

BRIEF COMMUNICATION

Psychometric properties of the modified Yale Food Addiction Scale 2.0 in a large Brazilian sample

Paulo R. Nunes-Neto,¹ Cristiano A. Köhler,¹ Felipe B. Schuch,^{2,3} João Quevedo,^{4,5,6,7} Marco Solmi,^{8,9} Andrea Murru,¹⁰ Eduard Vieta,¹⁰ Michael Maes,^{11,12} Brendon Stubbs,^{9,13,14,15} André F. Carvalho^{9,16,17}

¹Departamento de Medicina Clínica e Grupo de Pesquisa em Psiquiatria Translacional, Faculdade de Medicina, Universidade Federal do Ceará (UFC), Fortaleza, CE, Brazil. ²Hospital de Clínicas de Porto Alegre, Porto Alegre, RS, Brazil. ³Programa de Pós-Graduação em Saúde e Desenvolvimento Humano, Universidade La Salle, Canoas, RS, Brazil. ⁴Translational Psychiatry Program, Department of Psychiatry and Behavioral Sciences, McGovern Medical School, The University of Texas Health Science Center at Houston (UTHealth), Houston, TX, USA. ⁵Laboratório de Neurociências, Programa de Pós-Graduação em Ciências da Saúde, Unidade de Ciências da Saúde, Universidade do Extremo Sul Catarinense (UNESC), Criciúma, SC, Brazil. ⁶Center of Excellence on Mood Disorders, Department of Psychiatry and Behavioral Sciences, McGovern Medical School, UTHealth, Houston, TX, USA. ⁷Neuroscience Graduate Program, The University of Texas MD Anderson Cancer Center, UTHealth Graduate School of Biomedical Sciences, Houston, TX, USA. ⁸Neuroscience Department, University of Padua, Padua, Italy. ⁹Institute for Clinical Research and Education in Medicine (IREM), Padua, Italy. ¹⁰Bipolar Disorders Unit, Institute of Neuroscience, Hospital Clínic, University of Barcelona, IDIBAPS, CIBERSAM, Barcelona, Catalonia, Spain. ¹¹Department of Psychiatry, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand. ¹²IMPACT Research Center, Deakin University, Geelong, Australia. ¹³South London and Maudsley NHS Foundation Trust, London, United Kingdom. ¹⁴Institute of Psychiatry, Psychology and Neuroscience (IoPPN), King's College London, London United Kingdom. ¹⁵Faculty of Health, Social Care and Education, Anglia Ruskin University, Chelmsford, United Kingdom. ¹⁶Department of Psychiatry, University of Toronto, Toronto, ON, Canada. ¹⁷Centre for Addiction and Mental Health (CAMH), Toronto, ON, Canada.

Objective: The field of food addiction has attracted growing research attention. The modified Yale Food Addiction Scale 2.0 (mYFAS 2.0) is a screening tool based on DSM-5 criteria for substance use disorders. However, there is no validated instrument to assess food addiction.

Methods: The mYFAS 2.0 has been transculturally adapted to Brazilian Portuguese. The data for this study was obtained through an anonymous web-based research platform: participants provided socio-demographic data and answered Brazilian versions of the the mYFAS 2.0 and the Barratt Impulsivity Scale (BIS-11). Analysis included an assessment of the Brazilian mYFAS 2.0's internal consistency reliability, factor structure, and convergent validity in relation to BIS-11 scores.

Results: Overall, 7,639 participants were included (71.3% females; age: 27.2 ± 7.9 years). The Brazilian mYFAS 2.0 had adequate internal consistency reliability (Cronbach's alpha = 0.89). A single factor solution yielded the best goodness-of-fit parameters for both the continuous and categorical version of the mYFAS 2.0 in confirmatory factor analysis. In addition, mYFAS 2.0 correlated with BIS-11 total scores (Spearman's rho = 0.26, $p < 0.001$) and subscores.

Conclusion: The Brazilian mYFAS 2.0 demonstrated adequate psychometric properties in our sample; however, future studies should further evaluate its discriminant validity.

