Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity (2019) 24:37–45
https://doi.org/10.1007/s40519-018-0607-x

ORIGINAL ARTICLE

Psychometric properties of the modified Yale Food Addiction Scale Version 2.0 in an Italian non-clinical sample

Claudio Imperatori[1] · Mariantonietta Fabbricatore[1] · David Lester[2] · Gian Mauro Manzoni[3,4] · Gianluca Castelnuovo[3,5] · Giulia Raimondi[1] · Marco Innamorati[1]

Received: 31 August 2018 / Accepted: 24 October 2018 / Published online: 9 November 2018

Abstract

Purpose To assess the dimensionality and psychometric properties of the modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) in an Italian non-clinical sample.

Methods 262 adults (184 women) were administered the Italian versions of the mYFAS 2.0, and questionnaires measuring binge eating severity, anxiety and depression symptoms, and emotional dysregulation.

Results 15 individuals (5.7%) met the criteria for a diagnosis of food addiction according to the mYFAS 2.0. Bayesian confirmatory factor analysis supported a single-factor solution for the mYFAS 2.0. The mYFAS 2.0 had good internal consistency (Ordinal $\alpha = 0.91$), and convergent validity with binge eating severity ($r = 0.67$, $p < 0.001$), both anxiety ($r = 0.31$, $p < 0.001$) and depressive ($r = 0.35$, $p < 0.001$) symptoms, and difficulties in emotion regulation ($r = 0.35$, $p < 0.001$). Finally, both discriminant validity with dietary restraint (Gamma = 0.11; $p = 0.52$) and incremental validity in predicting binge eating severity over emotion dysregulation and psychopathology ($b = 0.52$; $t = 11.11$; $p < 0.001$) were confirmed.

Conclusions The Italian mYFAS 2.0 has satisfactory psychometric properties and can be used as a brief instrument for the assessment of addictive eating behaviors when time constraints prevent the use of the original version.

Level of Evidence Level V, cross-sectional descriptive study.

Keywords Food addiction · mYFAS 2.0 · Binge eating · Psychopathology · BMI · Bayesian confirmatory factor analysis

Introduction

In the last decade, the construct of food addiction (FA) has gained increasing attention from researchers and clinicians as a dysfunctional eating pattern frequently associated with obesity and eating disorders (EDs) [1, 2]. Indeed, although FA is frequently observed also in normal-weight individuals (about 11%) [1], it is more commonly diagnosed in patients with obesity (around 25%) [1] and with EDs, especially in individuals with binge eating disorder (rates range from 5.9 to 87.2%) and bulimia nervosa (rates range from 5.3 to 89.1%) [3].

Although many controversies have emerged regarding both the definition of FA and its nosological status [3, 4], the most common approach to conceptualize FA derives from the overlap with the latest editions of the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria [5, 6] for addictive disorders (e.g., craving, tolerance, withdrawal symptoms, etc.). The Yale Food Addiction Scale [YFAS; 7] has become the most widely used psychometric tool to assess FA in both clinical and non-clinical samples [1, 3]. The YFAS was originally developed in accordance with the DSM-IV-TR diagnostic criteria [5] for substance addiction. It was initially validated in U.S. undergraduate students, showing a single-factor structure and satisfactory psychometric properties [7]. Specifically, the internal reliability for the single factor was adequate (i.e., Kuder–Richardson

This article is part of topical collection on Food Addiction.

✉ Claudio Imperatori
imperatori.c@libero.it

[1] Department of Human Sciences, European University of Rome, Via degli Aldobrandeschi 190, 00163 Rome, Italy

[2] Stockton University, Galloway, NJ, USA

[3] Istituto Auxologico Italiano IRCCS, Psychology Research Laboratory, Oggebbio, Italy

[4] Faculty of Psychology, eCampus University, Novedrate, Como, Italy

[5] Department of Psychology, Catholic University, Milan, Italy

$\alpha = 0.75$) and the convergent validity with eating pathology (i.e., emotional eating and eating troubles) was satisfactory for both the symptom count and diagnostic version of the YFAS (i.e., Pearson correlation coefficient ranged from 0.46 to 0.61) [7]. Similarly, discriminant validity with other addictive related behaviors (i.e., alcohol-related problems) and incremental validity in predicting binge-eating behavior (i.e., $b = 0.48$, $p < 0.001$) was also adequate [7]. Good psychometric properties such as the one-factor structure, adequate internal consistency and convergent validity with eating pathology were also reported in clinical samples, such as patients with obesity and EDs [8–11], and in international studies [9, 11–18] (for a detailed overview about the psychometric properties of the YFAS and its adaptations, see [19]).

Following the changes in the section of the DMS-5 [6] related to substance-related and addictive disorders (e.g., the inclusion of craving and the use of a diagnostic continuum of severity) a revised version of the YFAS, the YFAS 2.0, was recently proposed [20]. The YFAS 2.0 is composed of 35 items rated on an eight-point Likert scale (from 0 = never to 7 = every day), and it includes two scoring options [20]: (i) a symptom-count version, assessing the number of diagnostic criteria met (from 0 to 11) and (ii) a categorical diagnostic version (FA is diagnosed when at least two symptoms and clinical impairment/distress from eating are present). Furthermore, the new scale provides a diagnostic continuum of severity according to three cutoffs [20]: mild (two to three symptoms), moderate (four to five symptoms), and severe (six or more symptoms).

