RESEARCH ARTICLE

Development of the Modified Yale Food Addiction Scale Version 2.0

Erica M. Schulte* & Ashley N. Gearhardt

Department of Psychology, University of Michigan, Ann Arbor, MI, USA

Abstract

The Yale Food Addiction Scale (YFAS) operationalizes indicators of addictive-like eating, originally based on the Diagnostic and Statistical Manual of Mental Disorders 4th edition Text Revision (DSM-IV-TR) criteria for substance-use disorders. The YFAS has multiple adaptations, including a briefer scale (mYFAS). Recently, the YFAS 2.0 was developed to reflect changes to diagnostic criteria in the DSM-5. The current study developed a briefer version of the YFAS 2.0 (mYFAS 2.0) using the participant sample from the YFAS 2.0 validation paper ($n = 536$). Then, in an independent sample recruited from Mechanical Turk, 213 participants completed the mYFAS 2.0, YFAS 2.0, and measures of eating-related constructs in order to evaluate the psychometric properties of the mYFAS 2.0, relative to the YFAS 2.0. The mYFAS 2.0 and YFAS 2.0 performed similarly on indexes of reliability, convergent validity with related constructs (e.g. weight cycling), discriminant validity with distinct measures (e.g. dietary restraint) and incremental validity evidenced by associations with frequency of binge eating beyond a measure of disinhibited eating. The mYFAS 2.0 may be an appropriate choice for studies prioritizing specificity when assessing for addictive-like eating or when a briefer measurement of food addiction is needed.

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Keywords

food addiction; obesity; eating disorders; substance-use disorders; addiction

***Correspondence**

Erica M. Schulte, Department of Psychology, University of Michigan, 2257 East Hall, 530 Church Street, Ann Arbor, MI 48109, USA.

Email: eorenste@umich.edu

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Introduction

Food addiction is a topic of growing scientific interest, though also raises points for debate, such as which food ingredients may have an addictive potential (Ahmed, Guillem & Vandaele, 2013; Gold, Frost-Pineda & Jacobs, 2003; Ziauddeen & Fletcher, 2013). The food addiction construct suggests that some individuals may experience addictive-like responses to highly processed foods (e.g. pizza, chocolate and chips), akin to drugs of abuse (Gearhardt, Davis, Kuschner & Brownell, 2011; Schulte, Avena & Gearhardt, 2015). Animal models provide preliminary support for this idea, demonstrating that rats exhibit biological (e.g. downregulation of dopamine receptors) and behavioural (e.g. bingeing, motivation to seek out foods despite negative consequences, withdrawal and cross-sensitization with amphetamine) indicators of addiction in response to foods high in fat and/or sugar (e.g. sucrose and cheesecake) but not nutritionally balanced chow (Avena, Rada & Hoebel, 2008; Oswald, Murdaugh, King & Boggiano, 2011; Robinson et al., 2015).

Unlike substance-use disorders (SUDs), there are not yet established diagnostic criteria to assess food addiction, as this line of research is in its early stages. The Yale Food Addiction Scale (YFAS) is the only self-report measurement designed to operationalize indicators of addictive-like eating (Gearhardt, Corbin & Brownell, 2009). The original YFAS adapts the Diagnostic and Statistical Manual of Mental Disorders 4th edition Text Revision (DSM-IV-TR; American Psychiatric Association, 2000) criteria for SUDs (e.g. use in greater quantities than intended, use despite consequences and withdrawal) when the substance is any food that individuals may experience problems with, priming specifically for highly reinforcing foods (e.g. pizza, chips, chocolate and sugar-sweetened beverages). The original 25-item self-report measure yields a continuous symptom count scoring method, reflecting how many of the seven DSM-IV-TR criteria are endorsed for highly processed foods, as well as a 'diagnostic' threshold which can be met by reporting three or more symptoms plus clinically significant impairment or distress.

The YFAS has good internal consistency, convergent validity with related measures of eating behaviour (e.g. emotional eating) and discriminant validity with measures of substance use (Gearhardt et al., 2009). The YFAS also exhibits incremental validity in predicting binge-eating behaviour above and beyond measures of eating pathology and emotional eating (Gearhardt et al., 2009). Further, YFAS scores have been associated with mechanisms implicated in addictive disorders, such as reward dysfunction, emotion regulation difficulties and impulsivity [for a review, see Schulte and colleagues (2016)], and genetic markers of addiction proneness (Davis et al., 2013). In support of the YFAS' utility, the measure has been translated to

numerous languages and adapted for children (Gearhardt, Roberto, et al., 2013).

