

# Food Addiction: definition, measurement and prevalence in healthy subjects and in patients with eating disorders

## *Food Addiction: definizione, misurazione e prevalenza in soggetti sani e in pazienti con disturbi del comportamento alimentare*

CLAUDIO IMPERATORI\*, MARIANTONIETTA FABBRICATORE, VIVIANA VUMBACA, MARCO INNAMORATI, ANNA CONTARDI, BENEDETTO FARINA

\*E-mail: imperatori.c@libero.it

Department of Human Sciences, European University, Rome, Italy

**SUMMARY.** The construct of “Food Addiction” (FA) has been introduced in the last decades to better understand abnormal eating patterns in obese and overweight people and in patients with Eating Disorders (EDs). Despite a substantial parallelism between drug addiction and FA, there is still no agreement in considering FA an independent ED or a useful convincing concept. Therefore, the purpose of this review is to aggregate available data, in order to increase knowledge about: 1) definition, measurement and general features of FA; 2) prevalence of FA in clinical and non-clinical samples. Available data suggest that FA seems to be a transnosografic construct and exists in all EDs, with higher prevalence in Bulimia Nervosa. Although the discussion on the autonomous diagnosis of FA within EDs remains open, studies have reported that comorbidity between FA and other EDs is associated with worse clinical conditions and symptoms, justifying, as a result, the usefulness of assessing and treating this condition.

**KEY WORDS:** food addiction, food craving, eating disorders, obesity, overweight.

**RIASSUNTO.** Il costrutto della “Food Addiction” (FA) è stato introdotto negli ultimi anni per meglio comprendere i pattern alimentari disfunzionali osservati nei pazienti obesi e in sovrappeso e nei pazienti con disturbi del comportamento alimentare (DCA). Nonostante i numerosi parallelismi tra la dipendenza da sostanze e la FA, non c'è ancora accordo nel considerare la FA come un indipendente DCA né un concetto utile. L'obiettivo della presente rassegna è stato quello di riassumere i dati disponibili al fine di aumentare le conoscenze su: 1) definizione, misurazione e caratteristiche generali della FA; 2) prevalenza della FA in campioni clinici e non clinici. I dati disponibili suggeriscono che la FA sia un costrutto transnosografico presente in tutti i DCA, con una prevalenza più elevata nella bulimia nervosa. Nonostante il dibattito sull'autonomia della FA come DCA rimanga aperto, gli studi riportati suggeriscono che la comorbidità tra FA e DCA sia associata con peggiori outcome clinici, giustificando di conseguenza l'assessment e il trattamento della FA.

**PAROLE CHIAVE:** food addiction, food craving, disturbi del comportamento alimentare, obesità, sovrappeso.

## INTRODUCTION

Obesity [body mass index (BMI)  $>30$  kg/m<sup>2</sup>] and being overweight (BMI between 25.0 and 29.9 kg/m<sup>2</sup>) are well-known conditions, caused by various factors, which appear to be spreading exponentially throughout the world. The prevalence of these conditions has increased dramatically in recent decades with estimates classifying more than a billion and a half adults as overweight and at least 400 million as obese<sup>1</sup>. This is particularly alarming because excessive adiposity is a major risk factor for several medical conditions<sup>2</sup> and several mental disorders<sup>3</sup>. The significant increase in dysfunctional coping strategies (e.g., the use of potentially toxic weight-loss products) as the “fastest” and “healthiest” ways to lose weight in both obese and non-obese individuals<sup>4,5</sup> is also alarming.

The construct of “Food Addiction” (FA) was introduced in the last decades to better understand abnormal eating pat-

terns in obese and overweight people<sup>6,7</sup>. This concept has gained increasing attention not only from the media<sup>8</sup>, but also from researchers, resulting in a significant increase in the number of published scientific articles<sup>9</sup> in recent years.