The YFAS 2.0 was initially validated in the U.S. population, with a single-factor structure revealed through a confirmatory factor analysis (CFA). Although the root mean square error of approximation (RMSEA) suggested a less than optimal fit (i.e., 0.108), the confirmatory fit index (CFI) and the Tucker Lewis Index (TLI), respectively 0.96 and 0.97, suggested a good fit for the one-factor model. Furthermore, a satisfactory internal consistency (i.e., Kuder–Richardson $\alpha = 0.90$) and good convergent validity with problematic eating behaviors (e.g., frequency of binge eating episodes) were reported (i.e., Pearson correlation coefficient ranged from 0.24 to 0.63) [20]. The one-factor structure and the good psychometric properties were recently replicated in clinical samples [21, 22] and in several European countries, including Spain [21], Italy [23], France [24], and Germany [22], although some cross-cultural differences have been observed in the prevalence of a diagnosis of FA. For example, the prevalence rate observed in US adults was 13.1% [25], similar to those reported in several European countries (i.e., France and Germany) [22, 24]. However, Italy, Spain (i.e., 3.3%), and some South American countries, such as Brazil (i.e., 4.3%), had lower prevalence rates [21, 26].

Based on the original version [27], a brief version of the YFAS 2.0, the so-called modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) has been recently developed [25]. The mYFAS 2.0 consists of 11 of the diagnostic items (those with the highest factor loadings) from the original YFAS 2.0, and two impairment/distress questions. The scale is characterized by the same main features of the original YFAS 2.0 (i.e., two scoring options and a diagnostic continuum of severity), and all items are rated on an eight-point Likert scale (from 0 = never to 7 = every day). In the original validation study on 213 U.S. adults, the mYFAS 2.0 showed a single-factor structure (CFI = 0.96, TLI = 0.95, RMSEA = 0.08), revealed through an exploratory factor analysis (EFA). The mYFAS 2.0 also exhibited good internal consistency (i.e., Kuder–Richardson $\alpha = 0.86$), as well as good convergent validity (i.e., a strong association with the frequency of binge-eating episodes). The one-factor structure (e.g., CFI = 0.93, RMSEA = 0.07) and the good psychometric properties (e.g., Cronbach's $\alpha = 0.89$) of the mYFAS 2.0 have been recently replicated in a large sample of Brazilian adults [26].

International research on the psychometric properties of the mYFAS 2.0 is still scarce, and, to the best of our knowledge, no previous studies have been conducted on the Italian population. Evaluating the psychometric properties of the mYFAS is considered an import topic in international FA research [25]. Indeed, the use of a brief measure for screening FA may be useful when time constraints impede the use of the original 35-item version, such as in large epidemiological cohort studies [25, 27]. Furthermore, the mYFAS could be also useful when investigating similarities and differences in eating behavior across large samples from different countries [28].

Therefore, the aims of the present study were to adapt an Italian version of the mYFAS 2.0 and to investigate its dimensionality and psychometric properties in a non-clinical sample. Furthermore, convergent and discriminant validities were assessed by administering measures assessing eating and emotional psychopathology (e.g., binge eating severity and anxiety and depressive symptoms), and distinct eating-related problems (i.e., dietary restraint), respectively. Finally, the incremental validity was investigated by the ability of the mYFAS 2.0 to predict binge eating severity over emotion dysregulation and psychopathology (i.e., depressive and anxiety symptoms).

Materials and methods

Participants

Two hundred and sixty-six participants of both sexes were recruited through advertisements (i.e., flyers, newspaper and online ads) posted for established community groups, such

as universities, hospitals, shopping centers, churches, and gyms in Central Italy.

Inclusion criteria were age of 18 and higher (in line with previous studies on the mYFAS 2.0 [25, 26]) and the ability to understand written Italian. All subjects voluntarily participated in the study (i.e., they did not receive payment or other compensation). Participants were assessed between October 2017 and July 2018. The questionnaires were individually delivered to each participant and completed in the presence of a researcher who helped them fill out the questionnaires if questions arose. All participants also received information about the general purpose of the research and provided written consent. The study was approved by the European University's ethics review board and was performed according to the Helsinki declaration standards.

Measures

All participants were administered the mYFAS 2.0 [25], the Binge Eating Scale (BES) [29], the Hospital Anxiety and Depression Scale (HADS) [30], and the Emotion Dysregulation Scale-short version (EDS-short) [31]. Furthermore, participants were also asked to complete a checklist assessing socio-demographic variables (e.g., sex, age, marital status, job, educational attainment) and clinical variables (e.g., tobacco and alcohol use in the last 6 months, use of recreational drugs in the last 6 months, dietary restraint in the last month) using dichotomous questions (Yes/No). Height and weight were also self-reported to calculate the body mass index (BMI).

Food addiction

The mYFAS 2.0 [25] is the short version of the YFAS 2.0 [20]. It is composed of 13 items, rated on an eight-point Likert scale (from 0 = never to 7 = every day) assessing addictive eating behaviors (e.g., "I had such strong urges to eat certain foods that I could not think of anything else"; "I ate to the point where I felt physically ill"). The mYFAS 2.0. provides two scoring options: a symptom count version (scores ranging from 0 to 11) and a diagnostic version based on the last edition of the DSM criteria [6] for substance-related and addictive disorder section (i.e., a categorical cut off diagnostic is met when at least two symptoms and clinically significant impairment/distress from eating are present).

In the 35-item version, each symptom is scored based on two or more theoretically related items [20]. In the short version, each symptom is scored based on one item with the exception of the "impairment and distress" criterion, which is assessed by two items. For the "diagnosis" scoring option, a participant can meet the criteria for mild FA (two to three symptoms), moderate FA (four to five symptoms) or severe FA (six or more symptoms). The mYFAS 2.0 items were translated as part of a research project whose objective was to create an Italian validated version of the YFAS 2.0 long-form. During the early phases of this project, two bilingual researchers, under the supervision of two coauthors (GMM and GC) of the present paper, adapted the Italian version of the questionnaire from the original English version using a back-translation procedure.

