



# Attributes of the food addiction phenotype within overweight and obesity

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## Abstract

**Purpose** Previous studies have demonstrated overlapping behavioral features between substance-use disorders and food addiction, the latter of which is particularly prevalent among individuals with overweight or obesity. However, the unique attributes of food addiction as a possible phenotype within overweight and obesity are not fully understood.

**Methods** This cross-sectional study recruited participants ( $n = 46$ ) with overweight or obesity, nearly half ( $n = 20$ ) of whom met the criteria for food addiction based on the Yale Food Addiction Scale 2.0 (YFAS 2.0) and examined responses to self-report questionnaires that indexed behavioral characteristics relevant to addictive disorders.

**Results** Individuals with food addiction exhibited significantly higher scores on the Palatable Eating Motives Scale overall score ( $p < .001$ ) and subscales for coping ( $p < .001$ ) and enhancement ( $p < .001$ ) of emotions, Dutch Eating Behavior Questionnaire Emotional Eating subscale ( $p < .001$ ), UPPS-P Impulsivity Scale negative urgency ( $p < .001$ ) and lack of perseverance ( $p = .01$ ) subscales, and the Food Craving Inventory overall score ( $p = .02$ ) and subscales of cravings for sweets ( $p < .01$ ) and fast food fats ( $p = .02$ ).

**Conclusion** Food addiction appears to represent a distinct phenotype within overweight and obesity, marked by greater emotion dysregulation, impulsivity, and cravings, which have been observed in prior studies examining features of individuals with addictive disorders.

**Level of evidence** Level III: Evidence obtained from well-designed cohort or case–control analytic studies.

**Keywords** Food addiction · Obesity · Behavioral phenotypes · Disordered eating

## Introduction

Food addiction posits that some individuals may exhibit a substance-based addiction towards highly processed foods, such as cheeseburgers, chocolate, and French fries [1–3]. Food addiction most commonly operationalized by the Yale

Food Addiction Scale 2.0 (YFAS 2.0) [4], which adapts the DSM-5 diagnostic criteria for substance use disorders (SUDs) to indicators of addiction that may occur in response to highly processed foods. For example, one symptom of a SUD is continued substance use despite negative consequences. The YFAS 2.0 adapts this symptom to assess addictive-like responses to highly processed foods with the question, “I kept eating the same way even though my eating caused physical problems.” Individuals can meet for a “diagnostic” score on the YFAS 2.0 by endorsing 2–11 symptoms plus clinically significant impairment or distress related to their addictive-like eating behavior. While this scoring metric on the YFAS 2.0 is not intended to be clinically diagnostic, it parallels the criteria that are used to diagnose SUDs and is the most widely used method of categorizing whether an individual has a food addiction. The global prevalence of food addiction has been estimated in a meta-analysis as approximately 11% among individuals with normal weight and higher rates closer to 25% observed

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among individuals with obesity [5]. Thus, while food addiction is not synonymous with obesity, the higher prevalence rates among this group have led to the suggestion that food addiction may be a clinically relevant behavioral phenotype within obesity [6, 7].

Previous studies have examined the behavioral features of individuals with elevated symptoms of YFAS food addiction to better define this phenotype and have observed similar characteristics as individuals with SUDs [6, 8–12]. Individuals who experience addictive-like eating have demonstrated increased cravings for highly processed foods [6, 8, 9] and have reported using highly processed foods to cope with negative emotions [10]. Further, those with higher YFAS symptoms of food addiction have endorsed greater impulsivity, particularly in the domains of negative urgency, or acting rashly while having negative emotions, and lack of perseverance in the face of difficult tasks [11–13]. However, these behavioral characteristics have also been reported among individuals with obesity more broadly [14–16]. Further, prior studies have often used the symptom score from the YFAS 2.0, rather than examining a sample of individuals who meet the “diagnostic” scoring threshold for food addiction. Examining individuals who meet for the “diagnostic” score on the YFAS 2.0 is important for understanding the characteristics of individuals who exhibit clinically significant impairment or distress related to their addictive-like eating.

