Food Insecurity and Food Addiction

by

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Abstract

Household food insecurity affects approximately 10.5% of US households and is associated with short and long-term negative health outcomes. Food addiction, which posits that highly processed foods are capable of triggering addictive responses akin to substance use disorders, occurs in approximately 15% of US adults. A recent study identified an association between food insecurity and food addiction in two samples of low-income women. Elements of food insecurity are consistent with established risk factors for addiction (increased stress, greater intake of potentially addictive highly processed food, intermittent access to food). This dissertation aimed to deepen scientific understanding of the relationship between food insecurity and food addiction and identify potential factors that may guide future research on this topic. Study 1 examined associations between retrospectively reported childhood food insecurity and food addiction and current adult food insecurity and food addiction in a community sample of adults. Current adult food insecurity was associated with current adult food addiction symptoms. Childhood food insecurity was associated with childhood food addiction symptoms and current adult food addiction symptoms. Individuals who reported both childhood and adult food insecurity reported more food addiction symptoms than those who only reported current adult food insecurity. Study 2 examined whether established mechanisms of addiction mediate the relationship between food insecurity and food addiction in a university sample. Food insecurity was indirectly related to food addiction symptoms through increased stress, increased food reward, and increased eating highly processed foods to cope with negative emotions. Although highly processed food

consumption was directly related to food addiction symptoms, it did not mediate the relationship between food insecurity and food addiction. Study 3 qualitatively examined whether adults with food insecurity and food addiction interpret questions on the Yale Food Addiction Scale 2.0 in line with the substance use disorder criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Participants overwhelmingly interpreted scale questions as expected, except for one individual whose responses seemed more driven by experiences of deprivation. Interpretations of tolerance and withdrawal were somewhat inconsistent with a substance use disorder conceptualization, as seen in samples of adults without food insecurity. Additionally, individuals described ways that availability of highly processed foods impacted their addictive eating patterns, their desire to prevent food waste contributed to overeating, and lack of access to highly processed foods contributed to withdrawal symptoms. These findings further demonstrate the association between food insecurity and food addiction across samples with varied demographic characteristics, which is mediated by mechanisms implicated in addiction. These findings may inform policy-level and individual intervention targets to reduce food addiction risk among individuals experiencing food insecurity, including increasing access to nutrition assistance programs, stress management skills, and alternative coping strategies for negative emotions. Future research should further consider the role of childhood food insecurity in food addiction and other health outcomes throughout the lifespan, probe specific critical developmental periods for the interaction between food insecurity and food addiction, and further explore the role of addiction mechanisms in the association between food insecurity, food addiction, and other substance use disorders.

Chapter 1 Introduction to Food Insecurity and Food Addiction

Household food insecurity, which refers to the lack of access to sufficient food to meet the nutritional needs of all household members, was estimated to affect 10.5% of U.S. households in 2019.[1] At the start of the COVID-19 pandemic in 2020, this estimate more than tripled to 38% of U.S. households, in the context of widespread unemployment and economic hardship.[2] More recent estimates suggest food insecurity rates have returned to pre-pandemic levels.[3] Food insecurity disproportionately affects communities from marginalized racial and ethnic groups, and households with children and single-parent households.[1,3] Food insecurity is consistently associated with negative health outcomes across the life span. Children in food-insecure households are more likely to experience general poor health, nutritional deficiencies, and asthma.[4] Children experiencing food insecurity also experience higher rates of behavioral and cognitive difficulties.[4] Adults in food-insecure households are more likely to experience diabetes, hypertension, and hyperlipidemia.[4] Food insecurity is also associated with poor mental health outcomes in children and adults, including increased rates of depression and anxiety.[4]

In economically developed countries, food insecurity is also associated with greater body mass index (BMI).[5,6] Although the role of gender in the relationship between food insecurity and BMI is not fully understood, several studies suggest women in food-insecure households are at greater risk for obesity than men in food insecure households.[5] Although some results regarding the association between food insecurity and childhood obesity are mixed,[7] food insecurity and obesity have been found to co-occur in children.[8] Food insecurity has been identified as an important factor for treating childhood obesity, as it may limit families' ability to access foods

recommended by obesity treatment programs.[8] Food insecurity is also associated with overall

eating disorder pathology,[9,10] increased incidence of diagnosable bulimia nervosa[11,12] and binge

eating disorder,[13] as well as dysfunctional eating symptoms, including dietary restraint[9,10,14,15]

and loss of control eating.[16,17] Although associations between food insecurity and diagnosable

anorexia nervosa have not been directly assessed due to low endorsement rates, a recent study

found that individuals with food insecurity had higher endorsement rates of symptoms consistent

with anorexia (e.g., <15lb weight loss in a three month period, feeling fat despite thinness) on an

eating disorder screening questionnaire, compared to those with high food security.[18]

Families and individuals experiencing food insecurity often have limited access to

nutrient-rich foods like fruits, vegetables, and lean proteins, and relatively greater access to less

expensive highly processed (HP) foods, which are high in refined carbohydrates (i.e., white flour

and sugar) and fat.[19] Individuals participating in public assistance programs, like the USDA

Supplemental Assistance Program (SNAP), consume even greater proportions of their diet from

HP foods relative to income-eligible and income-ineligible non-participants.[20] Although HP food

provides necessary calories, it is associated with several poor health outcomes, including

increased rates of cardiovascular disease, cerebrovascular disease, and depression.[21]

HP foods are much more effective than naturally-occurring, minimally processed foods

(e.g., fruits, vegetables, whole grains) at activating neural reward responses.[22] Although many

people are able to consume HP foods in moderation, a subset of the population consumes HP

food with behavioral patterns that mirror substance use disorders (SUDs), known as food

addiction.[23,24] Food addiction is measured by the Yale Food Addiction Scale (YFAS), which

assesses symptoms of SUD (e.g., compulsive use, unsuccessful attempts to cut down, tolerance,

withdrawal) in the context of HP foods.[24,25] In parallel to a SUD diagnosis, individuals are

considered to have a food addiction "diagnosis" if they endorse at least two symptoms and clinically significant impairment or distress.[24] Approximately 8-15% of adults in community samples report symptoms that meet criteria for diagnosable food addiction.[26] In clinical samples of adults (e.g., adults with obesity, adults seeking bariatric surgery, adults with type 2 diabetes), prevalence estimates range from 23-80%.[26] Meeting the diagnostic definition of food addiction is associated with adverse health outcomes, including diet-related disease (e.g., hypercholesteremia), depression, and poor quality of life.[27-30] Furthermore, higher endorsement of food addiction symptoms has been identified as a strong psychosocial predictor of weight gain and attrition during weight loss treatment.[31]

1.1 Construct Considerations regarding Food Insecurity and Food Addiction

Food addiction is distinguished from other eating disorders by its' focus on mechanisms of addiction in driving forward eating pathology, with strong emphasis on the role of the addictive substance and less emphasis on shape and weight concern.[32] Food addiction is commonly compared to binge eating disorder (BED), as there is overlap in some of the symptomatology (e.g., loss of control over food consumption).[32] Approximately 40-60% of individuals with BED meet criteria for food addiction.[33,34] Individuals who meet criteria for BED and food addiction are more likely than those with BED without FA to exhibit mechanisms implicated in addictive disorders, including heightened craving, emotion dysregulation, and impulsivity.[32] Additionally, prevalence estimates for food addiction (approximately 15%) are much higher than those for BED (approximately 3%), which suggests a substantial subset of individuals meet criteria for food addiction, but do not meet criteria for BED.

Findings regarding the relationship between food addiction and measures of socio-economic status (SES) have been mixed.[35-37] One study that examined food addiction prevalence

rates among low-income Hispanic, non-Hispanic White and non-Hispanic Black women seen at reproductive health clinics in Southeast Texas found lower endorsement rates compared to the general population (2.8% in this sample, compared to approximately 15% in the general population).[35] Conversely, a study examining correlates of food addiction among low-income African American women seen at various clinics at a public hospital in inner-city Atlanta found a food addiction prevalence rate of 18.3%, which is slightly higher than population estimates.[36] A study examining food addiction prevalence in a sample recruited to be representative of the US population found that food addiction was associated with income, such that individuals with higher income endorsed more food addiction symptoms and were more likely to meet diagnostic criteria for food addiction.[37] The study authors hypothesized that higher-income adults may endorse more food addiction symptoms because they are more aware of thin body ideals and more likely to perceive themselves as "overweight."[37] However, no research has specifically tested the interaction of socio-economic status and weight-related self-perception on food addiction endorsement.

Although food insecurity often occurs in the context of poverty, food insecurity and low income are not synonymous.[38] Families may have relatively higher incomes but experience food insecurity due to sudden financial stressors such as job loss, gaining a household member, or losing access to food benefits (e.g., SNAP). Additionally, a significant proportion of low-income families (including those with incomes below the poverty level) do not experience food insecurity. Although some studies of food addiction measure income, they typically do not measure food insecurity. Further, most prior studies on food addiction have used relatively high SES samples where it was unlikely many participants were experiencing food insecurity. This highlights the need for research examining these relationships specifically in low-income

samples that are adequately powered to detect relationships between food addiction, food insecurity, along with SES measures.

1.2 Potential Mechanisms Driving Association between Food Insecurity and Food Addiction

Food addiction has been associated with several risk factors that should be kept in mind when studying potential mechanisms of food insecurity and food addiction. These include biological predisposition for addiction (often measured by family history of problematic substance use or SUD),[39] psychological factors such as impulsivity[40,41] and history of trauma, particularly in childhood.[42,43] Food insecurity may be an additional risk factor for food addiction that has previously been overlooked.

Individuals experiencing food insecurity may be at increased risk of food addiction due to three interrelated key mechanisms of addiction. First, food insecurity is associated with low/poor diet quality.[44] Individuals experiencing food insecurity are more likely to consume HP foods, including salty snacks and sugar-sweetened beverages.[45] Food addiction theory posits that the refined ingredients in these HP foods parallel the process of distilling active ingredients in other addictive agents in order to make them more addictive (e.g., processing the coca leaf, which has little addictive potential, into powder cocaine, which has a higher addictive potential).[23] In the case of HP food, reinforcing ingredients (refined carbohydrates and fat) are concentrated into unnaturally high doses, which are then more rapidly consumed and absorbed by the body.[23] This combination of a high dose of the active ingredient combined with more rapid absorption mimics the profile that increases the addictive nature of addictive drugs.[46]

Second, people experiencing food insecurity may have uncertain or intermittent patterns of food availability (e.g., food resources are abundant at the beginning of a month, but scarce at

the end of the month once resources have been exhausted).[47] Animal and human research suggests intermittent access to addictive drugs facilitates addictive patterns of consumption.[46,48] Intermittent access also sensitizes the dopamine system involved in wanting in response to exposure to drug-related cues.[49] Animal research has replicated that intermittency increases the addictive potential of food.[50,51] However, this pattern only emerges in animals given intermittent access to sugar, but not intermittent access to chow, suggesting intermittency alone is not sufficient to induce an addictive response; it must be combined with HP food. Food insecurity may replicate these conditions by causing individuals to access potentially addictive HP foods in intermittent patterns that further increase risk for addictive eating. However, there are important differences between animal models and human experiences that may impact the role of intermittency in human risk for food addiction. Overall, animal models are not able to capture the complexity of biological, psychological, and social contributors to eating behavior. Moreover, in our current food environment, HP foods are always accessible. Even in the context of food insecurity, the foods that are typically most available during times of scarcity are also the foods that are associated with food addiction. Thus, cycles of availability and consumption for humans with food insecurity may vary greatly from animal models of intermittent access to addictive drugs and HP food.

Additionally, some individuals with food addiction report having preferred foods that they feel addicted to (e.g., a specific kind of ice cream), much like a preference for a specific brand of alcoholic beverage or cigarette.[52] If individuals with food insecurity follow this pattern of consumption, there may be times when their preferred foods are not available to them due to financial constraints. Limited "access" may also be simulated by cognitive restraint or restriction of certain foods, which may mimic the neural response to intermittent access to the addictive

substance. We might also consider the possibility of anticipation of intermittency affects addictive behavior, as individuals may worry that they will not have enough food. The fear that access may be taken away at any moment may impact individuals' tendency to eat HP food addictively. It will be important to keep this these factors in mind when probing for the role of intermittency in the relationship between food insecurity and food addiction.

Third, individuals experiencing food insecurity report higher stress levels, which are associated with greater food insecurity severity.[53] Chronic stress is an important risk factor for the development and maintenance of addiction.[54] Chronic stress is a common mechanism between addiction and obesity, as it alters the reward system in ways that potentiate overconsumption of both addictive drugs and HP foods.[55,56] A recent study found food insecurity was indirectly associated with higher body weight via increased distress and eating to cope.[57] Thus, the stress associated with food insecurity may increase individuals' propensity for food addiction.

Recent research suggests food insecurity may be associated with increased self-report of food addiction symptoms.[58] The first study to examine this replicated this finding in two samples of female-identified caregivers (pregnant individuals [n = 208] and caregivers of 8-10-year-old children [n = 181]). This research was an important first step for establishing a connection between food insecurity and food addiction. However, this study had several limitations, including a cross-sectional design, analysis of data from studies with different primary aims, and lack of validation of the YFAS in pregnant individuals (although this only applied to one sample). Thus, more work is needed to understand whether meaningful associations exist. Important next steps include evaluating this relationship in more diverse samples, examining whether mechanisms of addiction drive this association, and ensuring tools used to measure food

addiction accurately capture the lived experience of food addiction within the context of food insecurity.

1.3 Specific Aims

1. Replicate prior findings of the association between food insecurity and food addiction symptoms in more diverse community samples of adults (Study 1 and Study 2)

2. Examine associations between retrospectively reported childhood food insecurity and current food insecurity with food addiction in a community sample of adults (Study 1)

3. Examine whether established mechanisms of addiction mediate the relationship between food insecurity and food addiction in a university sample, specifically increased stress, increased food reward, increased use of HP food to cope with negative emotions, and higher daily levels of HP food consumption (Study 2)

4. Qualitatively evaluate the YFAS 2.0 for individuals experiencing food insecurity (Study 3)

Chapter 2 Food Insecurity and Food Addiction in an Online Community Sample of Adults

2.1 Introduction

Preliminary research on the relationship between food insecurity and food addiction has focused on samples of female-identified adults.[58] This represented an important step toward understanding whether an association between these factors may exist. However, prior results may have been impacted by unique characteristics of the samples used (female-identified caregivers and pregnant individuals). Further, people experience both food insecurity and food addiction across the spectrum of gender and age.[37,59] Thus, it is important to understand whether this finding generalizes to the broader population.

Another key area of exploration is how the association between food insecurity and food addiction may be impacted by development. There is some evidence that childhood eating behavior is important for shaping later eating behavior (including disordered eating) and health outcomes (e.g., elevated BMI, unfavorable lipid profiles) during childhood[60,61] and into adulthood.[62] Recent national reports estimate 8.4% of children are currently affected by food insecurity in the United States.[59] An even larger proportion of children (16.1%) live in food-insecure households, in which adults report food insecurity for themselves but do not report it for the children. Food insecurity during childhood is associated with several short and long-term negative health outcomes, including some which have also been associated with food addiction (i.e., elevated BMI, diabetes, disordered eating).[63-66]

Most substance use research has focused on adolescents and adults, as substance use typically begins during these developmental periods.[67] Food addiction is unique from other SUDs because use of the substance (HP food) begins early in life. HP food is estimated to make up approximately 21% of 2 to 5-year-old children's diets in the U.S., an estimate that more than doubles to 45.1% by the time children are 12-19 years old.[68] Children and adolescents also report symptoms consistent with food addiction. Approximately 12% of children in community samples and 19% of children with overweight or obesity are estimated to meet criteria for food addiction.[69]

Although prior research has found a concurrent association between food insecurity and food addiction during adulthood,[58] questions remain about whether this association may also be driven by earlier exposure to food insecurity and the temporal nature of the association. First, it is important to determine if food insecurity and food addiction are associated with one another during childhood (prior to age 18). If children experiencing food insecurity show more food addiction symptoms, it is important to intervene during early childhood to improve children's quality of life and prevent future negative health outcomes related to food addiction. Another pressing question is whether food insecurity early in life contributes to food addiction later in life, and if so, whether changes in food security status from childhood to adulthood impact this relationship. A recent longitudinal study found that severe food insecurity during adolescence predicted binge eating during young adulthood.[70] Continued examination of temporal relationships between food insecurity and problematic overeating behavior is important for identifying critical periods of risk and may inform food addiction prevention efforts. If children who experience food insecurity go on to develop food addiction later in life, even when food security is restored, this would further highlight the need for early intervention to ameliorate

food insecurity during childhood. Interventions currently aimed at adults may be adapted for children and/or their parents to intervene when food insecurity seems to convey the most risk for future food addiction. Cross-sectional research with children and longitudinal research spanning from childhood to adulthood are needed to examine these questions. However, longitudinal research is time- and effort- intensive for researchers and participants. Given the nascent nature of this research area, retrospective recall provides a helpful tool for determining whether longitudinal work is warranted on this topic.

This was a secondary analysis of an existing data set that aimed to examine the association between past experiences (including parental history and trauma), eating behavior, and substance use among an online community sample of adults. The first aim of the current study was to examine whether an association between current adult food insecurity and food addiction would be replicated in a gender-balanced adult sample. We hypothesized that current adult food insecurity would be associated with higher endorsement of current adult food addiction symptoms in an online community sample of adults. Second, this study aimed to use participant's retrospectively reported childhood experiences to determine whether associations exist between childhood food insecurity and childhood and adult food addiction symptoms. We hypothesized that retrospectively reported childhood food insecurity would be associated with higher endorsement of retrospectively reported childhood food addiction symptoms and higher endorsement of current adult food addiction symptoms. Third, this study aimed to examine whether changes in food security status from childhood to adulthood are associated with differences in current adult food addiction symptoms. We hypothesized that individuals would endorse current adult food addiction symptoms in the following order, from most symptoms endorsed to fewest symptoms endorsed: individuals with persistent food insecurity from

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childhood to adulthood, individuals with emergent food security from childhood to adulthood, individuals with emergent food insecurity from childhood to adulthood, individuals with persistent food security from childhood to adulthood.