Binge eating severity

The BES is a 16-item self-report scale assessing behavioral (e.g., "I don't have any difficulty eating slowly in the proper manner") and cognitive/emotional (e.g., "Because I feel so helpless about controlling my eating, I have become very desperate about trying to get in control") manifestations of binge eating [29]. The scores range from 0 to 46, with higher scores indicating greater binge eating severity. Marcus et al. [32] identified three different levels of severity: (1) non-clinical level of binge eating (i.e., total scores ranging from 0 to 17); (2) moderate level of binge eating (i.e., total scores ranging from 18 to 26); (3) and severe binge eating (i.e., total scores ranging from 27 to 46). Following Ricca et al., a cut-off value of 17 was used in the present study to discriminate between subjects with and without a clinical level of binge eating [33]. The psychometric properties of the BES have been investigated with satisfactory results in several countries [33–37]. In the present study, the Italian version of this scale was used [37] and Cronbach's α was 0.88.

Anxiety and depressive symptoms

The HADS [30] is a 14-item self-report questionnaire assessing both anxiety (e.g., "Worrying thoughts go through my mind") and depressive (e.g., "I feel as if I am slowed down") symptoms in clinical and non-clinical samples [38]. The anxiety (HADS-A) and depression (HADS-D) subscales are composed of seven items each, which are rated on a four-point scale (0–3). Total scores range from 0 to 21 for both subscales, with higher scores indicating more severe depressive and anxiety symptoms. The psychometric properties of the HADS have been investigated with satisfactory results [39]. In the present study, we used the Italian version [40] of this scale, and Cronbach's α in our sample was 0.82 and 0.70 for the anxiety and depression subscales, respectively.

Emotion dysregulation

The EDS-short [31] is an unidimensional self-administered questionnaire assessing behavioral and cognitive/emotional manifestations of emotion regulation (e.g., "Emotions overwhelm me"; "I have trouble soothing myself when I am upset"). It is composed of 12 items rated on a 7-point Likert

scale (from 1 = not true to 7 = very true) [31]. Total scores range from 12 to 84, with higher scores indicating greater problems with emotion regulation. Good psychometric properties were reported in the original validation study [31]. Cronbach's α for the present sample was 0.91.

Statistical analyses

As recommended [41], missing values were replaced with the individual's mean for the relevant total scale/subscale for protocols with two missing items or fewer (seven participants). Four protocols with three or more missing items were excluded from the analyses.

All the analyses were performed with the Statistical Package for the Social Sciences (SPSS) 19.0 for Windows, and Mplus 7.0 (Muthén and Muthén, 1998–2010). The Bayesian confirmatory factor analysis (BCFA) approach was used to investigate the uni-dimensionality of the mYFAS. We applied a BCFA using a Markov chain Monte Carlo (MCMC) algorithm to investigate whether the one-factor model fits the structure of the mYFAS 2.0 with all the eleven symptomatic dimensions included in the original version loading significantly on the latent factor. In this analysis, we used informative priors for items loadings based on the results from the original validation study [25]. A sensitivity analysis of the prior distribution was assessed comparing different levels of certainty about the values of the factor loadings. We let the priors variance vary between 0.05 (less certainty) and 0.001 (more certainty), and also re-ran the model with no informative priors (all priors set to 0.00 ± 5.00). The model fit was evaluated using the Bayesian Posterior Predictive Checking (PPC) and the Posterior Predictive *P* value (PPP) [42]. BCFA simulates replicated data under the model of interest, and PPC compares the proportion of iterations for which the replicated χ^2 exceeds the observed χ^2. The fit of the model was based on PPC confidence interval crossing the zero and PPP > 0.05. The deviance information criterion (DIC) was not used to compare models because it was not available in MPLUS when using categorical variables, and the sensitivity analysis used only inspection of PPC confidence intervals and PPP. For each variable, we reported factor loadings, thresholds and R^2, and their 95% Bayesian Credibility Intervals (95% BCI). The BCI can be interpreted as the probability that the population parameter is between the upper and lower bounds [43]. The Bayesian approach is preferred over the classical approach because it can incorporate previous knowledge into the analyses, such as the informative priors which contain numerical information that influences the final parameter estimate [43]. Furthermore, BCFA results could be more reliable with small samples, especially when it is possible to incorporate very informative priors in the models, as was possible in our study [43].

As a measure of reliability, we reported ordinal Cronbach α [44]. Convergent validity with the BES, BMI, emotion regulation and both anxiety and depressive symptoms was evaluated by calculating Pearson's *r* correlation coefficients. As in previous studies [20, 22, 25], discriminant validity was assessed using the Gamma coefficient correlations between mYFAS 2.0 total score and dietary restraint, defined as "the intention to restrict food for weight loss purposes" [20]. Finally, because of the strong association between FA and binge eating behaviors [3, 45], and as in the original validation studies of the YFAS [7], YFAS 2.0 [20] and mYFAS 2.0 [25], the incremental validity of the mYFAS 2.0 in predicting BES total score over emotion dysregulation and psychopathology (i.e., depressive and anxiety symptoms) was evaluated by means of a hierarchical linear regression analysis.

