RESEARCH ARTICLE

Food Addiction in Overweight and Obese Adolescents Seeking Weight-loss Treatment

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Abstract

Some forms of overeating closely resemble addictive behaviour. The *Yale Food Addiction Scale* (YFAS) was developed to measure such addiction-like eating in humans and has been employed in numerous studies for examining food addiction in adults. Yet, little is known about food addiction in children and adolescents. Fifty adolescents were recruited at the beginning of treatment in a weight-loss hospital and completed the YFAS among other questionnaires. Nineteen participants (38%) received a YFAS diagnosis, who did not differ in age, body mass and gender distribution from those not receiving a diagnosis. However, those with food addiction reported more binge days, more frequent food cravings, higher eating, weight and shape concerns, more symptoms of depression and higher attentional and motor impulsivity. Eating restraint and nonplanning impulsivity did not differ between groups. Results replicate findings from studies in obese adults such that food addiction is not related to age, gender, body mass or eating restraint, but to higher eating pathology, more symptoms of depression and higher impulsivity. Furthermore, results highlight that particularly attentional impulsivity is related to 'food addiction'. Addiction-like eating appears to be a valid phenotype in a substantial subset of treatment-seeking, obese adolescents.

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Keywords
food addiction; adolescence; obesity; binge eating; impulsivity

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Introduction

The term *food addiction*, which refers to eating behaviour that involves overconsumption of specific foods in an addiction-like manner, has been used in the scientific community for decades (Hinkle, Knowles, Fischer, & Stunkard, 1959; Randolph, 1956). However, studies that aimed at proving or disproving the validity of this concept remained rare in the 20th century, but mainstream media and scientific attention have dramatically increased in recent years (Brownell & Gold, 2012; Gearhardt, Davis, Kuschner, & Brownell, 2011; Tarman & Werdell, 2014). Numerous theoretical articles have examined the overlap between the diagnostic criteria of substance use disorders and eating behaviour in individuals with bulimia nervosa (BN), binge eating disorder (BED) or obesity (e.g. Barry, Clarke, & Petry, 2009; Davis, 2013; Davis & Carter, 2009; Gearhardt, Corbin, & Brownell, 2009a), have speculated about specific types of nutrients or ingredients, which might have an addictive potential (e.g. Cocores & Gold, 2009; Ifland et al., 2009; Thornley, McRobbie, Eyles, Walker, & Simmons, 2008) or have outlined parallels on a neuronal level between substance use and overeating (e.g. Avena, Rada, & Hoebel, 2008; Volkow, Wang, Tomasi, & Baler, 2013a, 2013b). However, the validity, usefulness, necessity or downsides of the food addiction model are still a highly controversial and heavily debated topic (Avena, Gearhardt, Gold, Wang, & Potenza, 2012; Benton, 2010; Meule, 2014; Meule & Kübler, 2012; Wilson, 2010; Ziauddeen, Farooqi, & Fletcher, 2012a, 2012b; Ziauddeen & Fletcher, 2013).

In recent years, addiction-like eating is usually measured with the *Yale Food Addiction Scale* (YFAS; Gearhardt, Corbin, & Brownell, 2009b). This self-report questionnaire was developed on the basis of the diagnostic criteria for substance dependence in the fourth revision of the Diagnostic and Statistical Manual of Mental Disorders. Accordingly, seven food addiction symptoms can be identified, and if at least three of these symptoms are met and there is a clinically significant impairment or distress, food addiction can be 'diagnosed'. A growing body of research has shown that prevalence rates of food addiction as measured with the YFAS are higher in obese samples than in nonobese samples (Meule & Gearhardt, 2014a; Pursey, Stanwell, Gearhardt, Collins, & Burrows, 2014). Moreover, within obese samples, individuals with a food addiction diagnosis can be differentiated from those without a food addiction diagnosis in terms of, for example, general psychopathology, eating pathology, impulsivity and neurochemical signalling (e.g. Davis et al., 2011; Davis, Levitan,

Kaplan, Kennedy, & Carter, 2014; Davis & Loxton, 2014; Davis et al., 2013).

