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Structural validity, measurement invariance, reliability and diagnostic accuracy of the Italian version of the Yale Food Addiction Scale 2.0 in patients with severe obesity and the general population

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Abstract

Purpose To examine the structural validity, measurement invariance, reliability, and some other psychometrical properties of the Italian version of the Yale Food Addiction Scale 2 (I-YFAS 2.0) in patients with severe obesity and the general population.

Methods 704 participants—400 inpatients with severe obesity and 304 participants enrolled from the general population—completed the I-YFAS 2.0 and questionnaires measuring eating disorder symptoms. A first confirmatory factor analysis (CFA) tested a hierarchical structure in which each item of the I-YFAS 2.0 loaded onto one of the twelve latent symptoms/criteria which loaded onto a general dimension of Food Addiction (FA). The second CFA tested a first-order structure in which symptoms/criteria of FA simply loaded onto a latent dimension. Measurement invariance (MI) between the group of inpatients with severe obesity and the sample from the general population was also tested. Finally, convergent validity, test–retest reliability, internal consistency, and prevalence analyses were performed.

Results CFAs confirmed the structure for the I-YFAS 2.0 for both the hierarchical structure and the first-order structure. Configural MI and strong MI were reached for hierarchical and the first-order structure, respectively. Internal consistencies were shown to be acceptable. Prevalence of FA was 24% in the group of inpatients with severe obesity and 3.6% in the sample from the general population.

Conclusions The I-YFAS 2.0 represents a valid and reliable questionnaire for the assessment of FA in both Italian adult inpatients with severe obesity and the general population, and is a psychometrically sound tool for clinical as well as research purposes.

Level of evidence Level V, descriptive study.

Keywords Food addiction · Obesity · YFAS · Scale validation · Psychometric properties · Measurement invariance

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Introduction

In the last 10 years, the construct of food addiction (FA) has become more and more popular [1–4], and has received increasing interest in both clinical and research practice [2, 5]. One of the reasons for its popularity could be attributed to its dual nature [2–4], that led to two hypotheses: Some individuals could be addicted to food and/or to their eating behavior [6]. Indeed, the construct of FA refers to the idea that high calories (and/or highly processed foods) should activate an addiction-like response in individuals [7] that may lead to excessive food consumption [8]. Therefore, FA seems to share clinical characteristics of some eating disorders (EDs, e.g., bulimia nervosa, binge eating disorder)

[7, 9] but also of substance-related and addictive disorders (SRAD) [10–12] as well as behavioral addictions [3, 13].

Individuals with problematic EDs—e.g., binge eating disorder (BED)—and/or with overweight/obesity are more exposed to FA [14–17] and often show a sort of addiction-like eating behaviors [16], reporting symptoms that can be seen also in addiction-related disorders—both SRAD as well as behavioral addictions [18–21]. These individuals often refer to a huge amount of time spent thinking of food and/or obtaining high palatable foods [20–22]. Moreover, they often report the inability to stop themselves to continue overeating despite well-known several adverse consequences [19, 21]. Furthermore, they also report the loss of control once they begin eating [23] as well as cravings symptoms [24]. As a consequence, these symptoms lead the individual to experience significant life impairment—physical, social, and psychological—and distress [9, 18–21, 25].

By a biological point of view, neuroscience revealed that aforementioned individuals showed alterations in brain circuitry similar to those with an addiction-related diagnosis—showing parallels between factors implicated in some EDs as well as in SRAD [24]. Indeed, akin to SRAD, an elevated activation in reward circuitry, through the release of dopamine, was observed in response to high palatable food cues [26], as well as a reduced stimulation of inhibitory regions in response to food consumption [27], that often lead to impulsive and/or compulsive food-intake behaviors [28]. Moreover, it was shown that 'food craving' in people can activate the hippocampus, caudate nucleus, and insula: which is analogous to 'drug craving' in people [29]. Furthermore, to complete the picture, it is well known that certain foods have a powerfully addictive and rewarding effect similar to drugs [30, 31].

These results suggest that the neural activation in response to high-caloric palatable foods (e.g., sweetened foods, foods with high levels of refined carbohydrates, and food with added fat) for individuals with addiction-like eating is comparable to that found in individuals with SRAD [32–35] and reinforces the hypothesis that—in some individuals with overweight/obesity—addictive processes may lead to a disproportionate food intake [36–38].

Considering this background, the second version of the Yale Food Addiction Scale (YFAS 2.0 [8, 39]) was developed at the light of DSM-5 SRAD criteria [10]. Whereas the first version of the YFAS was constructed on DSM-IV-TR substance dependence criteria [40] applied to palatable foods (e.g., chocolate, etc.) [41], the YFAS 2.0 reflects the DSM 5 version by assessing both abuse (e.g., failure in role obligations) and dependence (e.g., tolerance, withdrawal) criteria and the new criteria of craving (as well as clinically significant distress/impairment). Finally, by introducing a severity classification continuum (mild/moderate/severe), the YFAS 2.0 allows making a diagnostic interpretation of

the obtained score [8]. The YFAS 2.0 was translated and/or validated in several languages: German [42], French [43], Spanish [44], Italian [45], Arabic [46], Turkish [47], Korean [48], and Japanese [49]. Moreover, structural validity and other psychometric properties of this scale were tested in both general [8, 43, 45, 46, 49] and clinical populations [17, 44]—giving psychometrically sound results.

Considering structural validity findings from the general population, the original development study of Gearhardt et al. [8] was conducted on a first sample of 550 participants (average BMI = 26.67; SD = 6.76) and successively on a second sample of 224 participants (average BMI = 28.03; SD = 7.31). The two samples had an equal sex distribution. Authors specified a one-factor model solution by positing a single latent factor—Food Addiction—loaded by the eleven observed criteria measured by YFAS 2.0. Items evaluating the twelfth criterion (significant impairment and distress) were not included in the confirmatory factor analysis (CFA) because they assess clinical significance of the FA rather than indicators of individual criteria [8]. The performed CFA revealed an almost adequate model fit to the data, with factor loadings higher than 0.70. Moreover, the internal consistency was good as well as convergent, discriminant, and incremental validity [8]. The prevalence rate of FA diagnosis was 14.6% in participants of the first study and 15.8% in the second one. The German version [42] was validated first on a sample of 455 university students (study one), with a large majority of females (89%) and an average BMI equal to 22.32 (SD = 3.65), and further analyses were made on a second sample of 133 bariatric surgery candidates (study two) with a BMI of 48.80 (SD = 7.08). The CFA results for the sample of students revealed a good model fit to the data for the hypothesized single-factor structure. The prevalence rate of FA diagnosis was 9.7% in the first study and 47.4% in the second one. The Japanese version [49] was validated on a sample of 731 undergraduate students, with a large majority of females (78.5%) Even in this case, the CFA revealed a good model fit to the data for the single-factor structure and showed factor loadings ranging from 0.31 to 0.62. Internal consistency was found to be good. The prevalence rate of FA diagnosis was 3.3%. The first Italian study [45] was performed on a sample of 574 undergraduate medical students, balanced by sex, and with an average BMI of 22.5 (SD = 2.3). The CFA results showed a good model fit to the data, with factor loadings ranging from 0.79 to 0.93. Internal consistency was good, and the prevalence rate of FA diagnosis was 3.4%. The French validation study [43] was conducted on a sample of 330 participants, with a BMI of 23.3 (SD = 4.9). The CFA revealed a non-adequate fit for the single-factor structure (two out of three fit indices did not reach the threshold for good model fit to the data) with factor loadings ranging

from 0.31 to 0.74. However, internal consistency was satisfactory. The prevalence rate of FA diagnosis was 8.2%. Finally, the Arabic validation study [46] was conducted on a sample of 236 Egyptian medical students, balanced by sex, with an average BMI of 22.3 (SD = 4.1). Authors did not run a CFA testing the factorial structure of the YFAS 2.0. Internal consistency, measured with Cronbach's alpha, was found to be good and the prevalence rate of FA diagnosis was 11%.

To date, only two validation studies assessed the factorial validity of the YFAS 2.0 in the clinical population. The Spanish version of the YFAS 2.0 [44] was validated on three different samples: EDs patients (N = 135; average BMI = 26.89, SD = 10.17), gamblers (N = 166; average BMI = 26.48, SD = 4.83), and healthy controls (N = 152; average BMI = 22.12, SD = 4.08). The CFA revealed a good model fit to the data for the single-factor structure. Internal consistency was found to be good. The prevalence rate of FA diagnosis was 77.8% for EDs patients and 3.3% for healthy controls. The Australian study [17] assessed the psychometric properties of YFAS 2.0 in a sample of BED patients (average BM = 25.95, SD = 5.97) with a high majority of females (94%). The CFA revealed an almost adequate model fit for the single-factor solution, with factor loadings ranging from 0.61 to 0.93. The internal consistency was good as well as convergent, discriminant, and incremental validity. The prevalence rate of FA diagnosis was 42.3%.

As underlined by Meule and Gearhardt in a recent review [39], none of the aforementioned studies assessed whether the YFAS 2.0 items loaded onto the designed symptoms/criteria. Furthermore, among the YFAS 2.0 validation studies, only Meule [42] and Granero [44] provided a comparison between EDs patients and healthy controls. However, both studies did not report a thorough comparison between the structures of the YFAS 2.0 across these two populations and assumed that the model structure is equal between groups. It is crucial that the factorial structure of a scale is equivalent across different populations—due to the fact that the YFAS2.0 is retained as a screening instrument for FA, in clinical samples as well as in the general population.

However, to date, there is no study showing how the factorial structure of the YFAS 2.0 performs in different populations, such as people with severe obesity (BMI ≥ 35) and/or the general population.

Consequently, the present study was thus aimed to assess—for the first time—whether the YFAS 2.0 items loaded onto the designed symptoms/criteria as well as the test–retest reliability and measurement invariance of the I-YFAS 2.0 in a sample of inpatients with severe obesity compared to a sample of subjects enrolled from the general population, in addition to its structural validity and internal consistency.

Materials and methods

Participants

The sample comprised 704 participants: 400 inpatients with severe obesity [176 males (44.0%) and 224 females (56.0%) aged from 18 to 79 years (mean = 55.54, SD = 12.72)] and 304 individuals [91 males (29.9%) and 213 females (70.1%) aged from 18 to 87 years (mean = 34.26, SD = 16.29)] from the general population. Inpatients with severe obesity (BMI ≥ 35) were recruited at the San Giuseppe Hospital, IRCCS, Istituto Auxologico Italiano, Verbania (Italy) during the first week of a one-month inpatient program for weight reduction and rehabilitation. Individuals from the general population were enrolled in Padua (Italy). Inclusion criteria were: (A) being over 18 years old; (B) being native Italian-speaker; and—for inpatients with severe obesity only—(C) having a BMI higher or equal to 35 (BMI ≥ 35). Exclusion criteria were: (D) illiteracy; (E) inability to complete the assessment due to vision and/or cognitive impairments; and (F) denial of informed consent. All participants signed a written and informed consent.

Translation and cultural adaptation

According to international guidelines [50, 51], the Italian version of YFAS 2.0 was independently translated from the original English version into Italian by two bilingual clinicians who are experts in the field. To ensure equivalence between translations, a blind back-translation was conducted by an independent bilingual translator. The final version of the I-YFAS 2.0 was trialed with a random sample of 30 individuals (15 inpatients with severe obesity and 15 non-clinical participants) in order to assess items' comprehensibility. No further adjustments were required.

Measures

Bio-demographics

Information including age, gender, weight (in kg), height (in m), desired weight, minimum and maximum weight reached was collected with a self-report form preceding the I-YFAS 2.0. Weight and height data were used to compute BMI [52].

The Yale Food Addiction Scale 2.0 (YFAS2.0)

The YFAS 2.0 [8, 39] is a 35-item self-report questionnaire assessing FA symptoms in both general [43, 45, 46, 49] and clinical populations [8, 17, 44]. The YFAS 2.0 assesses the 11 DSM-5 diagnostic criteria for SRAD [10] and the

significant impairment and/or distress related to food. Items concern the key behavioral features of addiction-like eating behaviors in which the person engaged over the previous 12 months (1 year). Specifically, the criteria assessed by the YFAS 2.0 are: (A) "Substance taken in larger amount and for longer period than intended" (consumed more than intended); (B) "Persistent desire or repeated unsuccessful attempts to quit" (unable to cut down or stop); (C) "Much time/activity to obtain, use, recover" (great deal of time spent); (D) = "Important social, occupational, or recreational activities given up or reduced" (important activities given up); (E) = "Use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems)" (use despite physical/emotional consequences); (F) = "Tolerance (marked increase in amount; marked decrease in effect)"; (G) = "Characteristic withdrawal symptoms; substance taken to relieve withdrawal" (withdrawal); (H) = "Continued use despite social or interpersonal problems" (use despite interpersonal/social problems); (I) = "Failure to fulfill major role obligation (e.g., work, school, home)" (failure in role obligation); (J) = "Use in physically hazardous situations" (use in physically hazardous situations); (K) "Craving, or a strong desire or urge to use" (craving); (L) = "Significant distress/impairment" (distress). The questionnaire is scored on an 8-point Likert-type scale (ranging from 0 = "never" to 7 = "every day"). To compute the final score, each of the 35 items has to be transformed (dichotomized; 0 = "non-endorsed" vs. 1 = "endorsed") according to an item-specific cutoff [8]. Subsequently, according to Gearhardt et al. [8], it is possible to determine the presence (vs. absence) of each criterion via these thresholds.