Keywords: Food addiction; obesity; validation; Yale Food addiction scale; behavioral addiction; psychiatry

Introduction

The concept of food addiction is based on the premise that certain palatable and highly processed foods (e.g., pizza, chocolate and chips) may exert addictive-like properties in some individuals.¹ This concept has received support from human studies showing that aberrations in brain reward circuits may be involved in the development of overweight and obesity in a subgroup of individuals.² However, there is no formal diagnostic criteria for food addiction, and criticism of the disorder's clinical utility and validity has also emerged.^{3,4}

The Yale Food Addiction Scale (YFAS) is the only self-report measure of food addiction and was initially based on DSM-IV-TR criteria for substance dependence.⁵ This instrument has been validated in several languages and cultures,⁶⁻⁸ and has shown good internal consistency reliability, a single-factor structure, and adequate convergent validity with other constructs (e.g., binge eating).⁶ A new version of the YFAS, referred to as the YFAS version 2.0, was developed to account for changes in the criteria for substance use disorder (SUDs) in the DSM-5.⁹ Specifically, the YFAS 2.0 added items on craving, use despite interpersonal or social consequences, failure in role obligations, and use in physically hazardous situations.⁹ More recently, a briefer version of the YFAS 2.0 scale has been developed (henceforth referred to as the modified YFAS 2.0 or mYFAS 2.0).¹⁰ In the initial US study, this briefer 13-item version of the instrument was found to have adequate internal consistency, a one-factor

Correspondence: André F. Carvalho, Departamento de Medicina Clínica, Rua Prof. Costa Mendes, 1608, 4º andar, CEP 60430-160, Fortaleza, CE, Brazil.

E-mail: andrefc7@hotmail.com

Submitted Jul 31 2017, accepted Dec 05 2017.

structure, convergent validity with related constructs (e.g., weight cycling), discriminant validity with distinct measures (e.g., dietary restraint) and incremental validity, as evidenced by associations with the frequency of binge eating beyond a measure of disinhibited eating.¹⁰ Food addiction was also related to impulsivity. However, evidence indicates that these constructs differ.¹¹

To the best of our knowledge, no instrument for assessing food addiction has been developed and/or validated for use in Brazilian samples. Thus, the current study has four aims: 1) to adapt the mYFAS 2.0 to Brazilian Portuguese; 2) to determine the internal consistency reliability of the Brazilian mYFAS 2.0; 3) to assess the factor structure of the Brazilian mYFAS 2.0; and 4) to evaluate its convergent validity against a validated measure of impulsivity in a large Brazilian sample.

Methods

Participants

Consecutive participants were recruited through a large web-based Brazilian study (Portal Temperamento e Saúde Mental: www.temperamentoesaudemental.org).¹² This website provides an encrypted and confidential platform for data collection. The research ethics committee of the Hospital Universitário Walter Cantídio approved the procedures for online data collection (number 1.058.252). To access the surveys, participants were required to be at least 18 years old and to sign a digital informed consent form. A number of validation questions throughout the protocol ensured the reliability of the data. This exploratory study only included participants who provided reliable responses to the attention and validation questions.

Development of the Brazilian version of the mYFAS 2.0

One of the developers of the mYFAS 2.0 (Ashley N. Gearhardt) provided the original version of the instrument before its publication,¹⁰ which was independently translated to Brazilian Portuguese by two bilingual researchers. Both translations were compared and synthesized into a single version and then compared with the English version for inconsistencies by three authors of the current study (PRN-N, CAK, and AFC). Back-translation was carried out by two different translators blindly and independently. Those versions were harmonized through consensus among three authors (PRN-N, CAK, and AFC). The consensus version was then tested in a pilot sample of 10 outpatients from the psychiatry service of Hospital Universitário Walter Cantídio. No adaptation was required, and this pilot sample found all items of the instrument clear. The Brazilian version of the mYFAS 2.0 is provided in the online-only supplementary material.