Results

The final sample consisted of 262 Italian individuals (184 women and 78 men; mean age = 29.43, SD = 13.55 years; range 18–88). Participants had an average self-reported BMI of 22.45 kg/m^2 (SD = 3.12: range 16.30–33.20). According to the standard BMI cut-off [46], there were 18 (6.9%) underweight participants (i.e., BMI < 18.5 kg/m^2), 193 (73.7%) normal weight participants (i.e., BMI between 18.50 and 24.99 kg/m^2), 45 (17.2%) overweight participants (i.e., BMI between 25 and 29.9 kg/m^2), and 6 (2.3%) obese participants (i.e., BMI ≥ 30 kg/m^2) participants. There were 15 participants (5.7%) who met the criteria for a diagnosis of FA according to the mYFAS 2.0, 26 (9.9%) who met the criteria for clinical-level binge eating (BES > 17), and 11 (4.2%) who met both criteria. Of those who met FA criteria, 73.3% ($N = 11$) also satisfied criteria for clinical-level binge eating, whereas, of patients with clinical-level binge eating, 42.3% ($N = 12$) also satisfied the criteria for FA. The clinical and socio-demographic characteristics of the sample are reported in Table 1.

Dimensionality of the mYFAS 2.0

Table 2 reports PPC and PPP of the unidimensional model with different certainty about priors. A nonsignificant PPP indicated the fit of the model, while the sensitivity analysis suggested a prior data conflict, with more stringent prior variance being associated with wider Bayesian credibility intervals. The model with no informative priors had more stringent credibility intervals than other models. When comparing factor loadings for this model with the model with very informative priors (priors variance = 0.001), the factor loading estimates were lower for Time (0.345 vs. 0.596) and Situations (0.539 vs. 0.693) and higher for all the other

Table 1 Descriptive statistics for the sample ($N = 262$)

Variables	
Age, M ± SD	29.43 ± 13.55
Women, *N* (%)	184 (70.2)
Occupation	
Employed, *N* (%)	94 (35.9)
Unemployed, *N* (%)	14 (5.3)
Students, *N* (%)	154 (58.8)
Married or living with partner, *N* (%)	54 (20.6)
School attainment ≤ 13 years, *N* (%)	172 (65.6)
Tobacco use in the last 6 months, *N* (%)	121 (46.2)
Illegal drugs use in the last 6 months, *N* (%)	66 (25.2)
Alcohol use in the last 6 months, *N* (%)	189 (72.1)
Dietary restraint in the last month, *N* (%)	37 (14.1)
Self-reported BMI, M ± SD	22.45 ± 3.12
BMI < 18.5 kg/m^2, *N* (%)	18 (6.9)
BMI between 18.50 and 24.99 kg/m^2, *N* (%)	193 (73.7)
BMI between 25 and 29.9 kg/m^2, *N* (%)	45 (17.2)
BMI ≥ 30 kg/m^2, *N* (%)	6 (2.3)
mYFAS 2.0, M ± SD	0.76 ± 1.56
FA diagnosis, *N* (%)	15 (5.7)
Mild FA, *N* (%)	6 (2.3)
Moderate FA, *N* (%)	5 (1.9)
Severe FA, *N* (%)	4 (1.5)
BES, M ± SD	22.45 ± 3.12
BES > 17, *N* (%)	26 (9.9)
EDS-short, M ± SD	37.34 ± 17.82
HADS-A, M ± SD	6.71 ± 4.01
HADS-D, M ± SD	4.14 ± 3.15

M mean, *SD* standard deviation, *BMI* body mass index, *mYFAS 2.0* modified Yale Food Addiction Scale 2.0, *FA* food addiction, *BES* Binge Eating Scale, *EDS-short* Emotion Dysregulation Scale-short version, *HADS-A* Hospital Anxiety and Depression Scale-Anxiety Subscale, *HADS-D* Hospital Anxiety and Depression Scale-Depression Subscale

Table 2 Bayesian Posterior Predictive Checking (PPC) and Posterior Predictive *P* value (PPP) for the competing models

Priors	95% Confidence interval PPC		PPP
	Lower bound	Upper bound	
No informative priors (mean 0.00; variance = 5.00)	− 33.88	37.31	0.48
Prior variance = 0.05	− 32.71	39.72	0.43
Prior variance = 0.01	− 31.38	44.00	0.40
Prior variance = 0.001	− 30.87	45.49	0.36

variables. Despite the fact that the estimate of the factor loading was significant (posterior $p = 0.039$) (Table 3), credibility intervals for the variable Time crossed zero (95% BCI

Table 3 Standardized factor loadings, thresholds and R^2, and their 95% Bayesian credibility intervals (95% BCI)

mYFAS 2.0. item	Beta	Posterior *P* value	95% BCI		Thresholds	95% BCI		R^2	95% BCI	
			Lower bound	Upper bound		Lower bound	Upper bound		Lower bound	Upper bound
Item #1	0.683	0.000	0.417	0.848	1.657	1.399	1.938	0.466	0.174	0.718
Item #2	0.345	0.039	− 0.034	0.664	1.828	1.538	2.160	0.119	0.001	0.441
Item #3	0.684	0.000	0.448	0.844	1.450	1.222	1.704	0.468	0.201	0.713
Item #4	0.861	0.000	0.698	0.934	1.354	1.134	1.590	0.741	0.488	0.873
Item #7	0.894	0.000	0.740	0.963	1.401	1.186	1.648	0.799	0.548	0.927
Item #8	0.905	0.000	0.790	0.961	1.292	1.081	1.519	0.819	0.624	0.923
Item #9	0.802	0.000	0.583	0.914	1.694	1.422	1.984	0.643	0.340	0.836
Item #10	0.843	0.000	0.697	0.919	1.302	1.090	1.527	0.711	0.486	0.844
Item #11	0.670	0.000	0.469	0.806	1.294	1.081	1.514	0.449	0.220	0.650
Item #12	0.539	0.000	0.222	0.756	1.600	1.351	1.864	0.291	0.049	0.572
Item #13	0.742	0.000	0.545	0.865	1.243	1.045	1.458	0.551	0.297	0.749

All thresholds and R^2 are significant for $p < 0.001$

= − 0.034/0.664), indicating a high variability of the estimate with potential low correlation with the latent trait.