2.2 Methods

2.2.1 Participants

Participants (Qualifications: U.S. Location, > 95% approval rating by other investigators, Age > 18) were recruited through Amazon Mechanical Turk (MTurk) for a larger study examining how past experiences (e.g., parental history, trauma) impact health behaviors (eating, substance use). MTurk provides a platform for collecting high-quality data from demographically varied participants.[71,72] 386 participants participated in the study. To improve data quality[73] we excluded data from 29 participants who failed quality control checks (incorrectly answered ≥2 quality control questions [n = 15]; preferred not to answer ≥10% of questions [n = 7]; completed questionnaires in <10 minutes [n = 7]). Participant's ability to skip individual questions resulted in some participants missing data such that they were not included in any current analyses (n = 43). 314 participants were included in at least one analysis. Sample sizes varied for each analysis due to variability in missing data for specific measures: 13 participants were missing current adult food security status, 70 participants were missing retrospective childhood food security status, 5 participants were missing adult food addiction symptoms, and 10 participants were missing retrospective childhood food addiction scores. Participants were excluded from each analysis if they were missing data on either the independent or dependent variable for that analysis. Participants included in each analysis did not

differ from participants that were excluded on age, gender identity, race/ethnicity, education, or income (all p-values > .05).

297 participants provided sufficient data to be included in analysis Hypothesis 1. See **Table 1** for demographic characteristics of this sample, by current adult food security status. A greater proportion of participants with food insecurity identified as Black/African American, Hispanic/Latino, or American Indian/Alaska Native and a lesser proportion identified as White, Asian or Multiracial compared participants with food security. Participants with food insecurity also reported lower household income than participants with food security.

237 participants provided sufficient data to be included in analysis for Hypothesis 2. See **Table 2** for demographic characteristics of this sample, by retrospective childhood food security status. A greater proportion of participants who retrospectively reported childhood food insecurity identified as Black/African American, Hispanic/Latino, or American Indian/Alaska Native and a lesser proportion identified as White, Asian or Multiracial compared to participants who reported childhood food security. Participants who retrospectively reported childhood food insecurity also reported lower current adult household incomes than participants who reported childhood food security.

239 participants provided sufficient data to be included in analysis for Hypothesis 3. See **Table 3** for demographic characteristics of this sample, by retrospective childhood food security status. Participants who retrospectively reported childhood food insecurity were younger on average and reported lower household income than participants who reported childhood food security.

227 participants provided sufficient data to be included in analysis for Hypothesis 4. See **Table 4** for demographic characteristics of this sample, by food security persistence category.

Participants differed by gender identity, such that a greater proportion of male participants reported persistent food insecurity. Participants also differed by income, such that individuals who reported emergent and persistent food insecurity reported lower current household incomes.

2.2.2 Procedures

The University of Michigan Institutional Review Board approved all study procedures in accordance with provisions of the World Medical Association Declaration of Helsinki. The sample size was determined based on financial considerations. Participants consented and completed questionnaires through MTurk. Participants reported demographic information and were compensated $1.25 for their time (approximately 30 minutes).

2.2.3 Measures

US Household Food Security Survey Module. Food insecurity was measured by the 18-item US Household Food Security Survey Module (FSSM).[74] The FSSM is an 18-item scale designed to examine a family's level of household food security in the last 12 months. The first 10 questions assess adult respondents' experiences (the US Adult Food Security Module), and the remaining eight questions assess experiences of respondents' children if they are present in the household. Participants completed the US Adult Food Security Module about their experiences in the last 12 months, and an adapted version of the full FSSM in reference to their experiences prior to age 18. Questions were adapted by adding "When you were a child (prior to age 18)" to the beginning of each FSSM question. The adapted version of the full FSSM was created for this study, as there is currently no validated retrospective measure of food insecurity. The first three questions of each module assess for frequency of food insecurity experiences (e.g., worrying whether food would run out until they got money to buy more). The remaining

questions assess other experiences of food insecurity (e.g., cutting the size of meals or skipping meals because there wasn't enough money for food).

For each time period (current adult and retrospective childhood), participants were divided into two food security categories based on the number of affirmative responses ("often true," or "sometimes true," to the first three questions, or "yes" to questions with binary response options). Participants were designated as "food secure" if they endorsed up to two questions and "food insecure" if they endorsed at least three questions. The Adult Food Security Module showed excellent internal consistency in this sample ($\alpha = .91$). The adapted FSSM also showed excellent internal consistency in this sample ($\alpha = .95$).

Food Security Stability Score. A food security stability score was calculated for each participant. Responses were coded based on whether participants reported persistent food security from childhood to adulthood (participants reported food security in both childhood and adulthood; n = 155, 66.8%), emergent food security (participants reported food insecurity during childhood, but food security during adulthood; n = 19, 8.2%), emergent food insecurity (participants reported food security during childhood, but food insecurity during adulthood; n = 17, 7.3%), or persistent food insecurity (participants reported food insecurity during childhood and adulthood; n = 41, 17.17%).

Yale Food Addiction Scale 2.0. The Yale Food Addiction Scale 2.0 (YFAS 2.0) is a 35-item measure of food addiction based on the SUD diagnostic criteria in the DSM-5.[75] The YFAS 2.0 assesses for each of the eleven symptoms included in the DSM-5, plus impairment and distress. Participants reported the frequency of each symptom over the last 12 months, from "never," to "every day." Each symptom has a different frequency threshold that must be met to meet criteria for that symptom. For example, to meet criteria for the symptom "substance taken

in larger amount and for longer period than intended," participants must report that they "found that when they started eating certain foods, they ended up eating much more than planned" at least four times per week. Participant symptom endorsement was scored as 0 or 1 for each symptom based on the threshold for that symptom. The number of symptoms each participant endorsed were added to create a symptom count score. A symptom count of 2 is the current estimated threshold for a clinical level of addictive eating.[75] A symptom count was used rather than a dichotomous diagnostic score because continuous dimensional measures are more sensitive for detecting food addiction symptoms in community samples.[76] Responses were scored to indicate the number of symptoms endorsed (0 to 11). In the current sample, participants met criteria for an average of 3.38 symptoms (SD = 4.34). The YFAS 2.0 showed excellent internal consistency in this sample ($\alpha = .98$).

Dimensional Yale Food Addiction Scale for Children 2.0. The Dimensional Yale Food Addiction Scale for Children 2.0 (dYFAS-C 2.0) is a 16-item measure designed to assess for food addiction symptoms in children and adolescents.[77] Similarly to the adult version, the dYFAS-C 2.0 assesses for SUD symptoms listed in the DSM-5 in the context of HP foods. Participants reported the frequency of each symptom listed on the dYFAS-C 2.0 on a Likert-type scale from "never" to "always." Scores on the dYFAS-C 2.0 can range from 0 to 64, with higher scores indicating higher levels of food addiction pathology. The dYFAS-C 2.0 does not allow for food addiction "diagnosis," as research suggests dimensional approaches may be more sensitive and appropriate for younger cohorts.[78,79] The dYFAS-C 2.0 was adapted for this study to allow participants to report retrospectively on their experiences of food addiction during childhood. Each statement on the questionnaire was preceded by "when I was a child," to prime participants to reflect on their childhood experiences. On average, participants scored 16.21 points on the

dYFAS-C 2.0 (SD = 18.38). Participants reported the age range they thought about as they completed the dYFAS-C 2.0 by selecting one of four options: 3-5 years old (n = 9, 2.9%), 6-9 years old (n = 48, 15.3%), 10-12 years old (n = 112, 35.7%), or 13-17 years old (n = 145, 46.2%). The dYFAS-C 2.0 showed excellent internal consistency in this sample (α = .98).

2.2.4 Data Analytic Plan

Analyses were conducted in IBM SPSS Statistics, Version 28 (IBM Corp, 2021). Data was reviewed for outliers (+/- 3SD) and skewness (>2). Means and distributions in sociodemographic covariates were compared by food security status using univariate linear regression (for age) and chi-squared tests (for categorical variables). Gender identity and race/ethnicity were included as covariates in all adjusted analyses. Age, educational attainment, and income were included as covariates in adjusted analyses using current adult data only. Significance was set at $p<.05$ for all analyses, with Bonferroni correction for multiple comparisons where appropriate.[80]

Hypothesis 1: Multiple regression was conducted with current adult food security status as the independent variable (dummy coded: 0 = food secure; 1 = food insecure) and the current adult food addiction symptom count as the dependent variable.

Hypothesis 2: Multiple regression was conducted with retrospective childhood food security status as the independent variable (dummy coded: 0 = food secure; 1 = food insecure) and the retrospective childhood food addiction score as the dependent variable.

Hypothesis 3: Multiple regression was conducted with retrospective childhood food security status as the independent variable (dummy coded: 0 = food secure; 1 = food insecure) and the current adult food addiction symptom count as the dependent variable.

Hypothesis 4: A one-way ANCOVA was conducted with food security stability category (persistent food security, emergent food security, emergent food insecurity, and persistent food insecurity) as the independent variable and current adult food addiction symptom count as the dependent variable. Where significant effects were detected, pairwise comparisons were run and inspected with significance threshold adjusted for multiple comparisons.

2.3 Results

No outliers or skewness >2 were found for any variables. Demographic comparisons by current adult food security status can be found in **Table 1**. Food-secure and food-insecure participants did not differ by age, gender identity, or educational attainment. Food-secure and food-insecure participants differed by racial/ethnic identity, such that a smaller proportion of food-insecure participants identified as White and Asian, and a larger proportion of food-insecure participants identified as Black/African American, Hispanic/Latino, and American Indian/Alaska Native. Food-secure and food-insecure participants also differed by income status, such that a larger proportion of food-insecure participants reported annual incomes less than $59,999 and a smaller proportion reported annual incomes of $60,000 or more. Regression results for hypotheses one through three are summarized in **Table 2.**

Hypothesis 1: Unadjusted regression analysis showed current adult food insecurity was associated with more current adult food addiction symptoms ($\beta = 0.46$, p <.001). After adjusting for age, gender, race/ethnicity, education and income, current adult food insecurity was still associated with more current adult food addiction symptoms ($\beta = 0.45$, p <.001).

Hypothesis 2: Retrospective childhood food insecurity was associated with higher retrospective childhood food addiction scores ($\beta = 0.56$, p <.001). After adjusting for gender

identity and race/ethnicity, retrospective childhood food insecurity was associated with higher retrospective childhood food addiction scores ($\beta = 0.57$, p <.001).

Hypothesis 3: Retrospective childhood food insecurity was associated with more current adult food addiction symptoms ($\beta = 0.58$, p <.001). After adjusting for gender identity and race/ethnicity, retrospective childhood food insecurity was still associated with more current adult food addiction symptoms ($\beta = 0.58$, p <.001).

Hypothesis 4: A one-way ANCOVA adjusting for gender identity and race/ethnicity demonstrated a significant main effect of food security stability category on current adult food addiction symptoms [$F(3, 220) = 54.35$, p <.001, $\eta p2 = 0.43$]. Post hoc pairwise comparisons using Bonferroni correction indicated that participants with persistent food insecurity (7.62 ± 4.04) reported significantly more food addiction symptoms than participants with persistent food security (0.97 ± 2.36, p <.001), emergent food security (3.05 ± 4.40, p = .004), and emergent food insecurity (2.18 ± 2.86, p <.001). Participants with emergent food security (3.05 ± 4.40) reported significantly more food addiction symptoms than participants with persistent food security (0.97 ± 2.36, p <.001). Participants with emergent food insecurity did not significantly differ from participants with persistent food security or emergent food security. Mean food addiction symptoms for each food security stability category is demonstrated in **Figure 1.**

2.4 Discussion

This study was the first to examine associations between food insecurity and food addiction symptoms in a gender-balanced, online, community sample. The present findings replicated prior associations between food insecurity and food addiction symptoms among low-income female-identified adults.[58] This was a large effect, even after accounting for sociodemographic variables; on average, individuals with food insecurity reported approximately

four more symptoms than food-secure individuals, the difference between subclinical and moderate food addiction. The association between food insecurity and food addiction appears to generalize to the broader adult population.

Second, the findings from this study provide evidence that retrospectively reported childhood food insecurity is associated with childhood food addiction symptoms. Food addiction may be an overlooked factor contributing to the associations between childhood food insecurity and elevated BMI[63,81] and other adverse health outcomes such as elevated blood pressure[82] and diabetes.[66] Identifying potential risk factors for childhood food addiction, like food insecurity, is important to improve quality of life for children and prevent adverse physical and psychological health outcomes associated with food addiction that commonly track into adulthood (e.g., elevated BMI, depression).[83,84]

Third, this study found that retrospectively reported childhood food insecurity was associated with current adult food addiction symptoms, which suggests that experiences of food insecurity early in life may contribute to the development of food addiction symptoms later in life. These findings suggest longitudinal research is warranted to more deeply probe temporal relationships between food insecurity and food addiction and identify more specific critical risk periods. This further highlights the urgent need to intervene on childhood food insecurity to prevent both concurrent and future addictive eating behavior. Future research should examine whether food insecurity intervention during childhood may mitigate the risk of food addiction during childhood and later in life. For example, researchers may test whether children who are able to access to child-focused food security interventions, such as school breakfast and lunch programs, show differential food addiction outcomes.

As expected, individuals who experienced persistent food insecurity reported more food addiction symptoms than any other food security stability category. Also as expected, individuals who experienced persistent food security reported the fewest number of food addiction symptoms. The difference between symptoms endorsed by these two groups has important clinical significance: individuals with persistent food security reported only one symptom on average, which does not meet the threshold for clinical significance while individuals with persistent food insecurity reported approximately 7.5 symptoms on average, which falls into the "severe" food addiction range.[75] These appear to represent distinct groups with distinctly different food addiction symptom profiles.

Consistent with hypotheses, individuals who experienced childhood food insecurity, but were currently food secure in adulthood, reported significantly more food addiction symptoms than those with persistent food security. This suggests that experiencing food insecurity during childhood may increase risk for food addiction during adulthood, even if adequate access to food is restored. This builds upon prior research that suggests childhood is a critical period for the impact of food insecurity on the development of eating behavior[70] and highlights the importance of food security policies that directly target children and adolescents.

Conversely, individuals who did not experience food insecurity in childhood, but were currently experiencing food insecurity in adulthood reported significantly fewer food addiction symptoms than those with persistent food insecurity and did not significantly differ from those who experienced persistent food security or only experienced food insecurity during childhood. This suggests that food security throughout childhood may be protective against food addiction symptoms in adulthood, even if one experiences food insecurity during adulthood. If policies can ensure that children receive adequate access to nutritious food throughout childhood and

adolescence, they may be less likely to experience food addiction symptoms even if they experience economic hardship later in life.

Another key takeaway from this study is that individuals who experienced food insecurity during both childhood and adulthood reported significantly more food addiction symptoms than individuals who were food secure in childhood but experienced food insecurity in adulthood. This difference was both statistically and clinically significant (a difference of approximately 5 symptoms, or the difference between subclinical food addiction and severe food addiction). Currently, most studies of adult food insecurity only measure experiences of food insecurity in the last year. This leads participants who are currently experiencing food insecurity, but who may have had very different experiences of food insecurity to be categorized together. Combining these participants into one category may underestimate the magnitude of deleterious effects of food insecurity for participants who have experienced food insecurity during key developmental periods in childhood. Conversely, this may overestimate the negative effects of food insecurity for individuals who first experience food insecurity in adulthood. Future studies should consider asking individuals about their experiences of early life food insecurity and comparing those who have only recently experienced food insecurity in adulthood and those who experienced it during childhood. Future research should also seek to validate a retrospective measure of food insecurity, perhaps starting with an adapted version of the FSSM, as used in this study.[74]

This study was subject to several limitations, which must be considered when interpreting the findings. First, the use of Mturk is a limitation given recent concerns about the use of Mturk data for research (e.g., participant inattention, limited English proficiency).[72] However, several recommended strategies were used to exclude participants with invalid data (e.g., limiting the

participant pool to US residents, excluding participants who incorrectly answered quality control questions or completed the survey in less than 10 minutes). Data were based on self-report and key study variables were based on measures adapted for the study to measure retrospective recall of childhood events, which are subject to unique challenges. Participants could refer to any time prior to age 18 when completing retrospective questionnaires on childhood food insecurity and childhood food addiction symptoms, which may have introduced error due to memory limitations. Additionally, participants' experiences of childhood food insecurity and/or food addiction symptoms may not have co-occurred (e.g., an individual may have experienced loss of control over consumption at age 5, food insecurity at age 10, and withdrawal at age 17). Further, participants across the sample may have reported on varying time points within their childhoods, which may have varying implications for child and adult outcomes. Future retrospective research should more specifically examine the time periods in which individuals have experienced food insecurity, and recruit samples that are adequately powered to compare food addiction symptoms by timing and chronicity of food insecurity. Ideally, long-term longitudinal research will allow researchers to determine specific temporal relationships between food insecurity and food addiction throughout the lifespan.

Future research should also aim to validate retrospective measures of childhood food insecurity and food addiction symptoms. One approach would be to administer retrospective measures to adults who have previously participated in research in which their childhood experiences were documented in real time. Food insecurity should be reported by children directly, as child reports of food insecurity often differ from caregiver reports, and appear to be more closely tied to eating-related outcomes.[65,85] Researchers should also consider administering retrospective measures to control participants who have been documented to not have the

outcome(s) of interest and are matched for potentially confounding demographic variables (e.g., social class, race/ethnicity). A recent validation of a retrospective measure of childhood neglect serves as a helpful model for how to conduct this research.[86] In addition to determining how reliable individuals are at retrospectively reporting their food insecurity and food addiction experiences, future research should consider the value of perceived childhood history of food insecurity in its own right. Recent research has suggested that children's perceptions of food insecurity are more strongly associated with eating disorder risk factors and symptoms than caregiver-reported household food insecurity.[65] This may be due to factors that buffer or exacerbate children's experiences of food insecurity within the home, independent of the true availability of food. For example, many parents attempt to shield their children from experiences of food insecurity by ensuring they eat consistently despite parents reducing their intake.[85,87] Alternatively, a child may perceive food insecurity in the household if their caregivers restrict their access to food due to disordered eating or beliefs about food, which may be similarly associated with key eating outcomes. Thus, the perception of children (and potentially retrospective perceived food insecurity) may be equally relevant to food addiction outcomes than more objective measures of food insecurity.

