Eating Behaviors 15 (2014) 427–433

Contents lists available at ScienceDirect

Eating Behaviors

The association of "food addiction" with disordered eating and body mass index

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ARTICLE INFO

Article history:
Received 21 November 2013
Received in revised form 17 April 2014
Accepted 19 May 2014
Available online 27 May 2014

Keywords:
Food addiction
Binge eating
Bulimia nervosa
Eating disorders
Obesity

ABSTRACT

Introduction: The contribution of an addictive process to elevated body mass index (BMI) and disordered eating is an area of growing interest. Yet, little is known about how "food addiction" may be related to disordered eating and obesity. The ability of addictive-like eating to account for eating pathology not captured by traditional eating disorders is unknown. No prior research has examined the association of "food addiction" with bulimia nervosa (BN). Finally, little is understood about the association of "food addiction" with patterns of dieting and weight gain. The current study was conducted to address these gaps in the literature.
Material and methods: Participants (N = 815) were recruited from online advertisements nationwide and completed measures related to "food addiction", BMI, weight history, and disordered eating.
Results: Addictive-like eating was associated with elevated current and lifetime highest BMI, weight cycling, and eating pathology. The prevalence of "food addiction" was higher in participants with BN than in those with binge eating disorder (BED). "Food addiction" continued to be related to clinically relevant variables, especially elevated BMI, even when participants did not meet criteria for BED or BN. The co-occurrence of "food addiction" with eating disorders appears to be associated with a more severe variant of eating pathology.
Discussion: An addictive-type response to highly palatable food may be contributing to eating-related problems, including obesity and eating disorders. BN relative to BED appears to be more strongly associated with "food addiction." Additionally, the concept of "food addiction" appears to capture clinically relevant information in participants who do not meet criteria for either BN or BED. Further examination of "food addiction" may be important in understanding the mechanisms underlying certain types of problematic eating behavior.

1. Introduction

Evidence is growing that an addictive process may play a role in certain types of eating behavior. Theories of "food addiction" suggest that certain highly processed foods may have an addictive potential and that some types of obesity and disordered eating may be the result of an addictive response to these foods (Gearhardt, Davis, Kuschner, & Brownell, 2011; Gold, Frost-Pineda, & Jacobs, 2003). If an addictive mechanism contributes to eating patterns marked by compulsive overconsumption, this may lead to the development of novel eating-focused treatment approaches (e.g., addiction pharmacology, harm reduction). Behavioral (e.g., withdrawal, tolerance, bingeing) and biological (e.g., dopaminergic downgrading, opioid release) indicators of addiction in animals consuming highly palatable foods or ingredients in these foods (e.g., fat, sugar) have been found (Avena, Rada, & Hoebel, 2008; Johnson & Kenny, 2010). Neurobiological studies have identified shared neural underpinnings associated with obesity and substance dependence, such as increased activation in motivation-related regions in response to cues and diminished activation in reward regions in response to consumption (Volkow, Wang, Tomasi, & Baler, 2013). The development of the Yale Food Addiction Scale (YFAS) (Gearhardt, Corbin, & Brownell, 2009) has provided a tool to assess the diagnostic symptoms of substance dependence in relation to eating behavior. Elevated YFAS scores have been linked with patterns of neural activation associated with addictive behaviors Gearhardt, Yokum et al., 2011), a higher likelihood of a composite index of elevated dopamine signaling (Davis et al., 2013) and a greater severity of disordered eating (Davis, 2013a; Gearhardt, White, Masheb, & Grilo, 2013; Gearhardt et al., 2012). Despite increased interest in "food addiction," a number of areas require further research, such as further examination of the relationship of addictive-like eating with eating disorders and obesity.