Finally, in line with the first version of the YFAS (YFAS1.0; e.g., [16, 41]), also this version provides two different scoring options. The first one is the *symptom count* score: the number of FA symptoms experienced in the previous 12 months, ranging from 0 to 11; the L criterion (impairment/distress) should not be counted. The second one is the *diagnostic score*: FA is diagnosed when the participant reports (at least) 2 or more symptoms plus a clinically significant impairment/distress. Moreover, FA could be diagnosed as *mild* if there are 2 or 3 symptoms and clinically significant impairment/distress, *moderate* if there are 4 or 5 symptoms and significant impairment/distress, or *severe* if there are 6 or more symptoms and significant impairment/distress [8].

The Binge Eating Scale (BES)

The BES [53, 54] is a 16-item self-report measure of binge eating severity in both general [16] and clinical population [55]. The BES investigates the frequency of feelings, thoughts, and behaviors associated with BED; its items consist of groups of three or four statements increasing in severity which constitutes two subscales (FC—Feelings/Cognitions; and B—Behaviors) and a total score [55]. Usually, the BES has satisfactory internal consistency and several studies highlight its great ability to discriminate between clinical and non-clinical individuals [53], showing also a high concordance with the interview-based diagnosis of binge eating disorder [56]. The BES has generally received support as an adequately reliable and valid measure of eating-related pathology. In this study, Cronbach's alphas were 0.895, 0.825, and 0.806 for the BES Total scale, the FC scale, and the B scale, respectively.

The Dutch Eating Behavior Questionnaire (DEBQ)

The DEBQ [57, 58] is a 33-item self-report measure of behaviors and attitudes related to ED in both general [16, 59] and clinical populations [60]. Items concern the occurrence of key psychological as well as behavioral features of EDs in which the person engages. The questionnaire is scored on a 5-point Likert scale (1–5), and its item composes three subscales (Restrained Eating—RE; Emotional Eating—EE; and External Eating—ExE) and a total score. Also, the DEBQ has shown to be an adequately reliable and valid measure of eating-related pathology with a strong three-factor structure, high internal consistency, and high test–retest reliability after a 4-week period [57–60]. In this study, Cronbach's alphas were 0.920, 0.893, 0.965, and 0.829 for the total scale, the RE scale, the EE scale, and the ExE scale, respectively.

The Eating Disorder Examination Questionnaire 6.0 (EDEQ)

The EDEQ 6.0 [61, 62] is a 28-item self-report measure of ED behaviors, attitudes, and tendencies to psychopathology in both general [63, 64] and clinical populations [65]. Items concern the frequency of key behavioral features of EDs in which the person engages over the preceding 28 days. The questionnaire is scored on a 7-point Likert scale (0–6), and its item composes four subscales (Restraint—R; Eating Concern—EC; Shape Concern—SC; and Weight Concern—WC) and a global score. The EDEQ has generally received support as an adequately reliable and valid measure of eating-related pathology [63, 64]. In this study, Cronbach's alphas were 0.928, 0.802, 0.748, 889, and 0.729 for the EDEQ Total scale, the Restraint scale, the Eating Concern scale; the Shape Concern scale, and Weight Concern scale, respectively.

Statistical analyses

Statistical analyses were performed with R software (v. 3.5.3) [R-core project [66, 67] and the following packages:

psych (v. 1.8.12; [68]), lme4 (v. 1.1-21; [69]), lavaan (v. 0.6-5; [70, 71]), pROC (v. 1.13.0 [72]), and semTools (v. 0.5-2 [73]). Graphical representations—reported in Supplementary material 'S1'—were performed with the R package ggplot2 (v. 3.1.0 [74]).

Two different structural models were sequentially tested by means of CFA: a hierarchical model (Fig. 1) and a first-order model (Fig. 2). In the hierarchical model, each of the 35 items of the I-YFAS 2.0 loaded onto its specific criteria (from Criterion A to Criterion L), which in turn loaded onto an overarching general (second-order) latent dimension. In the first-order model, in line with previous validations of the YFAS 2.0 [8, 17, 43–46, 49], each of the eleven symptoms (from Criterion A to Criterion K) loaded onto a latent dimension.

Considering the binary response scale (non-endorsed vs. endorsed)—both for items and for criteria/symptoms (Table 5)—the diagonally weighted least square (DWLS) estimator was used to assess the factorial structure of the I-YFA S 2.0 [75–77]. Model fit was assessed by means of several indices: the Chi-square statistics (χ^2) [78], the Root-Mean-Square Error of Approximation (RMSEA) [79–81], the Comparative Fit Index (CFI) [82], and the ratio of χ^2 to the degrees of freedom (df) [77, 83, 84]. The following

criteria were used as cutoffs for an ideal fit [85, 86]. A χ^2 test non-significant is desirable [81, 87]. The RMSEA values should be lower than 0.08 for an 'acceptable' model fit [85, 88] and below 0.05 to indicate a 'good' fit [89]. The CFI values should be between 0.90 and 0.95 for an 'acceptable' fit [75, 85, 89] and higher than 0.95 to indicate a 'good' fit [88, 90]. Also, the χ^2/df should be lower or equal to 3 to indicate a 'good' fit [16, 84, 91–94].

Measurement invariance (MI) analyses were computed and specified to evaluate whether the two aforementioned structures of the I-YFAS 2.0 (the hierarchical model and the first-order model) were invariant between the sample of inpatients with severe obesity and the individuals from the general population [95]. The following procedure was performed for the hierarchical model—merging the technique suggested by Dolan [96, 97] and the current guidelines for the treatment of dichotomous data [75, 78, 98–101]. Three nested models were sequentially specified and constrained to equality: the hierarchical structure (Model 1: Configural Invariance); first-order factor loadings and thresholds (Model 2); first- and second-order factor loadings and thresholds of measured variables (Model 3: Strong Invariance); first- and second-order factor loadings, thresholds of measured variables, and factor means
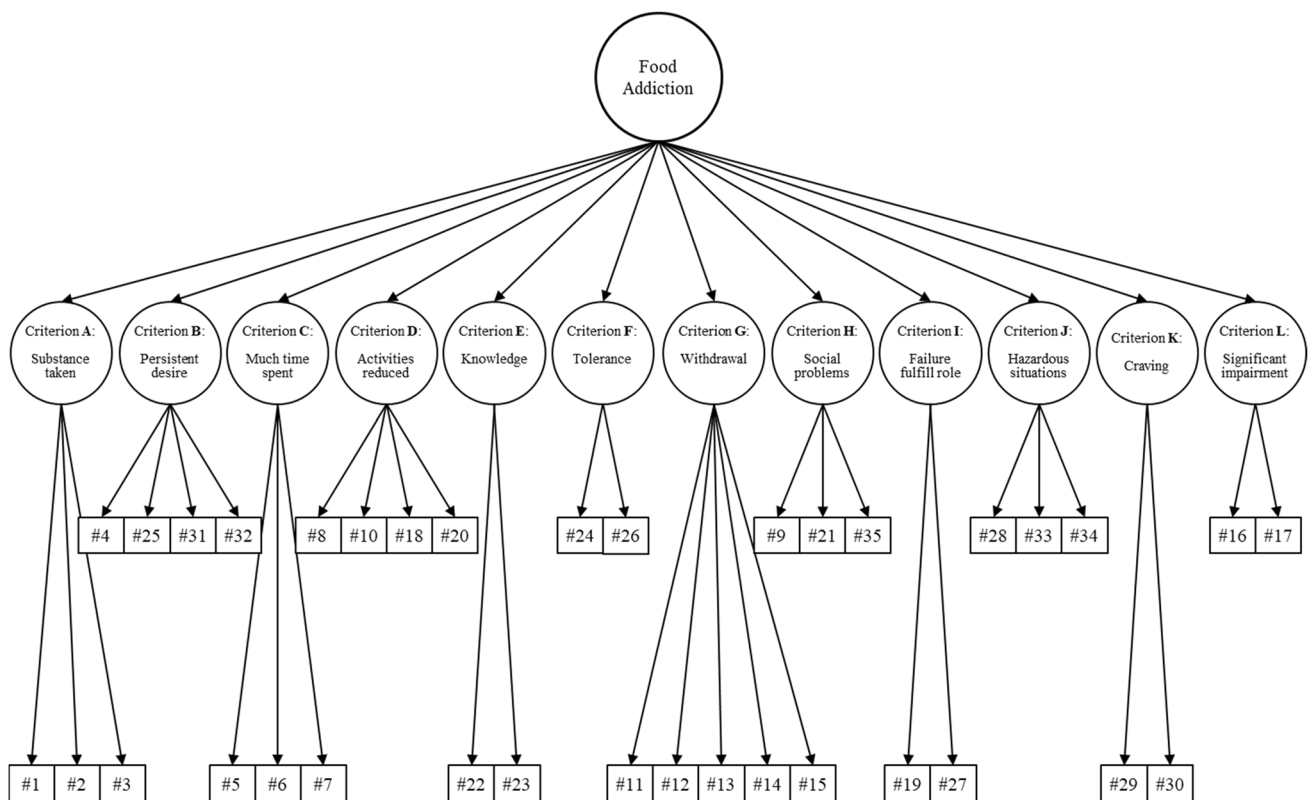

Fig. 1 The hierarchical model of the YFAS2.0. Items loaded onto its first-order latent symptom/criterion which in turn they loaded onto a second-order (general) latent variable
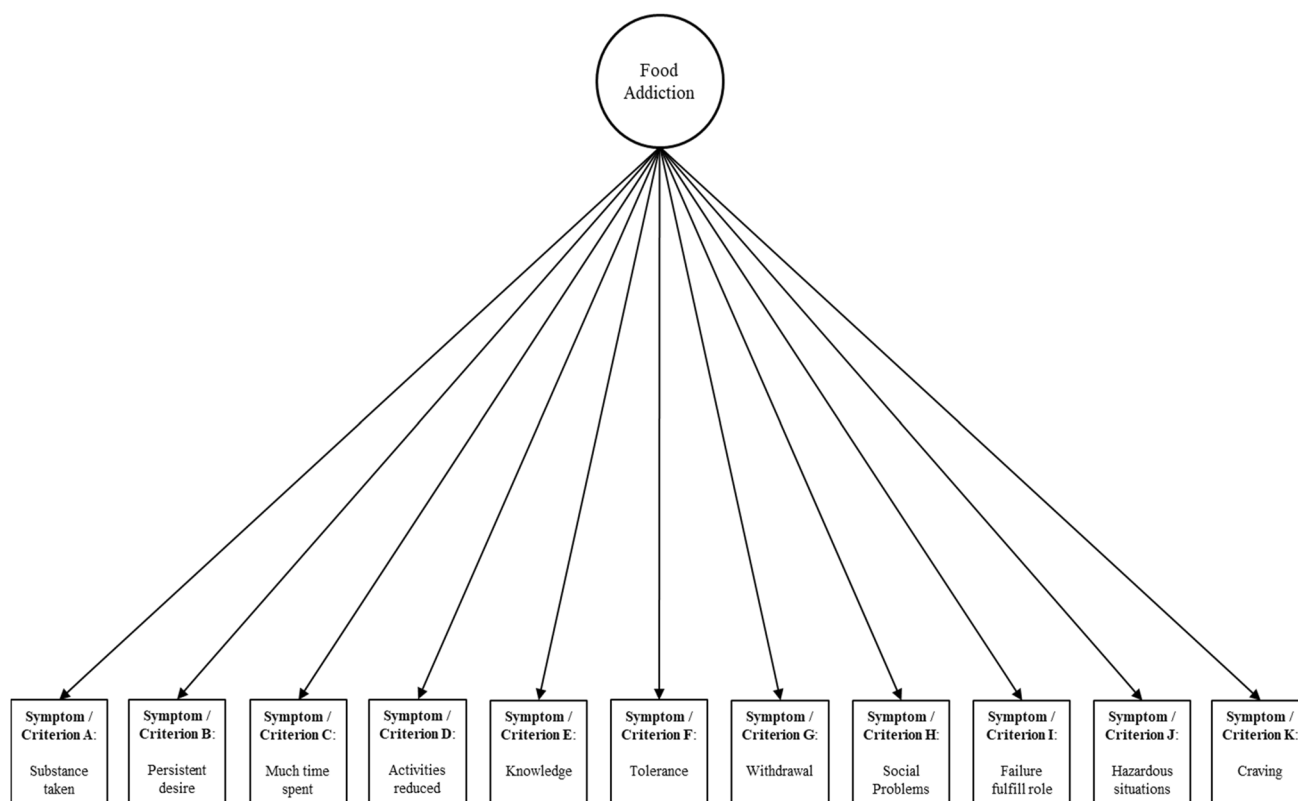
Fig. 2 First-order model of the YFAS2.0. Each of the eleven symptoms/criteria of food addiction loaded onto a first-order latent variable

(Model 4: Means Invariance). Differently, the 'usual' procedure for models with categorical indicators was followed for the first-order model [95, 98, 102–105]. In this case, the simple first-order model (Configural Invariance), the factor loadings and items' thresholds (Strong Invariance), and latent means (Means Invariance) were sequentially constrained to equality between groups.