Only few studies have yet explored eating behaviour from an addiction perspective in children and adolescents (cf. Burrows & Meule, in press). One study used a self-made questionnaire and found that 15.2% of overweight children indicated that they 'Often', 'Usually' or 'Always' think that they are addicted to food (Merlo, Klingman, Malasanos, & Silverstein, 2009). Another study qualitatively analysed responses of overweight and obese children and adolescents posted on a website. After participants were provided with a definition of addiction, 29% of respondents indicated that they see themselves as addicted to most foods (Pretlow, 2011). Most recently, the YFAS was revised to lower the reading level and incorporate parental prompts. Prevalence of food addiction as measured with this child version of the YFAS was 7.2% in $n = 75$ children (Gearhardt, Roberto, Seamans, Corbin, & Brownell, 2013).

To date, no study has investigated prevalence and correlates of YFAS diagnoses in adolescents. The aim of the present study was to close this gap by employing the YFAS among other questionnaires in a sample of obese, adolescent inpatients who were at the beginning of treatment in a weight-loss hospital.[1] Based on previous studies in obese adults (cf. Meule & Gearhardt, 2014a; Pursey et al., 2014), we expected that food addiction would be diagnosed in about 20–40% of the sample.

Furthermore, we hypothesized that those with food addiction would show more frequent experiences of food craving, higher eating pathology (eating, weight and shape concerns and binge eating frequency), more symptoms of depression and higher impulsivity than those without food addiction, similar to findings in obese adults (Meule, Heckel, Jurowich, Vögele, & Kübler, 2014). Although food addiction might be plausibly related to several facets of impulsivity such as low inhibitory control or disadvantageous decision making (Davis et al., 2011), previous studies in which impulsivity was measured with the *Barratt Impulsiveness Scale* (BIS) found that YFAS scores are particularly and most consistently associated with its subscale assessing *attentional impulsivity* (Meule, 2013; Meule et al., 2014; Meule, Lutz, Vögele, & Kübler, 2012a). Thus, we expected that food addiction would be particularly related to higher attentional impulsivity scores, while there would be only small or no associations with motor and nonplanning impulsivity as measured with the BIS.

Although food addiction has been associated with a higher body mass index (BMI; e.g. Flint et al., 2014), it has also been found that *within* obese samples, those with a YFAS diagnosis do not differ in BMI from those without a YFAS diagnosis (Meule, 2012). Thus, we expected that food addiction would be unrelated to BMI in the present sample as well. Moreover, it was expected that groups would not differ in age and eating restraint, similar to what has been found in obese adults (Meule et al., 2014). Finally, we explored endorsement rates of the single food addiction symptoms as measured with the YFAS.

[1]Note that at the time the study started, the child version of the YFAS was not available yet, which is why we used the adult version. Because of this, we only included patients with a minimum age of 14.

Materials and methods

Participants

Fifty-one overweight and obese, adolescent inpatients were recruited within the first 2 weeks of weight-loss treatment in a rehabilitation hospital in Germany. One patient did not agree to participate, leaving a final sample size of $n = 50$. Mean age and BMI are reported in Table 1. All participants had an age-specific and gender-specific body mass above the 92nd percentile. The sample comprised $n = 31$ (62%) girls and $n = 19$ (38%) boys. The most common physical comorbidities were hypertension ($n = 6$) and asthma ($n = 3$). The most common mental disorders were adjustment disorder ($n = 12$), BED ($n = 6$) and depression ($n = 5$). The most common medications were antihypertensives ($n = 6$) and thyroid hormones ($n = 3$).