Psychometric properties of the mYFAS

Ordinal α for the mYFAS 2.0 was satisfactory ($\alpha = 0.91$), with corrected item-total correlations ranging between 0.48 for Time and 0.92 for Consequences. Convergent validity was also satisfactory. The mYFAS 2.0 total score (i.e., symptom count) was strongly and positively related to the BES total score ($r = 0.67$, $p < 0.001$). The mYFAS 2.0 total score was also positively associated with the EDS-short score ($r = 0.35$, $p < 0.001$), and with both anxiety ($r = 0.31$, $p < 0.001$) and depressive ($r = 0.35$, $p < 0.001$) symptoms. A small but significant positive correlation between mYFAS 2.0 total score and BMI ($r = 0.16$, $p = 0.01$) was also identified. Discriminant validity with dietary restraint was also good (Gamma = 0.11; $p = 0.52$).

In a hierarchical linear regression model, the mYFAS 2.0 total score ($b = 0.52$; $t = 11.11$; $p < 0.001$), EDS-short total score ($b = 0.21$; $t = 3.82$; $p < 0.001$) and HADS-D total score ($b = 0.19$; $t = 3.48$; $p < 0.001$) were independently associated with the BES total score. In the first block, anxiety symptoms, depressive symptoms and emotion dysregulation explained 32.0% of the variability of the BES total score ($F = 39.98$, $p < 0.001$). In the second block, when the mYFAS 2.0 was added, the model explained 52% of the variability of the data ($F = 75.64$, $p < 0.001$; F Change = 123.39, $p < 0.001$).

Discussion

The aim of the present study was to assess the dimensionality and psychometric properties of the mYFAS 2.0 in an Italian non-clinical sample. Consistent with previous studies [25, 26] our data support a single-factor solution, although credibility intervals for the variable "Time" suggested a high variability of the estimate with a potential low correlation with the latent trait.

Nevertheless, our results showed that the psychometric properties of the Italian mYFAS 2.0 was satisfactory. In particular, consistent with previous reports investigating the psychometric properties of both the original [20–23, 25] and the short version of the YFAS 2.0 [25, 26], good internal consistency reliability was reported. Specifically, as reported elsewhere [25], our results suggest that the mYFAS 2.0 and full YFAS 2.0 performed similarly with respect to reliability and validity. For example, compared to the Italian version of the YFAS 2.0 [23], the reduced version showed a comparable reliability ($\alpha = 0.87$ and $\alpha = 0.91$, respectively).

Convergent validity with problematic eating behaviors (i.e., binge eating severity) and difficulties in emotion regulation was also good [20–23, 25, 26]. Furthermore, it is interesting to note that a small but significant association was observed between the mYFAS 2.0 score and self-reported BMI, which may be consistent with the hypothesis of a non-linear relationship between FA and BMI [47]. Another possibility is that the low number of obese participants in the present sample, and consequently a small BMI range, attenuates the correlation with the mYFAS 2.0 total score. Nevertheless, the strong association between the mYFAS 2.0 and binge eating severity, as well as the small but significant association with BMI, further confirm that the mYFAS 2.0 has similar convergent validity as the full YFAS 2.0. Indeed, Aloi and colleagues [23], reported that the Italian version of the YFAS 2.0 was strongly related to the BES total score ($r = 0.69$) and significantly associated with self-reported BMI ($r = 0.17$), although the effect size was small.

Finally, both discriminant validity with dietary restraint and incremental validity in predicting the BES total score over emotion dysregulation and psychopathology (i.e., depressive and anxiety symptoms) were also confirmed [20, 22, 25]. In line with previous findings [10, 45, 48–50], our results (i.e., the high prevalence of clinical binge eating in individuals with FA as well as the strong correlation between the mYFAS 2.0 and binge eating severity) seem to suggest that both the behavioral and emotional/cognitive features of uncontrolled eating could be considered key psychopathological elements of FA [45].

In the present sample, according to the mYFAS 2.0 diagnostic score, 5.7% of the study participants received a FA diagnosis, which is similar (i.e., 3.4%) to that reported using the YFAS 2.0 with Italian undergraduate students [23], but it is lower when compared to the prevalence rates found in other countries [20, 22, 24, 25]. For example, the prevalence rate observed in US adults was 13.1% [25], and in French and German samples 8.2% [24] and 9.7% [22], respectively. Instead, similar to the Italian figure, the prevalence rates were lower in non-clinical samples from other Latin countries, such as Brazil (i.e., 4.3%) and Spain (i.e., 3.3%) [21, 26], suggesting, as reported [51, 52] for other addictive eating behaviors (i.e., food craving), possible cross-cultural differences [2]. Although this interpretation remains speculative, it might be useful as a future research topic.

The study's contributions should be considered in light of some limitations. First, we did not investigate the psychometric properties of the mYFAS 2.0 in patients with EDs and/or with obesity, which make our interpretations specific to non-clinical individuals. Furthermore, in our sample there was a high proportion of female participants, young adults and normal weight subjects, limiting the generalizability of these findings to other populations (e.g., older adults and obese individuals). For example, the low number of male participants did not allow us to test the structural invariance of the mYFAS 2.0 by sex. This could be relevant because

previous research has found sex differences in addictive eating behaviors, such as food craving [53]. Therefore, further studies should be conducted to investigate the dimensionality of the mYFAS 2.0 across different groups, especially in males and females, as well as in obese and normal weight individuals. Third, we did not assess the stability of mYFAS 2.0 over time and its predictive validity for future disordered eating behaviors. Therefore, further longitudinal research using a test–retest procedure in large clinical samples should be conducted. Finally, our data are all self-reported. This could be particularly problematic in relation to the BMI. Indeed, although the self-reported measures of height and weight are widely used in studies investigating FA in non-clinical samples [23, 25, 45, 54–57], their validity is still debated [58–62].