Given that this was a secondary analysis, the current findings may also have been impacted by the sample used in this study. Participants were initially recruited for a study that asked questions about trauma throughout the lifespan. Thus, recruitment materials mentioned trauma to adequately inform participants of the sensitive nature of the survey. These materials may have contributed to higher trauma exposure among participants (approximately 26% of participants in the larger study met criteria for post-traumatic stress disorder), which may have been directly or indirectly related to higher endorsement of food insecurity and food addiction

symptoms.[88] Questions about trauma were always asked first, followed by questions about current and retrospective food insecurity, followed by questions about current and retrospective food addiction symptoms. The order of questioning may have impacted participant responses, such that reflecting on current experiences may have contributed to overreporting of retrospective experiences. However, these effects would have been held constant across all participants. Additionally, the racial/ethnic distribution of the sample was primarily white (77.6%), which limits generalizability of findings to non-White samples. Future research should examine food insecurity and food addiction in nationally representative samples.

In conclusion, this study has furthered research on the association between food insecurity and food addiction by demonstrating that this association replicates in a more gender-balanced community sample. The current findings suggest that the children who experience food insecurity may be at elevated risk for food addiction, which may also track into adulthood. These individuals may be at increased risk for food addiction in adulthood even if they no longer experience food insecurity as adults. Childhood is likely a critical period to target food insecurity to reduce addictive eating. In contrast to other SUDs, food addiction occurs in the context of the basic need for nutrition all humans have from birth. Children are uniquely vulnerable to the effects of food insecurity because they lack agency over their access to food and eating behavior. The fact that certain children are only able to access food in ways that increase their risk for food addiction represents a social justice issue that must be urgently understood and addressed. Further research with more nuanced assessment of food insecurity across the developmental span is needed to understand and prevent the impact of food insecurity on food addiction symptoms. This research will inform policy changes to improve food access for people across the lifespan and reduce their risk of food addiction and associated negative outcomes.

Chapter 3 Mediators of Association between Food Insecurity and Food Addiction in a University Sample

3.1 Introduction

Emerging adulthood (often defined as the period between ages 18 and 25) is another important life period for eating behavior.[89] During this time, many individuals seek postsecondary education, which is often marked by increased financial independence and increased decision-making around food.[90] University students experience disproportionately high rates of food insecurity. Recent research has found that 35 to 42% of currently enrolled college students report experiencing food insecurity, which is approximately double the prevalence of food insecurity in the general population.[91] Rising rates of food insecurity in university students have been attributed to a combination of changing college student demographics and decreases in available resources. Specifically, an increasing number of students from low-income families, students who are financially independent from their parents, and students with children have enrolled in universities in recent years.[92] At the same time, college costs have doubled over the last several decades, even accounting for inflation, and living expenses have also risen, while financial aid (including university resources and key federal programs such as Pell grants) has failed to keep pace with rising costs.[92] This combination of lower family resources, increased costs, and limited financial aid has contributed to rising rates of food insecurity among university students. Students of color, younger students, student parents, and students who are financially independent from their parents are all more likely to report food insecurity.[91]

University students are also at higher risk for disordered eating. Although it is becoming more common for people of all ages to seek postsecondary education, most students still attend approximately from ages 18-22, which coincides with the peak time period for eating disorder onset.[93] Approximately 11-17% of female students and 4% of male students screen positive for a clinically diagnosable eating disorder, with 20-67% experiencing subthreshold symptoms.[94] Among university students, food insecurity has been associated with increased likelihood of screening positive on a common eating disorder screening tool.[18] Further, food insecurity in this population has been associated with higher prevalence of diagnoses of bulimia nervosa and other specified feeding or eating disorder, objective binge eating, compensatory fasting, and eating disorder-related impairment.[95] However, no studies to date have examined the relationship between food insecurity and food addiction in a university setting.

Several mechanisms of addiction may contribute to the relationship between food insecurity and food addiction in a university population. As described earlier, intermittent access to addictive substances enhances their addictive potential. This has been demonstrated in animal models of addiction to several substances.[96-98] Importantly, intermittent access to any food (i.e. standard chow) seems insufficient to induce addictive responses in animal models; animals must consume HP foods, with ingredients thought to be addictive (i.e., unnaturally high levels of refined carbohydrates and fat).[99] Thus, it appears a combination of HP food and intermittent access amplifies food addiction in animal models. Intermittent access to food is inherent in the food insecurity construct, as individuals with food insecurity experience varying degrees of food availability over time. Although controlled human studies examining the effects of intermittent access to HP foods have not been conducted, cross-sectional research in the food insecurity

context may provide valuable information regarding the role of intermittent access to HP food in the real world.

A core component of food addiction theory is that HP foods are addictive substances; they (or ingredients within them such as refined carbohydrates and fat) play a crucial role in initiating and perpetuating food addiction.[100] Research has shown that both university students and individuals with food insecurity both consume high proportions of their diet from HP foods.[20,101] A recent systematic review that compared eating patterns of different age groups across the world found that young adults also eat significantly more HP foods compared to other age groups.[102] Food insecurity in university students has been specifically associated with lower daily consumption of fruits, vegetables and legumes.[103] This combination of intermittent access to food and a higher proportion of HP foods in the diet may contribute to increased experiences of food addiction for university students experiencing food insecurity.

Additionally, individuals experiencing food insecurity report higher stress levels, which are associated with greater food insecurity severity.[53] Stress levels may be particularly high for university students experiencing food insecurity, as they are experiencing food insecurity in addition to other stressors like intense academic workloads, financial and work concerns, and family and social relationships.[104] Chronic stress is an important risk factor for the development and maintenance of addiction.[54] Both animal models and human research have demonstrated that chronic stress causes alterations to the corticotropin-releasing factor (CRF) system and hypothalamic-pituitary-adrenal (HPA) axis, which increase activation of reward-related neural regions and decrease activity in prefrontal functioning, which decreases behavioral control and increases impulsivity. Further, stress contributes to similar dopaminergic adaptations as addictive

substances, which increase the likelihood of initiation of substance use, craving, and substance seeking.[105]

Stress is a common mechanism between addiction and obesity, as stress-related neural reward system alterations potentiate overconsumption of both addictive drugs and HP foods.[55,56] A recent study found food insecurity was indirectly associated with higher body weight via increased distress and eating to cope.[57] This research suggests the stress associated with food insecurity may make individuals experiencing food insecurity more likely to use HP food as a coping strategy for stress. Although food addiction is not synonymous with high body weight, using HP food to cope with difficult emotions over time may simultaneously increase risk for weight gain and food addiction.

The current study aimed to examine whether mechanisms drawn from the addiction literature mediate the relationship between food insecurity and food addiction. We hypothesized that increased perceived stress, higher food reward, higher tendency to use food to cope with negative emotions, and higher daily HP food intake would mediate the relationship between food insecurity and food addiction. This study also aimed to examine whether the association between food insecurity and food addiction would replicate in a large sample of university students. We hypothesized that food insecurity would be associated with higher endorsement of food addiction symptoms.

3.2 Methods

3.2.1 Participants

Study participants included actively enrolled students at a large, public, Midwestern university in the United States. A total of 885 students completed the study. A subset of this

sample (n = 412) was part of a longitudinal cohort of students. These participants were originally

selected to be part of a quasi-experimental study examining the effects of sugar-sweetened

beverage (SSB) warning labels on SSB consumption. Participants in the longitudinal cohort were

actively enrolled students who visited a dining hall at least 100 times within the first two months

of their first semester. Greater details of the longitudinal cohort study methods have been

described elsewhere.[106] The remaining participants (n = 473) not in the longitudinal cohort were

randomly selected by the Office of the Registrar, with oversampling for racial/ethnic minority

students, students whose parents completed high school or less, and students with an annual

household income less than or equal to $65,000. A total of 52 participants were excluded from

the analysis due to missing data for all variables of interest. The final sample comprised 833

students. Demographic information of participants is reported in **Table 3.**

3.2.2 Procedures

All study procedures were approved by the University of Michigan Institutional Review

Board. In December 2021, participants were invited via email to complete a survey about

"students' health behaviors." After informed consent, participants completed an online survey

and reported demographic information via Qualtrics. Students received a $10 Amazon gift card

upon completion of the survey.

3.2.3 Measures

US Adult Food Security Survey Module. Food insecurity was measured by the 10-item

US Adult Food Security Survey Module.[74] The US Adult Food Security Survey Module is

designed to examine an individual's level of household food security in the last 12 months. The

first three questions of the module assess for frequency of food insecurity experiences (e.g.,

worrying whether food would run out until they got money to buy more). The remaining questions assess other experiences of food insecurity (e.g., cutting the size of meals or skipping meals because there wasn't enough money for food).

The US Adult Food Security Survey Module allows for categorization by four food security categories based on the number of affirmative responses ("often true," or "sometimes true," to the first three questions, or "yes" to questions with binary response options). Individuals were designated as having "high food security" if they did not respond affirmatively to any questions, "marginal food security" if they endorsed one to two questions, "low food security" if they endorsed three to five questions, and "very low food security" if they endorsed six to ten questions. In this study, participants were divided into food secure (high and marginal food security; n = 649, 77.9%) and food insecure (low and very low food security; n = 184, 22.1%) for analyses. The Adult Food Security Module showed excellent internal consistency in this sample (α = .90).

Modified Yale Food Addiction Scale 2.0. The Modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) was developed to assess food addiction symptoms. The questions are based on the SUD criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5),[107] adapted to the context of HP food. The mYFAS 2.0 consists of 13 questions and assesses for the 11 SUD symptoms from DSM-5, plus clinically significant impairment and distress.[24] Participants reported the frequency of each symptom over the last 12 months, from "never," to "every day." Each symptom has a different frequency threshold that must be met to meet criteria for that symptom. For example, to meet criteria for the symptom "substance taken in larger amount and for longer period than intended," participants must report that they "ate to the point where they felt physically ill" at least once per week. Participant symptom endorsement was

scored as 0 or 1 for each symptom. The number of symptoms each participant endorsed were added to create a symptom count score. Symptom count scores could range from 0 to 11 (M = 0.91, SD = 1.86). A symptom count of 2 is the current estimated threshold for a clinical level of addictive eating.[24] A symptom count was used rather than a dichotomous diagnostic score because continuous dimensional measures are more sensitive for detecting food addiction symptoms in community samples.[76] The mYFAS 2.0 showed good internal consistency in this sample (α = .86).

Perceived Stress Scale. The Perceived Stress Scale (PSS) is a widely used 10-item scale designed to measure an individual's perceived stress during the last month. The PSS has demonstrated good psychometric properties across diverse community samples.[108] Each question asked participants how often they have experienced certain things in the last month (e.g., "how often have you felt you were unable to control the important things in your life?") Participants rated their responses to each question on a 5-point Likert-type scale from 0 (never) to 4 (very often). Responses were summed to create a PSS total score, which could range from 0 to 40, with higher scores indicating greater perceived stress (M = 19.89, SD = 6.64). The PSS showed good internal consistency in this sample (α = .83).

Reward-based Eating Drive Scale. The Reward-based Eating Drive Scale (RED-13) is a 13-item scale designed to measure the spectrum of reward-related eating, which includes lack of satiety, preoccupation with food, and lack of control over eating.[109] Participants responded to each question on a 5-point Likert scale from 0 (strongly disagree) to 4 (strongly agree). Responses were summed to create a RED total score, which could range from 0 to 52, with higher RED scores indicating more reward-based eating (M = 15.2, SD = 10.96). The RED-13 showed excellent internal consistency in this sample (α = .92).

Palatable Eating Motives Scale, Coping Subscale. The Palatable Eating Motives Scale

(PEMS) is a 20-item scale that was adapted from a measure of alcohol drinking motives to

measure individuals' motives for consuming highly palatable foods.[110] The PEMS has four

subscales (social, coping, enhancement, and conformity). The coping subscale was used in this

study and consists of 4 questions designed to measure the extent to which participants use food

to cope with negative emotions. Participants reported the frequency with which they have

experienced each item on a 5-point scale from 0 (almost never/never) to 4 (almost

always/always). Responses were averaged to create a PEMS coping subscale score, with higher

scores indicating more eating to cope with negative emotions (M = 1.88, SD = 1.00). The PEMS

coping subscale showed excellent internal consistency in this sample (α = .91).

Dietary Screener Questionnaire. The 26-item Dietary Screener Questionnaire (DSQ)

was created by the National Cancer Institute to measure frequency of consumption of several

common food and beverage groups over the last month.[111] Participants chose from one of 9

frequency indicators for each item from 1 (never) to 9 (2 or more times per day). An HP daily

food consumption score was calculated for each participant by recoding the response options to

reflect daily consumption rather than monthly consumption (i.e., once daily consumption was

recoded as 1, consumption two times per week was recoded as .27 [8 times per month divided by

30]) and summing the participant's reported consumption of foods deemed by the authors to

unambiguously fit HP food criteria (e.g., sugar-sweetened beverages, fried potatoes, pizza,

chocolate, donuts) and dividing it by 30 to get a daily estimate. Some items measured on the

DSQ could be considered either minimally processed or HP, depending on their preparation

(e.g., popcorn, processed meat). These items were not included in the daily HP food

consumption score. This daily HP food consumption score (M = 1.78, SD = 1.33) was included in the model as a measure of diet quality.

3.2.4 Data Analytic Plan

Data were analyzed using IBM SPSS Statistics (Version 28; IBM Corp, 2021) and Mplus 8 (Muthen & Muthen, 2021). Univariate distributions and missing data were examined for all variables. Structural equation modeling (SEM) was used to evaluate the proposed model using a robust (Huber-White) maximum likelihood algorithm to manage nonnormality and variance heterogeneity Full Information Maximum Likelihood (FIML) methods were used to address missing data. A variety of indices of model fit were evaluated, including global (chi square, Comparative Fit Index [CFI], Tucker-Lewis Index [TLI], Standardized Root Mean Square Residual [SRMR], Root Mean Square of Approximation [RMSEA]) and focused (standardized residuals and modification indices) fit indices. Acceptable fit was determined by a minimum cutoff of 0.95 for CFI and TLI, a maximum cutoff of 0.06 for RMSEA, a maximum cutoff of 0.08 for SRMR, standardized residuals < |2|, and modification indices < |4|.[112] Endogenous variables included food addiction symptoms (outcome variable) and 4 mediating variables (perceived stress, reward-based eating, eating to cope, and daily HP food consumption). The one exogenous variable was food insecurity. The following covariates were included for endogenous variables based upon theory and prior literature: age, gender, race/ethnicity, first generation college student status, and household income.

3.3 Results

3.3.1 Model Fit

The fit of the model in Figure 2 was evaluated with MPlus 8 using a maximum likelihood algorithm. The first model was statistically over-identified and a variety of indices of model fit were evaluated pointing towards overall poor model fit: the overall chi square test of model fit was not statistically significant ($X^2(23) = 159.63$, p <.001), the Root Mean Square Error of Approximation (RMSEA) was 0.08, the p value for the test of close fit was p <.001, the Comparative Fit Index (CFI) was 0.85, the Tucker-Lewis Index (TLI) was 0.74, and the standardized root mean square residual was 0.06. In addition to global fit indices, there were sizeable and theoretically meaningful modification indices leading to adding a correlation between RED and PEMS scores (MI = 52.12), PSS and PEMS scores (MI = 52.12), PSS scores and gender (MI = 54.64), and a path from age to daily HP food consumption (MI = 14.34).

The model was re-analyzed with the above theoretically coherent modification indices being addressed by adding three correlations and one pathway. The model fit statistics for this updated model were as follows: The overall chi square test of model fit was not statistically significant ($X^2(19) = 23.42$, p = .22), the Root Mean Square Error of Approximation (RMSEA) was 0.02, the p value for the test of close fit was p = .99, the Comparative Fit Index (CFI) was 0.995, the Tucker-Lewis Index (TLI) was 0.99, and the standardized root mean square residual was 0.02. There were no additional modification indices. All model fit indices pointed to good fit. Zero-order correlations for all variables of interest are reported in **Table 4.**

3.3.2 Parameter Estimates

Figure 2 presents the parameter estimates for the structural model. Unstandardized and standardized coefficients appear on each path separated by a backslash and include both standard errors in parentheses. The error and disturbance terms (residuals) shown in circles indicate the

proportion of unexplained variance for each of the endogenous variables in standardized form. Margins of error are based on 95% confidence intervals.

Food insecurity directly related to perceived stress and reward-based eating. Specifically, for every one unit increase in food insecurity, there was an average associated 4.35 unit increase in perceived stress (SE = 0.57, p <.001) and .324 unit increase in reward-based eating (SE = 1.01, p =.001), independently. Although not statistically significant at the p<.05 level, food insecurity was marginally directly related to food addiction symptoms (p = .05).

As for the endogenous mediation variables, perceived stress directly related to reward-based eating and food addiction symptoms. For every one unit increase in perceived stress, there was an average associated .40 unit increase in reward-based eating (SE = .06, p <.001) and .02 unit increase in food addiction symptoms (SE = 0.01, p = .04), independently. Reward-based eating directly related to eating to cope with negative emotions and food addiction symptoms. For every one unit increase in reward-based eating, there was an average associated .21 unit increase in eating to cope with negative emotions (SE = 0.06, p = .001) and .06 unit increase in food addiction symptoms (SE = 0.01, p <.001), independently. Eating to cope with negative emotions directly related to food addiction symptoms such that for every one unit increase in eating to cope with negative emotions, there was an average associated .64 unit increase in food addiction symptoms (SE = 0.09, p <.001). Lastly, daily HP food consumption directly related to food addiction symptoms such that for every one unit increase in daily HP food consumption, there was an average associated .10 unit increase in food addiction symptoms (SE = 0.05, p = .02).

Overall, perceived stress, reward-based eating, and eating to cope with negative emotions functioned as mediators in the tested model. Food security and food addiction symptoms were

indirectly related through perceived stress (b = 0.08, p = .048), reward-based eating (b = 0.19, p = .002), and the combination of perceived stress and reward-based eating pathways (i.e., food insecurity → PSS → RED → YAFS symptoms; b = 0.10 p <.001). Food insecurity also related to food addiction symptoms indirectly through the combination of perceived stress, reward-based eating, and eating to cope with negative emotions pathways (i.e., food insecurity → PSS → RED → PEMS coping → YAFS symptoms; b = 0.23, p = .001).