A growing body of literature has detected similarities between excessive and uncontrolled consumption of hyperpalatable foods and drug addiction, both on a behavioral and neurobiological level<sup>6,7,10-17</sup>. For example, different studies reported a dysregulation in the brain's dopamine pathway of obese patients<sup>18-22</sup> similar to that previously observed in drug addiction<sup>23,24</sup>. Furthermore, other studies observed an overlap between the Diagnostic and Statistical Manual of Mental Disorders 4th edition, text revision (DSM-IV-TR)<sup>25</sup> criteria for drug addiction, and some dysfunctional eating patterns observed in obese and in Eating Disorders (EDs) patients<sup>8,12,26</sup> such as “persistent desire or repeated unsuccessful attempts to quit”. Moreover, Food Craving (FC), defined as

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the intense desire to consume a specific food which is difficult to resist<sup>27-29</sup>, seems to be another important overlapping symptom. Although FC was only recently added to the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)<sup>30,31</sup>, it has been considered an essential component of drug addiction since the 50s and 60s<sup>32</sup>. Like substance abuse, FC was found to be a crucial component of FA<sup>33</sup> and was also found to be associated with: 1) Bulimia Nervosa (BN)<sup>34-37</sup>; 2) Anorexia Nervosa (AN)<sup>36,38</sup>; 3) overweight and obesity<sup>39,40</sup>; 4) Binge Eating Disorder (BED)<sup>41,42</sup>; 5) Night Eating Syndrome (NES)<sup>43</sup>.

Other significant equivalencies between drug addiction and FA come from animal and clinical neurosciences studies. Research mainly on animal models documented neurobehavioral changes related to intermittent sugar availability, similar to those associated with drug abuse (e.g., withdrawal symptoms)<sup>15,44,45</sup>. Likewise, clinical neuroscience studies detected various alterations of the reward circuit in EDs patients<sup>46-48</sup> and in obese individuals<sup>18,19,49,50</sup>.

Although there are substantial overlaps, there is still no agreement in considering FA as an independent ED<sup>51</sup> or a valid and useful concept<sup>52</sup>. For example, opponents of the FA construct have argued that certain core symptoms of substance dependence, such as tolerance and withdrawal, are restricted to animal models and require careful thought when translated to humans<sup>52</sup>. Furthermore, it is also observed that neuroimaging data on reward deficit in obese subjects as well as in BED patients are still limited and sometimes controversial<sup>52,53</sup>. Therefore, the purpose of this review is to aggregate available data and increase knowledge about: 1) definition, measurement and general features of FA; 2) prevalence of FA in clinical and non-clinical samples.

### **FOOD ADDICTION: DEFINITION, MEASUREMENT AND GENERAL FEATURES**

The idea that compulsive and dysregulated intake of high-calorie food can produce abnormal consumption patterns, similar to those observed in patients with substance-related and addictive disorders, has been proposed since the mid-50s<sup>54</sup>. Nevertheless, concrete attempts to operationalize this construct are quite recent.

FA refers to specific food related behaviors characterized by excessive and dysregulated consumption of high calorie food<sup>12,55</sup> (i.e., foods with high sugar and/or fat)<sup>56</sup>. While some behavioral addictions, such as Gambling Disorder, were recently identified as addictive disorders in DSM-5<sup>30</sup>, there is still no agreement in considering FA as an independent ED nor as a universally accepted definition<sup>51</sup>.

FA has been defined as a chronic and relapsing condition caused by the interaction of many complex variables that increase cravings for certain specific foods in order to achieve a state of high pleasure, energy or excitement, or to relieve negative emotional or physical states<sup>7,57</sup>. To date, the most widely employed definition<sup>12,26,58,59</sup> derives from the overlay with the DSM-IV-TR criteria<sup>25</sup> for drug addiction. These criteria include: 1) substance taken in larger amount and for longer period than intended; 2) persistent desire or repeated unsuccessful attempts to quit; 3) a large amount of time/activity necessary to obtain, to use or to recover; 4) important social, occupational, or recreational activities dismissed or

reduced; 5) continuative use despite knowledge of adverse consequences; 6) tolerance; 7) withdrawal symptoms.