Despite these limitations, to the best of our knowledge, this is one of the few international studies ever conducted, and the first study conducted in Italy, which investigated the dimensionality and psychometric properties of the mYFAS 2.0. Taken together, our results confirm that the Italian mYFAS 2.0 had satisfactory psychometric properties, performing similarly on measures of reliability and validity as the full YFAS 2.0. Therefore, our data suggest that the mYFAS 2.0 may be a useful brief instrument for the assessment of addictive eating behaviors when time constraints impede the use of the original YFAS 2.0 (e.g., large epidemiological cohorts studies). Furthermore, our study has also some clinical implications. FA is commonly diagnosed in both patients with obesity [1] and with EDs [3], and it is known that the co-occurrence of FA and other dysfunctional eating patterns is associated with worse clinical conditions (e.g., BMI) and psychopathological symptoms [55, 63]. Therefore, it is important for clinicians to screen obese and EDs patients for FA using a well-validated instrument. Identifying patients with addictive eating symptoms could help improve effectiveness of psychological treatments [64].

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Pursey KM, Stanwell P, Gearhardt AN, Collins CE, Burrows TL (2014) The prevalence of food addiction as assessed by the Yale food addiction scale: a systematic review. Nutrients 6:4552–4590. https://doi.org/10.3390/nu6104552
2. Imperatori C, Fabbricatore M, Vumbaca V, Innamorati M, Contardi A, Farina B (2016) Food addiction: definition, measurement and prevalence in healthy subjects and in patients with eating disorders. Riv Psichiatr 51:60–65. https://doi.org/10.1708/2246.24196
3. Burrows T, Kay-Lambkin F, Pursey K, Skinner J, Dayas C (2018) Food addiction and associations with mental health symptoms: a systematic review with meta-analysis. J Hum Nutr Diet. https://doi.org/10.1111/jhn.12532
4. Hebebrand J, Albayrak O, Adan R, Antel J, Dieguez C, de Jong J et al (2014) "Eating addiction", rather than "food addiction", better captures addictive-like eating behavior. Neurosci Biobehav Rev 47:295–306. https://doi.org/10.1016/j.neubiorev.2014.08.016
5. American Psychiatric Association (2000) Diagnostic and statistical manual of mental disorders—DSMIV-TR, 4th edn. American Psychiatric Association, Washington, DC
6. American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders—DSM-5, 5th edn. American Psychiatric Publishing, Arlington
7. Gearhardt AN, Corbin WR, Brownell KD (2009) Preliminary validation of the Yale food addiction scale. Appetite 52:430–436. https://doi.org/10.1016/j.appet.2008.12.003
8. Meule A, Heckel D, Kubler A (2012) Factor structure and item analysis of the Yale food addiction scale in obese candidates for bariatric surgery. Eur Eat Disord Rev 20:419–422. https://doi.org/10.1002/erv.2189
9. Innamorati M, Imperatori C, Manzoni GM, Lamis DA, Castelnuovo G, Tamburello A et al (2014) Psychometric properties of the Italian Yale food addiction scale in overweight and obese patients. Eat Weight Disord. https://doi.org/10.1007/s40519-014-0142-3
10. Gearhardt AN, White MA, Masheb RM, Morgan PT, Crosby RD, Grilo CM (2012) An examination of the food addiction construct in obese patients with binge eating disorder. Int J Eat Disord 45:657–663. https://doi.org/10.1002/eat.20957
11. Granero R, Hilker I, Aguera Z, Jimenez-Murcia S, Sauchelli S, Islam MA et al (2014) Food addiction in a Spanish sample of eating disorders: DSM-5 diagnostic subtype differentiation and validation data. Eur Eat Disord Rev 22:389–396. https://doi.org/10.1002/erv.2311
12. Meule A, Vögele C, Kübler A (2012) German translation and validation of the Yale food addiction scale. Diagnostica 58:115–126. https://doi.org/10.1026/0012-1924/a000047
13. Brunault P, Ballon N, Gaillard P, Reveillere C, Courtois R (2014) Validation of the French version of the yale food addiction scale: an examination of its factor structure, reliability, and construct validity in a nonclinical sample. Can J Psychiatry 59:276–284. https://doi.org/10.1177/070674371405900507
14. Swarna Nantha Y, Abd Patah NA, Ponnusamy Pillai M (2016) Preliminary validation of the Malay Yale Food addiction scale: factor structure and item analysis in an obese population. Clin Nutr ESPEN 16:42–47. https://doi.org/10.1016/j.clnesp.2016.08.001
15. Chen G, Tang Z, Guo G, Liu X, Xiao S (2015) The Chinese version of the Yale Food Addiction Scale: an examination of its validation in a sample of female adolescents. Eat Behav 18:97–102. https://doi.org/10.1016/j.eatbeh.2015.05.002
16. Torres S, Camacho M, Costa P, Ribeiro G, Santos O, Vieira FM et al (2017) Psychometric properties of the Portuguese version of the Yale food addiction scale. Eat Weight Disord 22:259–267. https://doi.org/10.1007/s40519-016-0349-6
17. Sevinçer GM, Konuk N, Bozkurt S, Saraçli Ö, Coşkun H (2015) Psychometric properties of the Turkish version of the Yale food addiction scale among bariatric surgery patients. Anadolu Psykiyatr De 16:44–53. https://doi.org/10.5455/apd.174345