Measurement invariance was assessed by using test differences in three fit indices and with the following criteria as cutoffs for model equivalence: DIFFTEST (equal to $\Delta\chi^2$; p value > 0.050), ΔCFI (< 0.010), and ΔRMSEA (< 0.015) [75, 78, 98, 106]. An excess of the cutoff in two out of these three indices, combined with worse fit indices, was considered as the evidence of model *non*-invariance.

Categorical McDonald's omega was used as a measure of internal consistency for the I-YFAS 2.0 in each CFA. More in detail, omega hierarchical (ωh; the proportion of the second-order factor explaining the total score, or the coefficient omega), omega total (ωt; the proportion of the second-order factor explaining the variance at first-order factor level), and omega partial (ωp; proportion of observed variance explained by the second-order factor after partialling the uniqueness from the first-order factor) were computed for the hierarchical model [107–111]. For the first-order model, ωt was computed [107–111] and it

was supported by the Kuder–Richardson coefficient (KR-20) [112].

Convergent validity was assessed with the Pearson correlation coefficient [113]. The strength of correlations was interpreted using the Cohen's benchmarks: $r < .10$, trivial; r from 0.10 to 0.30, small; r from 0.30 to 0.50, moderate; $r > 0.50$, large [114]. In addition, the χ^2 was performed to assess the associations between the I-YFAS 2.0 diagnostic score and the other measures' clinical thresholds [113]. A deepened analysis of the relation between BMI an I-YFAS 2.0 symptom count is reported in the Supplementary Material 'S1.'

According to guidelines [115, 116], the test–retest reliability of the first-order model was estimated on a subsample of 20 inpatients with severe obesity by using the two-way mixed intraclass correlation coefficient ($ICC_{consistency}$) [92, 117]. This statistic was used to evaluate also the stability of the FA diagnosis.

Considering that the YFAS 2.0 was conceptualized as a screening tool for FA [8, 41], a Receiver Operating Characteristics (ROC) curve methodology was used to assess its accuracy to differentiate between inpatients with severe obesity and individuals from the general population [118, 119]. Moreover, according to previous studies [44], the sample (inpatients with severe obesity versus the general population) was used as an

external criterion variable and the I-YFAS Symptom Count score was used as the dependent variable. Moreover, according to Gearhardt et al. [8], a latent multivariate variable (MLV) was created ad hoc by including the measures of EDs symptoms (the BES FC scale, the BES B scale, the DEBQ ExE, the DEBQ EE and the EDEQ EC) and its factor score (FS) was extracted. Values higher than the 75° percentiles of the MLV FS distribution were considered as indicators of ED and labeled as "case" (opposite, values lower than the 75° percentiles were labeled as "control") into the ROC curve analyses. The global accuracy–validity of the I-YFAS 2.0 was estimated with the area under the ROC curve (AUC; 5000 stratified bootstrap resamples)—interpreted using the Swets' benchmarks: AUC = 0.50, null; AUC from 0.51 to 0.70, small; AUC from 0.71 to 0.90, moderate; AUC from 0.91 to 0.99, large; and AUC = 1.00, perfect accuracy [120, 121]. Moreover, sensibility (Se) and specificity (Sp) were computed for the cutoff point [118, 119].

Incremental validity was examined performing two different stepwise hierarchical multiple regressions. The first analysis was conducted to assess whether the YFAS 2.0 symptom score predicts a statistically significant incremental variance (ΔR^2) in BMI. The second regression analysis was carried out to test whether the YFAS 2.0 symptom scores predict a statistically significant incremental variance (ΔR^2) in BED attitudes. For each regression analysis, potential confounds variables (e.g., EDs convergent measures, sociodemographic variables) were firstly entered in the regression equation and tested with a stepwise procedure. The YFAS 2.0 symptom score was then added, and the ΔR^2 was checked to evaluate the YFAS 2.0 symptom score contribution.

Prevalence analyses were performed concerning symptoms endorsement as well as the diagnosis (no FA vs. mild FA vs. moderate FA vs. severe FA).

Finally, the independent sample t-test and the one-way analyses of variance (ANOVA) were, respectively, performed to examine differences in the EDs measures between FA diagnoses (No FA vs. FA) and FA severity levels (mild FA vs. moderate FA vs. severe FA). The strength of differences was interpreted using the Cohen's f and Cohen's d [122] and their benchmarks: null ($f < 0.10$; $d < 0.20$); small (f from 0.10 to 0.25; d from 0.20 to 0.49); moderate (f from 0.25 to 0.40; d from 0.50 to 0.79); and large ($f \geq 0.40$; $d \geq 0.80$). Finally, the Games–Howell test was chosen for performing post-hoc analysis [113, 123–125].

Results

Sample characteristics

Inpatients with severe obesity

Inpatients' BMI ranged from 35.06 to 81.04 [mean = 42.99; SD = 6.47; skewness = 1.85; kurtosis = 6.28]. According to the WHO BMI classification, 152 individuals (38%) had an obesity class II BMI (from 35 to 39.99) and 248 (62%) an obesity class III BMI (BMI ≥ 40). The one sample's t test revealed that the mean BMI of inpatients with severe obesity was significantly different from the WHO obesity class I cutoff criterion (BMI = 34.99; $t = 25.47$; $p < 0.001$) The self-reported minimum weight reached by inpatients during adolescence ranged from 25 to 110 kg (mean = 56.40; SD = 16.09), and the self-reported maximum weight reached ranged from 30 to 160 kg (mean = 70.50; SD = 21.81). The self-reported minimum weight reached during the adulthood ranged from 40 to 210 kg (mean = 70.73; SD = 22.87), and the self-reported maximum weight reached ranged from 45 to 247.2 kg (mean = 121.22; SD = 34.57). Inpatients' desired weight ranged from 50 to 130 kg (mean = 81.97; SD = 15.58).

Individuals from the general population

BMI ranged from 14.84 to 39.26 [mean = 22.65; SD = 3.67; skewness = 0.85; kurtosis = 0.99]. Two hundred and seven individuals (68.1%) had a BMI that falls into a normal weight range (from 18.5 to 24.99). Twenty-five participants (8.2%) were underweight (BMI from 16 to 18.5), and 5 (1.6%) were severely underweight (BMI < 16). Fifty-six subjects (18.4%) had a BMI that falls into the overweight class (from 25 to 29.99), 10 participants (3.3%) had a BMI that falls into the obesity class I (from 30 to 34.99), and only one individual had a BMI that falls into the obesity class II (from 35 to 39.99). One sample's t tests revealed that the study sample was neither underweight (BMI = 18.49; t = 19.76; $p < 0.001$) nor overweight (BMI = 25; t = − 11.13; $p < 0.001$) on average. The self-reported minimum weight reached during adolescence ranged from 30 to 99 kg (mean = 51.34; SD = 9.70), and the self-reported maximum weight reached ranged from 42 to 110 kg (mean = 60.29; SD = 10.80). The self-reported minimum weight reached during adulthood ranged from 34 to 90 kg (mean = 55.35; SD = 9.58), and the self-reported maximum weight reached ranged from 45 to 110 kg (mean = 66.60; SD = 11.99). Participants' desired weight ranged from 42 to 98 kg (mean = 59.32; SD = 10.07).

Structural validity

Hierarchical model

The second-order model (Fig. 1) shows an acceptable fit to the data (Table 1) for the two samples combined. Despite the Chi-square statistic resulted to be statistically significant [χ^2 (548) = 938.403; $p < 0.001$], the CFI (CFI = 0.990), the RMSEA [RMSEA = 0.032; 90% CI 0.028–0.035; p(RMSEA < 0.05) = 1] and the χ^2/df (χ^2/df = 1.712) were indicative of an adequate model fit. As depicted in Table 1, all the first-order items' loadings were statistically significant (mean = 0.853; SD = 0.08) as well as the second-order loadings (mean = 0.888; SD = 0.06).

Regarding the sample of inpatients with severe obesity, the Chi-square statistic resulted to be statistically significant [χ^2 (548) = 719.408; $p < 0.001$]. However, the CFI (CFI = 0.994), the RMSEA [RMSEA = 0.028; 90% CI 0.022–0.033; p(RMSEA < 0.05) = 1], and the χ^2/df (χ^2/df = 1.313) were indicative of an good model fit. As depicted in Table 1, all the first-order items' loadings were statistically significant (mean = 0.843; SD = 0.09) as well as the second-order loadings (mean = 0.886; SD = 0.08).

Regarding the sample of individuals from the general population, the Chi-square statistic resulted to be statistically significant [χ^2 (548) = 1000.908; $p < 0.001$]. However, the CFI (CFI = 0.964), the RMSEA [RMSEA = 0.052; 90% CI 0.047–0.057; p(RMSEA < 0.05) = 0.233], and the χ^2/df (χ^2/df = 1.827) were indicative of a good model fit. As depicted in Table 1, all first-order items were statistically significant (mean = 0.858; SD = 0.129), as well as the second-order loadings (mean = 0.846; SD = 0.09).

First-order model

The single-factor model (Fig. 2) shows a good fit to the data for the two samples combined. Although the Chi-square statistic resulted to be statistically significant [χ^2 (44) = 60.645; $p = 0.049$], all the other fit indices revealed a good fit to the data: the CFI = 0.998, the RMSEA = 0.023; 90% CI 0.002–0.036; p(RMSEA < 0.05) = 1, and the χ^2/df = 1.378. As reported in Table 2, all the items' loadings were statistically significant and ranged from 0.728 (Criterion A) to 0.871 (Criterion E) (mean = 0.818; SD = 0.04).

Regarding sample of *inpatients* with *severe obesity*, all of the fit indices revealed a good fit to the data: χ^2 (44) = 40.186; $p = 0.636$ ns, the CFI = 1.000, the RMSEA = 0.000; 90% CI 0.000–0.029; p(RMSEA < 0.05) = 1], and the χ^2/df = 0.913. As shown in Table 2, all of the items' loadings were statistically significant ($p < 0.001$) and ranged from 0.706 (Criterion H) to 0.899 (Criterion K); *mean* = 0.809; SD = 0.06.

Also regarding *sample of the general population*, all fit indices revealed a good fit to the data: χ^2 (44) = 50.827; $p = 0.223$ ns, CFI = 0.996, RMSEA = 0.023; 90% CI 0.000–0.046; p(RMSEA < 0.05) = 0.974], and χ^2/df = 1.155. As reported in Table 2, all the items' loadings were statistically significant and ranged from 0.661 (Criterion F) to 0.936 (Criterion I) (mean = 0.795; SD = 0.08).

Measurement invariance

Hierarchical model

Configural invariance A second-order configural invariance model was specified between inpatients with severe obesity and the general population, and the same hierarchical model was estimated simultaneously within each group. Good model fit indices were found: χ^2 (1096) = 1720.316, $p < 0.001$; CFI = 0.984, RMSEA = 0.040; 90% CI 0.037–0.044; p(RMSEA < 0.05) = 1, and the χ^2/df = 1.569. The achieved configural invariance suggests that the hierarchical structure was similar between groups.

Strong invariance The second-order strong invariance model reported negative observed variances—and as a result, comparison of fit indices was not performed. Consequently, means invariance was not tested.

First-order model

Configural invariance A first-order configural invariance model was specified between groups. Good model fit indices were found (χ^2 (88) = 91.013, $p = 0.392$ ns; CFI = 1.00, RMSEA = 0.010; 90% CI 0.000–0.031; p(RMSEA < 0.05) = 1, and the χ^2/df = 1.034), suggesting that, even in this case, the factor structure was similar between inpatient with severe obesity and the general population.

Strong invariance Also the first-order strong invariance model still fitted data well: χ^2 (97) = 110.903, $p = 0.158$ ns; CFI = 0.998, RMSEA = 0.020; 90% CI 0.000–0.036; p(RMSEA < 0.05) = 1, and the χ^2/df = 1.143. In this case, *non*-significant decreases—in two out of three fit indices—were found (DIFTEST = 19.890; $p = 0.019$; ΔRMSEA = 0.010; ΔCFI = − 0.001), indicating that items were equivalently related to the latent factor between groups and had the same expected item response at the same absolute level of the trait.