The current study is the first study to strategically recruit a sample of individuals with overweight and obesity, nearly half of whom met the “diagnostic” criteria for moderate-to-severe food addiction (4–11 symptoms plus clinically significant impairment or distress) on the YFAS 2.0. Further, the present sample is novel in that individuals with eating disorders (anorexia, bulimia, or binge eating disorder) were excluded, to isolate the unique behavioral features of food addiction. Thus, the central aim of the present study was to examine differences in questionnaires that assess behavioral characteristics of addictive disorders to assess whether a “diagnosis” of food addiction may reflect unique features within the context of overweight and obesity. If features of addictive disorders characterize individuals with food addiction and overweight/obesity, this may highlight intervention targets that may warrant consideration within this population.

## Methods

The University of Michigan Health and Behavioral Sciences Institutional Review Board (IRB) approved the current study (HUM 00110867) and written consent was obtained from all participants. The present data reflect a component of the

study protocol, and the neuroimaging and behavioral data have been reported in two prior publications [17, 18].

## Participants

To enhance the homogeneity of demographic factors within our modest sample size ( $N=46$ ), participants were included if they were women between the ages of 25 and 40 years old ( $M=31$ ,  $SD=4.1$ ) with a self-reported BMI in the overweight or obese range ( $>25$  kg/m<sup>2</sup>) at the time of screening. This approach was adapted from prior studies of samples with food addiction symptoms or eating disorders [19, 20], and the modest sample size reflects the current findings being a subset of data from a neuroimaging study. Consistent with the recruitment protocol, all participants self-reported a BMI in the overweight or obese range during the screening process, although one participant had a normal body mass index (BMI) when measured in the lab. Thus, BMI based on in-lab measurements ranged from 24.7 to 51.0 kg/m<sup>2</sup> ( $M=33.9$ ,  $SD=5.5$ ). Self-reported racial identification was as follows: 52% ( $n=24$ ) White/Caucasian, 28% ( $n=13$ ) Black/African-American, 9% ( $n=4$ ) Hispanic, 7% ( $n=3$ ) Multiracial, 2% ( $n=1$ ) Asian, and 2% ( $n=1$ ) Arab-American. 43.5% of participants ( $n=20$ ) met criteria for moderate-to-severe YFAS 2.0 food addiction diagnostic score, reflecting endorsement of 4–11 of the DSM-5 criteria for substance-dependence (e.g., loss of control over consumption), when the substance is food, plus clinically significant impairment or distress as assessed through two questions on the measure [21]. In the group with YFAS 2.0 food addiction, symptom scores ranged from 4 to 11 ( $M=7.3$ ,  $SD=2.0$ ). The group without food addiction ( $n=26$ ) endorsed zero or one marker of addictive-like eating as measured by the YFAS 2.0 ( $M=0.2$ ,  $SD=0.4$ ). The participant groups did not differ by age, income, BMI, or race (coded as a dichotomous variable for White or non-White identification) (all  $ps > .13$ ).

Participants were recruited from Fall 2017 to Winter 2018 using convenience sampling techniques, such as the University of Michigan’s clinical research listserv (umhealthresearch.org), flyers posted in the Ann Arbor and Detroit metro areas, and advertisements posted to Craigslist. To recruit a significant portion of the sample with YFAS 2.0 food addiction, recruitment materials used language as, “Does your eating behavior feel out of control?” Interested individuals completed an online screener, including self-reported height and weight, to determine whether they had overweight/obesity, and the YFAS 2.0, to determine their eligibility for inclusion as a participant exhibiting food addiction or not. In an effort to isolate YFAS 2.0 food addiction as the key difference between the groups, individuals were excluded from participation

if they had a lifetime history of eating or substance-use disorders, or history of other major psychiatric disorders (e.g., depression) in the past 6 months, as assessed by the Mini International Psychiatric Interview [22]. Further, individuals were excluded for any conditions that may limit their ability to consume foods in the current study, such as self-reported diet-related disease (e.g., diabetes), dietary restrictions that would limit food consumption (e.g., lactose intolerance), and current participation in treatment for eating-related problems or enrollment in a weight loss program (e.g., Weight Watchers). Participants who completed the study were compensated \$75 for approximately 4 h of their time, which included a neuroimaging task [18], laboratory eating assessment [17], and self-report questionnaires.