Further, Flint et al. (2014) developed the modified YFAS (mYFAS) as a briefer assessment of food addiction. The mYFAS consists of nine self-report questions, with seven questions that assess the seven DSM-IV-TR SUD criteria and two questions that evaluate clinically significant impairment and distress. The measure performs similarly on indicators of reliability and validity as the full YFAS and also yields similar rates of food addiction symptoms and 'diagnostic' threshold scores (Flint et al., 2014; Lemeshow, Gearhardt, Genkinger & Corbin, 2016). The mYFAS was adapted for use in a large epidemiologic cohort (Nurses' Health Study) (Flint et al., 2014) and has been particularly useful for samples where participant burden is high (Mason, Flint, Field, Austin & Rich-Edwards, 2013) or when a brief screener of food addiction symptomology may be sufficient (Schulte, Tuttle, et al., 2016).

Recently, Gearhardt, Corbin and Brownell (2016) developed the YFAS 2.0, which updated the original YFAS to reflect the SUDs diagnostic criteria in the newest version of the DSM (DSM-5; American Psychiatric Association, 2013). In the DSM-5, SUDs are no longer diagnosed as abuse versus dependence but rather a single disorder with specifiers of mild, moderate and severe based on the number of symptoms experienced. SUDs are diagnosed based on 11 criteria, which include former features of abuse (e.g. use resulting in failure to fulfil major role obligations) and one new indicator, craving. In parallel, the 35-item YFAS 2.0 assesses the 11 SUD symptoms, when the substance is highly processed foods, lowers the 'diagnostic' criteria from three to two symptoms plus impairment or distress and uses mild, moderate or severe specifiers for the 'diagnostic' threshold.

The YFAS 2.0 appears to have better internal consistency than the original YFAS, and the two measures perform similarly in terms of convergent, incremental and discriminant validity with eating-related constructs (Gearhardt et al., 2016). The YFAS 2.0 validation paper observed that almost 6% more individuals met the 'diagnostic' threshold on the YFAS 2.0, relative to original YFAS, perhaps because the YFAS 2.0 assesses criteria formerly categorized as abuse and dependence, whereas the original YFAS only evaluates dependence criteria (Gearhardt et al., 2016). The YFAS 2.0 is beginning to replace the original YFAS in recent studies of food addiction (de Vries & , 2016), and adaptations of the original YFAS for different languages and populations are also evolving to reflect the YFAS 2.0 (Hauck et al., under review).

In order to continue evaluating whether food addiction is a clinically useful construct, it is necessary to update existing measures of food addiction to reflect the field's current conceptualization of addictive disorders in the DSM-5. Given the utility of the mYFAS for use in large epidemiological cohorts and as a brief screening measure, the current study will develop an abbreviated version of the YFAS 2.0—the mYFAS 2.0. The aims of this manuscript will be to select questions for inclusion in the mYFAS 2.0 and assess the measure's psychometric properties relative to the full YFAS 2.0 based on the constructs used by Gearhardt et al. (2016) validation of the YFAS 2.0. Thus, convergent validity will be assessed by related measures of eating behaviour [weight cycling, disinhibited eating, hunger, body mass index (BMI) and frequency of binge eating]; discriminant validity will be evaluated against distinct eating-related problems (dietary restraint, bulimia nervosa and binge-eating disorder); incremental validity will be examined by ability of both the mYFAS 2.0 and full YFAS 2.0 to predict frequency of binge-eating behaviour beyond a measure of disinhibited eating. Additionally, demographic associations (age, racial identification, gender and education level) will be assessed for both the mYFAS 2.0 and full YFAS 2.0.

Methods

The University of Michigan Health and Behavioural Sciences Institutional Review Board approved the current study (HUM00117661) as exempt from ongoing review.

Participants

Two samples were utilized in the present study, and demographic information for both samples is detailed in Table 1. First, the mYFAS 2.0 was developed using the sample from the YFAS 2.0 validation paper (Gearhardt et al., 2016). As detailed by Gearhardt et al. (2016), participants were recruited online using Amazon's Mechanical Turk (MTurk), and 536 individuals were included in the analyses. Of these individuals, 54.1% were women, age ranged from 18 to 81 (M = 33.84, *SD* = 12.01), and the weight categories ranged from underweight to obese with the average BMI in the overweight category (M = 26.67, *SD* = 6.76). Racial identification was as follows: 77.6% White, 6.7% Asian, 6.5% African American, 3.9% Hispanic and 5.2% Other.