Means invariance Finally, even the first-order means invariance model revealed adequate fit indices: χ^2 (98) = 201.428, $p < 0.001$; CFI = 0.987, RMSEA = 0.055; 90% CI 0.044–

Table 1 Structural validity of the YFAS2.0 second-order model presented in Fig. 1: Item factor loadings (λ) and explained variance (R^2)

	Overall sample (*n*=704)		Inpatients with obesity (*n*=400)		General population (*n*=304)	
	λ	R^2	λ	R^2	λ	R^2
Criterion A						
Item#1	0.778	0.605	0.792	0.627	0.689	0.475
Item#2	0.706	0.498	0.776	0.602	0.601	0.361
Item#3	0.977	0.954	0.996	0.993	0.973	0.947
Criterion B						
Item#4	0.658	0.433	0.609	0.371	0.569	0.324
Item#25	0.869	0.755	0.869	0.755	0.904	0.816
Item#31	0.910	0.828	0.880	0.774	0.976	0.953
Item#32	0.980	0.961	0.970	0.941	0.927	0.859
Criterion C						
Item#5	0.895	0.801	0.880	0.775	0.995	0.991
Item#6	0.796	0.634	0.860	0.739	0.565	0.320
Item#7	0.808	0.653	0.773	0.598	0.868	0.754
Criterion D						
Item#8	0.923	0.851	0.904	0.818	0.947	0.896
Item#10	0.725	0.522	0.727	0.529	0.933	0.871
Item#18	0.939	0.881	0.921	0.849	0.972	0.944
Item#20	0.847	0.717	0.841	0.708	0.897	0.804
Criterion E						
Item#22	0.893	0.798	0.910	0.828	0.801	0.642
Item#23	0.854	0.730	0.845	0.714	0.715	0.511
Criterion F						
Item#24	0.807	0.651	0.810	0.655	0.673	0.452
Item#26	0.969	0.938	0.968	0.936	0.986	0.972
Criterion G						
Item#11	0.851	0.725	0.834	0.696	0.852	0.726
Item#12	0.860	0.740	0.841	0.708	0.972	0.944
Item#13	0.921	0.848	0.927	0.860	0.896	0.804
Item#14	0.800	0.640	0.826	0.682	0.800	0.640
Item#15	0.860	0.739	0.880	0.775	0.733	0.537
Criterion H						
Item#9	0.838	0.703	0.778	0.605	0.952	0.906
Item#21	0.822	0.675	0.793	0.630	0.994	0.989
Item#35	0.740	0.547	0.644	0.414	0.687	0.472
Criterion I						
Item#19	0.892	0.795	0.824	0.679	0.995	0.990
Item#27	0.743	0.552	0.664	0.441	0.870	0.756
Criterion J						
Item#28	0.926	0.857	0.949	0.901	0.774	0.599
Item#33	0.837	0.700	0.869	0.755	0.931	0.868
Item#34	0.795	0.631	0.766	0.587	0.919	0.845
Criterion K						
Item#29	0.952	0.906	0.953	0.909	0.957	0.916
Item#30	0.962	0.926	0.969	0.939	0.918	0.842
Criterion L						
Item#16	0.907	0.823	0.890	0.793	0.917	0.840
Item#17	0.811	0.657	0.761	0.579	0.873	0.761
General dimension of Food Addiction (FA)						
Criterion A	0.770	0.593	0.734	0.539	0.864	0.747

Table 1 (continued)

	Overall sample ($n = 704$)		Inpatients with obesity ($n = 400$)		General population ($n = 304$)	
	λ	R^2	λ	R^2	λ	R^2
Criterion B	0.807	0.651	0.785	0.616	0.675	0.456
Criterion C	0.946	0.895	0.922	0.850	0.939	0.882
Criterion D	0.858	0.737	0.874	0.764	0.798	0.637
Criterion E	0.978	0.957	0.976	0.953	0.992	0.985
Criterion F	0.910	0.829	0.925	0.856	0.735	0.541
Criterion G	0.869	0.755	0.890	0.793	0.849	0.720
Criterion H	0.881	0.776	0.865	0.749	0.860	0.739
Criterion I	0.940	0.883	0.965	0.930	0.906	0.821
Criterion J	0.852	0.726	0.787	0.619	0.917	0.840
Criterion K	0.909	0.825	0.916	0.838	0.906	0.821
Criterion L	0.947	0.897	0.995	0.990	0.706	0.499

Criterion A = "Substance taken in larger amount and for longer period than intended"; *Criterion B* = "Persistent desire or repeated unsuccessful attempts to quit"; *Criterion C* = "Much time/activity to obtain, use, recover"; *Criterion D* = "Important social, occupational, or recreational activities given up or reduced"; *Criterion E* = "Use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems)"; *Criterion F* = "Tolerance (marked increase in amount; marked decrease in effect)"; *Criterion G* = "Characteristic withdrawal symptoms; substance taken to relieve withdrawal"; *Criterion H* = "Continued use despite social or interpersonal problems"; *Criterion I* = "Failure to fulfill major role obligation (e.g., work, school, home)"; *Criterion J* = "Use in physically hazardous situations"; *Criterion K* = "Craving, or a strong desire or urge to use"; *Criterion L* "Use causes clinically significant impairment or distress"

Table 2 Structural validity of the eleven YFAS2.0 symptoms/criteria: item factor loadings (λ) and explained variance (R^2)

	Overall sample ($n = 704$)		Inpatients with obesity ($n = 400$)		General population ($n = 304$)	
	λ	R^2	λ	R^2	λ	R^2
Criterion A	0.728	0.531	0.748	0.559	0.685	0.470
Criterion B	0.800	0.640	0.762	0.581	0.780	0.608
Criterion C	0.863	0.744	0.845	0.714	0.863	0.745
Criterion D	0.772	0.597	0.779	0.607	0.803	0.644
Criterion E	0.871	0.759	0.862	0.743	0.839	0.704
Criterion F	0.847	0.718	0.880	0.774	0.664	0.441
Criterion G	0.814	0.662	0.829	0.687	0.806	0.649
Criterion H	0.776	0.603	0.706	0.498	0.812	0.660
Criterion I	0.820	0.672	0.776	0.602	0.860	0.740
Criterion J	0.836	0.699	0.816	0.666	0.743	0.552
Criterion K	0.865	0.748	0.899	0.808	0.813	0.662

Criterion A = "Substance taken in larger amount and for longer period than intended"; *Criterion B* = "Persistent desire or repeated unsuccessful attempts to quit"; *Criterion C* = "Much time/activity to obtain, use, recover"; *Criterion D* = "Important social, occupational, or recreational activities given up or reduced"; *Criterion E* = "Use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems)"; *Criterion F* = "Tolerance (marked increase in amount; marked decrease in effect)"; *Criterion G* = "Characteristic withdrawal symptoms; substance taken to relieve withdrawal"; *Criterion H* = "Continued use despite social or interpersonal problems"; *Criterion I* = "Failure to fulfill major role obligation (e.g., work, school, home)"; *Criterion J* = "Use in physically hazardous situations"; *Criterion K* = "Craving, or a strong desire or urge to use." According to Gearhardt et al. (2016), the Criterion L (Significant distress/impairment) does not enter the "symptom count" factorial structure

0.066; p(RMSEA < 0.05) = 0.221, and the $\chi 2/df = 2.055$. However, decreases in fit indices compared to the strong invariance model were found (DIFTEST = 90.525, $p < 0.001$;

ΔRMSEA = 0.035; ΔCFI = −0.011), suggesting that groups had not the same expected latent mean of the traits.

Reliability

Reliability analysis revealed satisfying results. Indeed, for the hierarchical model, ωh was equal to 0.959, ωt was equal to 0.979 and ωp was equal to 0.987. In line with these results, ωt was equal to 0.900 and KR20 was 0.874 for the first-order model.

Convergent validity

As shown in Table 3, moderate-to-large correlations were found between the I-YFAS 2.0 symptom count and the BES scales (BES total score: $r = 0.664$, $p < 0.001$; FC scale: $r = 0.639$, $p < 0.001$; B scale: $r = 0.610$; $p < 0.001$), the DEBQ scales (DEBQ total score: $r = 0.448$, $p < 0.001$; EE scale: $r = 0.487$, $p < 0.001$; ExE scale: $r = 0.426$; $p < 0.001$), and the EDEQ 6 scales (EDEQ total score: $r = 0.511$, $p < 0.001$; EC scale: $r = 0.523$, $p < 0.001$; SC scale: $r = 0.480$, $p < 0.001$; WC scale: $r = 0.456$, $p < 0.001$). In addition, a moderate association was found between I-YFAS 2.0 symptom count and the BMI: $r = 0.311$, $p < 0.001$ (see Supplementary Material).

Furthermore, the Chi-square test showed statistically significant associations between the diagnostic scores and both the BES [$\chi^2 = 149.211$; $p < 0.001$], the EDEQ [$\chi^2 = 76.127$; $p < 0.001$], and the BMI [$\chi^2 = 65.053$; $p < 0.001$] clinical thresholds.

Test–retest reliability

Test–retest reliability statistics revealed good results. Indeed, the two-way mixed ICC was equal to 0.853 (95% CI 0.580–0.949) for the first-order model and equal to 0.96 (95% CI 0.886–0.896) for the FA diagnosis.

Accuracy of the YFAS 2.0 as a screening/diagnostic tool

The symptoms count of the I-YFAS 2.0 obtained good accuracy in discriminating between inpatients with severe obesity and the general population: AUC = 0.706; 95% CI = 0.670–0.741; s.e. = 0.018; $p < 0.001$; with a Se equal to 0.875 (95% CI 0.836–0.911) and a Sp equal to 0.412 (95% CI 0.363–0.463).

Considering the MLV, a preliminary CFA assessed its adequateness. Results of this preliminary analysis revealed an adequate fit to a one-factor solution (χ^2 (5) = 9379, $p = 0.095$ ns, CFI = 0.995, RMSEA = 0.043 (95% CI 0.000–0.085), SRMR = 0.043) with loadings that ranged from 0.532 to 0.880; these results supported the presence of a single MLV. The symptoms count of the I-YFAS 2.0 obtained good accuracy in discriminating between groups (MLV FS ≤ 75° vs. MLV FS ≥ 76°): AUC = 0.849; 95%

Table 3 Correlations between scales and subscales

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Symptom count	1.94	2.74	–													
2 BES—total	9.86	8.61	0.664	–												
3 Feelings	4.81	4.59	0.639	0.941	–											
4 Behaviors	5.05	4.56	0.610	0.940	0.769	–										
5 DEBQ—Total	2.67	0.67	0.448	0.625	0.621	0.555	–									
6 Restraint	2.77	0.91	$-0.018^{\S}$	$0.077^{\S}$	0.154	$-0.009^{\S}$	0.509	–								
7 Emotional	2.43	1.09	0.487	0.658	0.626	0.614	0.880	0.143	–							
8 External	2.88	0.73	0.426	0.507	0.464	0.490	0.681	$0.014^{\S}$	0.533	–						
9 EDEQ—total	2.04	1.04	0.511	0.596	0.649	0.470	0.563	0.496	0.451	0.217	–					
10 Restraint	1.77	1.62	0.299	0.293	0.350	0.201	0.421	0.585	0.246	$0.062^{\S}$	0.762	–				
11 Eating concern	1.07	1.22	0.523	0.655	0.677	0.555	0.506	0.253	0.481	0.299	0.804	0.483	–			
12 Shape concern	2.92	1.67	0.480	0.555	0.602	0.441	0.496	0.386	0.424	0.204	0.915	0.540	0.657	–		
13 Weight concern	2.41	1.45	0.456	0.562	0.613	0.443	0.497	0.417	0.407	0.202	0.904	0.512	0.664	0.887	–	
14 BMI	34.16	11.34	0.311	0.161	0.192	$0.110^{\dagger}$	$0.073^{\S}$	$0.080^{\S}$	$0.119^{\dagger}$	$-0.110^{\dagger}$	0.399	0.266	0.239	0.447	0.384	–

All correlations are statistically significant with $p < 0.001$, except: $^{\dagger}p < 0.010$; $^{\S}p > 0.050$ ns

CI = 0.806—0.891; s.e. = 0.022; $p < 0.001$; with a Se equal to 0.807 (95% CI 0.737–0.877) and a Sp equal to 0.768 (95% CI 0.724–0.810).

Incremental validity

The first stepwise hierarchical multiple regression was performed to examine the contribution of the YFAS 2.0 symptom count in predicting incremental variance in BMI (Table 4). In Step 1, two EDEQ subscales scores (SC and R) and two DEBQ subscales scores (ExE and RE) were entered into the regression and accounted for the 24.9% of BMI variance. In Step 2, the YFAS 2.0 symptom count was entered in the regression equation and was found to increase significantly the proportion of BMI variance accounted for by the model: 30.3%; $\Delta R^2 = 0.054$.