Measures

Sociodemographic variables were collected for the entire sample. In addition, participants answered the validated Brazilian version of the Barratt impulsivity scale (BIS-11).¹³ The BIS is a self-reported scale consisting of 30 items

with Likert-type questions that provide a total score for impulsiveness and three subscores or domains: non-planning impulsiveness (orientation towards the present, rather than the future), cognitive-attentional impulsiveness (lack of focus on the task at hand) and motor impulsiveness (fast reactions and restlessness).¹³ Total scores vary from 30 to 120, with higher scores indicating more prominent impulsiveness. In addition, participants answered the Brazilian mYFAS 2.0 (vide supra).¹⁰ The mYFAS consists of 13 Likert-type items. Eleven items are based on DSM-5 criteria for substance use disorders, while two items refer to the clinical significance of the symptoms. The mYFAS can be rated either as a continuous score or categorically. In addition, this instrument allows the severity of food addiction to be classified as mild, moderate or severe.¹⁰

Statistical analysis

All analyses were conducted in SPSS version 22.0 for Windows. Continuous variables are presented as mean \pm standard deviation. The Kolmogorov-Smirnov test was used to verify the normal distribution of the variables.

The internal consistency of the mYFAS 2.0 was measured using Cronbach's alpha coefficient with a 95% confidence interval (95%CI); a value of ≥ 0.7 was considered satisfactory. Exploratory factor analysis was carried out to assess the structure of the Brazilian mYFAS 2.0. Principal component analysis (PCA) with oblique rotation was used to extract the factors. A scree plot was used to determine the number factors; items with factor loadings ≥ 0.3 were included in each factor. The factorability of the correlation matrix was assessed with the Kaiser-Meyer-Olkin (KMO) statistic and Bartlett's test for sphericity. Confirmatory factor analysis (CFA) was then performed. We tested five different models. We performed additional factor analyses to select the components of each individual factor, extracting only two, three, four or five factors, and the dimension with the highest factor loading was selected. We estimated the goodness of fit of each model with the chi-square test (χ^2), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Although there is no absolute consensus in the literature, a RMSEA ≤ 0.06 , a SRMR ≤ 0.09 and CFI ≥ 0.90 are considered acceptable.¹⁴ To compare the different models, the Akaike information criterion (AIC) was used. Models with the lowest AIC were judged to fit the data better than alternative solutions.¹⁵ Exploratory and confirmatory factor analyses were performed for both the continuous version of the Brazilian mYFAS 2.0 (in which each item is scored from 1 to 11), as well as its categorical version, in which each item is dichotomized using a Likert-type threshold.

We assessed the convergent validity of the Brazilian mYFAS 2.0 by determining Spearman's correlations for the mYFAS and for each dimension of the BIS-11. In addition, separate multivariable analyses of covariance (ANCOVA) models were conducted with each BIS-11 impulsivity dimension as a dependent variable, and the presence and severity of food addiction according to the

Brazilian mYFAS 2.0 as independent variables. All models were adjusted for gender, age, and education. Statistical significance was set at an alpha level of 0.05.

Results

The initial sample included 9,585 participants answered the complete survey. After quality check, 7,639 participants remained eligible and were included in the final analyses (response rate: 79.7%). There were no significant differences in age, gender distribution or education between participants who were not included in the final sample and those who did not pass our quality check (data available upon request).

The final sample was predominantly young (mean age = 27.2 ± 7.9) and female (71.3%), with at least secondary school education (online-only supplementary material, Table S1). A total of 330 participants (4.31%) screened positive for food addiction according to the Brazilian mYFAS 2.0.

In the final sample, the Cronbach's alpha value was 0.89 (95%CI 0.89-0.90). For the continuous version of the Brazilian mYFAS 2.0, a scree plot inspection (online-only supplementary material, Figure S1) and factor loadings suggested a single factor structure (online-only supplementary material, Table S2). Similarly, for the categorical version of the scale, PCA pointed to a single factor structure (online-only supplementary material, Figure S1 and Table S2). Since all items loaded in a single factor, no rotation was performed. The KMO statistic confirmed sample adequacy (0.93 for the continuous version and 0.92 for the categorical version), while Bartlett's test of sphericity confirmed the factorability of both versions of the Brazilian mYFAS 2.0 ($p < 0.001$). Confirmatory factor analysis confirmed a single-factor solution for both versions of the scale (Table 1). Goodness-of-fit statistics for each model fitted against the sample data are provided for both the continuous and categorical versions of the scale.