Questionnaires

Yale Food Addiction Scale

The YFAS (Gearhardt et al., 2009b; Meule, Vögele, & Kübler, 2012) measures symptoms of food addiction. This 25-item instrument contains different scoring options (dichotomous and frequency scoring) to indicate experience of addictive eating behaviour within the past 12 months (e.g. 'I find that when certain foods are not available, I will go out of my way to obtain them. For example, I will drive to the store to purchase certain foods even though I have other options available to me at home.' and 'There have been times when I consumed certain foods so often or in such large quantities that I started to eat food instead of working, spending time with my family or friends, or

Table 1 Descriptive statistics of continuous study variables and correlations with the number of food addiction symptoms

$n = 50$	*M*	*SD*	Range	*r*
Yale Food Addiction Scale (symptom count)	3.38	2.11	0–7	—
Age (years)	16.50	1.84	14–21	.08
Body mass index (kg/m^2)	36.80	6.18	26.17–56.32	−.04
Standardized body mass index (zBMI)	2.27	0.42	1.47–3.33	−.04
Food Cravings Questionnaire—Trait	107.98	37.85	46–188	.83***
Eating Disorder Examination—Questionnaire				
Restraint	2.08	1.43	0.00–5.60	.24
Eating concern	1.99	1.38	0.00–5.20	.61***
Weight concern	3.46	1.33	0.20–5.80	.60***
Shape concern	3.83	1.46	0.13–6.00	.51***
Binge days	2.29	3.90	0–20	.32*
Center for Epidemiologic Studies Depression Scale	23.16	12.07	7–56	.61***
Barratt Impulsiveness Scale—short form				
Attentional impulsivity	11.16	3.22	5–17	.61***
Motor impulsivity	11.44	3.10	6–18	.42**
Nonplanning impulsivity	11.52	3.36	5–20	.30*

Note:$^{***}p < .001$;$^{**}p < .01$;$^{*}p < .05$.

engaging in other important activities or recreational activities I enjoy.'). A symptom count can be calculated, which can range between zero and seven food addiction symptoms. Moreover, a diagnosis of food addiction can be made if at least three symptoms and a clinically significant impairment or distress are present. Internal consistency was Kuder–Richardson's $\alpha = .88$ in the present study.

Food Cravings Questionnaire—Trait

The Food Cravings Questionnaire—Trait (Cepeda-Benito, Gleaves, Williams, & Erath, 2000; Meule, Lutz, Vögele, & Kübler, 2012b) measures the frequency and intensity of food craving experiences. Items are scored on a six-point scale ranging from *never/not applicable* to *always*. It comprises nine subscales measuring food cravings in relation to (1) intentions to consume food (e.g. 'Whenever I have cravings, I find myself making plans to eat.'); (2) anticipation of positive reinforcement (e.g. 'I eat to feel better.'); (3) relief from negative states (e.g. 'Eating calms me down.'); (4) lack of control over eating (e.g. 'Once I start eating, I have trouble stopping.'); (5) preoccupation with food (e.g. 'I daydream about food.'); (6) hunger (e.g. 'I crave foods when my stomach is empty.'); (7) emotions (e.g. 'I crave foods when I'm upset.'); (8) cues that trigger cravings (e.g. 'Being with someone who is eating often makes me hungry.'); and (9) guilt (e.g. 'I hate it when I give in to cravings.'). Only the total score was used in the current study, and internal consistency was Cronbach's $\alpha = .97$.

Eating Disorder Examination—Questionnaire

The Eating Disorder Examination—Questionnaire (Fairburn & Beglin, 1994; Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007) measures eating disorder psychopathology over the past 28 days. It consists of 22 items, and items are scored on a seven-point scale ranging from *no days/not at all* to *every day/markedly*. It comprises four subscales assessing (1) restraint [e.g. 'Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?' and 'Have you gone for long periods of time (8 waking hours or more) without eating anything at all in order to influence your shape or weight?']; (2) eating concern [e.g. 'Has thinking about food, eating or calories made it very difficult to concentrate on things you are interested in (for example, working, following a conversation or reading)?' and 'Have you had a definite fear of losing control over eating?']; (3) weight concern [e.g. 'Have you had a strong desire to lose weight?' and 'Has your weight influenced how you think about (judge) yourself as a person?']; and (4) shape concern [e.g. 'Have you had a definite desire to have a totally flat stomach?' and 'Has your shape influenced how you think about (judge) yourself as a person?']. Internal consistencies were Cronbach's $\alpha = .78$ (restraint), $\alpha = .73$ (eating concern), $\alpha = .72$ (weight concern), $\alpha = .86$ (shape concern) and $\alpha = .91$ (total scale) in the current study. Six additional items assess the frequency of other relevant behaviours, such as binge eating and self-induced vomiting, of which we only used the self-reported number of days with objective binge episodes (i.e. eating large amounts of food with a feeling of loss of control) over the last 28 days in the current analyses.