Theoretically, addiction and traditional eating disorder perspectives have different explanatory mechanisms about loss of control over eating. The "food addiction" perspective highlights the addictive potential

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http://dx.doi.org/10.1016/j.eatbeh.2014.05.001
1471-0153/

of the highly processed food and suggests that these foods may have the ability to "hijack" the reward system in at-risk individuals (Gearhardt, Davis et al., 2011; Gold et al., 2003). In contrast, traditional eating disorder approaches highlight rigid dietary restraint, as well as shape and weight concern as causal mechanisms (Fairburn, Cooper, Shafran, & Wilson, 2008; Polivy & Herman, 2002). Yet, overlap is also significant across these theoretical approaches, with impulsivity, reward dysfunction, and emotion dysregulation proposed as important contributors to eating psychopathology from both addiction and traditional eating disorder perspectives (Davis, Strachan, & Berkson, 2004; Dawe & Loxton, 2004; Fischer, Anderson, & Smith, 2004). The diagnostic criteria for binge eating disorder (BED) and substance dependence also share a number of characteristics, like diminished control over consumption and continued use despite negative consequences (Gold et al., 2003). This overlap has led to questions about the discriminant validity of "food addiction" from BED. In other words, the "food addiction" construct may be capturing variability already accounted for by BED. Prior research with obese individuals with BED found that YFAS "food addiction" and a diagnosis of BED did not completely overlap, with around fifty percent of obese patients diagnosed with BED meeting the "food addiction" threshold (Gearhardt, White et al., 2013; Gearhardt et al., 2012). In clinical BED samples, elevated YFAS scores were related to more frequent binge eating episodes, elevated emotion dysregulation, and increased eating pathology (Gearhardt, White et al., 2013; Gearhardt et al., 2012). Thus, "food addiction" may be associated with more severe pathology in the context of BED (Davis, 2013b). Further, Umberg, Shader, Hsu, and Greenblatt (2012) proposed that bulimia nervosa (BN) may be more likely than BED to be associated with "food addiction," since the binge/restrict pattern central to this disorder may increase the likelihood of affective and biological changes implicated in addictive disorders. To date, no studies have examined the construct of "food addiction" in a sample of participants with BN.

Further, there is no previous research on the association of "food addiction" and disordered eating in a sample that contains not only individuals with clinically relevant eating disorders, but also eating pathology that may not be captured by traditional eating disorder diagnoses – (e.g., subthreshold eating pathology or problematic eating not associated with binge eating). Understanding the ability of "food addiction" to account for problematic patterns of eating that are not captured by eating disorder categories may be particularly relevant given the high rates of Eating Disorder Not Otherwise Specified (EDNOS) diagnoses (Machado, Machado, Gonçalves, & Hoek, 2007). Although individuals with EDNOS diagnoses are considered to have a level of psychopathology that necessitates treatment (Ricca et al., 2001; Turner & Bryant-Waugh, 2004), the mechanisms underlying these unspecified eating patterns are not well understood, which limits the development of more targeted treatment approaches. Therefore, the capability of "food addiction" to provide relevant information outside of formal eating disorder diagnoses (e.g., BED, BN) speaks to the validity of the construct and may provide clinically useful information.

The association of "food addiction" with obesity is also relatively unknown. Elevated levels of addictive-like eating behavior hypothetically would be related to compulsive overconsumption of highly palatable (and calorie-dense) foods. This relationship should result in a greater risk of obesity. A recent study found that the risk of "food addiction" increased with obesity status and the severity of addictive-like eating was positively related to measures of adiposity (e.g., body fat, BMI) (Pedram et al., 2013). However, little is known about how "food addiction" may be related to specific patterns of weight history, such as weight cycling (e.g., repeated periods of losing and regaining weight), age at onset of dieting and weight gain, and current dieting behavior, which are known to influence adiposity, BMI, and problematic eating (Enriquez, Duncan, & Schur, 2013; Fairburn et al., 1998; Foster, Wadden, Kendall, Stunkard, & Vogt, 1996). Further, no prior research has examined whether the association of addictive-like eating with elevated BMI is confined to individuals with traditional eating disorders who are at increased risk for obesity (i.e., those with BED). Thus, it is possible that "food addiction" is only related to obesity among individuals who also have BED.

In the current study, we aim to address a number of gaps in the current literature on "food addiction" regarding disordered eating and obesity. We examine the association of "food addiction" with BED, BN, and BMI in a large non-clinical sample. This sample provides an opportunity to evaluate the potential link between "food addiction" and BN for the first time, as well as to investigate the ability of "food addiction" to account for eating pathology not captured by other eating disorders. Additionally, we will examine the association between addictive-like eating and body weight, including current BMI, highest lifetime BMI, dieting status and frequency of weight cycling. We will also identify whether "food addiction" is associated with elevated BMI outside of the context of eating disorders associated with increased adiposity (e.g., BED).