FA seems to have significant psychopathological overlaps with other EDs, especially with BED and BN. Consistently, addiction models of AN and BN have already been proposed<sup>60,61</sup>. Reduced control over eating, continued use despite negative consequences, elevated levels of impulsivity and psychopathology are several overlaps between FA and both BED and BN<sup>62,63</sup>. However, there are also some crucial differences between FA and other EDs. First, contrary to FA, BED is associated with elevated concerns with shape or weight<sup>62</sup>. In the same way BN and AN are characterized by body image disturbance, an overvaluation of body weight and shape that drives dysfunctional eating and related behaviors (i.e., restrained eating and/or compensatory behaviors)<sup>30</sup>. This crucial psychopathological core is not considered in patients with FA<sup>63,64</sup>. Furthermore, contrary to FA, BED and BN diagnoses specify that binge eating episodes must occur during a discrete period of time<sup>30</sup>. Finally, FA diagnosis assesses criteria such as withdrawal or tolerance, which are not included in any ED<sup>62</sup>.

In the last 15 years numerous psychometric questionnaires have been developed to investigate the general aspects of FA, such as impulsivity, disinhibition and craving.

Merlo et al.<sup>65</sup> developed the Eating Behaviors Questionnaire (EBQ) to investigate, in a pediatric sample, the three crucial components of FA, the so-called “3 Cs” of addiction: compulsive use, attempts to cut down (quitting attempts) and continued use despite consequences. Regardless of the good psychometric properties of the questionnaire, attempts to adapt this self-report to the adult population have not yet been pursued.

In the same year, Gearhardt et al.<sup>59</sup> developed a specific questionnaire for FA evaluation and diagnosis, the Yale Food Addiction Scale (YFAS). The YFAS is a 25-items self-report that investigates eating behaviors concerning hyper-palatable food consumed in the previous 12 months. The 25 YFAS items were developed in accordance with the DSM-IV-TR diagnostic criteria<sup>25</sup> for drug addiction, and also according to self-reports assessing behavioral addictions, such as pathological gambling or sexual addiction. The YFAS provides two scoring alternatives: a symptom count version and a diagnostic version. A categorical diagnostic cut off is met when three symptoms, together with a clinically significant impairment or distress from eating, are present<sup>59</sup>. The YFAS was initially validated in US undergraduate students showing a single factor structure and satisfying psychometric properties (e.g. Cronbach's alpha= 0.86)<sup>59</sup>. Furthermore, supporting its construct validity, YFAS' total score was positively associated with neural activation of the brain regions involved in the reward system (i.e., amygdala, anterior cingulate cortex) in response to anticipated intake of palatable food<sup>20</sup>. The one-factor structure and the good psychometric properties have been replicated in bariatric patients<sup>66</sup>, in obese BED patients<sup>67</sup> and in obese and overweight patients attending weight loss treatment<sup>68</sup>. YFAS has also been translated and validated in several European countries including Germany<sup>69</sup>, France<sup>70</sup>, Spain<sup>71</sup> and Italy<sup>68</sup>. Lastly, a short version of YFAS<sup>72</sup> and a version for children have recently been developed<sup>73</sup>.

Gender and age differences were reported for both FA and FC. FA diagnosis appears to be more frequent in women than men<sup>72,74</sup> and more frequent in middle-aged adults (45-

64 years) compared to elderly ones (62-88 years)<sup>72</sup>. Similarly, FC is more recurrent in younger than older adults<sup>75,76</sup> and in women than men<sup>76-81</sup>. According to recent neuroimaging studies<sup>82,83</sup> sex differences in FA could reflect the presence of some differences in the female brain's reward system such as the lower ability to suppress appetite<sup>83</sup>. Nevertheless, sex differences in FA could also be due to differences in the hormonal system or to the presence of endocrine disorders in women, such as polycystic ovary syndrome (PCOS). In fact, different studies have shown that the same addictive eating-patterns (i.e., compulsive overeating, food craving) are associated with the different phases of menstrual cycle<sup>84-86</sup> and with PCOS<sup>87-89</sup>.