In order to assess the psychometric properties of the mYFAS 2.0, an independent sample ($n = 225$) was recruited online using MTurk, and participants were compensated 25 cents for completing the survey, a rate consistent with other MTurk studies (Paolacci & Chandler, 2014). Individuals were able to access the survey if they lived in the USA, had completed at least one MTurk study previously and had an approval rate of 100% for their participation in previous assignments. Participants' data were excluded from analyses if they reported being pregnant ($n = 5$), reported a BMI outside of reasonable bounds (e.g. less than 10, greater than 70) ($n = 3$) or incorrectly answered any of the three 'catch' questions (e.g. 'Have you ever had a fatal heart attack?'), which assess attention to survey questions ($n = 4$).

Of the remaining participants ($n = 213$), 71.4% ($n = 152$) were women. Age ranged from 19 to 74 (M = 33.68, *SD* = 11.86), and the weight categories ranged from underweight to obese and the average BMI was in the overweight category (M = 27.52, *SD* = 7.23). Participants' self-reported racial identification was

Table 1 Demographic frequencies in participant samples

	Sample one ($n = 536$)	Sample two ($n = 213$)
Gender	54.1% female	71.4% female
Age	M = 33.84 (*SD* = 12.01)	M = 33.68 (*SD* = 11.86)
Body mass index	M = 26.67 (*SD* = 6.76)	M = 27.52 (*SD* = 7.23)
Racial identification	White: 77.6%	White: 73.7%
	Asian American: 6.7%	Asian American: 8.5%
	African American: 6.5%	African American: 5.2%
	Hispanic: 3.9%	Hispanic: 6.6%
	Other: 5.2%	Mixed/Other: 6.1%

73.7% White ($n = 157$), 8.5% Asian ($n = 18$), 6.6% Hispanic ($n = 14$), 5.2% African American ($n = 11$), 3.8% Mixed ($n = 8$) and 2.3% Other ($n = 5$).

Measures

Yale Food Addiction Scale 2.0

The current version of the YFAS 2.0 operationalizes behavioural indicators of 'food addiction' based on the DSM-5 diagnostic criteria for SUDs (American Psychiatric Association, 2013; Gearhardt et al., 2016). The measure consists of 35 self-report items that assess the 11 SUD criteria when the substance is certain highly palatable foods, plus clinically significant impairment or distress. The measure has two scoring methods. First, there is a continuous scoring method that summarizes how many of the 11 SUD criteria an individual endorsed with respect to the consumption of highly palatable foods. Second, the measure can be scored to assess a 'diagnostic' threshold, which can be met if an individual endorses two or more symptoms plus impairment or distress. For individuals who meet for a YFAS 2.0 'diagnosis' of food addiction, severity thresholds are also specified (mild = 2–3 symptoms plus impairment or distress, moderate = 4–5 symptoms plus impairment or distress, severe = 6 or more symptoms plus impairment or distress).

Three factor eating questionnaire

The Three Factor Eating Questionnaire (TFEQ) (Stunkard & Messick, 1985) consists of 51 self-report items that assess three facets of eating behaviour: disinhibition, hunger and dietary restraint. The TFEQ exhibits good internal consistency (Stunkard & Messick, 1985), which was demonstrated using Cronbach's alpha in the current study (disinhibition = 0.77, hunger 0.82 and dietary restraint = 0.80).

Eating Disorder Diagnosis Scale

The Eating Disorder Diagnosis Scale (EDDS) (Stice, Telch & Rizvi, 2000) is a 22-item self-report measure that evaluates symptoms of anorexia nervosa (AN), bulimia nervosa (BN) and binge-eating disorder (BED). This measure has demonstrated convergent validity with eating disorder diagnoses (Stice et al., 2000). The EDDS was scored to reflect DSM-5 diagnoses for AN, BN and BED. This measure was used to assess the average weekly frequency of binge-eating episodes, defined as consuming a large amount of food within a 2-hour period and experiencing a loss of control. The EDDS exhibited good internal consistency in the present sample (Cronbach's $\alpha = 0.83$).

Questionnaire of Eating and Weight Patterns—Revised

The Questionnaire of Eating and Weight Patterns—Revised (Spitzer, Yanovski & Marcus, 1993) is a self-report measure of current and past eating and weight patterns that has demonstrated high reliability and validity (Brody, Walsh & Devlin, 1994). The present study utilized a subset of questions that assess highest lifetime BMI (excluding pregnancy) and weight cycling (losing and regaining 20 or more pounds, excluding illness).