The second stepwise hierarchical multiple regression was carried out to explore the contribution of the YFAS 2.0 symptom count in predicting incremental variance in binge eating attitudes (BES) (Table 4). In Step 1, two EDEQ subscales scores (EC and WC) and three DEBQ subscales scores (ExE, EE and RE) were entered into the regression and accounted for the 61.1% of BMI variance. In Step 2, the entrance of the YFAS 2.0 symptom count increased significantly the proportion of variance in binge eating attitudes accounted for by the model: 65.4%; $\Delta R^2 = 0.043$.

Prevalence of FA symptoms and FA diagnosis

Regarding the two samples combined, the number of FA symptoms that were met by participants ranged from 0 to 11 (mean = 1.942; SD = 2.739; median = 1). The lowest endorsement rate was for "Substance taken in larger amount and for a longer period than intended" (Criteria C—10.23%), while the highest was for "Persistent desire or repeated unsuccessful attempts to quit" (Criteria H—36.8%). The diagnostic threshold for FA was met by 15.20% of participants ($n = 107$). More in detail, two or three symptoms (mild FA) were endorsed by 18 participants (2.56%), four or five symptoms (moderate FA) were endorsed by 25 participants (3.55%), and six or more symptoms (severe FA) were endorsed by 64 participants (9.09%). Finally, 10 subjects

Table 4 Incremental validity analyses

Predictors	β	t	p value	R^2_{adj}	ΔR^2_{adj}	$F(\Delta R^2_{adj})$	p value
First stepwise hierarchical regression analysis—dependent variable: BMI							
Step 1[a]							
EDEQ SC	0.493	10.109	$p < 0.001$				
DEBQ ExE	−0.198	−4.844	$p < 0.001$				
DEBQ RE	−0.161	−3.235	$p = 0.001$				
EDEQ R	0.109	1.996	$p = 0.047$	0.249			
Step 2							
EDEQ SC	0.374	7.365	$p < 0.001$				
DEBQ ExE	−0.282	−6.754	$p < 0.001$				
DEBQ RE	−0.091	−1.852	$p = 0.065$				
EDEQ R	0.050	0.941	$p = 0.347$				
YFAS2.0 symptom	0.290	6.064	$p < 0.001$	0.303	0.054	36.772	$p < .001$
Second stepwise hierarchical regression analysis—dependent variable: binge eating tendencies (BES)							
Step 1[a]							
DEBQ EE	0.367	9.891	$p < 0.001$				
EDEQ EC	0.307	7.453	$p < 0.001$				
DEBQ ExE	0.143	4.261	$p < 0.001$				
EDEQ WC	0.221	5.237	$p < 0.001$				
DEBQ RE	−0.099	−3.096	$p = 0.002$	0.611			
Step 2							
DEBQ EE	0.315	8.838	$p < 0.001$				
EDEQ EC	0.243	6.106	$p < 0.001$				
DEBQ ExE	0.103	3.209	$p = 0.001$				
EDEQ WC	0.151	3.708	$p < 0.001$				
DEBQ RE	−0.053	−1.730	$p = 0.084$				
YFAS2.0 symptom	0.265	7.611	$p < 0.001$	0.654	0.043	57.929	$p < .001$

a = step 1 is the final result of a stepwise procedure comprising several variables (e.g., BES total scale, EDEQ subscales, and DEBQ subscales) in which only the best predictors were kept into the model

(1.42%) met only the clinical impairment criterion but, according to Gearhardt et al [8], did not receive an FA diagnosis. Descriptive statistics are displayed in Table 5.

Regarding the sample of inpatients with severe obesity, the number of FA symptoms that were met ranges from 0 to 11 (mean = 2.745; SD = 3.055; median = 2). The lowest endorsement rate was for "Substance taken in larger amount and for a longer period than intended" (Criteria C—15%), while the highest was for "Continued use despite social or interpersonal problems" (Criteria H—54.5%). The diagnostic threshold for FA was met by 24% (n = 96). More in detail, two or three symptoms (mild FA) were endorsed by 13 (3.25%), four or five symptoms (moderate FA) were endorsed by 22 (5.5%), and six or more symptoms (severe FA) were endorsed by 4 (15.25%). Finally, 4 inpatients (1%) met only the clinical impairment criterion (and the most one criterion) but, according to Gearhardt et al. [8], did not receive an FA diagnosis.

Regarding the sample of the *general population*, the number of FA symptoms that were met ranges from 0 to 11 (mean = 0.885; SD = 1.775; median = 0). The lowest endorsement rate was for "Substance taken in larger amount and for a longer period than intended" (Criteria C—3.95%),

while the highest was for "Persistent desire or repeated unsuccessful attempts to quit" (Criteria G—12.5%). The diagnostic threshold for FA was met by 3.62% (n = 11). More in detail, two or three symptoms (mild FA) were endorsed by 5 (1.65%), four or five symptoms (moderate FA) were endorsed by 3 (0.99%), and six or more symptoms (severe FA) were endorsed by 3 (0.99%). Finally, 6 subjects (1.97%) met only the clinical impairment criterion (and the most one criterion) but, according to Gearhardt et al. [8], did not receive an FA diagnosis.

FA versus no FA comparisons on ED measures

The group of study participants who received an FA diagnosis showed significantly higher values in binge eating tendencies (BES total: $t = -10.42$, $d = 1.26$; FC: $t = -10.60$, $d = 1.27$; B: $t = -8.86$, $d = 1.08$), in disordered eating attitudes (DEBQ total: $t = -8.40$, $d = 0.91$; EE: $t = -8.26$, $d = 0.95$; ExE: $t = -6.23$, $d = 0.72$), in EDs tendencies (EDEQ total: $t = -10.62$, $d = 1.41$; R: $t = -6.61$, $d = 0.80$; EC: $t = -7.53$, $d = 1.03$; SC: $t = -12.68$, $d = 1.38$; WC: $t = -11.19$, $d = 1.31$), and in BMI ($t = -7.43$, $d = 0.74$) (Table 6).

Table 5 Prevalence of FA symptoms

	Overall sample (n = 704)		Inpatients with obesity (n = 400)		General population (n = 304)	
	%Not met	%Met	%Not met	%Met	%Not met	%Met
Criterion A	85.09	14.91	81.5	18.5	89.80	10.20
Criterion B	80.11	19.89	69.25	30.75	94.41	5.59
Criterion C	89.77	10.23	85	15	96.05	3.95
Criterion D	87.50	12.50	84.5	15.5	91.45	8.55
Criterion E	78.41	21.59	69.25	30.75	90.46	9.54
Criterion F	88.49	11.51	83.75	16.25	94.74	5.26
Criterion G	82.24	17.76	78.25	21.75	87.50	12.50
Criterion H	63.92	36.08	45.5	54.5	88.16	11.84
Criterion I	79.97	20.03	70.5	29.5	92.43	7.57
Criterion J	80.68	19.32	71.25	28.75	93.09	6.91
Criterion K	89.63	10.37	86.75	13.25	93.42	6.58
Criterion L	83.38	16.62	75	25	94.41	5.59
	n	*%*	*n*	*%*	*n*	*%*
No FA	597	84.80	304	76	293	96.38
Mild FA	18	2.56	13	3.25	5	1.65
Moderate FA	25	3.55	22	5.5	3	0.99
Severe FA	64	9.09	61	15.25	3	0.99

Criterion A = "Substance taken in larger amount and for longer period than intended"; *Criterion B* = "Persistent desire or repeated unsuccessful attempts to quit"; *Criterion C* = "Much time/activity to obtain, use, recover"; *Criterion D* = "Important social, occupational, or recreational activities given up or reduced"; *Criterion E* = "Use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems)"; *Criterion F* = "Tolerance (marked increase in amount; marked decrease in effect)"; *Criterion G* = "Characteristic withdrawal symptoms; substance taken to relieve withdrawal"; *Criterion H* = "Continued use despite social or interpersonal problems"; *Criterion I* = "Failure to fulfill major role obligation (e.g., work, school, home)"; *Criterion J* = "Use in physically hazardous situations"; *Criterion K* = "Craving, or a strong desire or urge to use"; *Criterion L* "Use causes clinically significant impairment or distress"

Table 6 Comparison of the YFAS 2.0 diagnoses (No FA vs. FA) and diagnostic categories (mild FA, moderate FA, and severe FA) with EDs measures and BMI

	No FA (n=597)		FA (n=107)				1—Mild FA (n=18)		2—Moderate FA (n=25)		3—Severe FA (n=64)		1 versus 2		1 versus 3		2 versus 3	
	Mean	SD	Mean	SD	t	d	Mean	SD	Mean	SD	Mean	SD	t	d	t	d	t	d
BES	8.04	7.08	18.83	9.79	−10.42*	1.26	15.94	7.10	10.41	5.92	22.73	9.42	2.65‡	0.84	−2.76†	0.81	−7.03*	1.57
FC	3.85	3.82	9.57	5.08	−10.60*	1.27	8.47	4.16	5.23	3.18	11.46	4.86	2.77‡	0.88	−2.31‡	0.66	−6.76*	1.52
B	4.19	3.84	9.26	5.42	−8.86*	1.08	7.47	4.09	5.18	3.26	11.27	5.41	1.94§	0.62	−2.68†	0.79	−6.17*	1.36
DEBQ	2.57	0.63	3.15	0.66	−8.40*	0.91	3.13	0.66	2.71	0.61	3.32	0.62	2.06§	0.66	−1.10§	0.30	−3.99*	1.00
RE	2.76	0.88	2.81	1.02	−0.57§	0.06	3.34	0.87	2.75	1.03	2.69	1.02	1.90§	0.62	−2.34‡	0.69	−0.24§	0.06
EE	2.26	0.99	3.29	1.15	−8.26*	0.95	2.99	1.04	2.57	0.98	3.63	1.10	1.30§	0.42	−2.13§	0.60	−3.96*	1.01
ExE	2.79	0.68	3.32	0.79	−6.23*	0.72	3.11	0.85	2.86	0.74	3.55	0.71	0.97§	0.31	−2.16§	0.56	−3.84†	0.95
EDEQ	1.80	1.16	3.32	0.99	−10.62*	1.41	3.59	0.80	2.97	0.84	3.37	1.07	2.14§	0.76	−0.71§	0.23	−1.39§	0.42
R	1.56	1.52	2.86	1.71	−6.61*	0.80	3.71	1.33	2.52	1.70	2.69	1.76	2.18§	0.78	2.23§	0.65	−0.35§	0.10
EC	0.87	1.07	2.16	1.41	−7.53*	1.03	1.92	0.97	1.66	1.04	2.44	1.61	0.73§	0.26	−1.48§	0.39	−2.22§	0.58
SC	2.63	1.59	4.50	1.08	−12.68*	1.38	4.77	1.06	4.23	0.87	4.52	1.15	1.58§	0.55	0.74§	0.23	−0.93§	0.28
WC	2.15	1.36	3.78	1.11	−11.19*	1.31	3.96	1.16	3.46	0.97	3.84	1.15	1.33§	0.47	0.35§	0.10	−1.21§	0.36
BMI	32.99	11.23	40.69	9.60	−7.43*	0.74	38.14	10.87	41.97	13.29	40.90	7.30	−1.00§	0.32	−1.01§	0.30	0.38§	0.10

t = independent sample t test; d = effect size (Cohen's d). t test's p values between diagnostic criteria are corrected with Games–Howell post-hoc test. All t test p values are: *$p < 0.001$; †$p < 0.010$; ‡$p < 0.050$; §$p > 0.050$ ns; d = effect size (Cohen's d)

FA severity levels comparisons in EDs measures

Statistically significant differences across the FA severity levels were found in the BES total score ($F = 18.537$, $p < 0.001$, and $f = 0.612$) as well as in the FC subscale ($F = 16.620$, $p < 0.001$; and $f = 0.579$) and the B subscale ($F = 14.317$, $p < 0.001$; and $f = 0.538$). Regarding the DEBQ EDs attitudes, statistically significant differences between the FA severity levels were found in the DEBQ total score ($F = 7.788$, $p = 0.001$; and $f = 0.397$) as well as in the EE subscale ($F = 8.699$, $p < 0.001$; and $f = 0.419$) and the ExE subscale ($F = 7.738$, $p = 0.001$; and $f = 0.395$). No statistically significant difference was found in the RE subscale ($F = 2.887$, $p = 0.061$; and $f = 0.241$). Regarding the EDEQ EDs tendencies, no statistically significant difference was found between the FA severity levels in any scale [EDEQ total score ($F = 1.733$, $p = 0.184$; and $f = 0.215$), the R subscale ($F = 2.486$, $p = 0.090$; and $f = 0.257$), the EC subscale ($F = 2.192$, $p = 0.119$; and $f = 0.242$), the SC subscale ($F = 1.006$, $p = 0.371$; and $f = 0.164$), and the WC subscale ($F = 0.965$, $p = 0.386$; and $f = 0.160$)]. Finally, no statistically significant difference was found in BMI ($F = 0.870$, $p = 0.422$; and $f = 0.127$) (Table 6).