Several studies observed a moderate association between BMI and FA in adults<sup>69,71,74,90</sup> and children<sup>65,73</sup>. Pedram et al.<sup>74</sup>, assessing the prevalence of FA in the general population, reported that FA symptoms were significantly correlated not only with BMI, but also with body weight, waist and hip circumferences, body fat and trunk fat percentages which suggests that FA contributes to obesity's severity. However, it is also possible to hypothesize that obesity contributes to FA's severity. Indeed, it is known that obesity is strongly associated with hormonal alterations, for example insulin resistance, which may play a crucial role in promoting "hedonic" responses to hyper-palatable food<sup>91</sup>. Additionally, it has been observed that FA symptoms are negatively associated with weight loss in overweight and obese patients seeking weight loss treatments<sup>92</sup>.

FA is also strongly associated with psychopathology<sup>11,59,67,71,92,93</sup>. Gearhardt et al.<sup>67</sup> reported that FA symptoms positively correlate with high emotional dysregulation, low self-esteem and high negative affective states in BED patients. The authors have also documented that FA patients were more likely to have a lifetime diagnosis for mood disorders, particularly major depression. No significant relationship was observed between FA and anxiety disorders or substance dependence<sup>67</sup>. The association between FA and depression was also observed in obese and overweight patients by Davis et al.<sup>11</sup> and Burmeister et al.<sup>92</sup> who respectively reported a relationship between FA and Attention Deficit Hyperactivity Disorder (ADHD) in children, and between FA and eating psychopathology (i.e., weight bias, body preoccupation, binge eating).

The association between addictive eating patterns and general psychopathology could be interpreted by referring to the self-medicate hypothesis<sup>94-96</sup>, which emphasizes that addictive behaviors are people's attempt «to medicate themselves for a range of psychiatric problems and painful emotional states»<sup>95</sup> (p. 1263). Following this hypothesis, patients with FA would use food to prevent or relieve negative emotional states which arise from withdrawal symptoms and/or from a reaction to stressful life events, similar to what is observed in drug addiction<sup>97</sup>. Compulsive and uncontrolled overeating in FA patients could reflect a dysfunctional coping strategy consisting of "comfort food" used to escape from unpleasant state and/or to self-regulate emotions<sup>17,98-101</sup>. Similarly, from a neurobiological point of view, it was suggested<sup>102-104</sup> that the natural reward of highly palatable food can reduce the activity of the Hypothalamic-Pituitary-Adrenal (HPA) axis and the production of cortisol. The constant repetition of this pattern could lead to neurobiological and behavioral adaptations promoting compulsive overeating<sup>102-104</sup>.

## FOOD ADDICTION PREVALENCE IN CLINICAL AND NON-CLINICAL SAMPLES

To date, YFAS is the most commonly used tool to assess FA in clinical and non-clinical samples<sup>51,105</sup>. Using YFAS, 11.4% of American students were diagnosed as addicted to food<sup>59</sup>. Comparable percentages were observed in non-clinical samples in France (8.7%)<sup>70</sup> and Germany (8.8%)<sup>69</sup>. Lower prevalence was reported in Italy (1.7%)<sup>68</sup> and Spain (2.7%)<sup>71</sup>, suggesting, as already hypothesized for FC<sup>80,106</sup>, the possibility of cross-cultural differences. Finally, a recent Canadian study<sup>74</sup> on 652 adults (415 women and 237 men) recruited from the general population, reported a prevalence of FA in 5.4% of the sample. In all these studies, the most reported symptom was "persistent desire or repeated unsuccessful attempts to quit".

A small amount of research has investigated FA in children and adolescents. Using EBQ, Merlo et al.<sup>65</sup> found that 15.2% of overweight children declared either "often", "frequently" or "always" as an answer when asked if they believed themselves to be dependent on food. A qualitative study conducted by Pretlow<sup>107</sup> on overweight and obese children detected that 29% of them felt addicted to food and that the most common symptoms were: 1) consumption of high quantities of food for long periods; 2) unsuccessful quitting attempts; 3) continued use despite consequences. Finally, Gearhardt et al.<sup>73</sup>, using a modified version of YFAS, investigated FA in 75 children (mean age= 8.32 years) recruited from the general population, and showed that 7.2% of participants met the diagnostic criteria for FA.