Barratt Impulsiveness Scale—short form

The BIS-15 (Meule, Vögele, & Kübler, 2011; Spinella, 2007) is a 15-item short form of the 11th version of the BIS (Patton, Stanford, & Barratt, 1995). It measures trait impulsivity on a four-point scale ranging from *rarely/never* to *almost always/always*. It comprises three subscales assessing (1) attentional (e.g. 'I am restless at lectures or talks.' and 'I get easily bored when solving thought problems.'); (2) motor (e.g. 'I buy things on impulse.' and 'I say things without thinking.'); and (3) nonplanning [e.g. 'I plan for the future (inverted).' and 'I plan tasks carefully (inverted).'] impulsivity. Internal consistencies were Cronbach's $\alpha = .65$ (attentional), $\alpha = .76$ (motor), $\alpha = .78$ (nonplanning) and $\alpha = .80$ (total scale) in the current study.

Center for Epidemiologic Studies Depression Scale

The Center for Epidemiologic Studies Depression Scale (Hautzinger, 1988; Radloff, 1977) measures depressive symptoms within the past week (e.g. 'I felt depressed.' and 'My sleep was restless.'). It consists of 20 items that are scored on a four-point scale ranging from *rarely or none of the time* to *most or all of the time*. Internal consistency was Cronbach's $\alpha = .90$ in the present study.

Procedure

Patients were approached individually within the first 2 weeks of treatment and asked to participate in a questionnaire study. Participation in the study was voluntary, and the study was approved by the ethical review board of the Medical Faculty at the University of Würzburg, Germany. Written informed consent was obtained from participants prior to study participation. After signing informed consent, participants completed the questionnaires. The experimenter (T. H.) aided participants during questionnaire completion in case of comprehension difficulties. Data on height, weight and medical conditions were obtained from the medical examination in the hospital.

Data analyses

Continuous study variables were compared with independent *t*-tests between individuals receiving a YFAS diagnosis and those who did not. Gender distribution between groups was compared with chi-square test. Pearson correlation coefficients were computed between YFAS symptom count and continuous study variables. Exact *p*-values (two-tailed) are reported in case of significance ($p < .05$), except when $p < .001$. *P*-values $\geq .05$ are displayed as *ns*.

Results

Nineteen patients (38%) received a YFAS diagnosis. The most common food addiction symptoms were *a persistent desire or repeated unsuccessful attempts to cut down consumption*, *tolerance* and *continued overeating despite physical or psychological problems* (Table 2). Individuals with a YFAS diagnosis had higher eating, weight and shape concerns, reported more days with binge eating episodes and food craving experiences, had more symptoms of depression and scored higher on attentional and motor impulsivity than individuals without a YFAS diagnosis (Table 3). These variables were also positively correlated with the YFAS symptom

Table 2 Endorsement rates of food addiction symptoms in the current sample

Food addiction symptom	*n* (%)
Unsuccessful attempts to cut down consumption	47 (94%)
Tolerance	29 (58%)
Physical or psychological problems through eating	25 (50%)
Reduction of important activities	21 (42%)
Impairment or distress because of eating behaviour	20 (40%)
Lack of control over eating	17 (34%)
Increased time effort	17 (34%)
Withdrawal symptoms	13 (26%)

count, with the exception that the YFAS symptom count was additionally correlated with nonplanning impulsivity (Table 1). Groups did not differ in gender distribution ($\chi^2_{(1)} = 0.54$, *ns*), age, BMI, eating restraint or nonplanning impulsivity (Table 3).