18. Manzoni GM, Rossi A, Pietrabissa G, Varallo G, Molinari E, Poggiogalle E et al (2018) Validation of the Italian Yale food addiction scale in postgraduate university students. Eat Weight Disord 23:167–176. https://doi.org/10.1007/s40519-018-0495-0
19. Meule A, Gearhardt AN (2014) Five years of the Yale food addiction scale: taking stock and moving forward. Curr Addict Rep 1:193–205. https://doi.org/10.1007/s40429-014-0021-z
20. Gearhardt AN, Corbin WR, Brownell KD (2016) Development of the Yale food addiction scale version 2.0. Psychol Addict Behav 30:113–121. https://doi.org/10.1037/adb0000136
21. Granero R, Jimenez-Murcia S, Gearhardt AN, Aguera Z, Aymami N, Gomez-Pena M et al (2018) Validation of the Spanish version of the Yale Food Addiction Scale 2.0 (YFAS 2.0) and clinical correlates in a sample of eating disorder, gambling disorder, and healthy control participants. Front Psychiatry 9:208. https://doi.org/10.3389/fpsyt.2018.00208
22. Meule A, Muller A, Gearhardt AN, Blechert J (2017) German version of the Yale Food Addiction Scale 2.0: Prevalence and correlates of 'food addiction' in students and obese individuals. Appetite 115:54–61. https://doi.org/10.1016/j.appet.2016.10.003
23. Aloi M, Rania M, Rodriguez Munoz RC, Jimenez Murcia S, Fernandez-Aranda F, De Fazio P et al (2017) Validation of the Italian version of the Yale Food Addiction Scale 2.0 (I-YFAS 2.0) in a sample of undergraduate students. Eat Weight Disord 22:527–533. https://doi.org/10.1007/s40519-017-0421
24. Brunault P, Courtois R, Gearhardt AN, Gaillard P, Journiac K, Cathelain S et al (2017) Validation of the French version of the DSM-5 yale food addiction scale in a nonclinical sample. Can J Psychiatry 62:199–210. https://doi.org/10.1177/0706743716673320
25. Schulte EM, Gearhardt AN (2017) Development of the modified yale food addiction scale version 2.0. Eur Eat Disord Rev 25:302–308. https://doi.org/10.1002/erv.2515
26. Nunes-Neto PR, Kohler CA, Schuch FB, Quevedo J, Solmi M, Murru A et al (2018) Psychometric properties of the modified Yale Food Addiction Scale 2.0 in a large Brazilian sample. Rev Bras Psiquiatr. https://doi.org/10.1590/1516-4446-2017-2432
27. Flint AJ, Gearhardt AN, Corbin WR, Brownell KD, Field AE, Rimm EB (2014) Food-addiction scale measurement in 2 cohorts of middle-aged and older women. Am J Clin Nutr 99:578–586. https://doi.org/10.3945/ajcn.113.068965
28. Rodriguez-Martin BC, Innamorati M, Imperatori C, Fabbricatore M, Harnic D, Janiri L et al (2016) Eating Behaviors in Cuban Adults: results from an exploratory transcultural study. Front Psychol 7:1455. https://doi.org/10.3389/fpsyg.2016.01455
29. Gormally J, Black S, Daston S, Rardin D (1982) The assessment of binge eating severity among obese persons. Addict Behav 7:47–55. https://doi.org/10.1016/0306-4603(82)90024-7
30. Zigmond AS, Snaith RP (1983) The hospital anxiety and depression scale. Acta Psychiatr Scand 67:361–370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x
31. Powers A, Stevens J, Fani N, Bradley B (2015) Construct validity of a short, self report instrument assessing emotional dysregulation. Psychiatry Res 225:85–92. https://doi.org/10.1016/j.psychres.2014.10.020
32. Marcus MD, Wing RR, Hopkins J (1988) Obese binge eaters: affect, cognitions, and response to behavioural weight control. J Consult Clin Psychol 56:433–439. https://doi.org/10.1037/0022-006X.56.3.433
33. Ricca V, Mannucci E, Moretti S, Di Bernardo M, Zucchi T, Cabras PL et al (2000) Screening for binge eating disorder in obese outpatients. Compr Psychiatry 41:111–115. https://doi.org/10.1016/S0010-440X(00)90143-3
34. Freitas SR, Lopes CS, Appolinario JC, Coutinho W (2006) The assessment of binge eating disorder in obese women: a comparison of the binge eating scale with the structured clinical interview for the DSM-IV. Eat Behav 7:282–289. https://doi.org/10.1016/j.eatbeh.2005.09.002
35. Robert SA, Rohana AG, Suehazlyn Z, Maniam T, Azhar SS, Azmi KN (2013) The validation of the malay version of binge eating scale: a comparison with the structured clinical interview for the DSM-IV. J Eat Disord 1:28. https://doi.org/10.1186/2050-2974-1-28
36. Dezhkam M, Moloodi R, Mootabi F, Omidvar N (2009) Standardization of the binge eating scale among iranian obese population. Iran J Psychiatry 4:143–146
37. Imperatori C, Innamorati M, Lamis DA, Contardi A, Continisio M, Castelnuovo G et al (2016) Factor structure of the binge eating scale in a large sample of obese and overweight patients attending low energy diet therapy. Eur Eat Disord Rev 24:174–178. https://doi.org/10.1002/erv.2384
38. Bjelland I, Dahl AA, Haug TT, Neckelmann D (2002) The validity of the hospital anxiety and depression scale. An updated literature review. J Psychosom Res 52:69–77. https://doi.org/10.1016/S0022-3999(01)00296-3
39. Olsson I, Mykletun A, Dahl AA (2005) The Hospital Anxiety and Depression Rating Scale: a cross-sectional study of psychometrics and case finding abilities in general practice. BMC Psychiatry 5:46. https://doi.org/10.1186/1471-244X-5-46
40. Iani L, Lauriola M, Costantini M (2014) A confirmatory bifactor analysis of the hospital anxiety and depression scale in an Italian community sample. Health Qual Life Outcomes 12:84. https://doi.org/10.1186/1477-7525-12-84
41. Fox-Wasylyshyn SM, El-Masri MM (2005) Handling missing data in self-report measures. Res Nurs Health 28:488–495. https://doi.org/10.1002/nur.20100
42. Muthen B, Asparouhov T (2012) Bayesian structural equation modeling: a more flexible representation of substantive theory. Psychol Methods 17:313–335. https://doi.org/10.1037/a0026802
43. van de Schoot R, Depaoli S (2014) Bayesian analyses: where to start and what to report. Eur Health Psychol 16:75–84
44. Zumbo BD, Gadermann AM, Zeisser C (2007) Ordinal versions of coefficients alpha and theta for likert rating scales. J Mod Appl Stat Methods 6:21–29. https://doi.org/10.22237/jmasm/1177992180
45. Burrows T, Skinner J, McKenna R, Rollo M (2017) Food addiction, binge eating disorder, and obesity: is there a relationship? Behav Sci. https://doi.org/10.3390/bs7030054
46. WHO (TheWorld Health Organisation). BMI Classifcation. Available online: http://apps.who.int/bmi/index.jsp?introPage=intro_3.htm. Accessed 10 Oct 2018
47. Meule A (2012) Food addiction and body-mass-index: a non-linear relationship. Med Hypotheses 79:508–511. https://doi.org/10.1016/j.mehy.2012.07.005
48. Gearhardt AN, White MA, Masheb RM, Grilo CM (2013) An examination of food addiction in a racially diverse sample of obese patients with binge eating disorder in primary care settings. Compr Psychiatry 54:500–505. https://doi.org/10.1016/j.comppsych.2012.12.009
49. Chao AM, Shaw JA, Pearl RL, Alamuddin N, Hopkins CM, Bakizada ZM et al (2017) Prevalence and psychosocial correlates of food addiction in persons with obesity seeking weight reduction. Compr Psychiatry 73:97–104. https://doi.org/10.1016/j.comppsych.2016.11.009
50. Ivezaj V, White MA, Grilo CM (2016) Examining binge-eating disorder and food addiction in adults with overweight and obesity. Obesity (Silver Spring) 24:2064–2069. https://doi.org/10.1002/oby.21607
51. Zellner DA, Garriga-Trillo A, Rohm E, Centeno S, Parker S (1999) Food liking and craving: a cross-cultural approach. Appetite 33:61–70. https://doi.org/10.1006/appe.1999.0234