Higher prevalence of FA has been reported in clinical samples. Studies were initially focused on the relationship between BED and FA, and between FA and obesity to understand if FA could be considered an independent ED. Using the YFAS, FA prevalence has been reported to oscillate between: 1) 41.5%<sup>67,108</sup> and 72.2%<sup>11</sup> in obese people with BED; 2) 15.2 %<sup>109</sup> and 53.7%<sup>66,110</sup> among patients attending weight-loss surgery programs; 3) between 15.2%<sup>68,92,93,109</sup> and 25%<sup>11</sup> among overweight and obese patients seeking weight-loss treatments. Cassin and von Ranson<sup>111</sup>, using a semi-structured interview based on the DSM-IV-TR diagnostic criteria for substance addiction, found that 92.4% of BED patients also revealed a FA diagnosis. This percentage, however, dropped to 40.5% after applying the changes to the diagnostic criteria for addiction suggested by Goodman<sup>112</sup>. A recent meta-analysis<sup>51</sup> reported that both FA diagnosis and FA symptoms explain the total variance of BED symptomatology. The incomplete overlap between BED diagnosis and FA, according to a dimensional perspective rather than a categorical one, has led some scholars<sup>113,114</sup> to consider FA as a more severe variant of BED. The high co-morbidity between BED and FA, however, has led other researchers<sup>52</sup> to believe FA is more like a phenotypic clinical manifestation rather than an independent ED, characterized by the overlap between several dysfunctional eating behaviors.

In addition to the widely investigated relationship between BED and FA, recent studies assessed the co-morbidity between FA and BN, Anorexia Nervosa Restrictive-type (AN-R) and Anorexia Nervosa Purging-type (AN-P). Using Goodman's<sup>112</sup> diagnostic criteria for addiction, Speranza et al.<sup>115</sup> reported FA prevalence rates in 65% of BN patients, in 48% of AN-P patients and in 35% of AN-R patients. Using



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YFAS, Granero et al.<sup>71</sup> observed a FA prevalence in 60% of AN patients, in 81% of BN patients, in 76.9% of BED patients and in 72.2% of Eating Disorders Not Otherwise Specified (EDNOS) patients. Gearhardt et al.<sup>63</sup> recently investigated the relationship between FA, EDs and BMI in a large non-clinical sample (815 subjects). The authors reported that participants with BN showed FA criteria more frequently than individuals with BED (83.6% vs 47.2%). Authors showed that, compared to BN and BED, FA is associated with a current higher BMI, a greater lifetime BMI and more severe eating disorders psychopathology (for example, concerns about body weight and food). Lastly, co-morbidity between FA and other EDs is associated with a more severe eating disorder, with a greater current and lifetime BMI, compared to healthy controls and compared to the “singular” forms of EDs.

The strong association between BN and FA was also detected by Meule et al.<sup>64</sup> who, through YFAS, observed that 100% of women with a current BN diagnosis also exhibited a FA diagnosis, compared with 30% of BN patients in remission.

## CONCLUSIONS

The reported data seem to suggest that FA is a transnosographic construct and exists in all EDs (with higher prevalence for BN) as well as in obese and overweight patients. Therefore, the debate on the independent diagnosis of FA within EDs remains open. However, it seems to be clear that the comorbidity between FA and other EDs is associated with worse clinical conditions and symptoms<sup>63</sup>. Thus, clinicians should carefully assess specific addictive eating patterns in EDs as well as obese and overweight patients. For these patients, FA symptoms should be a target of specific psychotherapeutic interventions. For instance, like for drug and substance addiction treatments<sup>116,117</sup>, new therapeutic approaches focused on the neurobehavioural correlates of self-regulation, such as neurofeedback, should be developed and implemented in patients with FA.