Body mass index

Individuals provided a self-report of their current height and weight, which was used to calculate BMI. Few individuals ($n = 5$) reported a BMI within the underweight range (BMI < 18.5). Given the underrepresentation of this group, analyses examining the association between addictive-like eating with weight class excluded underweight participants.

Data analytic plan

In order to develop the mYFAS 2.0, a confirmatory factor analysis was conducted using Mplus statistical package, version 7 (Muthén & Muthén, 1998–2011) on the full YFAS 2.0 using the participant sample from the validation paper ($n = 536$) (Gearhardt et al., 2016). As reported by Gearhardt et al. (2016), the comparative fit index (CFI = 0.96) and Tucker Lewis Index (TLI = 0.97) provided support for a one-factor model (CFI $\geq$ 0.95; TLI $\geq$ 0.95), although the root-mean-square error of approximation was less than optimal [root mean square error of approximation (RMSEA) = 0.11] (ideal RMSEA $\leq$ 0.06). A one-factor solution was utilized based on the latent structure of the YFAS 2.0 measure determined in the validation paper (Gearhardt et al., 2016). Next, factor loadings were examined for the 33 questions that assess each of the 11 YFAS 2.0 symptoms. Each symptom is scored based on theoretically related questions. Thus, for each symptom, factor loadings for the individual questions related to that symptom were evaluated, and the question with the highest factor loading for the overall measure was retained for the mYFAS 2.0. Finally, the two impairment and distress questions were then added to the measure to produce the 13-item mYFAS 2.0. Akin to the full YFAS 2.0, this measure can be scored to produce a continuous, symptom count score (ranging from 0 to 11) or 'diagnostic' threshold (two or more symptoms plus impairment or distress). Specification of severity also parallels the full YFAS 2.0 (mild = 2–3 symptoms plus impairment or distress, moderate = 4–5 symptoms plus impairment or distress, severe = 6 or more symptoms plus impairment or distress). Once the mYFAS 2.0 was developed, the current study collected online data using an independent sample ($n = 213$) to evaluate the factor structure of the measure and examine the psychometric properties of the mYFAS 2.0, relative to the full YFAS 2.0. Akin to the development of the original mYFAS (Flint et al., 2014), the current study computed the mYFAS 2.0 from the full YFAS 2.0 to compare its psychometric properties. Thus, reliability and validity of the mYFAS 2.0 and full YFAS 2.0 were evaluated in the independent sample, as well as associations with demographic variables (e.g. age, race, gender and education level).

Validity of the mYFAS 2.0 was examined using measures of eating behaviour that have been associated with the full YFAS 2.0. With respect to convergent and discriminant validity, correlational analyses assessed relationships between continuous variables, one-way analyses of variance evaluated associations between one continuous and one categorical variance and chi-squared tests investigated associations between two categorical variables. The Questionnaire of Eating and Weight Patterns—Revised questions assessing highest lifetime BMI and history of weight cycling have been positively related to the full YFAS 2.0 (Gearhardt et al., 2016) and were included as measures of convergent validity for the mYFAS 2.0. Further, the full YFAS

2.0 has been associated with average weekly frequency of binge-eating episodes, as measured by the EDDS (Gearhardt et al., 2016), and provided another index of convergent validity. The TFEQ was used to examine convergent and discriminant validity, as the YFAS 2.0 has been positively correlated with both the disinhibition and hunger subscales, but not significantly associated with dietary restraint (Gearhardt et al., 2016). Discriminant validity was also examined by comparing the diagnostic scoring method of the mYFAS 2.0 and full YFAS 2.0 with EDDS diagnoses of AN, BN and BED. Previous research has demonstrated overlap between indicators of food addiction and eating disorder diagnoses, although food addiction appears to represent a distinct form of problematic eating behaviour (Gearhardt, Boswell & White, 2014; Gearhardt, White, et al., 2013; Gearhardt et al., 2016). Finally, given the associations between TFEQ disinhibition, addictive-like eating and binge eating (Gearhardt et al., 2016), incremental validity was evaluated using multi-level regression techniques to assess whether scores on the mYFAS 2.0 predict frequency of binge-eating episodes above and beyond TFEQ disinhibition subscale scores in a similar manner as the full YFAS 2.0.

Results

Modified Yale Food Addiction Scale 2.0 factor structure and reliability

An exploratory factor analysis was conducted to assess the factor structure of the mYFAS 2.0. The CFI = 0.96 and TLI = 0.95 for the mYFAS 2.0 suggested a good fit for a one-factor model (CFI ≥ 0.95; TLI ≥ 0.95), and root-mean-square error of approximation supported a less than optimal fit (RMSEA = 0.08) (ideal RMSEA ≤ 0.06). In further support of a one-factor model, all questions had factor loadings for the single factor of 0.73 or higher (Table 2 for a list of questions and factor loadings). Thus, given the comparable goodness-of-fit parameters to the full YFAS 2.0 from the validation paper and good factor loadings for each item, a single-factor solution was retained for the mYFAS 2.0.