Associations between the continuous version of the Brazilian mYFAS 2.0 were weak but statistically significant for BIS-11 total score (Spearman's $\rho = 0.26$, $p < 0.001$), attention subscore ($\rho = 0.27$, $p < 0.001$), non-planning impulsivity ($\rho = 0.16$, $p < 0.001$), as well as

motor impulsivity ($\rho = 0.21$, $p < 0.001$). In addition, total and attention subdomain impulsivity scores were significantly higher for participants with mild food addiction, while participants with severe food addiction had higher impulsivity scores in all BIS-11 scores than either participants who screened positive for food addiction or those with mild food addiction, after multivariable adjustment for age, gender and education (online-only supplementary material, Figure S3). All ANCOVA models were statistically significant (adjusted R^2 values ranged from 0.40 to 0.55).

Discussion

The current study adapted and validated the mYFAS 2.0 instrument for use in Brazil. The prevalence of food addiction found in the present sample was 4.31%. A previous systematic review found that the prevalence of food addiction varies substantially across studies (from 5.4 to 56.8%), with higher prevalence rates being observed in clinical samples (e.g., individuals seeking treatment for overweight/obesity).¹⁶ Therefore, the prevalence of food addiction in our non-clinical sample is close to the lower end observed in this previous systematic review. Overall, our data indicate that this instrument has adequate internal consistency reliability. In addition, we verified that a single factor solution for the mYFAS provides the best goodness-of-fit parameters in CFA, which was also suggested by exploratory PCA. This finding agrees with the original validation study, which enrolled a web-based convenience sample in the US, and also found adequate internal consistency reliability and a single-factor solution for the mYFAS in CFA.¹⁰

The convergent validity of the Brazilian mYFAS 2.0 was also assessed in comparison to BIS-11 impulsivity scores. When the continuous version of the scale was considered, correlations with total BIS-11 scores, as well as with each of the impulsivity subscores (i.e., attention, non-planning and motor) were statistically significant, thus confirming that these constructs are related to each other. Moreover, participants with a severe food addiction had significantly higher scores in all BIS-11 dimensions than either participants without food addiction or those with a mild food addiction. An emerging body of evidence indicates

Table 1 Confirmatory factor analysis for the Brazilian version of the modified Yale Food Addiction Scale 2.0 (mYFAS 2.0)

Model	χ^2	df	χ^2/df	CFI	RMSEA (95%CI)	SRMR	AIC
mYFAS continuous							
1-factor	3,773.38	65	58.1	0.905	0.086 (0.084-0.089)	0.040	351,469.35
2-factor	3,615.85	64	56.5	0.909	0.085 (0.083-0.088)	0.038	351,313.81
3-factor	2,471.82	62	39.9	0.938	0.071 (0.069-0.074)	0.032	350,173.78
4-factor	1,560.62	59	26.5	0.962	0.058 (0.055-0.060)	0.027	349,268.58
5-factor*	-	-	-	-	-	-	-
mYFAS categorical							
1-factor	2,171.56	65	33.41	0.918	0.065 (0.063-0.068)	0.035	-8,484.49
2-factor	1,802.53	64	28.16	0.932	0.060 (0.057-0.062)	0.032	-8,851.53
3-factor	1,564.62	62	25.24	0.942	0.056 (0.054-0.059)	0.030	-9,085.44
4-factor	1,246.81	59	21.13	0.954	0.051 (0.049-0.054)	0.027	-9,397.25
5-factor*	-	-	-	-	-	-	-

95%CI = 95% confidence interval; AIC = Akaike information criteria; CFI = confirmatory factor index; df = degrees of freedom; mYFAS = modified Yale Food Addiction Scale; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

* No solution could be obtained for the 5-factor model.