## Measures

### Yale Food Addiction Scale 2.0 (YFAS 2.0)

The YFAS 2.0 is a validated measure for operationalizing the food addiction phenotype based on the DSM-5 criteria for substance use disorders [4] and was used in the current study to determine whether participants met criteria for food addiction. Consistent with the “diagnostic” scoring method of the YFAS 2.0, participants were categorized as having food addiction if they endorsed 4–11 symptoms plus clinically significant impairment or distress (paralleling moderate-to-severe diagnostic criteria). In the current sample, the internal consistency for the YFAS 2.0 was excellent ( $\alpha = .97$ ).

### Palatable Eating Motives Scale (PEMS)

The PEMS is a 20-item measure that assesses four motivations for consuming “tasty foods and drinks”: coping, enhancement, social, and conformity [23]. The PEMS was adapted from a measure used to assess these motivations for alcohol consumption [24]. Each question is reported on a Likert scale ranging from 1 to 5 and the subscales reflect a composite score. The examples are given for “tasty foods and drinks” are consistent with the current study’s definition of highly processed foods, such as fast foods, fried foods, sweets, and salty snacks. The present study utilized the total score, as well as the four subscale scores. The internal consistency was excellent in the current sample for the overall score ( $\alpha = .92$ ), as well as the subscales for social ( $\alpha = .90$ ), coping ( $\alpha = .95$ ), enhancement ( $\alpha = .90$ ), and conformity ( $\alpha = .82$ ).

### Dutch Eating Behavior Questionnaire-Emotional Eating (DEBQ-E)

The DEBQ-E consists of 13 items and has been validated for evaluating an individual’s tendency to eat for emotional reasons [25]. All items are reported as a Likert scale ranging from 1 to 5 and the total score reflects a composite of all items. In the current sample, the internal consistency for the DEBQ-E was excellent ( $\alpha = .96$ ).

### The UPPS Impulsivity Scale w/Positive Urgency Subscale (UPPS-P)

The UPPS-P is a 59-item measure that has been validated for assessing five facets of impulsive behavior: negative urgency, lack of premeditation, lack of perseverance, sensation seeking, and positive urgency [26]. The items are rated on a Likert scale ranging from 1 to 4 and each subscale is calculated as an average of the relevant items. The internal consistency in the current sample for each subscale were: negative urgency ( $\alpha = .89$ ), lack of premeditation ( $\alpha = .80$ ), lack of perseverance ( $\alpha = .88$ ), sensation seeking ( $\alpha = .84$ ), and positive urgency ( $\alpha = .87$ ).

### Food craving inventory (FCI)

The FCI is a 28-item questionnaire that has been used as a valid measure of cravings for four categories of foods: high fats (e.g., sausage), sweets (e.g., cookies), carbohydrates/starches (e.g., rice), and fast-food fats (e.g., French fries) [27]. The present work used the total score and the four subscale scores. Each question is rated on a Likert scale ranging from 1 to 5, and the scores represent average craving ratings for the food items in that particular category. In the current sample, the internal consistency was excellent for the total score ( $\alpha = .90$ ) and ranged from good to excellent for the subscales of cravings for high fats ( $\alpha = .64$ ), sweets ( $\alpha = .88$ ), carbohydrates ( $\alpha = .80$ ), and fast-food fats ( $\alpha = .67$ ).

### BMI

Height and weight were measured in the laboratory with an O’Leary Acrylic Stadiometer and Detecto Portable Scale in centimeters and kilograms (to the nearest tenth), respectively and utilized to calculate BMI ( $\text{kg}/\text{m}^2$ ). Participants were measured wearing light clothing and were asked to remove jackets, accessories, and shoes.