The mYFAS 2.0 exhibited good internal reliability, as measured by Kuder–Richardson alpha (mYFAS 2.0 = 0.86), relative to the excellent internal reliability of the full YFAS 2.0 (YFAS 2.0 = 0.97). As may be expected given the smaller number of questions, using the symptom count scoring method, fewer symptoms on average were endorsed on the mYFAS 2.0 (M = 1.48, *SD* = 2.44) compared with the full YFAS 2.0 (M = 2.09, *SD* = 2.97). Using the 'diagnostic' threshold scoring method on the mYFAS 2.0, 13.1% ($n = 28$) of the current sample met criteria for food addiction [3.8% mild ($n = 8$); 5.2% moderate ($n = 11$); 4.2% severe ($n = 9$)]. The mYFAS 2.0 had a lower 'diagnostic' rate of food addiction, relative to the full YFAS 2.0, which detected that 15.0% of the present sample met the diagnostic threshold for food addiction [1.4% mild ($n = 3$); 4.2% moderate ($n = 9$); 9.4% severe ($n = 20$)].

Measures of food addiction and demographics

One-way analyses of variance tests revealed a significant association between race and symptom count scores on both the mYFAS 2.0, $F(5, 207) = 4.30$, $p < 0.01$, $\eta 2 = 0.09$, and YFAS 2.0, $F(5, 207) = 3.88$, $p < 0.01$, $\eta 2 = 0.09$. *Post hoc* comparisons using Tukey honest significant difference (HSD) tests demonstrated that both measures of food addiction observed that Hispanic individuals reported greater symptoms (mYFAS 2.0: M = 4.07, *SD* = 3.47; YFAS 2.0: M = 5.14, *SD* = 4.29) than White individuals (mYFAS

Table 2 The modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) questions and factor loadings

DSM-5 SUD criteria	mYFAS 2.0 question	Factor loading
Substance taken in larger amount and for longer period than intended	I ate to the point where I felt physically ill.	0.75
Persistent desire or repeated unsuccessful attempts to quit	I tried and failed to cut down on or stop eating certain foods.	0.84
Much time/activity to obtain, use, recover	I spent more time feeling sluggish or tired from overeating.	0.75
Important social, occupational or recreational activities given up or reduced	I avoided work, school or social activities because I was afraid I would overeat there.	0.88
Use continues despite knowledge of adverse consequences	I kept eating in the same way even though my eating caused emotional problems.	0.73
Tolerance	Eating the same amount of food did not give me as much enjoyment as it used to.	0.80
Characteristic withdrawal symptoms; substance taken to relieve withdrawal	If I had emotional problems because I had not eaten certain foods, I would eat those foods to feel better.	0.76
Continued use despite social or interpersonal problems	My friends or family were worried about how much I overate.	0.87
Failure to fulfil major role obligations	My overeating got in the way of me taking care of my family or doing household chores.	0.94
Use in physically hazardous situations	I was so distracted by eating that I could have been hurt (e.g. when driving a car, crossing the street and operating machinery).	0.97
Craving, or a strong desire or urge to use	I had such strong urges to eat certain foods that I could not think of anything else.	0.81
Use causes clinically significant impairment	I had significant problems in my life because of food and eating. These may have been problems with my daily routine, work, school, friends, family or health.	Not included
Use causes clinically significant distress	My eating behaviour caused me much distress.	Not included

DSM-5, Diagnostic and Statistical Manual of Mental Disorders-5; SUD, substance-use disorder.

2.0: M = 1.20, *SD* = 2.14; YFAS 2.0: M = 1.77, *SD* = 2.67), with the full YFAS 2.0 also finding that Hispanic individuals also reported significantly more symptoms than African American participants (M = 1.73, *SD* = 3.26) (all *p*s < 0.05). Similarly, chi-squared tests revealed significant associations between race and the diagnostic scoring methods of both measures of food addiction [mYFAS 2.0: χ^2 (5) = 13.33, $p = 0.02$; YFAS 2.0: χ^2 (5) = 11.68, $p = 0.04$], with Hispanic individuals again exhibiting a higher diagnostic prevalence of food addiction [6 of 14 (42.9%) Hispanic participants met for YFAS food addiction], relative to White participants [17 of 157 (10.8%) White participants met for YFAS food addiction].