2. Materials and methods

2.1. Participants

Participants were drawn from a sample of 1141 community volunteers who responded to an online advertisement for a research study about "eating habits," "health behaviors," "dieting," or "weight control." Eight hundred and fifteen participants in the full sample completed the YFAS and were included in the sample for the current study. The study recruited participants through Craigslist classifieds postings in different United States cities (e.g. New York, Los Angeles, Washington DC) and required participants to be 18 years or older. Participants were on average 33 years old (range 18–73). The sample was 11.9% male ($n = 97$) and 88.1% female ($n = 717$) and one participant did not report gender. The racial/ethnic distribution for the study sample was: 79.1% Caucasian, 6.0% Hispanic, 5.7% African American, 5.5% Asian, and 3.7% reporting "other." One participant failed to report race/ethnicity. The participants' body weight ranged from underweight to severely obese (BMI range 14.60–69.23) with the average BMI in the overweight category ($M = 28.70$, $SD = 8.77$).

2.2. Procedures

Participants were required to provide informed consent prior to completing the survey, but no personal identifying information was collected. The study was approved by the Yale Institutional Review Board. All survey measures were hosted on SurveyMonkey (http://www.surveymonkey.com), a research-based data gathering website that uses a secure 128-bit encryption. Participants were offered a 1 in 20 chance to win a $50 gift certificate in exchange for participation.

2.3. Assessments and measures

Participants provided basic demographic information and completed a battery of self-report measures. Self-reported height and weight were used to compute participant BMI (kg/m^2).

The Eating Disorder Examination Questionnaire (*EDE-Q*) (Fairburn & Beglin, 1994) is the self-report version of the Eating Disorder Examination interview (Fairburn & Cooper, 1993) and assesses eating disorders and their features. The EDE-Q assesses the frequency of different overeating behaviors over the previous 28 days, such as objective binge eating episodes (OBEs; eating unusually large amounts of food while experiencing a subjective sense of loss of control), subjective binge eating episodes (SBEs; loss of control over eating but not eating an objectively large amount of food) and purging behaviors (e.g., self-induced vomiting, laxative misuse, diuretic misuse). The EDE-Q also contains four subscales that assess levels of dietary restraint, eating concern, shape concern, and weight concern and generates a global score. The EDE-Q has extensive psychometric support for use in disordered eating groups (Grilo, Masheb, Lozano-Blanco, & Barry, 2004; Grilo, Masheb, &

Wilson, 2001), community samples (Mond, Hay, Rodgers, & Owen, 2008; Mond, Hay, Rodgers, Owen, & Beumont, 2004; Roberto, Grilo, Masheb, & White, 2010) and has good internal consistency in the current measure (α = .90).

Questionnaire for Eating and Weight Patterns–Revised (*QEWP-R*) (Yanovski, 1993) assesses current and historical eating/weight patterns. The QEWP-R, which was used in the DSM-IV field trials, assesses each of the diagnostic criteria for binge eating disorder (BED) and bulimia nervosa (BN) and assesses eating and dieting history (e.g. age first overweight, age first dieting, current dieting, time spent dieting, highest BMI [excluding pregnancy], and history of weight cycling [excluding periods of weight loss due to sickness]). In the current study, only participants who reported being overweight or obese were asked about the age at which they first became overweight or started dieting. The QEWP-R has received psychometric support of its validity (Brody, Walsh, & Devlin, 1994; Nangle, Johnson, Carr-Nangle, & Engler, 1994) and concordance with the EDE-Q in determining binge eating and BED (Celio, Wilfley, Crow, Mitchell, & Walsh, 2004; Elder et al., 2006).

The Yale Food Addiction Scale (Gearhardt et al., 2009) measures signs of "addiction" toward certain types of food (e.g. high in fat and high sugar) based on criteria for substance dependence as stated in the DSM-IV (American Psychiatric Association, 2000). The scale includes items that assess specific criteria, such as diminished control over consumption, a persistent desire or repeated unsuccessful attempts to quit, withdrawal, and clinically significant impairment. The YFAS includes two scoring options: 1) a "symptom count" ranging from 0 to 7 that reflects the number of addiction-like criteria endorsed and 2) a dichotomous "diagnosis" that indicates whether a threshold of three or more "symptoms" plus clinically significant impairment or distress has been met. The YFAS has received psychometric support in a binge eating population (Gearhardt, White et al., 2013; Gearhardt et al., 2012), obese bariatric surgery patients (Clark & Saules, 2013; Meule, Heckel, & Kübler, 2012) and a diverse clinical sample (Davis et al., 2011). In the current sample, the YFAS exhibited adequate internal consistency (α = .77).