Discussion

In the last few years, FA has increased exponentially its popularity [1–4] and has received more and more interest in both clinical and research fields [2, 5]. According to Gearhardt et al. [8], FA relies on the evidence that some foods may be potentially addictive [20–22, 32–35]. Indeed, several studies highlighted that the neural reward response triggered by high palatable food (e.g., chocolate, pizza, etc.) is observed also in SRAD (e.g., drug and/or alcohol) [4, 13, 27, 126–130] as well as in certain EDs (e.g., bulimia nervosa, BED) [12, 39, 131, 132]. Based on this parallelism and in light of the DSM-5 SRAD criteria, the YFAS 2.0 [8] rapidly became the instrument of choice for the assessment of FA [6, 18, 39].

The aim of this study was to extensively examine—for the first time—several psychometrical properties of the I-YFAS 2.0 that have not been tested yet, such as the factorial structure at the item level and the measurement invariance between inpatients with severe obesity and the general population, filling thus the gap recently underlined in scientific literature [39].

Two different models were specified: at the item level (the hierarchical model; Fig. 1) and at the symptom/criteria level (the first-order model; Fig. 2). These models were assessed on the two samples combined as well as in the sample of inpatients with severe obesity and in the sample of the general population, separately. For each of the aforementioned samples, CFA successfully confirmed that all of the 35 items of the I-YFAS 2.0 loaded onto the supposed criteria that in turn loaded onto the general dimension of FA (Fig. 1). CFA revealed also that the I-YFAS 2.0 has good structural validity with good fit indices. Furthermore, first-order factor loading revealed a strong relationship between the items and the corresponding latent symptom/criteria [75, 77, 78, 85].

However, some differences emerged between the sample of inpatients with severe obesity and the general population. These differences suggest a different conceptualization of the latent construct of FA across these two samples. Item#3 (Criterion A: *"I ate to the point where I felt physically ill"*) and item#32 (Criterion B: *"I tried and failed to cut down on or stop eating certain foods"*) were the most representative item for the sample of inpatients with severe obesity, and these results could partially explain the strong association between FA, BED, and obesity [13, 15, 133]. On the other hand, item#5 (Criterion C: *"I spent a lot of time feeling sluggish or tired from overeating"*), item#19 (Criterion I: *"My overeating got in the way of me taking care of my family or doing household chores."*), and item#21 (Criterion H: *"I avoided social situations because people wouldn't approve of how much I ate."*) were the most representative for the sample from the general population. These results could be partially explained by the possible presence of people with a co-diagnosis of ED such as anorexia nervosa and/or bulimia nervosa [39, 133]. Furthermore, individuals from the general population are probably more tied to their social context than individuals with severe obesity—something that could work as a protection factor (buffer) from the development and/or onset of disordered eating attitudes and other psychological issues [134–139]. Furthermore, Criterion L (*"Use causes clinically significant impairment or distress"*) was the most representative for the sample of inpatients with severe obesity at the level of symptoms/criteria, while Criterion E ("Use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems) was the most representative for the sample from the general population. Taken together, these results suggest that individuals with severe obesity were more focused on the internal negative consequences of FA (both physical and psychological), probably due to a stronger food-dependency [13, 26, 39, 131]. Conversely, individuals from the general population were more focused on the external negative consequences of FA, for example, avoiding social situations and fulfilling social roles.

MI was thus tested to explore at which level (structural vs. loadings and thresholds) the differences between the two samples were. As advocated by Meule and Gearhardt [39], it was essential to investigate that items correctly loaded onto the respective criteria and that this factor structure was at least equivalent across different populations—like inpatients with severe obesity and the general population. The configural invariance was reached for the hierarchical model, and achieving structural invariance should be considered as a good result. Indeed, the YFAS 2.0 does not work at the level of the items but at the level of criteria [8, 39]; thus, the achievement of configural invariance demonstrated that the I-YFAS 2.0 symptoms/criteria were effectively loaded by the supposed items. These results provide the first scientific evidence that the YFAS 2.0 scoring procedure is correct.

Considering the first-order model (Fig. 2), CFA successfully confirmed that all the 11 symptoms/criteria of the I-YFAS 2.0 loaded onto a latent dimension of FA. Perfectly in line with the literature, CFA revealed that the I-YFAS 2.0 had excellent fit indices and an excellent structural validity [80, 82, 87, 92] in each sample (the two samples combined, the inpatients with severe obesity and the general population). As reported in Table 2, considering the overall sample, all of the items showed high factor loadings, revealing a strong relationship between the items and the latent dimension of FA. Moreover, both fit indices and factor loadings were in line with previous validation studies [42–49]—slightly observed differences could be due to differences in sample size, sample composition, and/or cultural differences [39]. Also in this case, some differences emerged between the sample of inpatients with severe obesity and the general population—that reinforce the idea of a different conceptualization of the latent construct of FA across these two samples. Criterion K (*"Craving, or a strong desire or urge to use"*) and Criterion F (*"Tolerance (marked increase in amount; marked decrease in effect)"*) were the most representative criteria for people with severe obesity—suggesting that the 'craving' symptom/criterion should be responsible of the overlap between FA, BED, and obesity [13, 15, 133]. These results also reinforce the idea that these individuals are more focused on physical and psychological negative consequences of FA—probably due to a stronger food-dependency than people in the general population [13, 26, 39, 131]. However, it should be highlighted that differences in results between the higher-order CFA and this first-order model are probably due to the absence of the distress symptom/criterion in the latter structural model (according to Gearhardt and colleagues [8]). On the other hand, Criterion C (*"Much time/activity to obtain, use, recover"*) and Criterion I (*"Failure to fulfill major role obligation (e.g., work, school, home)"*) were the most representative criteria for the general population. Even in this case, these results suggest that these individuals are more focused on negative consequences of FA not strictly related to psychological and physical dependency of food (interpersonal)—such as fulfill of social role.

MI analysis was performed to explore these differences between the two samples, and strong invariance was achieved. This kind of invariance suggests that the eleven items were equivalently related to the latent FA factor in each sample and that samples had the same expected item response at the same absolute level of the trait. The MI of the *first-order* factor structure [8, 39] was tested for the first time between two samples with clearly different characteristics—inpatients with severe obesity and the general population—which can be translated, in a very raw way, to a huge

difference in BMI. These results suggest that participants in the two samples interpreted the YFAS 2.0 questions in the same way (the factorial structure was equal across samples), with the same strength (items were related to the latent construct equally between the two samples), and with the same starting point (items thresholds were equal between the two samples). However, the latent trait was not equally distributed and related to inpatients with severe obesity and the general population (latent means were different between the two samples). These results suggest that the comparisons between these two samples should be taken with caution and attention (different latent means), but these two groups were perfectly comparable (equal items threshold) [80, 82, 87, 92].

Reliability analyses were also performed, providing satisfying results for both the structural models that were tested. Considering the dichotomous nature of the YFAS 2.0 response scale, categorical McDonald ω and KR20 were computed [107–112] and both showed a high internal consistency of the I-YFAS 2.0, which is in line with the literature [8, 39, 42–46, 49]. A totally new result was instead the good one-month test–retest reliability of both the I-YFAS 2.0 symptom count and diagnosis as was shown by the two-way mixed ICC [140].

Convergent validity analyses were also performed. In line with the previous validation studies, significant correlations were found between the I-YFAS 2.0 symptom count and EDs measures [39, 141]. The strongest correlations were found with the BES total score ($r = 0.664$), its subscales (BES feelings, $r = 0.639$; BES behaviors, $r = 0.610$), and the EDEQ eating concern scale ($r = 0.523$). These correlations suggest a strong association between FA and EDs, due to the imaginable presence of people with a co-diagnosis such as FA and BED or FA and bulimia nervosa [39, 133]. A significant, but small correlation was found also with BMI ($r = 0.311$). Despite the common idea that people with a high BMI is positively linearly associated with FA, these results showed a nonlinear relation between these two variables (Table 1, Supplementary material), as underlined by the correlations reported in Table 3 and as also argued by Meule [142] and Meule and Gearhardt [39].

In addition, results from the ROC analyses showed for the first time that the I-YFAS 2.0 is a good screening/diagnostic tool for the detection of FA in different populations. The I-YFAS 2.0 showed a good strength of accuracy (AUC = 0.706), modest Sp (0.412), and high Se (0.875) in discriminating between inpatients with severe obesity and individuals from the general population. Moreover, considering the ED's ad hoc created MLV, the I-YFAS 2.0 showed an excellent strength of accuracy (AUC = 0.849), high Sp (0.768), and high Se (0.807) in discriminating between participants with EDs tendencies and participants with no EDs tendencies. These results show the good ability of the I-YFAS 2.0 to correctly detect people with FA and support both the (small) association between YFAS 2.0 symptom count and BMI as well as the association between FA and EDs.

Furthermore, the I-YFAS 2.0 symptom score accounted for unique variance in BMI as well as in BED tendencies. Considering BMI, the I-YFAS 2.0 symptom score increased significantly the proportion of BMI variance accounted for by the model (total $R^2 = 30.3$) in line with previous studies [43]. This result suggests a (small) positive relationship between BMI and FA—that in some cases seems to be nonlinear: indeed, according to Meule, despite FA positively relates to BMI, the slope levels off in higher body weight ranges [39, 142]. Considering the BED tendencies, the I-YFAS 2.0 symptom score increased the proportion of BES variance accounted for by the model (total $R^2 = 65.4$).

Prevalence analysis revealed the classical 'J-shape curve' found in the previous studies [8, 44, 45, 49] for both the sample of inpatients with severe obesity and the general population. Considering the sample of inpatients with severe obesity, the diagnostic threshold for FA was met by 24% of participants ($n = 96$). More in detail, 'Mild FA' was endorsed by 13 participants (3.25%), 'Moderate FA' was endorsed by 22 participants (5.5%), and 'Severe FA' was endorsed by 61 participants (15.25%). Moreover, the lowest endorsement rate (15%) was for the Criteria C ("Substance taken in larger amount and for a longer period than intended"), while the highest (54.5%) was for Criterion H ("Continued use despite social or interpersonal problems"). Considering the sample of the general population, the diagnostic threshold for FA was met by 3.62% of participants ($n = 11$): More in detail, 'Mild FA' was endorsed by 5 participants (1.65%), 'Moderate FA' was endorsed by 3 participants (0.99%), and 'Severe FA' was endorsed by 6 participants (1.97%). Moreover, the lowest endorsement rate (3.95%) was for the Criteria C ("Substance taken in larger amount and for a longer period than intended"), while the highest (12.5%) was for Criteria G ("Characteristic withdrawal symptoms; substance taken to relieve withdrawal)—probably due to the presence of EDs diagnosis in comorbidity. Differences in endorsement rate—across the two samples of this study as well as between previous studies—should be due to cross-cultural differences and/or differences in sample size and/or in sample composition. Indeed, some studies may have enrolled individuals with a co-diagnosis of ED, thus modifying the endorsement of some symptoms/criteria (e.g., a high prevalence of individuals with BED and/or bulimia nervosa).

Statistically significant differences were found between individuals with FA and individuals without FA in almost all the EDs measures and also in BMI. The largest differences were found in the EDEQ total score ($d = 1.41$), the EDEQ shape concern subscale ($d = 1.38$), the EDEQ weight concern ($d = 1.31$), and the BES feelings subscale ($d = 1.27$).

These results are in line with previous studies that showed a good discriminant ability of the YFAS 2.0 between subjects with EDs and subjects without EDs [44] and are supported by the results of the ROC curve analysis. These results corroborate the aforementioned hypothesis that people with FA should be more prone to have an ED in comorbidity. Statistically significant differences in EDs measures were also found across the YFAS 2.0 severity levels—in particular, between 'Mild FA' and 'Severe FA'—with the exception of the DEBQ RE subscale, the EDEQ subscales, and the BMI. The lack of statistically significant differences in those variables is probably due to the characteristics of participants composing the three categories, which consisted of both inpatients with severe obesity (the majority, 89.7%) and people from the general population (the minority, 10.3%). Moreover, as argued before, the absence of differences in the aforementioned EDs measures between the YFAS 2.0 severity levels should be due to the conceivable presence of individuals with a co-diagnosis of an ED such as BED or bulimia nervosa across each YFAS 2.0 severity class [39, 44, 133].

Despite these interesting findings, several limitations have to be underlined. First of all, although the sample size was adequate to perform a CFA, small number of individuals with FA not allowed to perform a MI analysis of the I-YFAS 2.0 between participants with a FA diagnosis and the ones without a FA diagnosis. Also, this study lacks of a specific EDs screening, not allowing a comparison between the general population, inpatients with severe obesity, and subjects with ED—representing an interesting perspective for future studies. Moreover, the number of participants ($n=20$) who were re-administered the I-YFAS 2.0 was enough for the assessment of the test–retest reliability but was far from being adequate for a longitudinal MI analysis. Finally, no other measure of FA was used. However, it has to be highlighted that—to date—no other questionnaires assessed FA from the general perspective of DSM 5 SRAD. Indeed, for example, the 'Food Craving Questionnaire (state and trait)' refers solely to the specific 'craving' criterion. Moreover, the 'Rep(-EAT)-Q' as well as the 'Grazing Inventory' assessed the attitudes to graze, but they do not consider the SRAD criteria. Finally, the 'Addictive-Like Eating Behavior Scale' measures the eating addiction rather than FA.