3.4 Discussion

This was the first study to examine whether mechanisms of addiction mediate the relationship between food insecurity and food addiction in a university sample. Although food insecurity and food addiction were not directly related in this sample, they were indirectly related through perceived stress, reward-driven eating, and eating HP foods to cope with negative emotions. This is consistent with research from SUDs that shows that stress increases risk for addictive behavior,[113] and builds upon findings related to the relationship between food insecurity and weight gain[57] by demonstrating how food reward and food addiction may play a role in this association. Food insecurity appears to provide key conditions for increasing risk for addictive eating, including increased stress, increased reward response to HP food, and increased eating HP food to cope.

Understanding these mechanisms may inform interventions for university students experiencing food insecurity to reduce the risk of developing food addiction. The most obvious and important intervention is to change policy to ensure all students' access to adequate, nutritious food. Potential policy interventions may include widening eligibility criteria for students seeking federal assistance programs like SNAP and implementing or expanding university-based food resources such as food pantries. Given that stress appears to play an

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important role, implementing policies to reduce student stress, such as modifying exam structure and increasing access to student counseling services may also help reduce food addiction risk.[114] Students may also benefit from individual-level interventions for coping with stress and craving from increased food reward. These may include techniques that are effective in SUD treatment, such as mindfulness.[115] Distress tolerance skills from dialectical behavior therapy may also help students find ways other than HP food to manage intense negative emotions.[116]

Consistent with hypotheses, daily HP food intake was directly related to food addiction symptoms. This is consistent with food addiction research, which consistently shows associations between consumption of HP foods high in refined carbohydrates and fat and food addiction symptoms.[23,117,118] However, food insecurity was not directly related to HP food intake and HP food intake did not mediate the relationship between food insecurity and food addiction in this sample. This finding is contrary to prior research that has shown that food insecurity is associated with greater intake of HP food.[20] It is possible that this finding reflects that HP food consumption truly does not mediate the relationship between food insecurity and food addiction among university students. However, measurement of HP food intake using the DSQ in this study makes it difficult to draw firm conclusions from this result. Given that the highest frequency marker on the DSQ reflects consumption of "two or more times per day," individuals who chose this option could have potentially consumed HP foods many more than two times per day. The mean DSQ score in this sample was 1.78, which was close to the ceiling for the scale, suggesting that this measure may have undercounted HP food intake for many participants. The DSQ also does not account for serving size, which may account for variance in individual eating behavior. For example, an individual who ate an entire pizza once per day would potentially receive a lower score than someone who ate two slices of pizza at different times during the day.

Additionally, the daily HP food consumption variable was calculated by the authors rather than using a validated measure of HP food consumption. The authors took a conservative approach to categorizing foods as HP, such that many foods that are typically served as HP foods were labeled as minimally processed if there was any potential for the food to be served in a minimally processed way (e.g., popcorn can be consumed plain, but is most often eaten with butter). This may have further underestimated the frequency of HP food consumption in this sample. Alternatively, generally high levels of HP food consumption among university students[101] may have limited our ability to use HP food consumption to distinguish between students with and without food insecurity. Future research should consider using measures that have been designed to accurately categorize HP foods and better capture the upper end of HP food consumption. Future research may also consider using more objective measures of dietary intake such as the remote food photography method.[119]

This was the first study to investigate the relationship between food insecurity and food addiction among university students and the first study to examine whether mechanisms of addiction mediate this relationship. These findings add to the burgeoning literature showing associations between food insecurity and food addiction in various samples.[58] The mechanisms identified in this study may also contribute to increased risk for SUD more broadly, as food addiction often co-occurs with high-risk substance use.[39] These findings are particularly concerning in the context of COVID-19-era food assistance programs ending in early 2023 (e.g., expanded eligibility criteria for college students), which may contribute to rising rates of food insecurity among students.[120] Experiences with food insecurity and its associated negative outcomes, including addictive eating, may prevent many low-income university students from reaching their full academic and social potential.

This study was subject to several additional limitations. First, this study was cross-sectional and thus cannot provide information about temporal or causal relationships between variables of interest. Although the study had a large sample size, the sample sizes of students with food insecurity were relatively small (n = 184, 22%), which may have limited power to detect smaller effects. Several characteristics of the sample and educational setting should be taken into account with regard to potential generalizability to the broader postsecondary student population. This study was conducted at a four-year public university with relatively lower incidence of food insecurity and food addiction compared to general student samples. Further, a portion of the sample was also included in a longitudinal analysis for which the inclusion criteria required frequent use of a dining hall during their first year, which may have contributed to the lower rates of food insecurity in this sample.

Future research may consider multimodal assessment of the mediators tested in this model. For example, biomarkers of stress that have been associated with addictive behavior (e.g., adrenocorticotropic hormone)[121] may be helpful for understanding the role of physiological stress responses in the relationship between food insecurity and food addiction. Researchers may also consider examining various types of stress that specifically affect students, such as academic stress. Black and Hispanic students are also at increased risk for food insecurity,[91] and also at increased risk for racism-related stress, which has been associated with increased substance use.[122] Examining whether specific types of stress mediate the relationship between food insecurity and food addiction may help identify interventions for students at greatest risk. Additionally, more robust measurement of food reward through biological (e.g., neuroimaging) and behavioral measures (e.g., relative reinforcing value of food task) may provide additional

information about the role of food reward in the relationship between food insecurity and food addiction.

University students experience disproportionate rates of food insecurity and increased risk of problematic eating behavior during a time in their lives in which they face immense pressure to perform academically and begin to take on the responsibilities of adulthood. Thus, it is critical to identify ways to mitigate negative health outcomes among this population. This study has illuminated several mechanisms of addiction that appear to play a key role in food addiction among students experiencing food insecurity. Continued research on the mechanisms of the connection between food insecurity and food addiction among university students will aid researchers in developing policy- and individual-level interventions to ensure that all students are able to access food in ways that that do not increase their risk for addictive eating and associated negative health outcomes.

Chapter 4 Qualitative Evaluation of the Yale Food Addiction Scale 2.0 Among Individuals with Food Insecurity

4.1 Introduction

Preliminary research points to an association between food insecurity and food addiction.[58] Prior studies that have examined the relationship between food insecurity and food addiction have used the Yale Food Addiction Scale (YFAS), which is the most commonly used and widely validated tool for assessing food addiction.[76] Although some contention remains among researchers regarding whether food addiction should be considered a behavioral addiction or a SUD,[123] the dominant conceptualization of food addiction posits that HP foods are addictive substances, which contribute to symptoms and impairment akin to other SUDs.[100] The YFAS 2.0 (the most recent version of the scale) is based on the DSM-5 criteria for SUDs, applied to the context of HP food.[75] The YFAS 2.0 has been psychometrically validated in several populations,[76] and a recent qualitative analysis demonstrated that individuals generally interpret YFAS 2.0 questions in ways that are consistent with the DSM-5 conceptualization of SUDs.[52] However, the YFAS 2.0 has tended to be studied in relatively well-resourced samples that are less likely to experience food insecurity, and research examining food addiction in lower-income individuals has not examined food insecurity directly.[35,124] Thus, evaluating the YFAS 2.0 specifically within populations experiencing food insecurity is an important next step for research investigating associations between food insecurity and food addiction.

A recent qualitative analysis of the lived experience of food addiction identified food insecurity as an important theme (Schiestl et al., under review). Notably, approximately half of

participants reported having experienced food insecurity during childhood, which they explicitly linked with their current experiences of food addiction. This research suggests a history of food insecurity may be important for shaping the lived experience of adults with food addiction and highlights the need for further research on this topic. However, no qualitative research to date has directly examined co-occurring food insecurity and food addiction.

It is important to examine whether the YFAS 2.0 accurately captures the food addiction construct in individuals experiencing food insecurity, to determine whether adaptations may be warranted when measuring food addiction in a food insecurity context. If the YFAS 2.0 does not accurately reflect food addiction, individuals may be erroneously labeled as having food addiction, when their responses reflect difficulties specific to food insecurity that are not theoretically consistent with a SUD. The experience of food insecurity may impact individuals' responses to the YFAS 2.0, such that their endorsement indicates some other aspect of deprivation more generally rather than food addiction per se. Although the YFAS 2.0 was created to directly reflect the DSM-5 SUD criteria,[125] it is plausible that individuals experiencing food insecurity may interpret certain YFAS 2.0 questions in ways that make it difficult to distinguish between the effects of deprivation and an addictive phenotype. Qualitative evaluation of psychological measures is important to ensure that assessment tools accurately capture the experiences of individuals experiencing the condition that it aims to assess.[126] Through open-ended inquiry and follow-up questions, qualitative evaluation allows researchers to ensure participants are interpreting questions as intended.[126,127]

The current study utilized semi-structured interviews with Michigan residents who concurrently met criteria for food insecurity and food addiction, to qualitatively evaluate whether adults with food insecurity describe symptoms of food addiction in ways that are consistent with

the DSM-5 conceptualization of SUDs. As a secondary aim, this research sought to explore how food insecurity and food addiction may interact to affect individuals' lived experience as described in response to YFAS 2.0 questions.

4.2 Methods

4.2.1 Participants

Participants were recruited via the University of Michigan Health Research website, which is a free research recruitment resource available to individuals affiliated with the University of Michigan and the general public. The study advertisement invited participants to express interest in the study if they "sometimes struggled to afford food and felt their eating was out of control." The advertisement did not use any language related to addiction. Potential participants completed the modified Yale Food Addiction Scale 2.0 (mYFAS 2.0),[24] completed the US Food Security Survey Module,[74] and provided demographic information (e.g., age, race, gender, number of household members) through a secure online portal. Participants were eligible to participate if they met the following criteria: age 18 or older, current resident of Michigan, met food addiction criteria on the mYFAS 2.0, and met criteria for marginal, low, or very low food security based on the US Food Security Survey Module. Participants were required to be current residents of Michigan to contain the sample to individuals with relatively similar food environments and available resources. To avoid participants that were not involved in food decision-making in their households, we also required that participants self-identified as a main provider and/or preparer of food for their household. We aimed to interview between 15 and 25 participants based on average sample sizes for prior qualitative studies of food addiction.[52,128-130] Purposive sampling was used to recruit a range of participants across age, race, gender,

educational attainment, and household makeup (i.e., caretakers for children vs. non-caretakers) and self-perceived body size. We attempted to recruit participants with a range of food addiction severity (i.e., mild, moderate, and severe) and food insecurity severity (i.e., marginal, low, and very low food security).

355 individuals expressed interest in the study and were invited to complete the screening questionnaire. 259 individuals completed the screening questionnaire. Following completion of the screening questionnaire, 23 individuals were excluded from participation due to not living in Michigan, 43 were excluded due to not meeting the criteria for food insecurity, and 119 individuals were excluded due to not meeting the criteria for food addiction. 42 individuals were eligible but chose not to participate in the study or were lost to follow up. 29 participants completed the study visit. Five participants were initially eligible at screening but were excluded following study completion for not meeting criteria for food addiction (n = 2), food insecurity (n = 1), or both (n = 2) on the day of the study visit. One additional participant was excluded due to providing unreliable and contradictory information throughout the interview.

The final sample comprised 23 participants. Participant demographics, food security status, food addiction severity and EDDS diagnoses are detailed in **Table 5.** Based on the YFAS 2.0, 17 participants met criteria for severe food addiction and three met criteria for moderate food addiction. Three participants endorsed enough symptoms to meet the food addiction symptom criterion but did not endorse impairment or distress on the day of the study visit. This may have been due to changes in the time between screening and participation, which ranged from 7 to 76 days or due to participants feeling less comfortable endorsing their distress with the interviewer present. Although not endorsing impairment or distress prevented these participants from receiving a food addiction "diagnosis," they were included in the study based on meeting

the symptom criterion and prior research showing that individuals with food addiction symptoms who do and do not endorse the impairment or distress criteria do not meaningfully differ on markers of psychological distress.[131] These participants are noted as -I/D below.

4.2.2 Interview Guide Development

A semi-structured interview guide was developed by a team of researchers with expertise in food addiction, food insecurity, eating pathology, and qualitative research methods. The first portion of the interview focused on participant's thoughts as they completed the YFAS 2.0. Questions were modeled after a recent qualitative evaluation of the YFAS 2.0 in individuals who self-identified as having food addiction.[52] The remaining interview questions focused on participants' experiences of food insecurity and how their experiences of food insecurity may interact with food addiction symptoms they endorsed on the YFAS 2.0. Participants were also asked about their multiple intersecting social identities and how they may inform the experiences they share in the interview. The interviewer did not use language related to addiction (e.g., "addiction," "withdrawal," "tolerance") throughout the YFAS 2.0 interview. The full interview guide is included in Appendix A.

Interviews were completed via Zoom or on-site at the University of Michigan, depending on participant preference. First, participants completed written informed consent. Participants then filled out the YFAS 2.0 and completed a qualitative interview about their thoughts as they completed the YFAS 2.0 and their experiences of food insecurity. Participants then completed the Eating Disorder Diagnostic Scale to determine whether participants met criteria for clinically significant eating disorder pathology (i.e., anorexia nervosa, bulimia nervosa, binge eating disorder, night eating syndrome).[132] Afterward, participants were debriefed, offered a list of local resources for disordered eating treatment and food insecurity support, and compensated $40.

4.2.3 Measures

Yale Food Addiction Scale 2.0 (YFAS 2.0). The YFAS 2.0 is a 35-item, self-report questionnaire that applies the DSM-5 criteria for SUDs to the consumption of HP foods.[125] The full title of the YFAS 2.0 was not shared with participants at any point, to avoid biasing their responses toward addiction. Questions include, "When I started to eat certain foods, I ate much more than planned," and "I had such strong urges to eat certain foods that I couldn't think of anything else." The questionnaire asks participants to reflect on their eating behaviors in the last year and asks them to consider certain foods in their responses (e.g., sweets, salty snacks, sugary drinks, fast food). Response options range from 0 (Never) to 7 (Everyday) indicating the frequency that an individual engages in different food addiction behaviors. Each item represents a symptom from the DSM-5 criteria for SUDs (e.g., inability to cut down, tolerance) and has a specific frequency threshold (e.g., participants must endorse the first item at least four to six times per week in order to meet criteria for that item). If a participant meets the frequency threshold on any item, they meet criteria for that symptom. A participant must meet criteria for two symptoms and experience clinically significant impairment or distress to receive a "diagnosis" of food addiction. Mild food addiction was defined as meeting two to three symptoms, moderate food addiction was defined as meeting four to five symptoms, and severe food addiction was defined as meeting criteria for six or more symptoms. On average, participants reported 7.19 symptoms (SD = 3.55). The YFAS 2.0 had excellent internal consistency in this sample (α = 0.97).

US Household Food Security Survey Module. Food insecurity was measured by the 18-item US Household Food Security Survey Module (FSSM).[74] The FSSM is an 18-item scale designed to examine a family's level of household food security in the last 12 months. The first

10 questions assess adult respondents' experiences (the US Adult Food Security Module), and the remaining eight questions assess experiences of respondents' children if they are present in the household. Participants completed the FSSM about their or their families' experiences in the last 12 months. The first three questions of each module assess for frequency of food insecurity experiences (e.g., worrying whether food would run out until they got money to buy more). The remaining questions assess other experiences of food insecurity (e.g., cutting the size of meals or skipping meals because there wasn't enough money for food).

The FSSM allows for categorization by four food security categories based on the number of affirmative responses ("often true," or "sometimes true," to the first three questions, or "yes" to questions with binary response options). Participants were categorized by food security status to aid with purposive sampling. Thresholds for categorization as "low food security" and "very low food security" differ based on whether there are one or more children present in the household. Individuals were designated as having "high food security" if they did not respond affirmatively to any questions, "marginal food security" if they endorsed one to two questions, "low food security" if they endorsed three to five questions (or three to seven questions for household with one or more children are present), and "very low food security" if they endorsed six to ten questions (or eight to eighteen questions for households with one or more children present). On average, participants endorsed 9.29 items in the FSSM (SD = 4.40). The FSSM showed excellent internal consistency in this sample (α = 0.91).

Eating Disorder Diagnostic Scale. Comorbid eating disorder diagnoses were assessed using the DSM-5 version of the Eating Disorder Diagnostic Scale (EDDS).[132] The EDDS is a 23-item self-report measure that was originally designed and validated as a tool to briefly measure the diagnostic criteria for DSM-IV eating disorders, and was recently updated to reflect the

DSM-5 eating disorder criteria.[133] Participant BMI was calculated based on self-reported height and weight to determine weight loss criteria for eating disorder diagnosis. BMI was categorized by the authors for demographic purposes using standard BMI cutoff points.[134] The EDDS showed adequate internal consistency in this sample ($\alpha = 0.65$).

4.2.4 Data Analytic Plan

All interviews were audio-recorded and transcribed verbatim. Transcripts were uploaded into NVivo for review and analysis. Thematic analysis was used to analyze interviews and generate themes.[135] Reflexive thematic analysis was chosen as the pre-specified method of analysis because it allows for flexibility and the ability to uncover rich, detailed patterns across participants. Experiential and semantic orientations were used to develop themes, which center the participant's experience and assume that language reflects the reality of the participant. A combination of deductive and inductive approaches were used to analyze responses. To determine if participant responses were consistent with the DSM-5 conceptualization of SUDs, a deductive approach was used. After responses were analyzed deductively, an inductive approach was used to allow themes to emerge from participant responses.

Coding and analysis were conducted through an iterative process, with a team of four trained coders (three research assistants and the first author). The coding team read each transcript multiple times to increase familiarity with the data, note initial thoughts and questions, and highlight relevant sections of text. Memos and annotations were used to track coders' subjective experiences of the coding process.[136] Coders independently coded each transcript and met several times to discuss codes, identify and discuss discrepancies, and reach consensus.