that food addiction is associated with impulsivity.^{11,17} For example, VanderBroek-Stice et al.¹⁷ found that individuals with a food addiction had elevated impulsivity, based on composite positive and negative urgency scores, as well as steeper discounting of delayed rewards. This suggests that impulsivity may mediate 'emotional overeating' in response to stress and altered mood states.^{1,17} Therefore, our findings point to an adequate convergent validity of the Brazilian mYFAS 2.0. However, it should be noted that the food addiction construct should be further refined. It has been questioned, for example, whether food addiction could be more accurately conceptualized as a chemical or a behavioral addiction.¹⁸ Moreover, a recent report found a significant association between food addiction and a positive screen for skin picking disorder.¹⁹ Interestingly it has been proposed that significant phenomenological and neurobiological overlaps exist between behavioral addictions and obsessive-compulsive related disorders.²⁰ Furthermore, concerns have been raised regarding the precise demarcation of food addiction and other constructs related to overeating (e.g., binge eating).⁴ Therefore, further studies should assess the discriminant validity of food addiction as assessed with the Brazilian mYFAS 2.0 and related psychopathological constructs (e.g., binge eating and weight cycling).

Some limitations of the current study warrant discussion. First, given that we enrolled a convenience web-based sample that was predominantly young and female, our sample may not be representative of the Brazilian population. For example, the psychometric properties of the Brazilian mYFAS 2.0 could vary as a function of educational attainment (e.g., differences between literate and illiterate individuals). Second, we could not reliably assess body mass index as a proxy measure of overweight/obesity in our web-based research platform. Third, the cross-sectional design of this study precludes the establishment of causal inferences. Fourth, the YFAS remains the only instrument available for assessing food addiction. Thus, the current study could not determine receiver operating characteristics of the Brazilian mYFAS 2.0 against a 'gold standard'. The development of validated structured or semi-structured interviews to assess food addiction could represent a necessary next step in the development of this construct. Our study also has significant strengths. We enrolled a large sample, and we included in the analysis only participants who provided reliable responses. Second, anonymous participation via Internet provides a setting with low desirability bias for answering questions related to constructs like food addiction. This is an advantage, since individuals with food addiction may have significant shame regarding their eating behaviors and, thus, may under-report their symptoms.²¹

In conclusion, the current study indicates that the Brazilian mYFAS 2.0 has adequate internal consistency reliability, a consistent one-factor structure, and adequate convergence validity. Our findings also open important directions of further research. Clearly, the Brazilian mYFAS 2.0 should be validated in other samples (e.g., clinical samples of individuals seeking treatment for obesity), while further psychometric properties (e.g., test-retest reliability) should also be assessed. Such efforts could

contribute to the study of this emerging phenotype in Brazil.

Acknowledgements

AFC is supported by a research fellowship award from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). CAK is the recipient of a post-doctoral fellowship award from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). The Translational Psychiatry Program (USA) is funded by the Department of Psychiatry and Behavioral Sciences, McGovern Medical School, The University of Texas Health Science Center at Houston (UTHealth). The Laboratory of Neurosciences (Brazil) is one of the centers of Instituto Nacional de Ciência e Tecnologia – Medicina Molecular (INCT-MM) and one of the members of Núcleo de Excelência em Neurociências Aplicadas de Santa Catarina (NENASC). Its research is supported by grants from CNPq, Fundação de Amparo à Pesquisa e Inovação do Estado de Santa Catarina (FAPESC), Instituto Cérebro e Mente and Universidade do Extremo Sul Catarinense (UNESC). JQ is a 1A CNPq Research Fellow.

Disclosure

AM has received continuing medical education-related honoraria or consulting fees from Adamed, AstraZeneca, Bristol-Myers-Squibb, Janssen, Lundbeck, and Otsuka. EV has received grants and served as a consultant, advisor, or CME speaker for the following entities: AB-Biotics, Allergen, AstraZeneca, Bristol-Myers-Squibb, Ferrer, Forest Research Institute, Gedeon Richter, Glaxo-Smith-Kline, Janssen, Lundbeck, Otsuka, Pfizer, Roche, Sanofi-Aventis, Servier, Shire, Sunovion, Takeda, Telefonica, the Brain and Behaviour Foundation, the Spanish Ministry of Science and Innovation (Centro de Investigación Biomédica en Red de Salud Mental), the Seventh European Framework Programme (European Network of Bipolar Research Expert Centres), and the Stanley Medical Research Institute. The other authors report no conflicts of interest.