### Data analytic plan

To examine whether questionnaire responses differed by food addiction categorization, one-way ANOVA tests were used to evaluate the significance of mean differences.

Descriptive statistics of all study measures were used to determine the direction of significant variation. This analytic plan was pre-specified and no data-driven analyses were conducted based on the observed group differences. There was no missing data on the measures.

## Results

Table 1 illustrates the descriptive statistics of each measure for all participants and by food addiction categorization. Individuals with food addiction had significantly higher scores on the PEMS (overall score) ( $F = 17.51$ ,  $p < .001$ ,  $\eta^2 = .28$ ), PEMS coping motives subscale ( $F = 31.21$ ,  $p < .001$ ,  $\eta^2 = .42$ ), PEMS enhancement motives subscale ( $F = 15.47$ ,  $p < .001$ ,  $\eta^2 = .26$ ), DEBQ-E ( $F = 39.45$ ,  $p < .001$ ,  $\eta^2 = .47$ ), UPPS-P negative urgency subscale ( $F = 17.72$ ,  $p < .001$ ,  $\eta^2 = .29$ ), and UPPS-P lack of perseverance subscale ( $F = 6.84$ ,  $p = .01$ ,  $\eta^2 = .14$ ), FCI (overall score) ( $F = 5.58$ ,  $p = .02$ ,  $\eta^2 = .11$ ), FCI sweets subscale ( $F = 9.98$ ,  $p < .01$ ,  $\eta^2 = .19$ ), and FCI fast-food fats subscale ( $F = 5.64$ ,  $p = .02$ ,  $\eta^2 = .11$ ).

## Discussion

The current approach was the first to systematically recruit a sample of individuals with overweight/obesity, half of whom met the YFAS 2.0 “diagnostic” scoring criteria for food addiction. Further, no participants had a history of or current eating disorder diagnoses. Thus, the objective of the present study was to investigate the characteristics of food addiction, in the absence of other eating disorders, as a potential phenotype within overweight/obesity. The findings support this aim. Individuals with food addiction exhibited behavioral characteristics related to problematic foods that have been observed in prior studies of individuals with SUDs with respect to their drug of choice, including using food to cope with negative emotions or enhance positive emotions, greater emotional eating, higher impulsivity in response to negative emotions (negative urgency) or in the face of difficult tasks (lack of perseverance), and greater general food cravings and cravings for sweets and fast food specifically. These behavioral features were uniquely elevated among individuals with overweight or obesity and food addiction, relative to those with only overweight or obesity, which provides support for the relevance of food addiction as a unique phenotype in the absence of other eating disorders.

**Table 1** Descriptive statistics of measures by food addiction (FA) categorization

Questionnaire	Overall ( $n = 46$ ) $M$ (SD)	FA ( $n = 20$ ) $M$ (SD)	No FA ( $n = 26$ ) $M$ (SD)	Sig. ( $p$ )	Effect size ( $\eta^2$ )
PEMS total	40 (14.0)	48 (12.8)	34 (11.3)	< .001**	.28
PEMS social	11 (4.6)	11 (4.9)	10 (4.3)	.27	.03
PEMS coping	10 (5.3)	14 (4.7)	7 (3.6)	< .001**	.42
PEMS enhancement	13 (5.4)	16 (5.7)	10 (3.8)	< .001**	.26
PEMS conformity	7 (2.8)	8 (2.5)	7 (2.9)	.23	.03
FCI total	2 (0.6)	3 (0.6)	2 (0.6)	.02*	.11
FCI sweets	3 (1.0)	3 (1.0)	2 (0.8)	< .01**	.19
FCI high-fat foods	2 (0.6)	2 (0.6)	2 (0.6)	.87	.00
FCI fast food fats	3 (0.8)	3 (0.9)	3 (0.7)	.02*	.11
FCI high-carbohydrate foods	2 (0.8)	2 (0.8)	2 (0.8)	.14	.05
DEBQ-E TOTAL	39 (15.7)	51 (10.6)	30 (12.2)	< .001**	.47
UPPS-P negative urgency	2 (0.7)	3 (0.6)	2 (0.6)	< .001**	.29
UPPS-P lack of deliberation	2 (0.4)	2 (0.5)	2 (0.4)	.68	.00
UPPS-P lack of perseverance	2 (0.6)	2 (0.7)	2 (0.5)	.01*	.14
UPPS-P sensation seeking	3 (0.6)	3 (0.7)	2 (0.6)	.25	.03
UPPS-P positive urgency	2 (0.5)	2 (0.5)	2 (0.5)	.08	.07