Once the coding process was complete, the first author reviewed categorizations of participant responses from the deductive coding approach for accuracy and to identify patterns

within each YFAS 2.0 question. Interpretations of questions and symptoms were considered potential themes if they were interpreted similarly across two or more participant responses. Given the primary aim of the study, misinterpretations of YFAS 2.0 questions coded as directly related to food insecurity were evaluated for potential themes even when described by a single participant. The first author identified candidate themes for the inductive coding approach by reviewing responses that seemed to follow patterns (e.g., endorsed by two or more participants) that emerged across the data set. Relevant sections of text were collated under each candidate theme. Thematic maps were used throughout this process to organize candidate themes and continually check the candidate themes' fit with the larger dataset. Finally, candidate themes were reviewed to ensure they accurately reflected participant responses, to determine if themes should be combined, and to determine if additional themes should be added. The first author continually consulted with the dissertation committee chair to discuss and resolve uncertainty throughout the analytic process. Participants did not provide feedback to the investigators during the analytic process.

4.3 Results

Responses were categorized into four groups, according to the goals of the study: responses consistent with the DSM-5 conceptualization of SUD where participants' experiences of food insecurity were not readily apparent, responses where food insecurity appeared to directly influence participants' consistent experiences of food addiction, responses in which food insecurity appeared to contribute to misinterpretation of YFAS 2.0 questions, and responses that reflected misinterpretations that seemed to be driven by factors outside of food insecurity.

4.3.1 Responses Consistent with DSM-5 Conceptualization of SUD

Most participants who endorsed items on the YFAS 2.0 described their experiences as consistent with food addiction based on the DSM-5 conceptualization of SUD. Although all participants endorsed experiences of food insecurity within the last year, most participants did not actively connect their experiences of food insecurity with their experiences of food addiction symptoms. Included below are representative responses in which participants described their interpretations of each DSM-5 SUD symptom, without directly implicating their experiences of food insecurity.

4.3.1.1 Substance Taken in Larger Amount or for Longer Period than Intended

In SUDs, individuals may persistently consume an addictive substance in larger quantities or for longer periods than they initially intended.[107] Participants in this study consistently described eating larger amounts of HP foods than they intended in a given period. For example, one participant shared her difficulty managing her consumption of donuts:

"I can't even be in the same vicinity as Krispy Kreme or any type of donuts, 'cause I will finish a dozen all by myself and I'm type 2 diabetic. So, that could kill me, and I know that and I know that I shouldn't be eating all those. I shouldn't be eating one, let alone a whole dozen. But for some reason I just can't stop eating them." (participant with low food security and severe food addiction)

Another participant described eating HP foods until he felt physically ill:

"Like in terms of like physical illness, I just meant like feeling uneasy and feeling like vomity... Especially when I mix a lot of things, like if I'm having a burger with fries and coke and some dessert, and then I might just stuff myself a lot and then I just feel like, that

I might puke or something." (participant with very low food security and severe food

addiction – I/D)

4.3.1.2 Persistent Desire or Repeated Unsuccessful Attempts to Quit

SUDs can also be marked by an individual's persistent desire or repeated attempts to

reduce or stop their consumption of the substance.[107] Participants described repeatedly

attempting to reduce their consumption of HP foods but having difficulty managing their intake,

and ultimately returning to prior intake levels. A participant shared difficulty cutting down on

snack consumption:

"This is a lot of like snacks, I feel like, the salty, sweet things where it's like, now that I

have chips in my house, it's a lot easier to eat chips. I don't actually really want to eat chips

that often. And so part of me is always like trying to not, or trying to find something else,

but then sometimes I still end up finding myself there, and then similar with things like

candy or cookies or snack bar type things." (participant with very low food security and

severe food addiction)

Another participant described his difficulty reducing his intake of various HP foods:

"[I experience this with] foods which have a high salt content and a high sugar content and

maybe sometimes fried food like chips and stuff. So I would say I wanna try and limit my

sugar content, but it just doesn't happen easily. Like for example, if I'm having coffee... I

start with putting one teaspoon lesser, but it just doesn't work well, so I end up coming back

to my level." (participant with very low food security and severe food addiction – I/D)

4.3.1.3 Much Time or Activity to Obtain, Use, or Recover

A third indicator of SUD is a significant amount of time and/or energy spent to obtain,

use, or recover from the effects of the substance.[107] Recovering from the substance varies across

substances depending on the effects of the substance. For non-intoxicating, widely accessible substances like tobacco, this symptom is often met based on time spent using the substance (e.g., "chain-smoking").[107]

The YFAS 2.0 assesses time/activity spent to obtain the substance as going out of one's way to get HP foods, despite having other food available to eat. Several participants described seeking out specific foods from stores or neighbors even when they had access to more minimally processed options or less preferred HP foods at home. For example, one participant described driving out of her way to get a specific food she was craving:

"I do it all the time, but just one example is, I went to [name of mall], which is 30 or 40 minutes away from my house just to get a Cinnabon [chuckle] and I got extra sauce on it… If I have other foods in the house… I might have my fruits and vegetables in there but I'll still go to the store and get the Reese's peanut butter cups and then Doritos and two or three pops." (participant with very low food security and severe food addiction)

Some participants described convenience as a driving factor in their spending excess time seeking out certain foods. For example, one participant described seeking out fast food despite having other HP options at home that required preparation:

"We have a lot of frozen stuff, like mini corn dogs and stuff. And, we have stuff to make grilled cheese and all that. But I go out and I'll get Wendy's, Taco Bell, McDonald's. Usually one of those three." (participant with very low food security and severe food addiction)

Several participants described eating HP foods consistently throughout the day, which corresponds to time spent using the substance. A participant described eating snacks throughout the day:

"I have snacks in my car, I have something next to me. I have something in my room. I'll always make sure I have the food. I don't really have a specific kind, but it's just snacks in general. I will just make sure that I have that and then I can just eat it all day…Like I can just not, like nonstop eating snacks." (participant with low food security and severe food addiction)

For most participants in this study, time spent recovering from the HP food consumption entailed feeling tired or sluggish for several hours following consumption of HP foods. A participant described feeling sluggish into the following day:

"If I eat too much, if I eat a whole thing of Chinese food and Reese's peanut butter cups and Doritos and all that kind of stuff, big old meal, in about an hour I'll feel very sluggish and tired from eating and even actually the next day where I can barely function." (participant with very low food security and severe food addiction)

4.3.1.4 Important Social, Occupational, or Recreational Activities Given Up or Reduced

In SUDs, individuals often describe giving up activities that were previously important to them in order to engage in substance use or to recover from the effects of the substance.[107] Most participants in this study described giving up social activities, particularly events like birthday parties, weddings, and baby showers where large amounts of HP food are often served, because of concerns that they may overeat and be judged by others. One participant described prioritizing eating over spending time with family and friends:

"For a while there, I just shut myself off. I seemed to get such satisfaction from eating that it was like if I took time out to spend with my friends and family I was taking away the time that I would spend eating, and to me at that point eating was more important than my family and friends." (participant with very low food security and severe food addiction)

Another participant described eating taking away time from engaging with hobbies:

> "Well, I'm thinking about stuff around the house or doing creative projects. 'Cause when I eat the foods, I'm not doing these positive things…So the time I take getting these foods and eating these foods and then being tired and lethargic from them gets in the way of me doing some housework or using my talents to do something creative, for example." (participant with very low food security and severe food addiction)

Although several participants described avoiding social activities at work or school due to fear of overeating, no one in this study described avoiding working or attending school due to food addiction symptoms. Some participants attributed their lack of endorsement to ease of access to and portability of HP foods. A participant described it as such:

> "I've never avoided it because of the food. If I know that I might not get something there, I would carry it with myself just in case. Like I always have something to snack on or like a quick dessert in my bag at all times. So that has never been a problem for me." (participant with very low food security and severe food addiction -I/D)

Although these participants did not endorse the symptom, their interpretation of the question was in line with its intended meaning and consistent with a food addiction presentation.

4.3.1.5 Continued Use Despite Knowledge of Adverse Consequences

Individuals with SUDs often continue to use an addictive substance despite having knowledge of adverse consequences associated with substance use.[107] Participants who endorsed continued use despite adverse consequences described a range of negative effects, including concern for future health problems, exacerbation of existing physical and psychological health problems, physical symptoms such as headaches, back pain, and increased heart rate, and shame

related to overeating and weight gain. A participant described continued overconsumption of HP foods despite health consequences and self-judgment:

"Going back to the diabetes and just knowing... It almost feels trashy and disgusting how I ate. Like, I am better than this. I was raised better than this. But here I am falling trap to this hold. It's really an addiction. I think I'm using other words to not overly admit that I might have a food addiction and an issue with food because it does upset me." (participant with low food security and severe food addiction)

A participant described continuing to overeat HP foods despite the pain of weight stigma and a range of psychological problems related to eating:

"Well, emotional problems because people make fun of me. I think that's the main thing. And I'll try for a while, one or two days and then I'll keep eating the same way even though it caused me emotional problems such as being made fun of, feeling upset and just all the things that come along with oh, my nervousness, my irritability, my anxiety and depression about the weight gain and eating the sugar and feeling, feeling bad, feeling depressed from the sugar after I come down from it or the caffeine or the whatever it is." (participant with very low food security and severe food addiction)

Another participant described continued problematic eating behavior despite a range of physical health problems:

"Whenever I eat, which is all the time, I'll get diarrhea, acid reflux. I'm pre-diabetic, I have a low thyroid, all these different things and I'm still eating the same way despite all of that." (participant with very low food security and severe food addiction)

4.3.1.6 Tolerance

In SUDs, tolerance is defined as needing more and more of a substance over time to achieve the initial desired effect, or a lessening of the desired effect over time.[107] Approximately half of participants described their experiences in ways that were consistent with the DSM-5 conceptualization. Participants described needing more and more of certain foods over time to change their emotional state or achieve a sense of satiety. Many of them described difficulty eating enough of a food to achieve the "high" they previously experienced when eating the food. For example, a participant explained:

"Maybe I would buy a smaller bag of an item, but then I had to start buying a larger sized bag... I would consume that and it didn't give me that high, and so I would consume it again and it wouldn't give me that high and…it's not giving me that escape or something, like I was getting a tolerance to cheese or something." (participant with very low food security and severe food addiction)

Others framed their experience of tolerance in terms of not being able to feel full or satisfied with the same amount of food. A participant described:

"I remember they have these pizza rolls and it's got pepperoni and cheese, you've probably seen them at the gas station, and just one... I could barely finish one before. I remember my stomach would feel so full and I was like, "Wow, I can't even eat a whole one." I remember used to thinking that, now I eat two, two whole ones to feel good, to feel like I'm happy and then physically, like my stomach is full enough. So before, I would feel happy with just eating one. Now I don't feel happy with just eating one, and physically, I can't just eat one. And it's like that with pretty much all the food." (participant with very low food security and severe food addiction)

Several other participants described no longer experiencing pleasure despite eating large amounts of HP foods. One participant described:

"Now food just tastes like nothing. And I used to enjoy food and now I just kind of shove it in my mouth to feel better throughout the day. I don't really taste the food or anything like that." (participant with very low food security and severe food addiction)

4.3.1.7 Withdrawal

In SUDs, withdrawal is conceptualized as the cascade of uncomfortable symptoms that emerge upon reducing or stopping consumption of an addictive substance.[107] Withdrawal symptoms vary widely depending on the effects of the substance, but the most common withdrawal symptoms across substances are psychological in nature, including irritability, anxiety, and strong craving for the substance.[107] Criteria for withdrawal can also be met by using the substance in order to prevent withdrawal symptoms from occurring.[107] Participants described a wide range of physical and emotional symptoms upon reducing their consumption of HP foods, including headache, fatigue, anxiety, irritability, and craving.

Most participants described difficulty distinguishing between physical and emotional symptoms, which the YFAS 2.0 asks about separately. For example, a participant described her experience with cutting down on candy and chocolate:

"Say I'm gonna be a good girl and not eat sugar this week, I'm not gonna buy the licorice, I'm not gonna buy chocolate. But then literally after about a day, I start thinking to myself again, you know, "you can control yourself, you don't have to gorge on things, you know, because you like them." And with chocolate, I swear, I get a headache, I get physically ill, and I don't know if that's real or not, for or if it's just psychological." (participant with very low food security and severe food addiction)

Another participant described fatigue when reducing consumption of HP foods:

"The fatigue is just at the beginning when I cut down on the unhealthy food. I just don't feel that rush of energy that I get from the sugar or from the potato chips. Like the rush from the fats or the salt or the additives. So yeah, it's like I get a like a high from it. And so like, maybe it just seems like I have a fatigue because it's not such a roller coaster when I cut down." (participant with very low food security and severe food addiction)

As expected, any participants' experiences of withdrawal were dominated by psychological symptoms, such as irritability, depression, and anxiety. A participant described her behavior when attempting to reduce her consumption of sweet foods:

"It's ugly. It's ugly. I just am nasty and snarky and mean and... hateful to people. And I think I was doing that because I felt miserable inside and I wanted to make everybody else as miserable as I was." (participant with very low food security and severe food addiction)

Another participant provided a clear example of consuming HP food to ameliorate withdrawal symptoms, using the term "withdrawal" to describe her experience:

"Like when I had to call my neighbor for chocolate, if I don't have it, I'll find it and I don't feel better until I do. I feel crappy physically. It feels like withdrawal almost. So I will work hard to find some. And Motrin won't help… No, the only thing that's gonna help is chocolate…Not just like, "I'll eat a piece of fruit." No, that's not gonna help. It's not the kind of sweet I want." (participant with very low food security and severe food addiction)

Participants also described strong craving for HP foods when they attempted to reduce or stop their consumption. Their descriptions of craving were consistent with the DSM-5 conceptualization of craving as a strong urge to consume the substance, which often occurred in response to cues for HP food (e.g., seeing the item they were craving in media, at the store, or

being consumed by someone else).[107] For example, a participant shared about her experience when trying to cut down on sweet foods:

> "All I can think about is it's at the back of my mind, whatever I'm craving… For example, we're watching TV and then the caramel is, something that I'm craving and then I'm like, "Well, now I'm seeing it, so now I really have to eat it," kind of thing. It's almost like a magnetism feeling, I guess. I'm just drawn to it." (participant with low food security and severe food addiction)

4.3.1.8 Continued Use Despite Social or Interpersonal Problems

Another criterion for SUD is continued use of the substance despite social or interpersonal problems.[107] Given that HP food is not intoxicating, individuals with food addiction are more likely to experience concern or criticism from others regarding their eating behavior or avoid social events either because they fear they will overeat or because they would not be able to access HP foods. Participants in this study described continued consumption of HP foods despite family members and friends expressing concern about their eating behavior. For example, a participant described concern from her husband about her eating patterns:

> "With my husband, he'll be like, "I'm worried you're saying that you're anxious about how you feel and you're not doing anything to change your habits," and then it just doesn't stick. Then like two days later he's forgotten and he is not really holding me accountable. And then the cycle just continues." (participant with low food security and severe food addiction)

Participants also described avoiding social situations in which they may overeat, for fear of judgmental comments from others about their eating behavior. One participant described:

"The holidays are coming up and I know this is gonna be an issue and sometimes I would

like fake having an anxiety attack so I didn't have to go and I didn't have to hear the

comments and worry about how much I ate and how much I didn't eat."

(participant with very low food security and severe food addiction)

4.3.1.9 Failure to Fulfill Major Role Obligations

SUDs can also be marked by failure to fulfill major role obligations at work, school, or

home due to time spent using the substance or the effects of the substance.[107] Participants

described overeating HP foods as interfering with their ability to fulfill a range of major role

obligations, including completing household chores, working, and caring for dependent family

members. For example, one participant described difficulty completing household chores due to

overeating:

"Sometimes because I ate a lot again, I like just laying on my couch and not doing

anything. So maybe I should like meet because I have a roommate… Maybe we agree,

okay we should wash dishes. Like, I should do the vacuum, or I should do this. Like, some

kind of like housework. But I'll be like, "okay, I want myself to feel better now because I

just ate and I feel I should make sure I'm okay." Then I will just like, "okay the dishes can

wait. I can vacuum another day." And then sometimes just delay and delay. But then my

roommate still kept her promise to finish her part, but I didn't do my part because of that."