References

- 1 Sinha R. Role of addiction and stress neurobiology on food intake and obesity. *Biol Psychol.* 2018;131:5-13.
- 2 Volkow ND, Wang GJ, Tomasi D, Baler RD. Obesity and addiction: neurobiological overlaps. *Obes Rev.* 2013;14:2-18.
- 3 Finlayson G. Food addiction and obesity: unnecessary medicalization of hedonic overeating. *Nat Rev Endocrinol.* 2017;13:493-8.
- 4 Long CG, Blundell JE, Finlayson G. 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.* 2015;8:386-401.
- 5 Gearhardt AN, Corbin WR, Brownell KD. Food addiction: an examination of the diagnostic criteria for dependence. *J Addict Med.* 2009;3:1-7.
- 6 Meule A, Gearhardt AN. Five years of the yale food addiction scale: taking stock and moving forward. *Curr Addict Rep.* 2014;1:193-205.
- 7 Torres S, Camacho M, Costa P, Ribeiro G, Santos O, Vieira FM, et al. Psychometric properties of the Portuguese version of the yale food addiction scale. *Eat Weight Disord.* 2017;22:259-67.
- 8 Brunault P, Ballon N, Gaillard P, Reveillere C, Courtois R. Validation of the French version of the yale food addiction scale: an examination

- of its factor structure, reliability, and construct validity in a nonclinical sample. *Can J Psychiatry*. 2014;59:276-84.
- 9 Gearhardt AN, Corbin WR, Brownell KD. development of the yale food addiction scale version 2.0. *Psychol Addict Behav*. 2016;30:113-21.
 - 10 Schulte EM, Gearhardt AN. Development of the modified Yale Food Addiction Scale version 2.0. *Eur Eat Disord Rev*. 2017;25:302-8.
 - 11 Schulte EM, Grilo CM, Gearhardt AN. Shared and unique mechanisms underlying binge eating disorder and addictive disorders. *Clin Psychol Rev*. 2016;44:125-39.
 - 12 Lima AB, Kohler CA, Stubbs B, Quevedo J, Hyphantis TN, Koyanagi A, et al. An exploratory study of the heterogeneity of the jealousy phenomenon and its associations with affective temperaments and psychopathological dimensions in a large Brazilian sample. *J Affect Disord*. 2017;212:10-6.
 - 13 von Diemen L, Szobot CM, Kessler F, Pechansky F. Adaptation and construct validation of the Barratt Impulsiveness Scale (BIS 11) to Brazilian Portuguese for use in adolescents. *Rev Bras Psiquiatr*. 2007;29:153-6.
 - 14 Browne MW, Cudeck R. Alternative ways of assessing model fit. In: Bollen KA, Long JS, editors. *Testing structural equation models*. Newbury Park: Sage; 1993. p. 136-61.
 - 15 Akaike H. A new look at the statistical model identification. *IEEE Control Systems Society*. 1974;19:716-23.
 - 16 Pursey KM, Stanwell P, Gearhardt AN, Collins CE, Burrows TL. The prevalence of food addiction as assessed by the yale food addiction scale: a systematic review. *Nutrients*. 2014;6:4552-90.
 - 17 VanderBroek-Stice L, Stojek MK, Beach SR, vanDellen MR MacKillop J. Multidimensional assessment of impulsivity in relation to obesity and food addiction. *Appetite*. 2017;112:59-68.
 - 18 Albayrak O, Wolffe SM, Hebebrand J. Does food addiction exist? A phenomenological discussion based on the psychiatric classification of substance-related disorders and addiction. *Obes Facts*. 2012;5:165-79.
 - 19 Nunes-Neto PR, Kohler CA, Schuch FB, Solmi M, Quevedo J, Maes M, et al. Food addiction: prevalence, psychopathological correlates and associations with quality of life in a large sample. *J Psychiatr Res*. 2017;96:145-52.
 - 20 Figee M, Pattij T, Willuhn I, Luigjes J, van den Brink W, Goudriaan A, et al. Compulsivity in obsessive-compulsive disorder and addictions. *Eur Neuropsychopharmacol*. 2016;26:856-68.
 - 21 Burmeister JM, Hinman N, Koball A, Hoffmann DA, Carels RA. Food addiction in adults seeking weight loss treatment. Implications for psychosocial health and weight loss. *Appetite*. 2013;60:103-10.