2.4. Data analytic plan

Participants who met the YFAS "food addiction" threshold were compared to participants not endorsing addictive-like eating on a number on demographic characteristics (e.g., age, sex), weight/dieting-related variables (e.g., BMI, weight cycling) and disordered eating psychopathology (e.g., shape and weight concern) using chi-square and independent t-test analyses.

Next, participants were classified into five groups based on their responses to the EDE-Q, QEWP-R and YFAS: 1) "food addiction" (FA)-only, 2) BED or BN-only, 3) BN & FA 4) BED & FA and 5) healthy control. Participants were classified as FA-only if they met the YFAS "food addiction" threshold and did not meet criteria for BED or BN (n = 76). To examine whether FA may account for eating problems not captured by specific eating disorder diagnoses, participants who met the "food-addiction" cutoff and had subclinical eating concerns (i.e., binge eating, purging) but who did not meet criteria for BED/BN were classified in the "food addiction" group. To be classified as either BED or BN, an individual must have reported binge eating at least four times over the previous 28 days (i.e., meeting the frequency threshold of once weekly, consistent with DSM-5 diagnostic criteria). Individuals classified as BN also reported purging (i.e., self-induced vomiting, laxative, or diuretic use as a means of controlling shape or weight) at least four times over the previous 28 days. Participants classified as BED reported no purging behaviors in the previous 28 days. Participants with BED-only (n = 56) were grouped together with BN-only (n = 12) due to the small number of participants who only met for BN (i.e., BN in the absence of FA). Thus the BED/BN-only group consisted of participants who met the requirements for either of these disorders, but did not meet the FA threshold (n = 68).[1] The third group included individuals who endorsed FA and BN simultaneously (n = 61). The fourth group was composed of participants who met for both FA and BED (n = 50). Healthy controls did not report any binge eating or purging in the last 28 days and denied FA (n = 388). Participants with clinically significant purging behaviors in the absence of binge eating were excluded (n = 18), as were participants with less frequent binge eating and/or purging (i.e., less than weekly) who did not meet the FA threshold (n = 110).

The association of clinically relevant domains (e.g., BMI, weight cycling, disordered eating attitudes) with the five groups was evaluated with one-way analysis of variance (ANOVA) analyses for continuous variables and chi-square analyses for categorical variables. Significant omnibus differences among the groups were followed up with post-hoc tests that examined differences between each of the five groups (Bonferroni corrected for multiple comparisons). Analysis-appropriate effect sizes were also computed (eta-squared for t-tests and ANOVA analyses, Cramer's phi for chi-square analyses).

3. Results

3.1. YFAS food addiction classification: associated demographic and clinical features

The diagnostic threshold for "food addiction" based on the YFAS (i.e., three or more "symptoms" and clinically significant impairment or distress) was met by 25.7% (n = 207) of participants. The mean number of "food addiction symptoms" met on the YFAS in the overall sample was 3.05 (*SD* = 2.00). Participants classified with versus without YFAS "food addiction" did not differ on age, race/ethnicity, and sex (all *p*-values > .20).

3.2. YFAS food addiction classification: associations with body weight and dieting behavior

Table 1 summarizes the relationship of "food addiction" classification with dieting and body weight variables. YFAS "food addiction" was associated with higher current BMI, higher lifetime BMI, and an earlier age of first dieting ($p < .001$). Time spent dieting, current dieting and elevated weight cycling were also positively related to YFAS "food addiction" ($p < .001$). "Food addiction" status was not significantly related to age of first becoming overweight ($p = .140$), although higher YFAS symptom count scores were associated with an earlier age of first becoming overweight ($p < .05$).

3.3. YFAS food addiction: associations with measures of eating pathology

Table 2 displays the relationship between disordered eating behaviors (e.g., binge eating behaviors) and eating-related psychopathology (i.e., dietary restraint, shape, weight, and eating concern) with "food addiction". YFAS "food addiction" was significantly associated with all disordered eating variables ($p < .001$).