Finally, future neuroscience studies are needed in order to understand the differences and similarities between FA and other EDs and to determine whether, in addition to the psychopathological level FA, on a neuro-physiological level, can also be considered an independent ED.

*Conflict of interests:* the authors declare they have no competing interests.

## REFERENCES

1. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA* 2012; 307: 491-7.
2. Bean MK, Stewart K, Olbrisch ME. Obesity in America: implications for clinical and health psychologists. *J Clin Psychol Med Settings* 2008; 15: 214-24.
3. Simon GE, Von Korff M, Saunders K, et al. Association between obesity and psychiatric disorders in the US adult population. *Arch Gen Psychiatry* 2006; 63: 824-30.
4. Bersani FS, Coviello M, Imperatori C, et al. Adverse Psychiatric Effects Associated with Herbal Weight-Loss Products. *Biomed Res Int* 2015; 2015: 120679.
5. Bersani FS, Santacroce R, Coviello M, et al. Cannabis: a self-medication drug for weight management? The never ending story. *Drug Test Anal* 2015 Oct 12. doi: 10.1002/dta.1891.
6. Davis C, Carter JC. Compulsive overeating as an addiction disorder. A review of theory and evidence. *Appetite* 2009; 53: 1-8.
7. von Deneen KM, Liu Y. Obesity as an addiction: why do the obese eat more? *Maturitas* 2011; 68: 342-5.
8. Corwin RL, Grigson PS. Symposium overview. Food addiction: fact or fiction? *J Nutr* 2009; 139: 617-9.
9. Meule A. Back by popular demand: a narrative review on the history of food addiction research. *Yale J Biol Med* 2015; 88: 295-302.
10. Avena NM. Food and addiction: implications and relevance to eating disorders and obesity. *Curr Drug Abuse Rev* 2011; 4: 131-2.
11. Davis C, Curtis C, Levitan RD, Carter JC, Kaplan AS, Kennedy JL. Evidence that ‘food addiction’ is a valid phenotype of obesity. *Appetite* 2011; 57: 711-7.
12. Gearhardt AN, Corbin WR, Brownell KD. Food addiction: an examination of the diagnostic criteria for dependence. *J Addict Med* 2009; 3: 1-7.
13. Pelchat ML. Food addiction in humans. *J Nutr* 2009; 139: 620-2.
14. Volkow ND, Wang GJ, Tomasi D, Baler RD. Obesity and addiction: neurobiological overlaps. *Obes Rev* 2013; 14: 2-18.
15. Avena NM, Rada P, Hoebel BG. Sugar and fat bingeing have notable differences in addictive-like behavior. *J Nutr* 2009; 139: 623-8.
16. Blumenthal DM, Gold MS. Neurobiology of food addiction. *Curr Opin Clin Nutr Metab Care* 2010; 13: 359-65.
17. Fortuna JL. The obesity epidemic and food addiction: clinical similarities to drug dependence. *J Psychoactive Drugs* 2012; 44: 56-63.
18. Wang GJ, Volkow ND, Logan J, et al. Brain dopamine and obesity. *Lancet* 2001; 357: 354-7.
19. Stice E, Yokum S, Blum K, Bohon C. Weight gain is associated with reduced striatal response to palatable food. *J Neurosci* 2010; 30: 13105-9.
20. Gearhardt AN, Yokum S, Orr PT, Stice E, Corbin WR, Brownell KD. Neural correlates of food addiction. *Arch Gen Psychiatry* 2011; 68: 808-16.
21. Avena NM, Rada P, Hoebel BG. Evidence for sugar addiction: behavioral and neurochemical effects of intermittent, excessive sugar intake. *Neurosci Biobehav Rev* 2008; 32: 20-39.
22. Johnson PM, Kenny PJ. Dopamine D2 receptors in addiction-like reward dysfunction and compulsive eating in obese rats. *Nat Neurosci* 2010; 13: 635-41.
23. Blum K, Braverman ER, Holder JM, et al. Reward deficiency syndrome: a biogenetic model for the diagnosis and treatment of impulsive, addictive, and compulsive behaviors. *J Psychoactive Drugs* 2000; 32 Suppl: i-iv, 1-112.
24. Evans AH, Pavese N, Lawrence AD, et al. Compulsive drug use linked to sensitized ventral striatal dopamine transmission. *Ann Neurol* 2006; 59: 852-8.
25. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders – DSM-IV-TR*, 4th Edn. Washington, DC: American Psychiatric Association, 2000.
26. Ifland JR, Preuss HG, Marcus MT, et al. Refined food addiction: a classic substance use disorder. *Med Hypotheses* 2009; 72: 518-26.
27. Weingarten HP, Elston D. The phenomenology of food cravings. *Appetite* 1990; 15: 231-46.
28. Weingarten HP, Elston D. Food cravings in a college population. *Appetite* 1991; 17: 167-75.
29. White MA, Whisenhunt BL, Williamson DA, Greenway FL, Netemeyer RG. Development and validation of the food-craving inventory. *Obes Res* 2002; 10: 107-14.
30. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders – DSM-5*. Arlington, TX: American Psychiatric Publishing, 2013.