PEMS Palatable Eating Motives Scale, FCI Food Craving Questionnaire, DEBQ-E Dutch Eating Behavior Questionnaire-Emotional Eating Subscale, UPPSP-P Impulsive Behavior Scale

\* $p < .05$ ; \*\* $p < .01$

## Eating motives

Individuals with food addiction reported higher scores on the PEMS overall and the subscales that assess the use of palatable foods to cope with negative emotions or to enhance positive emotions. In the context of substance use, these motivations have been associated with increased frequency and quantity of use and a higher risk of developing an SUD, given the reliance on the substance as a tool to modulate emotional experiences [24, 28]. Prior studies have observed that YFAS symptoms of food addiction have been associated with PEMS overall scores and the coping and enhancement subscales [23], and those symptoms of food addiction fully mediated the relationship between the PEMS coping and enhancement subscales and higher BMI [10]. Thus, individuals with food addiction seem to be more likely to utilize palatable, highly processed foods to cope with negative emotions or enhance a positive experience. This may pose risk for increased consumption of these foods and likelihood of developing an addictive response to them, both of which may perpetuate overeating and the maintenance of a higher BMI as unique mechanisms for individuals with overweight or obesity exhibiting the food addiction phenotype.

## Emotional eating

Relatedly, individuals with, compared to without, food addiction exhibited elevated scores on the DEBQ-E, which indexes the propensity for emotional eating. In parallel, prior studies of individuals with SUDs have observed that negative affect may prompt drug use and reinforce continued dependence on the substance [29–31]. The association between food addiction and emotional eating adds to the current findings with the PEMS and supports the plausibility of intense emotional states being a strong trigger for addictive-like eating behavior. Collectively, the present work suggests that emotion regulation may be especially important to address in treatments for individuals with overweight or obesity who exhibit the food addiction phenotype.

## Impulsivity

Individuals with overweight or obesity and food addiction had higher scores on the UPPS-P subscales that assess negative urgency, reflecting the tendency to act impulsively in response to negative emotions, and lack of perseverance to finish tasks, compared to those with only overweight or obesity. This replicates findings from a prior study examining associations between YFAS symptoms and UPPS scores [11], suggesting that these two features may be particularly related to food addiction. Notably, in a meta-analysis of individuals who consumed alcohol, lack of perseverance

was closely associated with increased substance use and negative urgency was related to a greater risk for exhibiting substance dependence [32]. It may be that negative urgency is a shared mechanism that relates to emotion dysregulation in food addiction and SUDs, where an individual experiences negative affect and impulsively utilizes highly processed foods (or a drug of abuse in the case of a SUD) to downregulate the uncomfortable emotion. Further, lack of perseverance may reflect the common feature of struggling to value a long-term reward, which may present challenges to adhering to treatment goals. Thus, while impulsivity has been observed broadly among individuals with obesity [33], the current study provides insight into specific attributes that may perpetuate problematic eating behavior and higher BMI to a greater degree for individuals with food addiction.