Additionally, the association of the symptom count scoring method of the mYFAS 2.0 with age approached significance ($r = -0.13$, $p = 0.06$), with younger individuals reporting elevated addictive-like eating behaviours. This relationship was significant, although effect size was small, for the full YFAS 2.0 ($r = -0.15$, $p < 0.05$). No significant associations were found between age and the diagnostic scoring method of the two measures (all *p*s > 0.14). Gender and education level were not associated with the symptom count or diagnostic scores of the two measures (all *p*s > 0.18).

Convergent validity

Using the symptom count scoring method, the mYFAS 2.0 and the full YFAS 2.0 were positively associated with TFEQ disinhibition, TFEQ hunger, current BMI, highest lifetime BMI and average weekly frequency of binge-eating episodes (all *p*s < 0.001) (Table 3). Weight cycling was associated with addictive-like eating symptoms on both the mYFAS 2.0, $F(3, 209) = 30.09$, $p < 0.001$, $\eta 2 = 0.07$, and YFAS 2.0, $F(3, 209) = 42.49$, $p < 0.01$, $\eta 2 = 0.07$, with *post hoc* Tukey HSD tests revealing that individuals who reported losing and regaining 20 or more pounds on five or more occasions endorsing significantly greater symptoms of food addiction (mYFAS 2.0: M = 3.36, *SD* = 3.50; YFAS 2.0: M = 3.14, *SD* = 3.35) than those who reported no instances of weight cycling (mYFAS 2.0: M = 0.83, *SD* = 1.78; YFAS 2.0: M = 0.77, *SD* = 1.71). Symptom scores on both measures of addictive-like eating differed by weight class [mYFAS 2.0: $F(3, 205) = 5.78$, $p < 0.01$, $\eta 2 = 0.05$; YFAS 2.0: $F(3, 205) = 8.00$, $p < 0.001$, $\eta 2 = 0.07$]. Individuals with obesity reported significantly greater symptoms of addictive-like eating (mYFAS 2.0: M = 2.41, *SD* = 3.08; YFAS 2.0: M = 3.36, *SD* = 3.44) than normal weight individuals (mYFAS 2.0: M = 1.04, *SD* = 2.18; YFAS 2.0: M = 1.39, *SD* = 2.54).

The diagnostic scoring method of the mYFAS 2.0 and full YFAS 2.0 yielded similar results as the symptom count scores, with one exception being a trend-level association with highest lifetime BMI (mYFAS 2.0: $p = 0.06$, $\eta 2 = 0.02$; YFAS 2.0: $p = 0.07$, $\eta 2 = 0.02$), which was a significant association with the symptom count versions of the scales.

Discriminant validity

Symptom count scores on both the mYFAS 2.0 and full YFAS 2.0 were not significantly related to the TFEQ restraint subscale (mYFAS 2.0: $p = 0.86$; YFAS 2.0: $p = 0.51$), demonstrating good discriminant validity (Table 3). Diagnostic scoring methods for both measures of food addiction were also non-significantly related to TFEQ restraint scores (all *p*s < 0.55). The EDDS found that 80.3% ($n = 171$) of the current sample did not meet criteria for any eating disorder diagnosis, 8.0% ($n = 17$) met for BN, 11.7% ($n = 25$) met for BED and no individuals met for AN. There was overlap between the diagnostic scoring method on both measures of addictive-like eating with BN (mYFAS 2.0: 58.8%, YFAS 2.0: 64.7%) and BED (mYFAS 2.0: 28.0%; YFAS 2.0: 40.0%). Further, on both food addiction measures, there were individuals who met the diagnostic threshold score but no EDDS diagnoses of other eating disorders (mYFAS 2.0: 32.1%; YFAS 2.0: 34.4%).

Incremental validity

Hierarchical multiple regression models were used to investigate incremental validity of the mYFAS 2.0, relative to the full YFAS 2.0 and original mYFAS. Symptom count scores on each measure of addictive-like eating were entered separately along with a measure of disinhibited eating (TFEQ disinhibition subscale) to assess their association with of average weekly frequency of binge-eating episodes. The TFEQ disinhibition score was entered into step one of the regression model, and each measure of food addiction was entered as step two in separate models. The TFEQ disinhibition score was significantly associated with binge-eating frequency in step one of both regression models, ($t = 4.10$,