Discussion

The aim of the present study was to examine prevalence and correlates of food addiction as measured with the YFAS in treatment-seeking obese adolescents. Results largely replicated findings from studies conducted in obese adults and thus show that the YFAS appears to be an appropriate measure of food addiction in adolescents, and that this addiction-like eating behaviour as assessed with YFAS is not restricted to adults but does already occur in adolescents.

Several review articles suggest that the prevalence of YFAS diagnoses is about 15–25% in obese adults, with higher prevalence rates (up to 40–50%) in obese adults with BED or surgical treatment-seeking adults with extreme obesity (Meule, 2011, 2012; Meule & Gearhardt, 2014a; Murray, Tulloch, Gold, & Avena, 2014; Pursey et al., 2014). In the current sample, 38% of patients received a YFAS diagnosis. Thus, this percentage is higher than in nontreatment-seeking obese adults and is in line with studies in obese adults showing that samples with higher psychopathology or impairment/distress (i.e. individuals with BED or bariatric patients) have a higher food addiction prevalence, almost up to 40%.

The most often endorsed YFAS symptoms were *a persistent desire or repeated unsuccessful attempts to cut down consumption*, *tolerance* and *continued overeating despite physical or psychological problems*, while the least often endorsed symptom was *withdrawal*, which, again, parallels findings in obese adults (Meule, Heckel, & Kübler, 2012). Almost all participants fulfilled the criterion of *persistent desire or repeated unsuccessful attempts to cut down*, which suggests that this criterion has low specificity for diagnosing food addiction. In future versions of the YFAS, diagnostic thresholds may need to be adjusted to accommodate for this. Furthermore, results show that withdrawal symptoms do not appear to be an essential feature of food addiction in humans, at least when they are based on subjective reports.

In line with previous findings in obese adults (Meule et al., 2014), those with a YFAS diagnosis showed higher eating pathology, had more symptoms of depression and reported higher attentional impulsivity than those without a YFAS diagnosis. Similarly, these variables were positively correlated with the YFAS symptom count. Contrary to our hypotheses, those with a YFAS diagnosis also reported higher motor impulsivity than those without a YFAS diagnosis, and scores on motor and nonplanning impulsivity were weakly, positively correlated with the YFAS symptom count. A recent examination of the subscales of the BIS-11/BIS-15 revealed that particularly attentional and motor impulsivity scores are related to overeating, while nonplanning impulsivity appears to be unrelated to overeating (Meule, 2013). Similarly, a combination of high scores on attentional and motor impulsivity predicted higher BMI and binge eating severity in women, while nonplanning impulsivity was even negatively related to these measures (Meule & Platte, 2015). The correlation between YFAS scores and impulsivity was highest for the attentional subscale in the current study. Thus, although associations

Table 3 Differences on continuous study variables between 'food addicted' and 'nonaddicted' participants

n = 50	Food addiction (*n* = 19)		No food addiction (*n* = 31)		*t*	*p*
	M	*SD*	*M*	*SD*		
Yale Food Addiction Scale (symptom count)	5.47	1.31	2.10	1.33	8.79	<.001
Age (years)	16.79	1.72	16.32	1.92	0.87	*ns*
Body mass index (kg/m2)	35.98	4.80	37.30	6.93	0.73	*ns*
Standardized body mass index (zBMI)	2.20	0.38	2.31	0.44	0.94	*ns*
Food Cravings Questionnaire—Trait	145.47	27.78	85.00	20.99	8.74	<.001
Eating Disorder Examination—Questionnaire						
Restraint	2.42	1.88	1.88	1.05	1.32	*ns*
Eating concern	3.08	1.42	1.32	0.83	5.54	<.001
Weight concern	4.53	0.96	2.80	1.07	5.75	<.001
Shape concern	4.87	1.16	3.20	1.26	4.68	<.001
Binge days	3.92	4.92	1.29	2.76	2.43	.02
Center for Epidemiologic Studies Depression Scale	31.74	12.79	17.90	8.05	4.71	<.001
Barratt Impulsiveness Scale—short form						
Attentional impulsivity	13.42	2.85	9.77	2.62	4.62	<.001
Motor impulsivity	12.79	3.03	10.61	2.88	2.54	.01
Nonplanning impulsivity	12.37	3.85	11.00	2.98	1.41	*ns*