## Food cravings

Participants with food addiction reported higher scores on the FCI for overall food cravings and specifically for foods categorized as sweets (e.g., cookies, donuts, ice cream) and fast food fats (e.g., pizza, French fries, potato chips). The majority of the items on the FCI (25 of 28) and all of the items on the sweets and fast food fats subscales are highly processed foods, which have been most closely associated with food addiction in prior studies [2, 3, 17, 34]. If highly processed foods exhibit an addictive potential, it may be expected that individuals with food addiction phenotype would experience higher cravings for these foods, as indicated by the current findings. Craving is a key feature of SUDs that drives continued substance use and is a risk factor for relapse [35, 36]. Thus, individuals with food addiction may benefit from specific intervention techniques for craving management that have been helpful for those with SUDs, to reduce their addictive-like consumption of highly processed foods.

## Limitations and future directions

The present study was cross-sectional and included a modest sample size of only women, which may limit generalizability. Future research is needed to disentangle the temporal associations for how these behavioral characteristics may translate into addictive-like eating behavior. For instance, it may be interesting to utilize ecological momentary assessment to evaluate how negative urgency may result in addictive-like consumption of highly processed foods among a larger sample of individuals with food addiction. Further, while one strength of the current approach was excluding individuals with other eating disorders to isolate the effect of food addiction, this study could not compare the behavioral features of food addiction versus eating disorders such as binge eating disorder. Future studies could consider

comparing the features of food addiction versus binge eating disorder in the context of overweight and obesity, which may help differentiate the clinical relevance of characteristics shared in both conditions (e.g., impulsivity). Similarly, while the present study included individuals with either overweight or obesity, further work may aim to delineate whether phenotypic differences exist for individuals with food addiction who have overweight versus obesity, which the present sample size was underpowered to detect.

Given that the reported behavioral features of participants with food addiction and overweight/obesity closely parallel the characteristics of individuals with a SUD, evidence-based treatments for reducing substance use may help individuals with food addiction cut down on highly processed foods. For example, harm reduction is an intervention for decreasing problematic substance use that does not emphasize abstinence but rather helps individuals determine which substances or environments elevate the risk for overconsumption (e.g., drinking hard liquor while alone after a stressful day) [37, 38]. In parallel, harm reduction may be a way to help individuals with food addiction determine which foods are “high risk” (e.g., donuts) instead of having to become completely abstinent from a whole class of foods (e.g., all highly processed foods). This treatment approach would target behavioral features identified as relevant to food addiction in the present study, given that it facilitates insight into food cravings and reduces impulsivity.

## Conclusion

The current research examined individuals with overweight or obesity, nearly half of whom met the “diagnostic” criteria for food addiction based on YFAS 2.0. Participants with food addiction exhibited a number of behavioral characteristics observed in prior studies of individuals with SUDs, broadly reflecting greater emotion dysregulation, impulsivity, and craving. These findings provide support for overlapping features between individuals with food addiction and SUDs and also demonstrate the unique attributes of food addiction as a phenotype within overweight and obesity. Thus, individuals with food addiction may benefit from novel intervention techniques for addressing addictive-like eating behavior or for weight management that specifically target these behavioral features.

## What is already known on this subject?

Food addiction is a topic that has piqued scientific and public interest in the past decade, and the phenotype appears to be more prevalent among individuals with overweight/obesity and binge eating disorder.

## What does this study add?

This is the first study to recruit based on food addiction status while excluding those with lifetime history of eating disorders, including binge eating disorder, to isolate unique features of food addiction a subtype within overweight/obesity. Individuals with food addiction exhibited features shared across addictive disorders, such as greater emotion dysregulation, impulsivity, and cravings.

**Author contributions** ES and AG designed the research study, conducted the analyses, and authored the manuscript. All authors have approved the final article.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

**Ethics approval** The University of Michigan Health and Behavioral Sciences Institutional Review Board (IRB) approved the current study (HUM 00110867).

**Consent to participate** Written informed consent was obtained from all participants.

**Consent for publication** Written informed consent included consent to publish the overall findings.

**Availability of data and material** The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

**Code availability** The data syntax used to analyze the findings from the current study are available from the corresponding author on reasonable request.

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