Table 3 Correlations between continuous variables

	YFAS 2.0 symptom count	mYFAS 2.0 symptom count	TFEQ hunger	TFEQ disinhibition	TFEQ restraint	Current BMI	Highest BMI	Binge frequency
YFAS 2.0 symptom count	1	0.94*	0.58*	0.57*	−0.05	0.23†	0.22†	0.52*
mYFAS 2.0 symptom count		1	0.53*	0.53*	−0.01	0.23†	0.23†	0.56*
TFEQ hunger			1	0.71*	−0.08	0.21†	0.23†	0.33‡
TFEQ disinhibition				1	0.02	0.31‡	0.34‡	0.27†
TFEQ restraint					1	−0.05	0.02	−0.04
Current BMI						1	0.93*	0.10
Highest BMI							1	0.10
Binge frequency								1

Note: YFAS 2.0, Yale Food Addiction Scale 2.0; mYFAS 2.0, modified Yale Food Addiction Scale 2.0; TFEQ, Three Factor Eating Questionnaire; BMI, body mass index.
*Large effect size ($r > 0.50$).
†Small effect size ($r > 0.10$).
‡Moderate effect size ($r > 0.30$).

$\beta = 0.24$, $p < 0.001$), accounting for 7.4% of the variance. In both models, when the symptom count scores were entered in step two, TFEQ disinhibition scores became insignificant (mYFAS 2.0 model: $t = -0.47$, $\beta = -0.03$, $p = 0.64$; full YFAS 2.0 model: $t = -0.51$, $\beta = -0.03$, $p = 0.61$), and both the mYFAS 2.0 and full YFAS 2.0 were significantly related (mYFAS 2.0 model: $t = 8.51$, $\beta = 0.72$, $p < 0.001$; full YFAS 2.0 model: $t = 7.48$, $\beta = 0.55$, $p < 0.001$), accounting for additional variance in binge-eating frequency (mYFAS 2.0 model: 23.8% of the remaining variance, full YFAS 2.0 model: 19.5% of the remaining variance).

This pattern of results was replicated with the diagnostic scoring versions of both the mYFAS 2.0 and full YFAS 2.0. After controlling for the variance accounted for by TFEQ disinhibition scores in step one, the diagnostic scores of both measures of addictive-like eating were significantly associated at step two of each model (mYFAS 2.0 model: $t = 5.20$, $\beta = 3.22$, $p < 0.001$; full YFAS 2.0 model: $t = 4.66$, $\beta = 2.79$, $p < 0.001$), accounting for additional variance in binge-eating frequency (mYFAS 2.0 model: 10.6% of the remaining variance, full YFAS 2.0 model: 8.7% of the remaining variance).

Discussion

The YFAS is the only existing self-report measure to operationalize indicators of food addiction, originally based on the DSM-IV-TR criteria for diagnosing SUDs. A short, nine-item version of the YFAS, the mYFAS, was developed in 2014 and has been utilized in large epidemiological cohorts and studies where a brief measure of addictive-like eating was sufficient (Flint et al., 2014; Schulte, Tuttle, et al., 2016). In 2016, the YFAS 2.0 was developed to reflect the DSM-5 SUDs diagnostic criteria. In the current study, the YFAS 2.0 was adapted into a briefer, 13-item questionnaire, the mYFAS 2.0, and its psychometric properties were evaluated in comparison with the full YFAS 2.0.

The mYFAS 2.0 had both a lower symptom count and 'diagnostic' threshold score, relative to the full YFAS 2.0. However, it was expected that the full YFAS 2.0 would yield a higher average symptom count, as an individual has the chance to endorse each symptom through multiple questions, whereas the mYFAS 2.0 selects one question as a screener for each symptom. Relatedly, the full YFAS 2.0 yielded a slightly higher prevalence of food addiction as assessed by the 'diagnostic' threshold, although the clinical significance of this difference is unknown. Thus, the mYFAS 2.0 may be an appropriate choice for studies that aim to prioritize specificity over sensitivity or where participant burden may be high. Alternatively, the full YFAS 2.0 may be preferred in studies that need a more sensitive measure of addictive-like eating behaviour.