31. Biondi M, Bersani FS, Valentini M. [The Italian edition of DSM-5]. *Riv Psichiatr* 2014; 49: 57-60.
32. Kozlowski LT, Wilkinson DA. Use and misuse of the concept of craving by alcohol, tobacco, and drug researchers. *Br J Addict* 1987; 82: 31-45.
33. Meule A, Kubler A. Food cravings in food addiction: the distinct role of positive reinforcement. *Eat Behav* 2012; 13: 252-5.
34. van der Ster Wallin G, Norring C, Holmgren S. Binge eating versus nonpurged eating in bulimics: is there a carbohydrate craving after all? *Acta Psychiatr Scand* 1994; 89: 376-81.
35. Waters A, Hill A, Waller G. Bulimics' responses to food cravings: is binge-eating a product of hunger or emotional state? *Behav Res Ther* 2001; 39: 877-86.
36. Moreno S, Rodríguez S, Fernandez MC, Tamez J, Cepeda-Benito A. Clinical validation of the trait and state versions of the Food Craving Questionnaire. *Assessment* 2008; 15: 375-87.
37. Moreno S, Warren CS, Rodríguez S, Fernández MC, Cepeda-Benito A. Food cravings discriminate between anorexia and bulimia nervosa. Implications for "success" versus "failure" in dietary restriction. *Appetite* 2009; 52: 588-94.
38. Gendall KA, Sullivan PF, Joyce PR, Bulik CM. Food cravings in women with a history of anorexia nervosa. *Int J Eat Disord* 1997; 22: 403-9.
39. Vander Wal JS, Johnston KA, Dhurandhar NV. Psychometric properties of the State and Trait Food Cravings Questionnaires among overweight and obese persons. *Eat Behav* 2007; 8: 211-23.
40. Fabbriatore M, Imperatori C, Morgia A, et al. Food craving and personality dimensions in overweight and obese patients attending low energy diet therapy. *Obe Metab* 2011; 7: e28-e34.
41. White MA, Grilo CM. Psychometric properties of the Food Craving Inventory among obese patients with binge eating disorder. *Eat Behav* 2005; 6: 239-45.
42. Fabbriatore M, Imperatori C, Pecchioli C, et al. Binge eating and BIS/BAS activity in obese patients with intense food craving who attend weight control programs. *Obe Metab* 2011; 7: e21-e27.
43. Jarosz PA, Dobal MT, Wilson FL, Schram CA. Disordered eating and food cravings among urban obese African American women. *Eat Behav* 2007; 8: 374-81.
44. Di Segni M, Patrono E, Patella L, Puglisi-Allegra S, Ventura R. Animal models of compulsive eating behavior. *Nutrients* 2014; 6: 4591-609.
45. Avena NM. The study of food addiction using animal models of binge eating. *Appetite* 2010; 55: 734-7.
46. Grob S, Pizzagalli DA, Dutra SJ, et al. Dopamine-related deficit in reward learning after catecholamine depletion in unmedicated, remitted subjects with bulimia nervosa. *Neuropsychopharmacology* 2012; 37: 1945-52.
47. Mathes WF, Brownley KA, Mo X, Bulik CM. The biology of binge eating. *Appetite* 2009; 52: 545-53.
48. Frank GK. Altered brain reward circuits in eating disorders: chicken or egg? *Curr Psychiatry Rep* 2013; 15: 396.
49. Stice E, Yokum S, Burger KS, Epstein LH, Small DM. Youth at risk for obesity show greater activation of striatal and somatosensory regions to food. *J Neurosci* 2011; 31: 4360-6.