3.4. YFAS food addiction: comparison of body weight and dieting among eating groups

Table 3 summarizes the relationship among eating groups 1) FA-only, 2) BED/BN-only, 3) BN & FA, 4) BED & FA, and 5) healthy control regarding body weight and dieting practices. Participants with BN met the FA criteria (83.6%) more frequently than individuals with BED (47.2%) ($p < .001$). Significant differences among the eating groups were found for current and lifetime of BMI. The FA-only group was

[1] To examine whether combining BN only and BED only participants altered the results, the analyses were rerun with the BN only participants excluded. The same pattern of results was found.

Table 1
Relationship of "food addiction" diagnosis with body weight and dieting [a,b].

	Food addiction (n = 207) M (SD)	No food addiction (n = 599) M (SD)	Test statistic (t or χ^2)	P value	Effect size (η^2)
BMI	31.14 (SD = 10.39)	27.72 (SD = 7.73)	24.88	<.001	.03
Highest BMI	33.80 (SD = 11.28)	30.16 (SD = 8.63)	22.62	<.001	.03
Age 1st overweight	16.58 (SD = 12.30)	18.04 (SD = 9.90)	2.19	.140	.00
Age 1st dieting	19.48 (SD = 6.63)	22.24 (SD = 8.96)	12.38	<.001	.02
Time spent dieting N (%)	152 (73.8%)	262 (43.7%)	55.40	<.001	.26[c]
Current dieting N (%)	125 (60.4%)	272 (45.6%)	13.52	<.001	.13
Weight cycling N (%)	162 (78.3%)	335 (55.9%)	32.49	<.001	.20

[a] The Yale Food Addiction Scale (YFAS) Symptom Count exhibits the same pattern of results, except there is a significant negative relationship with age 1st overweight ($p < .05$).
[b] Weight cycling = 20 pounds lost and regained one or more times, time spent dieting = since the age of 18, been dieting at least half of the time.
[c] Cramer's Phi used as effect size statistic for chi-square analyses (time spent dieting, currently dieting, weight cycling).

associated with a significantly higher current BMI relative to the BED/BN-only, BN & FA, and the healthy control groups. The BED & FA group was related to a significantly higher current BMI than the BED/BN-only and healthy control groups. For highest lifetime BMI, the FA-only group reported higher levels than the BED/BN-only and healthy control groups. The BED & FA group also indicated higher lifetime BMI than the healthy control group.

Significant differences were found for comparisons of dieting and weight history across groups. The BN & FA group reported a significantly earlier age of dieting than the healthy control group. All problematic eating groups indicated greater time spent dieting relative to the healthy control group, with the BN & FA and the BED & FA groups reporting more dieting than the FA-only and BED/BN-only groups. Further, all problematic eating groups had significantly higher levels of current dieting and weight cycling relative to the healthy control group.

3.5. YFAS food addiction: comparison of eating pathology among eating groups

Table 4 examines differences between the eating groups and eating-related psychopathology. Except the FA-only group, SBEs were elevated in all groups relative to the healthy control group. The BN & FA group endorsed the highest levels of SBEs relative to the other problematic eating groups and the BED & FA group reported more SBEs compared to the FA-only group. Restraint scores were elevated in the FA-only, BN & FA, BED & FA groups relative to healthy controls with the BN & FA group having the highest overall levels. Shape and weight concern was elevated in all binge eating and FA groups relative to healthy controls, but the BED/BN-only group had significantly lower levels than all FA groups for weight concern, and lower levels than the BN & FA and BED & FA groups for shape concern. All problematic-eating groups had higher eating concern than the healthy control group. The FA groups reported more eating concern than the BED/BN-only group and the BN & FA and BED & FA groups also had higher levels than FA-only. For total EDE scores, all eating pathology groups had higher levels than the healthy control group, but all FA groups had higher levels than the BED/BN-only group; on global EDE scores, the FA & BN group had elevated scores relative to the FA-only group.