between food addiction symptomatology and motor and nonplanning impulsivity were unexpected, results are in line with previous literature showing that the relationship between addiction-like eating and attentional impulsivity is stronger and more consistent than with other facets of impulsivity. As impulsivity is assumed to be a risk factor for the development of various mental disorders, including BN, BED or obesity (Guerrieri, Nederkoorn, & Jansen, 2008; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001; Waxman, 2009), and attentional impulsivity may increase the likelihood to allocate attention to high-calorie food stimuli (Hou et al., 2011), future studies may establish a causal effect of this relationship, that is, that impulsivity (and attentional impulsivity in particular) may predict development of food addiction symptomatology.

Age, body mass and gender distribution were not associated with food addiction symptomatology. This is, again, in line with findings from studies in obese adults (e.g. Burmeister, Hinman, Koball, Hoffmann, & Carels, 2013; Davis et al., 2011; Davis et al., 2013; Eichen, Lent, Goldbacher, & Foster, 2013). Although YFAS diagnoses are related to higher BMI, it has been proposed that there may be a nonlinear relationship between these variables (Meule, 2012). Specifically, no difference in body mass between those with a YFAS diagnosis and those without a YFAS diagnosis is often found within obese samples (Meule, 2012). This may be due to ceiling effects, for example, that reaching physical limits might constrain a further increase in body mass despite addictive-like eating patterns. Another explanation might be that within obese samples, those with and without food addiction may differ in several aspects of eating behaviour (e.g. eating rate and macronutrient intake), but not in total amount of daily energy consumed. Whatever explanation might prove right, the current finding is in line with prior results showing that YFAS diagnoses are usually not associated with higher body mass within obese samples, but that a positive relation can be found when large samples with a wide range in BMI are investigated (Flint et al., 2014; Meule & Gearhardt, 2014a).

Interpretation of results is limited by the fact that sample size was moderate. Thus, future studies that investigate larger samples are necessary to replicate results and to extend findings to the general population or to other clinical samples, in which high rates of YFAS diagnoses have been observed, for example, individuals with BN (Granero et al., 2014; Meule, von Rezori, & Blechert, 2014). Furthermore, this was a cross-sectional study, and thus, longitudinal studies are necessary to establish causality of the associations found in the current study. Finally, self-report measures can potentially be biased, which may be particularly critical when food addiction symptoms such as withdrawal or tolerance are reported (Meule & Gearhardt, 2014b; Meule & Kübler, 2012). While validity of some measures, which were used in the current study such as the Eating Disorder Examination—Questionnaire or BIS-15 has been shown by associations with results from interview assessments or behavioural tasks (Hilbert et al., 2007; Meule & Kübler, 2014), similar evidence is largely unavailable for the YFAS. However, although the YFAS does not prove the existence of food addiction and scores may be biased as they rely on self-report, it is, to date, the only available instrument for the assessment of addiction-like eating behaviour. Thus, we would argue that although the YFAS is not perfect, it nonetheless is useful for identifying individuals who are the most likely to be experiencing an addictive response to food.

To conclude, in a sample of obese adolescents, this study largely replicated findings on the prevalence and correlates of food addiction in obese adults as measured with the YFAS. This suggests that the YFAS cannot only be validly applied in adults but also in adolescents. Moreover, this study showed that addictive-like eating behaviour occurs already in adolescents and that a substantial subset of treatment-seeking, obese adolescents receive a YFAS diagnosis. Those can be differentiated from their 'nonaddicted' counterparts by elevated eating pathology and psychopathology as well as heightened levels of specific aspects of impulsivity.

Conflicts of interest statement

Neither author has any conflicts of interest.

Author contributions

A. M. designed this study. T. H. collected the data. A. M. conducted statistical analyses and wrote the first draft of the manuscript. All authors contributed to revising the manuscript and approved the final version.

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