(participant with low food security and severe food addiction)

Others described difficulty with their performance at work and school. For example,

"I was going to [university] and I wouldn't even show up for class because I would go out

to eat. That's for school and work, it's the same thing. I was just eating and eating and

eating and I ended up, in a size 22 pants. I was 220 pounds and I barely could walk. My

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legs were really bad and I had to end up quitting because I couldn't walk around. So the more I ate the fatter I got and then the, like for example, I would, like eat at my desk and stuff like that instead of doing the job, so I ended up having to leave." (participant with very low food security and severe food addiction)

4.3.1.10 Use in Physically Hazardous Situations

Individuals with SUDs may continue to use a substance in situations that may put their physical safety at risk.[107] Because HP food is not intoxicating, hazardous situations are conceptualized as consuming HP foods despite potential severe adverse health effects (such as complications of diabetes or heart disease), or consuming HP foods while driving or operating machinery. Participants described continuing to eat HP foods despite significant hazards to their health, including exacerbating existing life-threatening conditions such as diabetes and autoimmune disorders. One participant described their consumption of HP foods despite knowing its contribution to poor health outcomes:

"Yes, I have very high cholesterol, I have high triglycerides. And I eat the same, I just eat whatever I want. Ice cream, like I said yesterday. Yep, I'm a pre-diabetic and I will definitely run my numbers up and you know that my numbers will go up to 250, stuff like that, and it's supposed to be 150, is the highest you're supposed to go, so I think, yeah, despite being pre-diabetic and having high triglycerides and high cholesterol, I keep eating the certain foods and it is physically dangerous but I do it anyway." (participant with very low food security and severe food addiction)

Although questions about consuming HP foods in hazardous situations such as driving or operating machinery were endorsed less often, participants who did endorse them described

situations in alignment with the intended meaning of the question. One participant described being so focused on obtaining McDonald's that she drove in a way that felt unsafe:

"On my way home I passed a few places where there might be a McDonald's and that's all I could think about. All I could think about was McDonald's, McDonald's, McDonald's. And then I got off at the wrong exit going home and I got lost. It was dark. I don't like driving at night 'cause my eyesight has deteriorated a little bit but all I could think about was McDonald's. McDonald's, McDonald's and I could have gotten in an accident or worse." (participant with low food security and severe food addiction)

4.3.1.11 Craving

In addition to craving experienced in the context of withdrawal, generalized intense craving for the substance can be a key part of SUDs.[107] The YFAS 2.0 assesses for craving by asking how often participants experienced such strong cravings for HP foods that they could not think of anything else and/or felt like they needed to eat the food right away. Participants described intense wanting for certain foods, which led them to seek out the foods they were craving. One participant described "obsessing" over chocolate and ultimately reaching out to a neighbor to get some:

"When I finally texted my neighbor and asked for chocolate, it's all I could think about. Where in the house, might I have some, what could I do? And then I had the Hershey syrup and it wasn't it, that's not what I wanted. I had to have some *chocolate* chocolate. And it does, I start to obsess. Even if I'm doing something I like or watching a show I really like, or it's like I even stop thinking about that and just start obsessing over what I want to have." (participant with very low food security and severe food addiction)

Importantly, participants distinguished between hunger, thirst, and craving for specific HP foods. For example, one participant described a specific craving for soda despite being adequately hydrated:

"In spite of drinking a lot of water, I just feel like something is missing. You know, like I need that sugary, bubbly thing down my throat." (participant with very low food security and severe food addiction -I/D)

4.3.1.12 Use Causes Clinically Significant Impairment or Distress

In order to meet criteria for a psychological disorder, including SUD, an individual's symptoms must contribute to clinically significant impairment or distress.[107] Impairment is defined as symptoms getting in the way of important life domains (e.g., relationships, work, daily routine), while distress refers to the subjective dissatisfaction one has with their experience. Participants in this study described impairment in terms of health effects and disruptions to their daily routine. For example, one participant shared:

"I've been overweight for so long since I was little. So that has always been a concern and I think I was borderline diabetic yet still eating sweets and all that stuff I shouldn't have been doing. So that's not good. That's definitely a problem. In my daily routine, slash work, slash family, like I said that going to sneak that Wendy's before I go get the kids or trying to squeeze in that Wendy's before I'm going to get her from work and being a couple minutes late that's a problem, yeah that's a big problem." (participant with very low food security and severe food addiction)

Another participant described their impairment generally across various life domains:

"Yes, I have problems with my daily routine because I just wanna sit there eating and laying in bed. Work, I had to quit my job. School, I had to quit school. Friends and family,

like I said, yesterday, I hadn't seen [my brother] in nine years, so I had to make contact with him. Yeah. But yeah, I definitely have problems with the people around me. I'm constantly wanting to eat and asking about food and "is that something you wanna do?" And "let's go to Burger King" and "let's go here" and "why don't we eat?" And "I'm gonna make these cookies for us" and I end up eating 'em all myself anyway. So yeah, I mean, it causes me a big problem 'cause it's like that's all I'm doing." (participant with very low food security and severe food addiction)

Distress was often attributed to difficulty changing eating behavior despite a strong desire to change:

"It does because I'm always, always thinking about it. I'm always trying to figure out either to plan something, when am I going to eat or what am I going to eat next? What am I going to eat this week at work? And I always feel like I have to try to do better with the diabetes 'cause if I have to eat cookies every night, then obviously I'm not doing the right thing. Obviously, I'm not doing enough. So yeah, I would say it causes me a lot of distress." (participant with very low food security and severe food addiction)

Others attributed their distress to self-judgment and difficulty losing weight:

"Yes, just with me surprising myself on how much I can eat and how the foods that I allow myself to eat, I'm like, "Wow, you really just allowed yourself to eat nothing healthy for the entire day?" I go through days like that, I wouldn't eat one vegetable or fruit, it would be like chocolate ice cream, pizza for breakfast, it'll be like some cookies and coffee and at the end of the day is over, the end of the day, I'm like "wow." I feel like my behavior is concerning me because of sometimes with the types of food I eat and the amounts…and when I'm eating Taco Bell and Wendy's how am I supposed to lose the weight? And so, it

can be pretty stressful and stuff like that, but I know it's a long-term thing and you can't

quit quitting, but it hasn't worked yet." (participant with very low food security and severe

food addiction)

4.3.2 Food Insecurity Contributing to Correct Endorsement of YFAS 2.0 Items

Additionally, several participants described ways that food insecurity has impacted their

lived experience of food addiction symptoms as assessed by the YFAS 2.0, in ways that were

consistent with a DSM-5 conceptualization of SUD. Themes included overeating in the context

of HP food becoming available after not being available or in anticipation of running low on

food, overeating HP foods to prevent food waste, and lack of access to HP foods contributing to

withdrawal symptoms.

4.3.2.1 Role of HP Food Availability

Participants varied in terms of how they described the role of availability of money for

food when describing their thoughts related to YFAS 2.0 items. Some participants attributed their

overeating of HP foods to not having been able to access them previously due to economic

circumstances. For example, one participant described overeating HP foods that were new to him

given experiences with food insecurity over the last few years:

"Well for instance, there's a time when I feel hungry and then somebody present me with

some foods, quite a number of meals, so for example, let's say I've taken my beef fries and

then there is chocolate there, there's yogurt there, there's ice cream there. I normally get

myself ending up taking all of them because of the... Before, I never used to have such kind

of meals because of the situation in my background, so presented with such kind of foods I

normally take all of them till I feel like I'm feeling uncomfortable, like having abdominal

discomfort, like constipation, such kind of thing." (participant with very low food security and mild food addiction -I/D)

Some participants described food addiction symptoms as worse when money first became available, in anticipation of money for food running out soon. One participant described overeating fast food despite not being hungry, because she knew that food would be limited the following day:

"Yeah, I think it was maybe last week or something, and it was just kinda the same stuff with the fast food; getting a bunch of fast food I'm just determined that I'm just gonna go ahead and eat this, [chuckle] but you know you're not hungry, you don't need to be eating this, but then I'm like I tell myself those excuses like, "Well, this will be all you'll have to eat today. And so just why not? 'Cause we're not gonna eat tomorrow." Yeah. So recently, it's just been fast food and stuff. I want more than what I need, and I know it, but I still go ahead and, I don't know, try my best, [chuckle] even though I cannot physically handle that." (participant with very low food security and severe food addiction)

Another participant described wanting to cut down on HP foods, but feeling like he couldn't because he knew they would not be available the following month:

"Yeah, that's of my recent scenario of December. I really wanted to cut down on eating certain kinds of food, like these foods that I have not been used to. Of course, I want to eat but I just had that feeling of cutting them, but I could not because they're sweet, it's not something that I eat more often. But I had that fear like, "I'm eating this. What about next month?" So I felt that like I couldn't have, yeah." (very low food security and moderate food addiction)

4.3.2.2 Overeating to Prevent Food Waste

Several participants described overeating in order to avoid wasting food or money spent on food, despite a desire to reduce their consumption of HP food. For example, one participant described overeating various sweet foods because of a combination of the taste and a strong belief against wasting food:

"When I have like a large milkshake with whipped cream, syrup, sprinkles, and a lot of toppings…just from the first sip, I can tell, "Whoa! Wow, this is very sugary." But it tastes great or something. Or also, I have like, "Oh, I just spent $5 on this, so I don't wanna waste my money." So even though it doesn't taste that good, I drink it anyway. And it's kind of a bad habit of mine with eating, is not wasting food. Because I feel it's kind of shameful to waste food…So I always finish what I'm eating no matter what it is. I try to throw away food, but I feel... It's hard for me to do it. And so I'll drink the whole shake, or I'll eat everything or drink everything to the point where it makes me sick." (participant with very low food security and severe food addiction)

4.3.2.3 Lack of Access Contributes to Withdrawal

Additionally, withdrawal symptoms for many participants resulted from a reduction in HP food consumption that was driven by lack of access rather than a deliberate attempt to cut down. For example, a participant noted lack of money as a contributing factor to cutting down on certain foods:

"There have been times when, for whatever reason I choose to cut down, whether I physically don't have the money to buy that particular item, or I just really just wanna cut down, I get anxious, I get jittery, I'm rather grumpy to put it mildly. It's because I am not

giving myself that instant gratification." (participant with very low food security and severe

food addiction)

4.3.3 Food Insecurity Contributing to Misinterpretation of YFAS 2.0 Items

Although nearly all participants shared interpretations that were consistent with the

DSM-5 conceptualization of SUD, one participant met criteria for several YFAS 2.0 symptoms

by interpreting questions in ways that did not necessarily reflect an addictive response to specific

foods but seemed better explained by experiences of scarcity and deprivation. The participant

described severe undereating due to food insecurity, which made it difficult to distinguish certain

food addiction symptoms (i.e., withdrawal, failure to fulfill role obligations) from the effects of

food insecurity. For example, the participant endorsed emotional withdrawal symptoms, but upon

explanation was clearly an emotional response to lack of access to adequate food:

"From the start of January, the foods that I had, they all was over, I had now something so

small that I won't have compared with December… I felt sometimes like I'm sad because I

don't have that much I used to eat the last month." (participant with very low food security

and moderate food addiction)

The participant also endorsed distress and impairment related to their eating behavior but

described these experiences directly in terms of food insecurity. They described their distress as

related to stress and frustration at not being able to consistently provide an adequate and

balanced diet for themselves and their family. For example, the participant described various

problems related to inadequate nutrition:

"I am experiencing many types of problems now in my life because of food, and I can see

that these problems comes as a result of not getting enough to eat, not affording enough,

not getting a balanced diet at any given day. So I think that problems comes in with my daily routine because if I were to afford balanced diet every day, I think that will be very good. But having not to afford it on a daily basis gives me a lot of stress, and that give me that problems, thinking of my family, my kids getting to eat every day." (participant with very low food security and moderate food addiction)

4.3.4 Inconsistent Responses to Food Addiction Symptoms Unrelated to Food Insecurity

Although several symptoms had one or two responses that were inconsistent with a DSM-5 conceptualization of SUDs, no patterns were observed in these responses. Only two symptoms were described inconsistently often enough to develop themes related to misinterpretation of the questions. Participants endorsed questions related to withdrawal and tolerance in ways that were potentially inconsistent with food addiction but were not explicitly connected to food insecurity.

4.3.4.1 Withdrawal

Several participants who endorsed the item assessing for psychological withdrawal symptoms described emotional eating that may or may not be indicative of withdrawal. Participants frequently described eating in response to negative emotions but did not attribute those emotions to cutting down on certain foods. For example, one participant vividly described using food to try to manage loneliness or sadness, but did not attribute that loneliness or sadness to the absence of HP food:

"If I'm like experiencing loneliness or sadness or even if I'm happy, I'll use the food to be part of that emotion…If I'm lonely it's just like stuffing my emotions or sad, that I feel, again, with the advertising in the media with the item, like it'll make me happy. Because the licorice package, it's cute and it's fun, and like the chocolate bar it's reassuring the package,

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and it seems like it's old fashioned and quaint and charming and stuff. And yeah, the donut

package seems like it's for a fun time, so you eat the donuts and you'll be having coffee and

donuts with friends or something. I guess indirectly, there's scenarios in my head when I

have the sadness or loneliness or even happiness when I eat the food." (participant with

very low food security and severe food addiction)

Although this participant's experience is not necessarily incompatible with an experience of food

addiction, her interpretation of withdrawal did not include all the necessary components.

Another participant described eating HP foods in response to anxiety, without specifying

that he had reduced his consumption:

"Sometimes it's the go to when I'm really feeling anxious... It's again, that buzzing that

kinda happens at the back of my skull. And I know that I need to get rid of it and the only

way I know how to get rid of it is to eat…[Mexican restaurant] doesn't always have to be

the solution but the solution is always some type of food." (participant with very low food

security and severe food addiction)

Importantly, despite misinterpretations of the emotional aspects of withdrawal, nearly all

participants who met criteria for withdrawal endorsed at least one question with an

interpretation that was consistent with a DSM-5 conceptualization of withdrawal. Thus, this

type of misinterpretation did not appear to misclassify participants as experiencing withdrawal

symptoms. The only exception was the participant who misinterpreted questions throughout the

YFAS 2.0 due to food insecurity.

4.3.4.2 Tolerance

Participants' inconsistent experiences of tolerance fell into two themes. First, participants described no longer getting the same amount of enjoyment from food due to self-judgment or an awareness of the negative consequences of overeating. One participant described it as such:

"Well, I was thinking that now it doesn't give me the same enjoyment as it used to. It's not as... What is a good word? It's not as important as it was to me, I guess I would say. What's so fun about eating a lot especially if you're full, are you just gonna just keep eating? Like why would I keep eating if I'm full and I'm not hungry anymore? So, I don't know. It's like when I was eating like I was, it would give me... I would be happy still doing that little happy dance 'cause I'm eating. Then it's like, okay, that's enough now... But it doesn't give me the same enjoyment as it used to." (participant with very low food security and severe food addiction)

Another participant shared:

"I used to love food. Like I would love to cook and love to bake and then be so proud of myself, like, "Oh yeah guys, try this. It's so good. Oh my God." And now I'm like, I don't even wanna try it. Because I'm starting to really see that I have a problem that's gone unnoticed for so long." (participant with very low food security and severe food addiction)

Although these experiences are valid reactions to problematic eating behavior, they do not appear to be indicative of a biological tolerance to HP foods or their ingredients.

Second, in response to the question which asked about needing more and more of certain foods to get what they wanted from eating, participants again emphasized the emotional effects of the food (either to increase pleasure or decrease negative emotions), without regard to changes over time. For example, one participant described:

"Sometimes I eat, just because I've suffered from severe chronic depression and have for years and guilt and all kinds of things. So yeah, I will do that. I'm feeling crappy, so I'll have something to eat and make me feel better." (participant with very low food security and severe food addiction)

Other participants described eating to increase pleasure without acknowledging any shift in the amount required over time:

"I definitely would say that I glamorize food. I really enjoy the feeling of eating. It's the whole experience, it's the taste, it's the visual appeal, it's the smell, it's the way it feels in my mouth. I definitely do not look at the nutrition or the ingredients that go into... Or the amount of certain ingredients that go into it. Yeah, so it's the whole experience that I find very pleasurable." (participant with very low food security and severe food addiction -I/D)

Although these experiences are not incompatible with the experience of addiction, they did not appear to reflect experiences of tolerance to HP foods.

4.4 Discussion

4.4.1 YFAS 2.0 is an Appropriate Tool for Assessing Food Addiction among People Experiencing Food Insecurity

This was the first qualitative evaluation of the YFAS 2.0 among individuals experiencing food addiction and food insecurity. Data from this study suggest that individuals experiencing food insecurity interpret the questions on the YFAS 2.0 similarly to individuals with food addiction that have been recruited without regard to food security status.[52] Most participants who endorsed YFAS 2.0 symptoms described their experiences in ways that were consistent with a DSM-5 conceptualization of food addiction. Contrary to expectations, most participants did not

mention their experiences of food insecurity when describing their symptoms of food addiction, suggesting experiences of food addiction are not qualitatively distinct between individuals with and without food insecurity. Overall, the ways that participants misinterpreted questions related to withdrawal and tolerance were consistent with prior qualitative research examining interpretations of the YFAS 2.0 among adults with food addiction without respect to food insecurity.[52] Thus, these responses do not seem to be unique to individuals experiencing food insecurity. In sum, the YFAS 2.0 continues to be a helpful tool for assessing food addiction among individuals with food addiction and provides a foundation for further research in this area.

Importantly, food addiction symptoms described by participants were not merely consistent with a SUD framework, many of them clearly exemplified the core elements of addiction: compulsive use despite negative consequences and intense craving for the substance.[137] The experiences participants described mirror those described by individuals managing tobacco use in the context of food insecurity, in that both groups described difficulty stopping their use despite a strong desire to and negative effects on their lives.[138] Additionally, many participants vividly described the intense and life-altering effects of such an addiction. These data contribute to the body of research demonstrating the validity of the food addiction construct more broadly (not just limited to individuals experiencing food insecurity). Although food addiction is sometimes considered less serious than other SUDs, the participants in this study provided powerful examples of severe impairment (including losing their livelihoods and withdrawing from social contact) and deep suffering because of their food addiction symptoms. The level of impairment described by some participants in this study parallel the life-threatening experiences described by individuals with alcohol use disorder.[139] Notably, many participants

used language related to addiction without any priming from study materials or the interviewer, which speaks to participants' awareness of addiction principles and perceived application to their own experiences.

Although most participants described their food addiction symptoms in ways that were consistent with a SUD framework, one participant described their symptoms in a way that was more consistent with experiences of food insecurity rather than food addiction. Future research should prioritize further examination of this signal, as it may point to important misinterpretations of the YFAS 2.0 in the context of food insecurity. A combination of qualitative and quantitative research will be helpful for further identifying factors that may make some individuals more likely to misinterpret the YFAS 2.0. Quantitative approaches may include confirmatory factor analysis to examine measurement invariance between individuals with and without food insecurity. Prior research examining measurement invariance of the YFAS 2.0 among gender and racial groups may serve as a helpful model for conducting this research.[140] Quantitative and qualitative methods may be combined in research employing more brief qualitative methods among larger representative samples of individuals experiencing food insecurity. For example, surveys may include brief open-ended questions about participants' interpretations of study questions, akin to those asked in the current study. Future research should also consider that food insecurity and food addiction may act synergistically for certain individuals. For example, the individual described experiencing both chronic deprivation and overconsumption of HP foods. Future research should further explore the ways these two experiences may interact and whether different assessment methods or interventions may be warranted for individuals whose experience of food addiction appears to be more significantly impacted by food insecurity.

4.4.2 Food Insecurity Contributes to Food Addiction Symptoms

Several themes emerged related to the role of food insecurity in the development of food addiction symptoms, including a tendency to overeat HP foods when they become available (following experiences of food insecurity and/or in anticipation of limited access to food), overeating to avoid food waste, and withdrawal symptoms emerging when access to HP food is limited due to financial constraints. This builds upon prior research by suggesting additional potential mechanisms of the relationship between food insecurity and food addiction that have not yet been explored. Participant responses speak to the intermittency aspect of food insecurity, in which food access may be variable and unpredictable. Future mechanistic research may use ecological momentary assessment to explore whether certain patterns of food access are associated with different food addiction experiences and the specific temporal relationships between them.