4. Discussion

The current study examined the association of "food addiction" with BED, BN, and BMI in a large non-clinical sample. To our knowledge, this is the first examination of the association of "food addiction" with BN. Of participants meeting the criteria for BN, 83.6% also met the "food addiction" threshold. This is significantly higher than the 47.1% of BED participants who endorsed "food addiction." Further, the BN & FA group had higher levels of pathology in certain arenas (i.e., earlier age of dieting, time spent dieting, SBEs, disordered eating attitudes) relative to the other problematic eating groups. These findings are consistent with theoretical proposals that the intermittency of binging/purging in BN may be particularly likely to sensitize behavioral and biological systems in an addictive manner (Umberg et al., 2012). Alternatively, individuals with BN often exhibit more severe pathology than BED participants (de Jonge, Van Furth, Lacey, & Waller, 2003; Núñez-Navarro et al., 2011), thus the greater rates of "food addiction" for BN participants may solely reflect elevated levels of pathology. It will be important to conduct future research that does not rely on self-report (e.g., neuroimaging) to examine the potential role of addictive mechanisms in BN.

The food-addiction-only group and the BED/BN-only groups were similarly distinct from healthy participants on most dieting-related and eating psychopathology variables. Therefore, participants meeting only the "food addiction" criteria may be experiencing similar level of clinically relevant psychopathology as participants with eating disorder diagnoses. Individuals who endorse addictive-like eating, but do not meet criteria for BED/BN, would likely receive an EDNOS diagnosis. Future research on the prevalence of "food addiction" in patients with

Table 2
Relationship of "food addiction diagnosis" with disordered eating[a].

	Food addiction (n = 207) M (SD)	No food addiction (n = 599) M (SD)	T statistic	P value	Effect size (η^2)
Objective overeating	6.99 (SD = 7.50)	1.88 (SD = 3.84)	158.28	<.001	.16
OBE episodes	6.22 (SD = 7.20)	1.18 (SD = 3.09)	191.50	<.001	.19
SBE episodes	5.09 (SD = 6.56)	1.61 (SD = 3.43)	93.81	<.001	.11
EDE restraint	3.23 (SD = 1.66)	2.09 (SD = 1.50)	84.10	<.001	.10
EDE shape concern	5.02 (SD = 1.08)	3.32 (SD = 1.63)	194.28	<.001	.20
EDE weight concern	4.34 (SD = 1.11)	2.74 (SD = 1.49)	199.17	<.001	.20
EDE eating concern	3.42 (SD = 1.39)	1.26 (SD = 1.17)	462.08	<.001	.37
EDE total	3.99 (SD = 1.06)	2.35 (SD = 1.24)	291.42	<.001	.27

[a] The Yale Food Addiction Scale (YFAS) symptom count exhibited the same pattern of results for all variables. OBE = objective binge eating episode, SBE = subjective binge episode, EDE = Eating Disorder Examination.

Table 3
Comparison of body weight and dieting among eating groups [a,b].

	FA-only (n = 76) M (SD)	BED/BN-only (n = 68) M (SD)	BN & FA (n = 61) M (SD)	BED & FA (n = 50) M (SD)	Neither FA or BED/BN (N = 388) M (SD)	Test statistic (*F* or χ^2)	*P* value [c]	Pairwise Diff.	Effect size (η^2)
BMI	32.96 (11.23)	27.96 (6.32)	28.34 (9.31)	32.73 (SD = 10.11)	27.57 (SD = 8.12)	8.95	<.001	1,4 > 2; 1 > 3; 1,4 > 5	.05
Highest BMI	35.43 (12.50)	30.71 (7.12)	31.69 (9.99)	34.80 (11.12)	29.83 (8.99)	7.37	<.001	1 > 2; 1,4 > 5	.04
Age 1st overweight	16.88 (16.40)	17.33 (7.97)	14.98 (7.33)	18.49 (11.24)	18.36 (10.64)	1.08	.366		.01
Age 1st dieting	19.72 (6.17)	21.43 (8.08)	17.22 (4.70)	22.05 (7.90)	22.61 (9.15)	4.82	<.001	3 < 5	.04
Time spent dieting	48 (61.8%)	37 (54.4%)	47 (78.7%)	40 (81.6%)	144 (37.1%)	70.01	<.001	1,2,3,4 > 5; 3,4 > 1,2	.33[d]
Currently dieting	432 (55.3%)	38 (55.9%)	39 (64.0%)	29 (58.0%)	152 (39.4%)	22.68	<.001	1,2,3,4 > 5	.19
Weight cycling	57 (75.0%)	49 (72.0%)	51 (83.6%)	38 (76.0%)	192 (49.5%)	48.25	<.001	1,2,3,4 > 5	.27

[a] FA = food addiction, BED = binge eating disorder, BN = bulimia nervosa.
[b] Weight cycling = 20 pounds lost and regained one or more times, time spent dieting = since the age of 18, been dieting at least half of the time.
[c] 1 = FA-only, 2 = BED/BN-only, 3 = BN & FA, 4 = BED & FA, 5 = neither FA or BED/BN, all reported pairwise differences $p < .05$.
[d] Cramer's Phi used as effect size statistic for chi-square analyses (time spent dieting, currently dieting).