Despite these limitations, this study indicates that the I-YFAS 2.0 is a good instrument for the assessment of FA in both the clinical and the general populations, and it can also be considered as a valid and reliable tool to be used in the research of FA.

Finally, the I-YFAS2.0 should be considered as a starting point for the assessment of FA and in the planning of psychological treatments [143–150]. By means of both the I-YFAS 2.0 symptom count and diagnosis, healthcare professionals could get support in making clinical decisions about patients with severe obesity as well as individuals from the general population who request a visit for problems related to weight, food, and EDs.

What is already known on this subject?

Parallels in the biological, psychological, and behavioral factors implicated in addiction and problematic eating have led to the hypothesis that an addictive process may contribute to excessive food consumption.

To date, the Yale Food Addiction Scale 2.0 (YFAS 2.0) is currently the most important instrument to investigate the addiction-like eating behavior according to the DSM-5 Substance-Related Use Disorder (SRAD) criteria.

The YFAS 2.0 was successfully translated and/or validated in several languages: German, French, Spanish, Italian, Arabic, Turkish, Korean, and Japanese.

What does this study add?

The present study aimed to cover a lack underlined by Meule and Gearhardt in a recent review [39]: Indeed, none of the aforementioned validation studies assessed whether the YFAS 2.0 items loaded onto the designed symptoms/criteria.

The present study aimed—for the first time—to assess measurement invariance of the Italian version of the YFAS 2.0 in a sample of inpatients with severe obesity compared to a sample of subjects enrolled from the general population.

The present study aimed to provide a first reliable estimation of prevalence of food addiction in a sample of inpatients with severe obesity and the general population.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is 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 Written informed consent was obtained from all participants. Informed consent was obtained from all participants included in the study prior to accessing the survey.

References

1. Meule A (2015) Back by popular demand: a narrative review on the history of food addiction research. Yale J Biol Med 88:295–302
2. Gordon EL et al (2018) What is the evidence for "food addiction"? A systematic review. Nutrients 10:477
3. Hebebrand 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
4. Albayrak Ö, Wölfle SM, Hebebrand J (2012) Does food addiction exist? A phenomenological discussion based on the psychiatric classification of substance-related disorders and addiction. Obes Facts 5:165–179. https://doi.org/10.1159/000338310
5. Long CG, Blundell JE, Finlayson G (2015) A systematic review of the application and correlates of YFAS-diagnosed 'food addiction' in humans: are eating-related 'addictions' a cause for concern or empty concepts? Obes Facts 8:386–401. https://doi.org/10.1159/000442403
6. 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
7. Davis C et al (2011) Evidence that 'food addiction' is a valid phenotype of obesity. Appetite 57:711–717. https://doi.org/10.1016/j.appet.2011.08.017
8. 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
9. Brewerton TD (2017) Food addiction as a proxy for eating disorder and obesity severity, trauma history, PTSD symptoms, and comorbidity. Eat Weight Disord 22:241–247. https://doi.org/10.1007/s40519-016-0355-8
10. American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders, 5th edn. American Psychiatric Association, Washington, DC
11. Grant JE et al (2010) Introduction to behavioral addictions. Am J Drug Alcohol Abuse 36:233–241. https://doi.org/10.3109/00952990.2010.491884
12. García-García I et al (2014) Reward processing in obesity, substance addiction and non-substance addiction. Obes Rev 15:853–869. https://doi.org/10.1111/obr.12221
13. Davis C (2013) Compulsive overeating as an addictive behavior: overlap between food addiction and binge eating disorder. Curr Obes Rep 2:171–178. https://doi.org/10.1007/s13679-013-0049-8
14. 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
15. Gearhardt AN et al (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
16. Manzoni GM 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
17. Linardon J, Messer M (2019) Assessment of food addiction using the Yale Food Addiction Scale 2.0 in individuals with binge-eating disorder symptomatology: factor structure, psychometric properties, and clinical significance. Psychiatry Res. https://doi.org/10.1016/j.psychres.2019.03.003
18. Meule A, Gearhardt AN (2014) Food addiction in the light of DSM-5. Nutrients 6:3653–3671. https://doi.org/10.3390/nu6093653
19. Meule A, Hermann T, Kubler A (2015) Food addiction in overweight and obese adolescents seeking weight-loss treatment. Eur Eat Disord Rev 23:193–198. https://doi.org/10.1002/erv.2355
20. Pursey KM et al (2014) The prevalence of food addiction as assessed by the Yale Food Addiction Scale: a systematic review. Nutrients 6:4552–4590
21. Schulte EM, Smeal JK, Gearhardt AN (2017) Foods are differentially associated with subjective effect report questions of abuse liability. PLoS ONE 12:e0184220. https://doi.org/10.1371/journal.pone.0184220
22. Jiménez-Murcia S et al (2017) Food addiction in gambling disorder: frequency and clinical outcomes. Front Psychol. https://doi.org/10.3389/fpsyg.2017.00473
23. MacLean PS et al (2017) Biological control of appetite: a daunting complexity. Obesity 25:S8–S16. https://doi.org/10.1002/oby.21771
24. Rogers PJ (2017) Food and drug addictions: similarities and differences. Pharmacol Biochem Behav 153:182–190. https://doi.org/10.1016/j.pbb.2017.01.001
25. Nolan LJ (2017) Is it time to consider the "food use disorder?". Appetite 115:16–18. https://doi.org/10.1016/j.appet.2017.01.029
26. Onaolapo AY, Onaolapo OJ (2018) Food additives, food and the concept of 'food addiction': Is stimulation of the brain reward circuit by food sufficient to trigger addiction? Pathophysiology 25:263–276. https://doi.org/10.1016/j.pathophys.2018.04.002
27. Gearhardt AN et al (2011) Neural correlates of food addiction. JAMA Psychiatry 68:808–816. https://doi.org/10.1001/archgenpsychiatry.2011.32
28. Volkow ND, Wise RA, Baler R (2017) The dopamine motive system: implications for drug and food addiction. Nat Rev Neurosci 18:741–752. https://doi.org/10.1038/nrn.2017.130
29. Pelchat ML et al (2004) Images of desire: food-craving activation during fMRI. Neuroimage 23:1486–1493. https://doi.org/10.1016/j.neuroimage.2004.08.023
30. Volkow ND, Wise RA (2005) How can drug addiction help us understand obesity? Nat Neurosci 8:555–560. https://doi.org/10.1038/nn1452
31. Volkow ND et al (2012) Food and drug reward: overlapping circuits in human obesity and addiction. In: Carter CS, Dalley JW (eds) Brain imaging in behavioral neuroscience. Springer, Berlin, pp 1–24
32. Stice E et al (2009) Relation of obesity to consummatory and anticipatory food reward. Physiol Behav 97:551–560. https://doi.org/10.1016/j.physbeh.2009.03.020
33. Volkow Nora D et al (2008) Overlapping neuronal circuits in addiction and obesity: evidence of systems pathology. Philos Trans R Soc B Biol Sci 363:3191–3200. https://doi.org/10.1098/rstb.2008.0107
34. Davis C et al (2014) Food cravings, appetite, and snack-food consumption in response to a psychomotor stimulant drug: the moderating effect of "food-addiction". Front Psychol 5:403. https://doi.org/10.3389/fpsyg.2014.00403
35. Davis C et al (2013) "Food addiction" and its association with a dopaminergic multilocus genetic profile. Physiol Behav 118:63–69. https://doi.org/10.1016/j.physbeh.2013.05.014
36. Avena NM, Rada P, Hoebel BG (2008) Evidence for sugar addiction: behavioral and neurochemical effects of intermittent, excessive sugar intake. Neurosci Biobehav Rev 32:20–39. https://doi.org/10.1016/j.neubiorev.2007.04.019

37. Gold MS, Frost-Pineda K, Jacobs WS (2003) Overeating, binge eating, and eating disorders as addictions. Psychiatr Ann 33:117–122. https://doi.org/10.3928/0048-5713-20030201-08

38. Volkow ND et al (2013) Obesity and addiction: neurobiological overlaps. Obes Rev 14:2–18. https://doi.org/10.1111/j.1467-789X.2012.01031.x

39. Meule A, Gearhardt AN (2019) Ten years of the Yale Food Addiction Scale: a review of version 2.0. Curr Addict Rep. https://doi.org/10.1007/s40429-019-00261-3

40. American Psychiatric Association (1994) Diagnostic and statistical manual of mental disorders, 4th edn. American Psychiatric Association, Washington, DC

41. 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

42. Meule A et al (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

43. Brunault P 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

44. Granero R 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 9:1–11. https://doi.org/10.3389/fpsyt.2018.00208

45. Aloi M 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-x

46. Fawzi M, Fawzi M (2018) Validation of an Arabic version of the Yale Food Addiction Scale 2.0. East Mediterr Health J 24:745–752. https://doi.org/10.26719/2018.24.8.745

47. Senguzel E, Oztora S, Dagdeviren HN (2018) Internal reliability analysis of the Turkish version of the Yale Food Addiction Scale. Eur J Family Med 7:14–18

48. Shin SM et al (2018) Validation study of the Korean version of the YFAS 2.0. Korean J Woman Psychol 23:25–49

49. Khine MT et al (2019) Validation of the Japanese Version of the Yale Food Addiction Scale 2.0 (J-YFAS 2.0). Nutrients. https://doi.org/10.3390/nu11030687

50. Beaton DE et al (2000) Guidelines for the process of cross-cultural adaptation of self-report measures. Spine (Phila Pa 1976) 25:3186–3191

51. Guillemin F, Bombardier C, Beaton DE (1993) Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. J Clin Epidemiol 46:1417–1432

52. WHO (2005) Physical status: the use and interpretation of anthropometry. Technical Report Series, Genevre

53. Gormally J et al (1982) The assessment of binge eating severity among obese persons. Addict Behav 7:47–55

54. Ricca V et al (2000) Screening for binge eating disorder in obese outpatients. Compr Psychiatry 41:111–115

55. Imperatori C 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

56. 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

57. Van Strien T et al (1986) The Dutch Eating Behaviour Questionnaire (DEBQ) for assessment of restrained, emotional and external eating behaviour. Int J Eat Disord 5:747–755

58. Dakanalis A et al (2013) Italian version of the Dutch Eating Behavior Questionnaire. Psychometric proprieties and measurement invariance across sex. BMI-status and age. Appetite 71:187–195. https://doi.org/10.1016/j.appet.2013.08.010

59. Van Strien T, Herman CP, Verheijden MW (2013) Eating style, overeating and weight gain. A prospective 2-year follow-up study in a representative Dutch sample. Appetite 59:782–789

60. Riva G, Molinari E (2004) Clinical psychology of obesity. Bollati Boringhieri, Turin

61. Fairburn CG, Beglin SJ (2008) Eating disorder examination questionnaire (EDE-Q 6.0). In: Cognitive behavior therapy and eating disorders. Guilford Press: New York, pp 309–313

62. Calugi S et al (2017) The eating disorder examination questionnaire: reliability and validity of the Italian version. Eat Weight Disord 22:509–514. https://doi.org/10.1007/s40519-016-0276-6

63. Simpson S et al (2018) Factorial structure and preliminary validation of the schema mode inventory for eating disorders (SMI-ED). Front Psychol 9:600. https://doi.org/10.3389/fpsyg.2018.00600

64. Pietrabissa G et al (2019) Evaluation of the reliability and validity of the Italian version of the schema mode inventory for eating disorders: short form for adult with dysfunctional eating behavior. Eat Weight Disord. https://doi.org/10.1007/s40519-019-00644-5

65. Pietrabissa G et al (2019) Brief strategic therapy for bulimia nervosa and binge eating disorder: a clinical and research protocol. Front Psychol 10:373. https://doi.org/10.3389/fpsyg.2019.00373

66. Team RC (2017) R: A language and environment for statistical computing, R Foundation for Statistical Computing

67. Team RC (2014) The R project for statistical computing, 2014

68. Revelle W (2018) psych: procedures for personality and psychological research, Northwestern University, Evanston, Illinois, USA

69. Bates D et al (2015) Fitting linear mixed-effects models using lme4. J Stat Softw 67:1–48. https://doi.org/10.18637/jss.v067.i01

70. Rosseel Y (2012) lavaan: an R package for structural equation modeling. J Stat Softw 48:1–36. https://doi.org/10.18637/jss.v048.i02

71. Rosseel Y et al (2015) Package 'lavaan', pp 1–89

72. Robin X et al (2011) pROC: an open-source package for R and S+ to analyze and compare ROC curves. BMC Bioinform 12:77. https://doi.org/10.1186/1471-2105-12-77

73. Contributors S (2016) semTools: useful tools for structural equation modeling

74. Wickham H (2016) ggplot2: elegant graphics for data analysis. Springer, New York

75. Brown TA (2015) In: Little TD (ed) Confirmatory factor analysis for applied research, 2nd edn, The Guilford Press, New York