Additionally, the fact that participants specifically described withdrawal as being impacted by food insecurity suggests that future quantitative research should explore the impact of food insecurity at the symptom level in addition to food addiction symptoms overall. Perhaps differences in food addiction between individuals with and without food insecurity are driven by certain symptoms that are more closely tied to HP food access, such as withdrawal. For example, individuals who have consistent access to HP food may be less likely to experience withdrawal than individuals who are sometimes unable to access the foods they eat addictively. Importantly, experiencing withdrawal due to lack of access to the substance is not unique to food addiction; individuals with various SUDs report symptoms related to temporary reductions in use driven by reduced access to the substance.[141] However, food addiction differs from other SUDs in that all people need to eat to live. Data that suggesting individuals with food insecurity experience

unique susceptibility to food addiction highlight the urgent social justice issue at hand. Future qualitative and quantitative research should further examine the role of food insecurity in the development of food addiction and work to identify strategies to ensure all individuals and families have adequate access to a variety of minimally processed foods.

Participants in this study endorsed more current eating disorders than a prior qualitative study of individuals with food addiction.[52] Although the sampling method used in this study does not allow for assessment of the prevalence of eating disorders among individuals with food insecurity and food addiction, the high proportion of comorbid eating disorders in this sample is consistent with quantitative research that has found associations between food insecurity and increased risk for a range of eating disorders.[10,12] Importantly, most eating disorder measures (including the EDDS) have not been qualitatively or quantitatively validated among individuals with food insecurity. Thus, the EDDS may not have been adequate to accurately assess for eating disorders in this sample (further highlighted by the low internal consistency of the EDDS observed this sample). Future research should evaluate the usefulness of current eating disorder measures for individuals experiencing food insecurity, perhaps using a recent examination of the SCOFF questionnaire among individuals with food insecurity as a model.[142]

4.4.3 Limitations and Future Directions

This research was subject to several limitations. First, the study sample was recruited to reflect a particular experience (co-occurring food insecurity and food addiction), which naturally excluded individuals that may provide important insights into the relationships between these constructs (e.g., individuals who identify as addicted to food but do not experience clinically significant symptoms, individuals who have experienced food insecurity in the past, but not currently). Additionally, the nature of qualitative research prevents us from making generalizable

claims about the relationship between food insecurity and food addiction. Further quantitative research will be needed to test whether findings apply in more representative samples. Lastly, the qualitative interview and coding were conducted by researchers and research assistants who study food addiction and believe in its merits as a clinical and scientific construct. Although efforts were made not to prime participants with information related to food addiction, the interviewer may have inadvertently pursued lines of questioning that contributed to participants' description of experiences consistent with food addiction. Further qualitative research on food insecurity and food addiction should be conducted by researchers with varied orientations to the food addiction construct.

Despite these limitations, this research has important implications for future research regarding associations between food insecurity and food addiction. It has demonstrated that the YFAS 2.0 generally captures the food addiction construct in a theoretically consistent way among individuals experiencing food insecurity and has identified important elements of participants' lived experience that are not captured directly by the YFAS 2.0. Themes identified in this study also provide important future research questions and hypotheses regarding mechanisms of the association between food insecurity and food addiction. For example, future research should further examine sociodemographic characteristics that may contribute to misinterpretation of the YFAS 2.0 among individuals with food insecurity and explore new methods of assessing food addiction among these groups. Although data were not adequate to develop meaningful themes, several participants also described the role of comorbid psychological disorders and their cultural/ethnic backgrounds in the development of food addiction symptoms.

Future research may include the development of a clinical interview for the YFAS 2.0 to gather more contextual information or adding questions to the YFAS 2.0 to assess whether responses implicate food insecurity or other characteristics. This research may also inform potential food addiction interventions based on an individual or family's level of food security. For example, recommending individuals consume a diet composed of mostly minimally processed foods makes theoretical sense based on food addiction research, but seems unrealistic for families experiencing food insecurity due to barriers to access. Rather, policy and societal-level changes may be needed to mitigate food addiction risk, particularly for people experiencing food insecurity.

Chapter 5 Overall Summary and Future Directions

This dissertation sought to address four main aims in service of deepening scientific understanding of the relationship between food insecurity and food addiction. First, it sought to examine whether prior associations between food insecurity and food addiction would replicate in community samples of adults. Both Study 1 and Study 2 demonstrated that food insecurity and food addiction are associated among across samples with varying demographic characteristics.

Second, this dissertation aimed to examine associations between retrospectively reported childhood food insecurity and current adult food insecurity with food addiction in a community sample of adults. Retrospectively reported childhood food insecurity was associated with both retrospectively reported childhood food addiction and current adult food addiction symptoms. Additionally, individuals who retrospectively reported childhood food insecurity reported more current adult food insecurity symptoms regardless of whether they endorsed current food insecurity, suggesting that childhood is a critical period for the influence of food insecurity on the development of food addiction. Notably, individuals who reported both childhood food insecurity and current adult food insecurity showed much higher food addiction symptoms than those who only reported current adult food addiction symptoms. Thus, only measuring current food insecurity without considering early life experiences appears to overestimate food addiction symptoms for some while underestimating food addiction symptoms for those who are most vulnerable to addictive eating.

Third, this dissertation aimed to examine whether mechanisms of addiction (stress, increased food reward, eating to cope with negative emotions, higher consumption of HP foods) mediated the relationship between food insecurity and food addiction among university students. Results suggest food insecurity and food addiction are indirectly related, with stress, increased food reward, and eating HP food to cope with negative emotions serving as mediators. These mechanisms provide key direction for interventions to reduce risk for food addiction among university students. Interestingly, although Study 3 was not designed to explore mechanisms, many participants provided clear examples of elevated stress, an intense reward drive for food, and eating HP food to cope with emotions like sadness and loneliness when describing their experiences of food addiction.

Fourth, this dissertation aimed to qualitatively evaluate whether the YFAS 2.0, the most widely used food addiction assessment tool, accurately captured the food addiction construct among individuals with food insecurity and food addiction. Participants overwhelmingly interpreted YFAS 2.0 questions in line with the DSM-5 conceptualization of SUDs, and most misinterpretations were consistent with prior qualitative research examining the YFAS 2.0 among a sample recruited regardless of food security status. Thus, the YFAS 2.0 appears to operate among people with food insecurity much in the same way as samples of adults where food security status is not known. This increases confidence in using the YFAS 2.0 for future research among populations experiencing food insecurity. Although limitations of the YFAS 2.0 appear to occur regardless of food security status, future research should explore how to better capture the constructs of tolerance and withdrawal in the context of HP food.

Taken together, these studies suggest that the developmental trajectory of food insecurity is important for food addiction risk. Experiencing food insecurity during childhood appears to

confer increased risk for food addiction during childhood and adulthood, even if food security is restored. Further, the developmental period of emerging adulthood presents unique social and environmental circumstances that may increase their risk for both food insecurity and food addiction. Future research should continue to probe the influence of food insecurity on food addiction risk throughout the lifespan, with emphasis on early life experiences of food insecurity. Future research may also more specifically probe developmental periods to identify when food insecurity and food addiction interact in ways that most strongly influence health outcomes. Studies may begin to probe these associations by retrospectively assessing for childhood food insecurity, asking when food insecurity first began, and at what periods it was the most severe. Longitudinal research will also help to accurately capture associations between food insecurity and food addiction over time. Additionally, qualitative research exploring participants' childhood experiences of food insecurity and food addiction may further illuminate factors that contribute to this association during key developmental periods.

As food addiction is conceptualized as a SUD, findings from this dissertation may have implications for the study of food insecurity and addictive behavior more broadly. The combination of intermittent access to food, increased stress, increased food reward, and eating HP foods to cope appear to play an important role in food addiction risk. These mechanisms may also play a role in associations between food insecurity and substance use. Future studies may consider exploring whether mechanisms identified in this research in mediate relationships between food insecurity, high-risk substance use, and SUDs.

Lastly, the findings of this dissertation have important implications for potential policy change and public health intervention. However, devising policy strategies to address food addiction among people experiencing food insecurity presents unique challenges. Further

understanding of the hypothesized mechanism of intermittent access to HP foods may help refine

SNAP policy to improve food addiction outcomes. If SNAP participants overconsume HP foods

at the beginning of the month when benefits are first disbursed, followed by experiences of

scarcity at the end of the month, this intermittent pattern may contribute to food addiction. To

address this, the SNAP program may consider disbursing benefits more frequently (e.g., weekly

or biweekly) to reduce intermittency of HP food consumption. A recent qualitative study found

that most participants supported biweekly disbursement of SNAP benefits.[143] This policy change

could be evaluated by randomly piloting biweekly disbursement among some individuals within

a community and comparing food addiction symptoms among these individuals and those

continuing to receive monthly SNAP benefits.

Another consideration when devising policy initiatives is the key role of HP foods in the

development of food addiction. Research shows that individuals who participate in SNAP

consume more HP foods on average than income-eligible non-participants.[20] Some have

proposed limiting items that can be purchased using SNAP, perhaps by prohibiting individuals

from using SNAP benefits to purchase HP foods.[144] However, this approach may undermine

participants' autonomy and does not address reasons why individuals may rely on HP foods

(e.g., affordability and convenience compared to minimally processed options).[143] Any

restrictions on foods that may be purchased with SNAP should make efforts to address these

challenges. For example, affordability could be addressed by increasing benefits to cover the cost

of fresh produce, and convenience could be addressed by providing pre-prepared minimally

processed meals or meal kits designed to be prepared quickly. Policymakers may also consider

incentivizing purchase of minimally processed foods, as Michigan has done with the *Double Up*

Food Bucks program, in which SNAP dollars are matched if used to purchase fresh fruits and

vegetables. This approach also appears to be supported by SNAP participants.[143] However, food addiction research suggests that introducing more minimally processed options into the food environment may be insufficient to curb consumption of HP foods, due to intensive marketing of these foods, particularly in low-income areas.[145] Additionally, the ability of HP foods to sensitize neural motivation and reward pathways may lead people to continue to choose them, even when minimally processed options are available.[146] Thus, widespread approaches to reduce the dominance of HP foods in the food environment for everyone may be a more sensible approach to reducing food addiction among those experiencing food insecurity. These interventions can be directly modeled on interventions to curb consumption of alcohol and tobacco, and may include limiting HP food companies from marketing to children, imposing taxes on sugar-sweetened beverages, and restricting retail density within communities.[147]

Tables

Table 1. Study 1, Question 1 Demographics by Current Adult Food Security Status (n = 297)

	Total (n = 297)	Food-Secure (n = 220)	Food-Insecure (n = 77)	P
Age, mean ± SD	41.62 ± 12.15	42.24 ± 12.29	39.83 ± 11.62	.137
Gender Identity				
Female	150 (50.8%)	115 (52.5%)	35 (46.1%)	.506
Male	144 (48.8%)	103 (47.0%)	41 (53.2%)	
Nonbinary	1 (0.3%)	1 (0.5%)	-	
Racial/Ethnic Identity				.046
White	224 (75.7%)	170 (77.3%)	54 (71.1%)	
Black / African American	31 (10.5%)	19 (8.6%)	12 (15.8%)	
Asian	21 (7.1%)	18 (8.2%)	3 (3.9%)	
Hispanic / Latino	14 (4.7%)	8 (3.6%)	6 (7.8%)	
Multiracial	5 (1.7%)	5 (2.3%)	-	
American Indian / Alaska Native	1 (0.3%)	-	1 (1.3%)	
Educational Attainment				.203
High school degree	27 (9.1%)	20 (9.1%)	7 (9.1%)	
Some college	30 (10.1%)	25 (11.4%)	5 (6.5%)	
Associates degree	37 (12.5%)	31 (14.2%)	6 (7.8%)	
Bachelor's degree	160 (54.1%	110 (50.2%)	50 (64.9%)	
Advanced degree	42 (14.2%)	33 (15.1%)	9 (11.7%)	
Income				<.001
Less than $10,000	7 (2.4%)	3 (1.4%)	4 (5.3%)	
$10,000 - $19,999	18 (6.2%)	9 (4.2%)	9 (11.8%)	
$20,000 - $29,999	27 (9.2%)	17 (7.9%)	10 (13.2%)	
$30,000 - $39,999	37 (12.7%)	23 (10.6%)	14 (18.4%)	
$40,000 - $49,999	36 (12.3%)	25 (11.6%)	11 (14.5%)	
$50,000 - $59,999	39 (13.4%)	25 (11.6%)	14 (18.4%)	
$60,000 - $69,999	26 (8.9%)	21 (9.7%)	5 (6.6%)	
$70,000 - $79,999	29 (9.9%)	24 (11.1%)	5 (6.6%)	
$80,000 - $89,999	16 (5.5%)	14 (6.5%)	2 (2.6%)	
$90,000 - $99,999	13 (4.5%)	13 (6.0%)	-	
$100,000 - $149,999	24 (8.2%)	23 (10.6%)	1 (1.3%)	
More than $150,000	20 (6.8%)	19 (8.8%)	1 (1.3%)	

Notes. Differences in *n*s are due to "prefer not to answer" responses.

Table 2. Study 1, Question 2 Demographics by Retrospective Childhood Food Security

Status (n = 237)

	Total (n = 237)	Food-Secure (n = 173)	Food-Insecure (n = 64)	*P*
Age, mean ± SD	41.98 ± 12.50	42.91 ± 12.83	39.48 ± 11.27	.062
Gender Identity				.188
Female	118 (50.2%)	89 (52.0%)	29 (45.3%)	
Male	116 (49.4%)	82 (48.0%)	34 (53.1%)	
Nonbinary	1 (0.4%)	-	1 (1.6%)	
Racial/Ethnic Identity				.037
White	177 (74.7%)	132 (76.3%)	45 (70.3%)	
Black / African American	24 (10.1%)	13 (7.5%)	11 (17.2%)	
Asian	19 (8.0%)	17 (9.8%)	2 (3.1%)	
Hispanic / Latino	13 (5.5%)	8 (4.6%)	5 (7.8%)	
Multiracial	3 (1.3%)	3 (1.7%)	-	
American Indian / Alaska Native	1 (0.4%)	-	1 (1.6%)	
Educational Attainment				.230
High school degree	24 (10.2%)	17 (9.9%)	7 (10.9%)	
Some college	22 (9.4%)	19 (11.1%)	3 (4.7%)	
Associates degree	30 (12.8%)	25 (14.6%)	5 (7.8%)	
Bachelor's degree	123 (52.3%)	83 (48.5%)	40 (62.5%)	
Advanced degree	36 (15.3%)	27 (15.8%)	9 (14.1%)	
Income				.001
Less than $10,000	6 (2.6%)	4 (2.4%)	2 (3.1%)	
$10,000 - $19,999	13 (5.6%)	10 (5.9%)	3 (4.7%)	
$20,000 - $29,999	22 (9.4%)	13 (7.6%)	9 (14.1%)	
$30,000 - $39,999	30 (12.8%)	20 (11.8%)	10 (15.6%)	
$40,000 - $49,999	28 (12.0%)	16 (9.4%)	12 (18.8%)	
$50,000 - $59,999	29 (12.4%)	14 (8.2%)	15 (23.4%)	
$60,000 - $69,999	23 (9.8%)	20 (11.8%)	3 (4.7%)	
$70,000 - $79,999	20 (8.5%)	15 (8.8%)	5 (7.8%)	
$80,000 - $89,999	13 (5.6%)	12 (7.1%)	1 (1.6%)	
$90,000 - $99,999	9 (3.8%)	7 (4.1%)	2 (3.1%)	
$100,000 - $149,999	21 (9.0%)	20 (11.8%)	1 (1.6%)	
More than $150,000	20 (8.5%)	19 (11.2%)	1 (1.6%)	

Notes. Differences in *n*s are due to "prefer not to answer" responses.

Table 3. Study 1, Question 3 Demographics by Retrospective Childhood Food Security Status (n = 239)

	Total (n = 239)	Food-Secure (n = 174)	Food-Insecure (n = 65)	*P*
Age, mean ± SD	41.79 ± 12.48	42.85 ± 12.75	38.98 ± 11.36	.033
Gender Identity				.164
Female	116 (48.7%)	88 (50.9%)	28 (43.1%)	
Male	121 (50.8%)	85 (49.1%)	36 (55.4%)	
Nonbinary	1 (0.4%)	-	1 (1.5%)	
Racial/Ethnic Identity				.063
White	180 (75.3%)	133 (76.4%)	47 (72.3%)	
Black / African American	24 (10.0%)	13 (7.5%)	11 (16.9%)	
Asian	19 (7.9%)	17 (9.8%)	2 (3.1%)	
Hispanic / Latino	13 (5.4%)	8 (4.6%)	5 (7.7%)	
Multiracial	3 (1.3%)	3 (1.7%)	-	
Educational Attainment				.069
High school degree	24 (10.1%)	17 (9.8%)	7 (10.8%)	
Some college	11 (9.2%)	20 (11.6%)	2 (3.1%)	
Associates degree	29 (12.2%)	25 (14.5%)	4 (6.2%)	
Bachelor's degree	126 (52.9%)	84 (48.6%)	42 (64.6%)	
Advanced degree	37 (15.5)	27 (15.6%)	10 (15.4%)	
Income				.002
Less than $10,000	7 (3.0%)	4 (2.3%)	3 (4.6%)	
$10,000 - $19,999	13 (5.5%)	10 (5.8%)	3 (4.6%)	
$20,000 - $29,999	22 (9.3%)	13 (7.6%)	9 (13.8%)	
$30,000 - $39,999	29 (12.2%)	20 (11.6%)	9 (13.8%)	
$40,000 - $49,999	29 (12.2%)	17 9.9%)	12 (18.5%)	
$50,000 - $59,999	30 (12.7%)	15 (8.8%)	15 (23.1%)	
$60,000 - $69,999	22 (9.3%)	19 (11.0%)	3 (4.6%)	
$70,000 - $79,999	21 (8.9%)	15 (8.7%)	6 (9.2%)	
$80,000 - $89,999	14 (5.9%)	13 (7.6%)	1 (1.5%)	
$90,000 - $99,999	9 (3.8%)	7 (4.1%)	2 (3.1%)	
$100,000 - $149,999	21 (8.9%)	20 (11.6%)	1 (1.5%)	
More than $150,000	20 (8.4%)	19 (11.1%)	1 (1.5%)	

Notes. Differences in *n*s are due to "prefer not to answer" responses.