EDNOS will be important in evaluating whether the assessment of addictive-like eating may improve diagnostic clarity. Further, the BED/BN-only group reported lower levels of eating concern, weight concern, and total pathological eating attitudes than the food-addiction-only group, which suggests that "food addiction" may be related to more severe pathology even when other eating disorders are not present. The FA-only group did report significantly lower levels of SBEs relative to other problematic-eating groups, which suggests that in FA, diminished control over consumption is unlikely to occur without the consumption of an objectively large amount of food. "Food addiction" in the context of BED and BN is related to greater severity across a number of domains (i.e., time spent dieting, SBE episodes, disordered eating attitudes), which is consistent with prior suggestions that addictive-like eating behavior associated with an eating disorder may represent a more severe variant of the condition (Davis, 2013a,b; Gearhardt, White et al., 2013; Gearhardt et al., 2012). The utility of including the YFAS as a screening tool in the clinical treatment of disordered eating to identify severe presentations is an important future direction.

"Food addiction" was also related to higher current/lifetime BMI, with participants meeting the "food addiction" threshold being obese on average. Participants who met the YFAS "food addiction" cut-off (but not BED or BN) had higher current and lifetime BMI than either participants with only BED/BN or healthy controls. This is consistent with the proposal that addictive-like eating is related to compulsive consumption of calorie-dense foods, which would increase the risk of obesity. Thus, addictive-like eating behavior (not accounted for by eating disorders) may be particularly relevant to obesity.

Further, "food addiction" was associated with increased frequency of objective overeating, an earlier age of dieting onset, and weight cycling, which have been associated with increased risk of adiposity and restrictive eating (Enriquez et al., 2013; Fairburn et al., 1998; Foster et al., 1996). Our findings replicate a prior association between "food addiction" and earlier age of dieting onset, but did not replicate the association between "food addiction" and earlier age of overweight (Gearhardt, White et al., 2013) (although higher scores on the "symptom count" version of the YFAS was significantly associated with an earlier age of becoming overweight). Thus, addictive-like eating appears to be related to clinically relevant factors that increase risk of obesity and eating psychopathology.

There are limitations to consider for the current study. First, the current study relied on self-report measures and the identification of eating disorders was based on behavioral features only (i.e., binge eating and purging), but did not include cognitive features (e.g., undue influence of shape/weight) to determine eating disorder classifications. Further, a diagnosis of BED or BN requires that the binging/purging behavior occurs at least once weekly over a 3-month period (American Psychiatric Association, 2013), but in the current study we only capture a 1-month period. Thus, some individuals with subthreshold disordered eating may be included in the BED or BN groups. Self-report was also used to assess height and weight, which can result in biased reports by participants (Elgar, Roberts, Tudor-Smith, & Moore, 2005; Niedhammer, Bugel, Bonenfant, Goldberg, & Leclerc, 2000). It should be noted, however, that self-reported height and weight are highly correlated (i.e., r's > .9) (Kuczmarski, Kuczmarski, & Najjar, 2001; Stunkard & Albaum, 1981)

Table 4
Comparison of eating pathology among eating groups [a,b].

