths of association among weight consideration, desired weight, weight control, food insecurity, and BMI category, we first 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 (Model 1). In Model 2, we adjusted for BMI category only, and in Model 3 further adjusted for race, age category, education, and household income. To accommodate potential effect modification, we fit models separately by sex, and, given the complex sampling methodology of NHANES, all analyses were adjusted for survey design.

Data management and analysis were performed in R, version 3.6.1, and RStudio, version 1.2.5019 (R Core Team, 2019), using the RNHANES (Susmann, 2016) and dplyr (Wickham, Francois, Henry, & Müller, 2015) packages for data management, the survey package (Lumley, 2004) for design-based analyses and the nnetpackage (Ripley & Venables, 2016) for multinomial logistic regression.

**Results**

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