With respect to the measures' associations with demographic variables, Hispanic individuals reported significantly more symptoms and 'diagnostic' prevalence of food addiction than White individuals on both the mYFAS 2.0 and full YFAS 2.0. Additionally, on the full YFAS 2.0, Hispanic persons endorsed significantly greater symptoms of addictive-like eating than African American individuals. One possible explanation may be that Hispanic and African American persons have higher prevalence rates of obesity relative to White individuals (Bleich, Thorpe, Sharif-Harris, Fesahazion & Laveist, 2010; Fitzgibbon et al., 1998; Pan et al., 2009). However, given that no differences were observed between the YFAS 2.0 and individuals' racial identification in the validation paper (Gearhardt et al., 2016), future research is needed to understand the relationship between YFAS 2.0 food addiction scores and race and which factors, perhaps unaccounted for in the current study, may contribute to this association. In the current sample, younger individuals reported elevated symptoms of food addiction on both the mYFAS 2.0 and full YFAS 2.0, although this association was only significant for the full YFAS 2.0. This finding is also inconsistent with the YFAS 2.0 validation paper (Gearhardt et al., 2016). It may be that younger individuals exhibit more indicators of addictive-like eating because disordered eating is broadly elevated among persons younger than 40 (Hoek & van Hoeken, 2003), although replication is needed given the conflicting nature of this finding. Finally, there were no differences in food addiction scores on either the mYFAS 2.0 or full YFAS 2.0 by gender. Overall, the demographic associations for the full YFAS 2.0 and mYFAS 2.0 in the current sample are inconsistent with the validation paper for the YFAS 2.0, which observed a significant relationship for gender, with women reporting greater YFAS 2.0 symptoms and 'diagnosis' threshold scores (Gearhardt et al., 2016). Thus, future work is needed to understand how the YFAS 2.0 relates to demographic variables, ideally in a nationally representative sample.

Overall, the mYFAS 2.0 and full YFAS 2.0 performed similarly on measures of reliability and validity. The mYFAS 2.0 had good reliability, relative to the excellent reliability of the full YFAS 2.0. However, it is expected that the mYFAS 2.0 would have a slightly lower value given the sensitivity of measures of internal consistency to the length of a measure (Tavakol & Dennick, 2011). The mYFAS 2.0 had comparable convergent validity with the full YFAS 2.0 on theoretically related constructs (e.g. disinhibited eating, weight cycling) and discriminated as effectively as the full YFAS 2.0 on theoretically distinct concepts (e.g. dietary restraint and eating disorders). Additionally, both the mYFAS 2.0 and full YFAS 2.0 similarly predicted frequency of binge eating above and beyond an index of disinhibited eating, suggesting that addictive-like eating may be a relevant contributor to bingeing for some individuals.

While the current findings demonstrate overlap between food addiction and binge-type eating disorders, about one-third of individuals met 'diagnostic' criteria for food addiction on both measures and no other eating disorders. This provides support that food addiction may represent a unique phenotype of problematic eating behaviour with potential for clinical utility. Further, although binge eating has been related to addictive-like eating (Gearhardt et al., 2012; Gearhardt et al., 2016), there are behavioural and theoretical features that differentiate BED and food addiction (Schulte, Grilo, et al., 2016). For example, addictive-like eating could occur by bingeing or grazing, akin to how those with alcohol-use disorder may experience problems related to binge drinking or consuming alcoholic beverages over the course of the day.

The current study had several limitations. First, the data were collected from Amazon MTurk, which yields a diverse, but not nationally representative sample (Paolacci & Chandler, 2014). Additionally, the data were all self-report, including variables that may have been more accurately collected through direct

measurement (e.g. height and weight) or structured interviews (e.g. eating disorder diagnoses). As such, future research that utilizes the mYFAS 2.0 should use a variety of approaches to examine associations with food addiction. Further, replication of the psychometric properties of the mYFAS 2.0 is warranted to confirm the reliability and validity of this measure. Lastly, the YFAS appears to vary in its association with demographic variables (Pursey, Stanwell, Gearhardt, Collins & Burrows, 2014), motivating recent research evaluating the measurement invariance of the YFAS 2.0 (Carr, Catak, Pejsa-Reitz, Saules & Gearhardt, 2016). Thus, assessment of measurement invariance of the mYFAS 2.0 across demographic characteristics appears to be an important next step to investigate the utility of this measure in a variety of populations.

Summary

The full YFAS 2.0 was adapted into a briefer, 13-item measure, the mYFAS 2.0. In the current sample, the mYFAS 2.0 demonstrated good reliability and performed similarly as the full YFAS 2.0 on indexes of convergent, discriminant and incremental validity using other measures of eating behaviour. The symptom count and 'diagnostic' threshold scores on the mYFAS 2.0 and full YFAS 2.0 were highly correlated, although the mYFAS 2.0 yielded lower scores on average. Overall, the mYFAS 2.0 is psychometrically similar to the full YFAS 2.0 and may be an appropriate alternative to the full YFAS 2.0 for studies with high participant burden (e.g. large epidemiological samples) or as a briefer screening tool for food addiction.

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