	FA-Only (n = 76)	BED/BN-Only (n = 68)	BN & FA (n = 61)	BED & FA (n = 50)	Neither FA or BED/BN (N = 388)	Test statistic	*P* value [c]	Pairwise Diff.	Effect size (η^2)
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	(*F* or $\chi 2$)			
SBE episodes	2.24 (3.68)	3.72 (6.10)	9.20 (8.60)	5.18 (5.36)	0.97 (2.34)	57.26	<.001	4 > 1; 3 > 1,2,4; 2,3,4 > 5	.26
EDE restraint	2.80 (1.63)	2.35 (1.46)	4.01 (1.53)	2.82 (1.58)	1.83 (1.48)	32.48	<.001	3 > 1,2,4; 1,3,4 > 5	.17
EDE shape concern	4.88 (1.15)	4.20 (1.47)	5.13 (1.00)	5.16 (.91)	2.93 (1.63)	68.31	<.001	3,4 > 2 ; 1,2,3,4 > 5	.30
EDE weight concern	4.24 (1.13)	3.56 (1.31)	4.58 (1.05)	4.27 (.98)	2.40 (1.46)	69.91	<.001	1,3,4 > 2; 1,2,3,4 > 5	.30
EDE eating concern	2.90 (1.32)	2.13 (1.20)	4.13 (1.30)	3.56 (1.34)	0.90 (1.00)	179.66	<.001	3,4 > 1; 1,3,4 > 2; 1,2,3,4 > 5	.53
EDE total	3.70 (1.01)	3.06 (1.15)	4.46 (1.01)	3.95 (.97)	2.01 (1.18)	105.28	<.001	3 > 1; 1,3,4 > 2; 1,2,3,4 > 5	.40

[a] FA = food addiction, BED = binge eating disorder, BN = bulimia nervosa.
[b] SBE = subjective binge episode, EDE = eating disorder examination.
[c] 1 = FA-only, 2 = BED/BN-only, 3 = BN & FA, 4 = BED & FA, 5 = neither FA or BED/BN, all reported pairwise differences $p < .05$.

with clinic measures, even among obese groups with binge eating (White, Masheb, Burke-Martindale, Rothschild, & Grilo, 2007; White, Masheb, & Grilo, 2010) suggesting that self-reported height and weight are an adequate proxy for measured weights. The use of clinical interviews to identify eating disorders and laboratory measurement of height and weight would increase confidence in these measures. Next, though the current study is the first to examine "food addiction" in a relatively large community sample, it is not representative, having been a convenience sample drawn from internet advertising. Further, the sample has a higher rate of women (88.1%), who are more likely than men to experience disordered eating (Croll, Neumark-Sztainer, Story, & Ireland, 2002). Additionally, the rates of disordered eating endorsed in the sample are relatively high, which may reflect greater pathological eating among individuals motivated to respond to an advertisement for a study on eating habits, health behaviors, dieting, and weight control. Future research in nationally representative, randomly selected, and gender-balanced samples will be important next steps. Further, the small number of participants meeting criteria for BN-only led to the combining of this group with the BED-only group for analyses. Future studies with BN participants are needed to further compare food addiction only, BN-only, and BN & FA groups. Finally, the current study is cross-sectional in nature, which prevents interpretation regarding time course and causality. Further, retrospective data were collected to provide some understanding of patterns of weight gain and dieting across the lifespan, which may be more prone to error and bias. Given the elevated rates of disordered eating in adolescence (Reijonen, Pratt, Patel, & Greydanus, 2003), it will be particularly important to examine whether the current findings generalize to younger samples. The development of the Yale Food Addiction Scale for Children (Gearhardt, Roberto, Seamans, Corbin, & Brownell, 2013) may provide a useful tool to evaluate the potential role of an addictive process in eating across the lifespan. Examining the relationship between "food addiction," obesity, and disordered eating in longitudinal studies across development will be of particular importance.

5. Conclusions

In sum, "food addiction" as measured by the YFAS appears to be higher in BN relative to BED and is associated with elevated current/lifetime BMI and eating pathology. "Food addiction" continues to be related to clinically relevant variables, including elevated BMI, even outside of the context of other eating disorders. The co-occurrence of "food addiction" with eating disorders appears to be associated with a more severe variant of eating pathology. Thus, further examination of "food addiction" may be important in understanding the mechanisms underlying certain types of problematic eating behavior.

Role of funding sources

Dr. White was supported in conducting the current research by NIH/NIDDK K23 DK071646.

Contributors

AG developed the analytic plan, conducted analyses, and wrote the manuscript. RB participated in conducting analyses and wrote portions of the manuscript. MW designed the study, collected the data, and contributed to data analysis and manuscript writing. All authors reviewed the final manuscript and had final approval of the paper.

Conflicts of interest statement

The authors report no competing interests. Dr. White was supported in conducting the current research by NIH/NIDDK K23 DK071646.

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