Table 4. Study 1, Question 4 Participant Demographic Characteristics by Food Security Persistence Category (n = 227)

	Total (n = 227)	Persistent Food Security (n = 152)	Emergent Food Security (n = 19)	Emergent Food Insecurity (n = 17)	Persistent Food Insecurity (n = 39)	P
Age, mean ± SD	41.93 ± 12.46	42.96 ± 12.62	39.53 ± 10.95	42.76 ± 14.84	38.74 ± 11.09	.075
Gender Identity						.040
Female	110 (48.5%)	76 (49.7%)	10 (52.6%)	9 (52.9%)	15 (38.5%)	
Male	115 (50.7%)	75 (50.3%)	8 (42.1%)	8 (47.1%)	24 (61.5%)	
Nonbinary	1 (0.4%)	-	1 (5.3%)	-	-	
Racial/Ethnic Identity						.182
White	172 (75.8%)	117 (77.0%)	13 (68.4%)	14 (82.4%)	28 (71.8%)	
Black / African American	23 (10.1%)	11 (7.2%)	4 (21.1%)	1 (5.9%)	7 (17.9%)	
Asian	18 (7.9%)	16 (10.5%)	-	-	2 (5.1%)	
Hispanic / Latino	11 (4.8%)	5 (3.3%)	2 (10.5%)	2 (11.8%)	2 (5.1%)	
Multiracial	3 (1.3%)	3 (2.0%)	-	-	-	
Educational Attainment						.157
High school degree	22 (9.7%)	15 (9.9%)	1 (5.3%)	1 (5.9%)	5 (12.8%)	
Some college	19 (8.4%)	14 (9.3%)	-	4 (23.5%)	1 (2.6%)	
Associates degree	28 (12.4%)	23 (15.2%)	2 (10.5%)	1 (5.9%)	2 (5.1%)	
Bachelor's degree	122 (54.0%)	75 (49.7%)	11 (57.9%)	9 (52.9%)	27 (69.2%)	
Advanced degree	35 (15.5%)	24 (15.9%)	5 (26.3%)	2 (11.8%)	4 (10.3%)	
Income						.001
Less than $10,000	6 (2.7%)	3 (2.0%)	-	1 (5.9%)	2 (5.1%)	
$10,000 - $19,999	13 (5.9%)	7 (4.7%)	-	3 (17.6%)	3 (7.7%)	
$20,000 - $29,999	21 (9.3%)	10 (6.7%)	3 (15.8%)	2 (11.8%)	6 (15.4%)	
$30,000 - $39,999	28 (12.4%)	14 (9.3%)	3 (15.8%)	6 (35.3%)	5 (12.8%)	
$40,000 - $49,999	26 (11.6%)	15 (10.0%)	3 (15.8%)	-	8 (20.5%)	
$50,000 - $59,999	28 (12.4%)	13 (8.7%)	2 (10.5%)	2 (11.8%)	11 (28.2%)	
$60,000 - $69,999	22 (9.8%)	17 (11.3%)	1 (5.3%)	2 (11.8%)	2 (5.1%)	
$70,000 - $79,999	19 (8.4%)	15 (10.0%)	3 (15.8%)	-	1 (2.6%)	
$80,000 - $89,999	14 (6.2%)	13 (8.7%)	-	-	1 (2.6%)	
$90,000 - $99,999	8 (3.6%)	6 (4.0%)	2 (10.5%)	-	-	
$100,000 - $149,999	20 (8.9%)	19 (12.7%)	1 (5.3%)	-	-	
More than $150,000	20 (8.9%)	18 (12.0%)	1 (5.3%)	1 (5.9%)	-	

Notes. Differences in *n*s are due to "prefer not to answer" responses.

Table 5. Study 1 Regression Results

	Estimate	SE	95% CI	*P*	f^2
Hypothesis 1: Current adult food insecurity predicting current adult food addiction symptoms					
Unadjusted	4.34	0.49	3.38, 5.30	*<.001*	*0.27*
Multivariate adjusted[a]	4.24	0.50	3.25, 5.23	*<.001*	*0.44*
Hypothesis 2: Retrospective childhood food insecurity predicting retrospective childhood food addiction score					
Unadjusted	22.89	2.18	18.60, 27.19	*<.001*	*0.47*
Multivariate adjusted[b]	23.11	2.17	18.83, 27.38	*<.001*	*0.50*
Hypothesis 3: Retrospective childhood food insecurity predicting current adult food addiction symptoms					
Unadjusted	5.20	0.47	4.28, 6.13	*<.001*	*0.52*
Multivariate adjusted[b]	5.18	0.46	4.28, 6.08	*<.001*	*0.63*

[a]Adjusted for age, race/ethnicity, gender identity, education and income

[b]Adjusted for race/ethnicity and gender identity

Table 6. Study 2 Participant Demographic Characteristics (N = 833)

	n (%)
Age *(M = 20.58, SD = 1.59, min-max = 17-34)*	
17 or younger	5 (0.6%)
18-19	179 (21.5%)
20-21	503 (60.4%)
22-23	135 (16.2%)
24 or older	11 (1.3%)
Gender Identity	
Female	501 (60.1%)
Male	302 (36.3%)
Genderqueer/gender non-conforming/non-binary	24 (2.9%)
Other	4 (0.5%)
Transgender Female/Woman	1 (0.1%)
Transgender Male/Man	1 (0.1%)
Race/Ethnicity	
Asian	317 (38.1%)
White	275 (33.0%)
Hispanic / Latino	93 (11.2%)
Black / African American	67 (8.0%)
Multi-racial / Multi-ethnic	59 (7.1%)
Middle Eastern / North African	17 (2.0%)
Other	5 (0.6%)
Current Degree Program	
Undergraduate / Bachelor's	778 (93.4%)
Masters or Professional	39 (4.7%)
Doctoral	16 (1.9%)
First Generation College Student	
No	449 (53.9%)
Yes	366 (43.9%)
Parent's / Guardian's Household Income	
Under $25,000	117 (14.0%)
$25,000 to less than $50,000	171 (20.5%)
$50,000 to less than $75,000	138 (16.6%)
$75,000 to less than $100,000	122 (14.6%)
$100,000 to less than $125,000	79 (9.5%)
$125,000 or more	192 (23.0%)

Notes. Differences in *n*s are due to "prefer not to answer" responses

Table 7. Study 2 Zero-Order Correlations

	Food Insecurity	PSS	RED	PEMS Coping	Daily HP Food Score	YFAS Symptoms
Food Insecurity	1.00					
PSS	0.26***	1.00				
RED	0.18***	0.28***	1.00			
PEMS Coping	0.18***	0.37***	0.50***	1.00		
Daily HP Food Score	0.22***	0.06	0.03	0.09*	1.00	
YFAS Symptoms	0.21***	0.31***	0.56***	0.56***	0.08*	1.00

*p < .05, **p<.01, ***p<.001 (two-tailed test)

Table 8. Study 3 Participant Demographics (N = 23)

|	*n* (%)
Age *(M = 37.96, SD = 12.44, min-max = 23-67)*	
BMI *(M = 33.97, SD = 11.04, min-max = 18.13-59.34)*	
BMI Category	
Underweight	1 (4.3%)
Healthy Weight	7 (30.4%)
Obesity	15 (65.2%)
Gender Identity	
Cisgender Woman	16 (69.6%)
Cisgender Man	4 (17.4%)
Nonbinary	2 (8.7%)
Transgender Man	1 (4.3%)
Race	
White	14 (60.9%)
Black	6 (26.1%)
Asian	3 (13%)
Number of Children in Household	
None	15 (65.2%)
One	2 (8.7%)
Two	3 (13%)
Three	1 (4.3%)
Four	1 (4.3%)
Five	1 (4.3%)
Food Security Status	
Low Food Security	4 (17.4%)
Very Low Food Security	19 (82.6%)
YFAS 2.0 Severity	
Mild -I/D	2 (8.7%)
Moderate	3 (13%)
Severe -I/D	1 (4.3%)
Severe	17 (73.9%)
EDDS Diagnosis	
None	7 (30.4%)
Bulimia Nervosa	6 (26.1%)
Atypical Anorexia Nervosa	4 (17.4%)
Anorexia Nervosa, Binge Purge Subtype	1 (4.3%)
Binge Eating Disorder	2 (8.7%)
Night Eating Syndrome	3 (13%)

Figures

Figure 1. Current Adult Food Addiction Symptoms by Food Security Stability Category
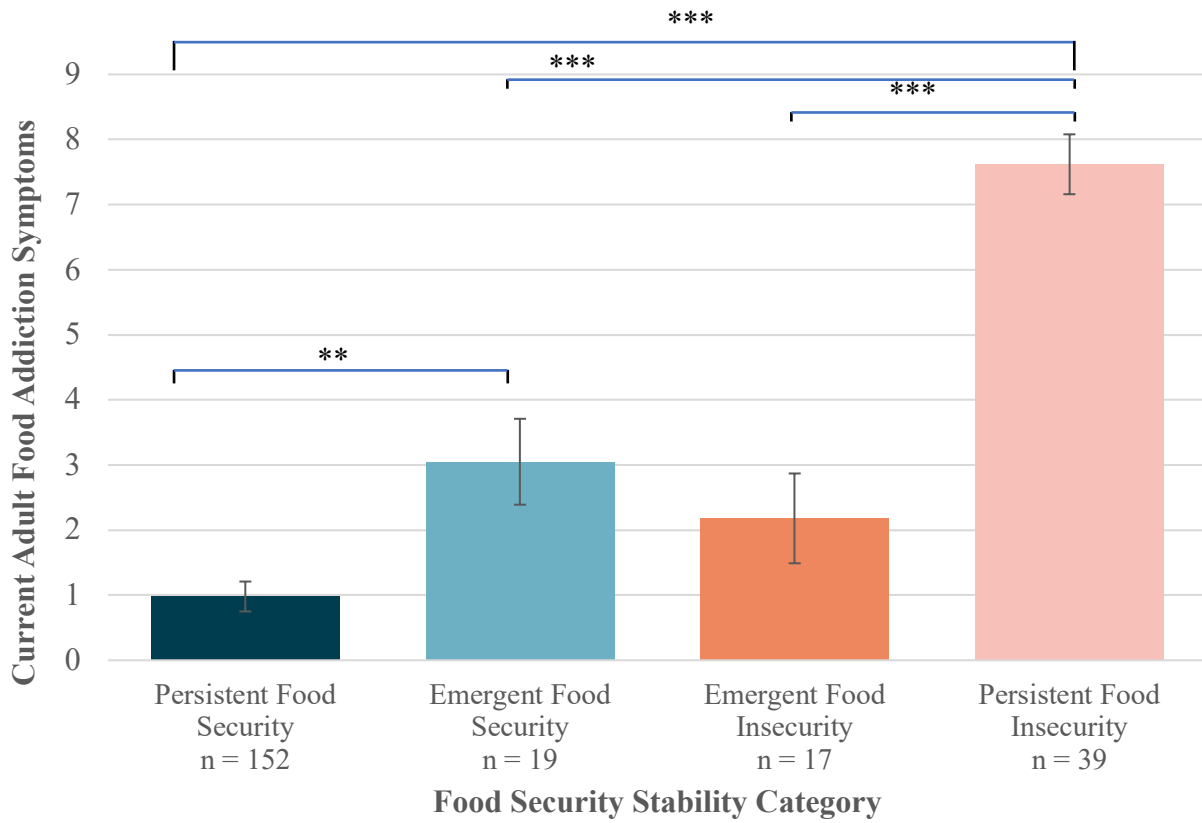
**Bonferroni corrected p<.01

***Bonferroni p<.001

Figure 2. Study 2 Parameter Estimates and Error Terms
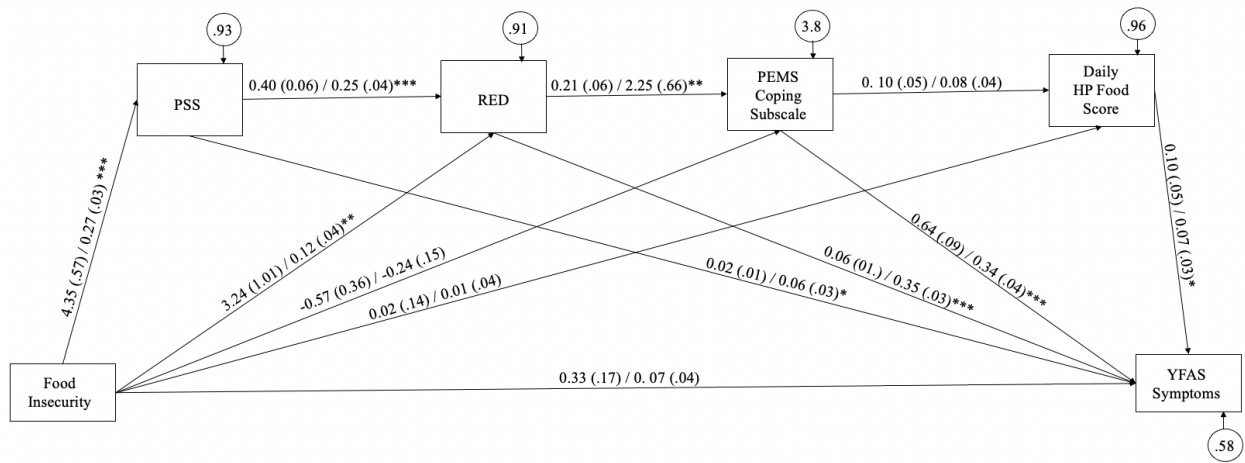
*p < .05, **p<.01, ***p<.001

Appendix: Qualitative Interview Guide

Note: More questions were asked in the qualitative interview than are reported in this dissertation. Additional questions are outside the aims of the dissertation and will inform other studies.

Questions analyzed for this dissertation:

Interpretations of the YFAS 2.0

A few minutes ago, you filled out a questionnaire, which asked about your eating habits in the last year. I'd like to know more about what was going through your mind as you answered each question.

For each question (if endorsed):

- What were you thinking about when you answered this question?

    o Can you describe a specific example of when that happened to you in the last year?

- How is this different from your response to [previous question]?

For each question (if not endorsed):

- Can you tell me how you know you do not engage in this behavior?

- What might it look like if you did engage in these behaviors?

Questions not analyzed for this dissertation:

Once each question has been discussed:

- Are there any questions on the questionnaire that were confusing or hard to understand?

- What foods were you thinking about as you were filling out the survey?

- Are there any foods you believe should be excluded or included on the list of foods at the top of the scale?

- There are many important parts of identity and culture that shape our experiences, including gender, race, ethnicity, sexual orientation, age, etc [show social identity wheel]. This diagram just shows a range of different parts of identity – don't worry about taking them all into account.

  o How do you think your identities/culture may have influenced how you interpreted or answered any of the questions?

- A lot of the foods we have in our food environment are really rewarding. Some of these foods are so rewarding that people experience an addiction to them, much like someone would with tobacco or alcohol.

  o Do you feel like you experience an addiction to food?

  o If yes:

    ▪ What foods do you feel most addicted to?

    ▪ Do you experience this all the time, or are there times you experience it more than others?

- Do you feel like your symptoms are pretty consistent, or do they tend to fluctuate? What do you notice about these patterns?
    - o If no:
        - How would you describe your relationship with food?
        - What helps you know that you aren't addicted to food?
        - What would it mean to have a "food addiction"?
        - What would that look like?
        - What do you think someone with a food addiction would do? What might be some of the behaviors?

We've completed the first portion of the interview. Would you like to take a break to use the restroom or grab a drink of water?

Follow-up Questions about Food Insecurity

Now we'll move on to the second part of the interview. These next several questions may seem a bit personal, so I want you to take your time in responding and share as much with me as you feel comfortable. What you say will help us to understand how different people/families manage their food budget.

In the last few years, a lot of people/families have had trouble making ends meet, especially when it comes to food. When these people/families describe their food situation to me, they say things like they were worried about their food running out before they had money to buy more, ate foods that were cheaper or less desirable than the foods they really wanted to eat, or even skipped meals because there wasn't enough money for food.

- Tell me about your/your family's food situation in the past 12 months.

    o Potential probes:

        ▪ Have there been times when it's been hard to afford enough food?

        ▪ Have you always been able to get what you need?

        ▪ Generally speaking, how has it been for you in terms of putting food on the table?

        ▪ Have there been things that have been challenging about putting food on the table?

    o How do/did you feel about this?

    o Did this experience change your food shopping habits?

        ▪ If more detail needed: walk me through a typical grocery trip at the beginning vs end of the month (where they shop, what they're buying)

    o If no difficulty meeting food needs:

        ▪ Have you worried about being able to afford enough food?

        ▪ Can you tell me more about that?

    o When was the first time you had trouble affording enough food?

    o Did your family ever have trouble affording enough food when you were a child?

- What do you do to help you/your family stretch your food budget to last throughout the month?

- You mentioned you... [Refer back to behaviors they endorsed in YFAS 2.0]. What about when money is low for food?

    o Does it still happen then?

- o Is it different then?

- o Did money being low for food change your eating behaviors? [again, refer to behaviors endorsed in the YFAS]

- o Can you tell me a little bit more?

- Potential probes when discussing hunger:

  - o If you did have other food available, were you still going out of your way to seek out certain foods?

  - o Even when you have just eaten, do you still have this drive to eat certain foods?

Additional Questions (as needed)

- You say you have times when…Could you talk about any differences you might see in your eating habits or symptoms when you first get money? What about when money is running low?

- Do you tend to eat different foods when you first get money compared to when money is running low?

  - o What foods do you tend to eat more of when you first get money?

  - o What foods do you tend to eat more of when money is running low?

- Has your tendency to overeat certain foods when money is available ever led you to run out of food when money is low?

  - o Can you tell me about a specific time that happened?

- Has your tendency to overeat certain foods when money is available led you to change the kinds of foods you eat when money is low?

- o   Can you tell me about a specific time that happened?
- When money is low, do you cut out certain foods that you crave in order to make it through?
  - o   What foods do you tend to cut out?
  - o   Can you tell me about a specific time that happened?
- Have you found ways to get the foods you were craving even when you were out of money?
  - o   What foods?
  - o   What did you do to get these foods?

Role of Identities

- [Show identity wheel again]
  - o   Are there any parts of your identity or culture that feel important for understanding your experiences we've talked about in the second part of the interview today?
  - o   Can you tell me more about that?

Wrapping Up

- We've talked a lot about …. Is there anything else you want to say that we haven't covered that you think is important for us to know?

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