76. Kline RB (2016) Principles and practice of structural equation modeling, 4th edn. The Guilford Press, New York

77. Hoyle RH (2012) Handbook of structural equation modeling. The Guildford Press, New York

78. Muthén LK, Muthén BO (1998–2012) In: Muthén M (ed) Mplus user's guide, 7th edn, Los Angeles

79. Steiger JH, Lind JC (1980) Statistically-based test for the number of common factors, in annual meeting. Psychometric Society, Iowa City

80. Steiger JH (1990) Structural model evaluation and modification: an interval estimation approach. Multivar Behav Res 25:173–180. https://doi.org/10.1207/s15327906mbr2502_4

81. Barrett P (2007) Structural equation modelling: adjudging model fit. Personal Individ Differ 42:815–824. https://doi.org/10.1016/j.paid.2006.09.018

82. Bentler PM (1990) Comparative fit indexes in structural models. Psychol Bull 107:238–246

83. Jöreskog KG (1969) A general approach to confirmatory maximum likelihood factor analysis. Psychometrika 34:183–202

84. Marsh HW, Hocevar D (1985) Application of confirmatory factor analysis to the study of self-concept: first-and higher order factor models and their invariance across groups. Psychol Bull 97:562

85. van de Schoot R, Lugtig P, Hox J (2012) A checklist for testing measurement invariance. Eur J Dev Psychol 9:486–492. https://doi.org/10.1080/17405629.2012.686740

86. Yu CY (2002) Evaluating cutoff criteria of model fit indices for latent variable models with binary and continuous outcomes. University of California, Los Angeles

87. Bentler PM, Bonett DG (1980) Significance tests and goodness of fit in the analysis of covariance structures. Psychol Bull 88:588–606. https://doi.org/10.1037/0033-2909.88.3.588

88. Hu LT, Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model 6:1–55. https://doi.org/10.1080/10705519909540118

89. Browne MW, Cudeck R (1989) Single sample cross-validation indices for covariance structures. Multivar Behav Res 24:445–455. https://doi.org/10.1207/s15327906mbr2404_4

90. Browne MW, Cudeck R (1992) Alternative ways of assessing model fit. Sociol Methods Res 21:230–258. https://doi.org/10.1177/0049124192021002005

91. Wheaton B et al (1977) Assessing reliability and stability in panel models. Sociol Methodol 8:84–136

92. Manzoni GM et al (2018) Feasibility, validity, and reliability of the Italian pediatric quality of life inventory multidimensional fatigue scale for adults in inpatients with severe obesity. Obes Facts 11:25–36. https://doi.org/10.1159/000484565

93. Pietrabissa G et al (2017) Stages of change in obesity and weight management: factorial structure of the Italian version of the University of Rhode Island Change Assessment Scale. Eat Weight Disord 22:361–367. https://doi.org/10.1007/s40519-016-0289-1

94. Rossi Ferrario S et al (2019) Development and psychometric properties of a short form of the Illness Denial Questionnaire. Psychol Res Behav Manag 12:727–739. https://doi.org/10.2147/PRBM.S207622

95. Vandenberg RJ, Lance CE (2000) A review and synthesis of the measurement invariance literature: suggestions, practices, and recommendations for organizational research. Organ Res Methods 3:4–70. https://doi.org/10.1177/109442810031002

96. Dolan CV (2000) Investigating Spearman's hypothesis by means of multi-group confirmatory factor analysis. Multivar Behav Res 35:21–50. https://doi.org/10.1207/s15327906mbr3501

97. Beaujean AA (2014) Testing invariance in a higher-order model. In: Beaujean AA (ed) Latent variable modeling using R: a step-by-step guide. Routledge, New York

98. Millsap RE (2012) Statistical approaches to measurement invariance. Statistical approaches to measurement invariance. Routledge, New York, pp 1–368

99. Hirschfeld G, Von Brachel R (2014) Multiple-group confirmatory factor analysis in R-A tutorial in measurement invariance with continuous and ordinal indicators. Pract Assess Res Eval 19:1–12

100. Millsap RE, Yun-Tein J (2004) Assessing factorial invariance in ordered-categorical measures. Multivare Behav Res 39:479–515. https://doi.org/10.1207/s15327906mbr3903_4

101. Muthén B, Asparouhov T (2002) Latent variable analysis with categorical outcomes: multiple-group and growth modeling in Mplus. Mplus Web Notes 4:1–22

102. Meredith W (1993) Measurement invariance, factor analysis and factorial invariance. Psychometrika 58:525–543

103. Wu H, Estabrook R (2016) Identification of confirmatory factor analysis models of different levels of invariance for ordered categorical outcomes. Psychometrika 81:1014–1045. https://doi.org/10.1007/s11336-016-9506-0

104. Kloessner S, Klopp E (2019) Explaining constraint interaction: how to interpret estimated model parameters under alternative scaling methods. Struct Equ Model 26:143–155. https://doi.org/10.1080/10705511.2018.1517356

105. Carr MM et al (2018) Measurement invariance of the Modified Yale Food Addiction Scale 2.0 across gender and racial groups. Assessment. https://doi.org/10.1177/1073191118786576

106. Cheung GW, Rensvold RB (2002) Evaluating goodness-of-fit indexes for testing measurement invariance. Struct Equ Model 9:233–255. https://doi.org/10.1207/S15328007SEM0902_5

107. Reise SP, Bonifay WE, Haviland MG (2013) Scoring and modeling psychological measures in the presence of multidimensionality. J Person Assess 95:129–140. https://doi.org/10.1080/00223891.2012.725437

108. McDonald RP (1999) Test theory: a unified treatment. Lawrence Erlbaum Associates, Mahwah

109. Green SB, Yang Y (2009) Reliability of summed item scores using structural equation modeling: an alternative to coefficient alpha. Psychometrika 74:155–167. https://doi.org/10.1007/s11336-008-9099-3

110. Giuntoli L et al (2019) Measuring cognitive vulnerability to depression: further evidence on the factorial and predictive validity of negative cognitive style. J Behav Ther Exp Psychiatry 65:101479. https://doi.org/10.1016/j.jbtep.2019.04.005

111. Gignac GE (2008) Higher-order models versus direct hierarchical models: g as superordinate or breadth factor? Psychol Sci 50:21–43

112. Kuder GF, Richardson MW (1937) The theory of the estimation of test reliability. Psychometrika 2:151–160

113. Tabachnick BG, Fidell LS (2014) Using multivariate statistics. Harlow, Pearson

114. Cohen J (1960) A coefficient of agreement for Nominal Scales. Educ Psychol Meas 20:37–46. https://doi.org/10.1177/001316446002000104

115. Berchtold A (2016) Test–retest: agreement or reliability? Methodol Innov. https://doi.org/10.1177/2059799116672875

116. Koo TK, Li MY (2016) A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 15:155–163. https://doi.org/10.1016/j.jcm.2016.02.012

117. de Vet HC et al (2006) When to use agreement versus reliability measures. J Clin Epidemiol 59:1033–1039. https://doi.org/10.1016/j.jclinepi.2005.10.015

118. Pepe MS (2003) The statistical evaluation of medical tests for classification and prediction. Oxford Universtiy Press, New York

119. Zhou XH, Obuchowski N, McClish D (2002) Statistical methods in diagnostic medicine. Wiley, New York

120. Swets JA (1998) Measuring the accuracy of diagnostic systems. Science 240:1285–1293. https://doi.org/10.1126/science.3287615

121. Zweig MH, Campbell G (1993) Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. Clin Chem 39:561–577

122. Cohen J (1988) Statistical power analysis for the behavioral sciences. Lawrence Erlbaum Associates, New Jersey

123. Howell DC, Methods S (2013) Statistical methods for psychology. Wadsworth, Cengage Learning, Belmont

124. Games PA, Howell JF (1976) Pairwise multiple comparison procedures with unequal N's and/or variances: a Monte Carlo Study. J Educ Stat 1:113–125. https://doi.org/10.3102/10769986001002113

125. Ruxton GD, Beauchamp G (2008) Time for some a priori thinking about post hoc testing. Behav Ecol 19:690–693. https://doi.org/10.1093/beheco/arn020

126. Leigh S-J, Morris MJ (2018) The role of reward circuitry and food addiction in the obesity epidemic: an update. Biol Psychol 131:31–42. https://doi.org/10.1016/j.biopsycho.2016.12.013

127. Davis C (2014) Evolutionary and neuropsychological perspectives on addictive behaviors and addictive substances: relevance to the "food addiction" construct. Subst Abuse Rehabil 5:129–137. https://doi.org/10.2147/SAR.S56835

128. Markus CR et al (2017) Eating dependence and weight gain; no human evidence for a 'sugar-addiction' model of overweight. Appetite 114:64–72. https://doi.org/10.1016/j.appet.2017.03.024

129. Morin J-P et al (2017) Palatable hyper-caloric foods impact on neuronal plasticity. Front Behav Neurosci. https://doi.org/10.3389/fnbeh.2017.00019

130. Schulte EM, Avena NM, Gearhardt AN (2015) Which foods may be addictive? The roles of processing, fat content, and glycemic load. PLoS ONE 10:e0117959. https://doi.org/10.1371/journal.pone.0117959

131. Carter A et al (2016) The neurobiology of "food addiction" and its implications for obesity treatment and policy. Annu Rev Nutr 36:105–128. https://doi.org/10.1146/annurev-nutr-071715-050909

132. Schulte EM et al (2016) Neural systems implicated in obesity as an addictive disorder: from biological to behavioral mechanisms. Prog Brain Res 223:329–346. https://doi.org/10.1016/bs.pbr.2015.07.011

133. Burrows T et al (2017) Food addiction, binge eating disorder, and obesity: is there a relationship? Behav Sci (Basel). https://doi.org/10.3390/bs7030054

134. Freeman LMY, Gil KM (2004) Daily stress, coping, and dietary restraint in binge eating. Int J Eat Disord 36:204–212. https://doi.org/10.1002/eat.20012

135. Limbert C (2010) Perceptions of social support and eating disorder characteristics. Health Care Women Int 31:170–178. https://doi.org/10.1080/07399330902893846

136. Ratti MM et al (2017) Social support, psychological distress and depression in hemodialysis patients. Psicol Salute 1:112–122. https://doi.org/10.3280/pds2017-001006

137. Wonderlich-Tierney AL, Vander Wal JS (2010) The effects of social support and coping on the relationship between social anxiety and eating disorders. Eat Behav 11:85–91. https://doi.org/10.1016/j.eatbeh.2009.10.002

138. Rorty M et al (1999) Social support, social adjustment, and recovery status in bulimia nervosa. Int J Eat Disord 26:1–12. https://doi.org/10.1002/(sici)1098-108x(199907)26:1%3c1:aid-eat1%3e3.0.co;2-i

139. Boffo M, Mannarini S, Munari C (2012) Exploratory structure equation modeling of the UCLA loneliness scale: a contribution to the Italian adaptation. TPM Test Psychometr Methodol Appl Psychol 19:345–363. https://doi.org/10.4473/tpm19.4.7

140. Pursey KM et al (2016) The stability of 'food addiction' as assessed by the Yale Food Addiction Scale in a non-clinical population over 18-months. Appetite 96:533–538. https://doi.org/10.1016/j.appet.2015.10.015

141. Imperatori C et al (2019) Psychometric properties of the modified Yale Food Addiction Scale Version 2.0 in an Italian non-clinical sample. Eat Weight Disord 24:37–45. https://doi.org/10.1007/s40519-018-0607-x

142. 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

143. Dimitrijević I et al (2015) Food addiction-diagnosis and treatment. Psychiatr Danub 27:101–106

144. Davis C, Carter JC (2014) If Certain foods are addictive, how might this change the treatment of compulsive overeating and obesity? Curr Addict Rep 1:89–95. https://doi.org/10.1007/s40429-014-0013-z

145. Vella S-LC, 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

146. Jackson JB et al (2018) Brief strategic therapy and cognitive behavioral therapy for women with binge eating disorder and comorbid obesity: a randomized clinical trial one-year follow-up. J Consult Clin Psychol 86:688–701. https://doi.org/10.1037/ccp0000313

147. Rossi A, Mannarini S (2019) The Italian version of the attitudes toward seeking professional psychological help scale—short form: the first contribution to measurement invariance. TPM Test Psychometr Methodol Appl Psychol 26:93–100. https://doi.org/10.4473/tpm26.1.5

148. Shriner R, Gold M (2014) Food addiction: an evolving nonlinear science. Nutrients 6:5370–5391

149. Schulte EM et al (2017) Future directions in "food addiction": next steps and treatment implications. Current Addict Rep 4:165–171. https://doi.org/10.1007/s40429-017-0140-4

150. Yau YHC et al (2014) Chapter 7—food addiction: evidence, evaluation, and treatment. In: Rosenberg KP, Feder LC (eds) Behavioral addictions. Academic Press, San Diego, pp 143–184

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