52. Osman JL, Sobal J (2006) Chocolate cravings in American and Spanish individuals: biological and cultural influences. Appetite 47:290–301. https://doi.org/10.1016/j.appet.2006.04.008
53. Hallam J, Boswell RG, DeVito EE, Kober H (2016) Gender-related differences in food craving and obesity. Yale J Biol Med 89:161–173
54. Murphy CM, Stojek MK, MacKillop J (2014) Interrelationships among impulsive personality traits, food addiction. and body mass index. Appetite 73:45–50. https://doi.org/10.1016/j.appet.2013.10.008
55. Gearhardt AN, Boswell RG, White MA (2014) The association of "food addiction" with disordered eating and body mass index. Eat Behav 15:427–433. https://doi.org/10.1016/j.eatbeh.2014.05.001
56. Pursey KM, Collins CE, Stanwell P, Burrows TL (2015) Foods and dietary profiles associated with 'food addiction' in young adults. Addict Behav Rep 2:41–48. https://doi.org/10.1016/j.abrep.2015.05.007
57. Imperatori C, Innamorati M, Lamis DA, Farina B, Fabbricatore M, Contardi A (2018) Body uneasiness is associated with food addiction symptoms: a cross-sectional study. Eur Eat Disord Rev. https://doi.org/10.1002/erv.2640
58. Niedhammer I, Bugel I, Bonenfant S, Goldberg M, Leclerc A (2000) Validity of self-reported weight and height in the French GAZEL cohort. Int J Obes Relat Metab Disord 24:1111–1118. https://doi.org/10.1038/sj.ijo.0801375
59. Jacobson BH, DeBock DH (2001) Comparison of body mass index by self-reported versus measured height and weight. Percept Mot Skills 92:128–132. https://doi.org/10.2466/pms.2001.92.1.128
60. Kuczmarski MF, Kuczmarski RJ, Najjar M (2001) Effects of age on validity of self-reported height, weight, and body mass index: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. J Am Diet Assoc 101:28–34. https://doi.org/10.1016/S0002-8223(01)00008-6 quiz 5–6.
61. Spencer EA, Appleby PN, Davey GK, Key TJ (2002) Validity of self-reported height and weight in 4808 EPIC-Oxford participants. Public Health Nutr 5:561–565. https://doi.org/10.1079/PHN2001322
62. Lois K, Kumar S, Williams N, Birrell L (2011) Can self-reported height and weight be relied upon? Occup Med (Lond) 61:590–592. https://doi.org/10.1093/occmed/kqr140
63. Imperatori C, Innamorati M, Lamis DA, Farina B, Pompili M, Contardi A et al (2016) Childhood trauma in obese and overweight women with food addiction and clinical-level of binge eating. Child Abuse Negl 58:180–190. https://doi.org/10.1016/j.chiabu.2016.06.023
64. Vella SC, Pai NB (2017) A narrative review of potential treatment strategies for food addiction. Eat Weight Disord 22:387–393. https://doi.org/10.1007/s40519-017-0400-2