50. Imperatori C, Fabbriatore M, Innamorati M, et al. Modification of EEG functional connectivity and EEG power spectra in overweight and obese patients with food addiction: an eLORETA study. *Brain Imaging Behav* 2015; 9: 703-16.
51. 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.
52. Ziauddeen H, Fletcher PC. Is food addiction a valid and useful concept? *Obes Rev* 2013; 14: 19-28.
53. Ziauddeen H, Farooqi IS, Fletcher PC. Obesity and the brain: how convincing is the addiction model? *Nat Rev Neurosci* 2012; 13: 279-86.
54. Randolph TG. The descriptive features of food addiction; addictive eating and drinking. *Q J Stud Alcohol* 1956; 17: 198-224.
55. Avena NM, Bocarsly ME, Hoebel BG, Gold MS. Overlaps in the nosology of substance abuse and overeating: the translational implications of "food addiction". *Curr Drug Abuse Rev* 2011; 4: 133-9.
56. Schulte EM, Avena NM, Gearhardt AN. Which foods may be addictive? The roles of processing, fat content, and glycemic load. *PLoS One* 2015; 10: e0117959.
57. Parylak SL, Koob GF, Zorrilla EP. The dark side of food addiction. *Physiol Behav* 2011; 104: 149-56.
58. Hone-Blanchet A, Fecteau S. Overlap of food addiction and substance use disorders definitions: analysis of animal and human studies. *Neuropharmacology* 2014; 85: 81-90.
59. Gearhardt AN, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale. *Appetite* 2009; 52: 430-6.
60. Szmukler GI, Tantam D. Anorexia nervosa: starvation dependence. *Br J Med Psychol* 1984; 57 (Pt 4): 303-10.
61. Umberg EN, Shader RI, Hsu LN, Greenblatt DJ. From disordered eating to addiction: the "food drug" in bulimia nervosa. *J Clin Psychopharmacol* 2012; 32: 376-89.
62. Gearhardt AN, White MA, Potenza MN. Binge eating disorder and food addiction. *Curr Drug Abuse Rev* 2011; 4: 201-7.
63. Gearhardt AN, Boswell RG, White MA. The association of "food addiction" with disordered eating and body mass index. *Eat Behav* 2014; 15: 427-33.
64. Meule A, von Rezori V, Blechert J. Food addiction and bulimia nervosa. *Eur Eat Disord Rev* 2014; 22: 331-7.
65. Merlo LJ, Klingman C, Malasanos TH, Silverstein JH. Exploration of food addiction in pediatric patients: A preliminary investigation. *J Addict Med* 2009; 3: 26-32.
66. Meule A, Heckel D, Kubler A. Factor structure and item analysis of the Yale Food Addiction Scale in obese candidates for bariatric surgery. *Eur Eat Disord Rev* 2012; 20: 419-22.
67. Gearhardt AN, White MA, Masheb RM, Morgan PT, Crosby RD, Grilo CM. An examination of the food addiction construct in obese patients with binge eating disorder. *Int J Eat Disord* 2012; 45: 657-63.
68. Innamorati M, Imperatori C, Manzoni GM, et al. Psychometric properties of the Italian Yale Food Addiction Scale in overweight and obese patients. *Eat Weight Disord* 2015; 20: 119-27.
69. Meule A, Vögele C, Kübler A. German translation and validation of the Yale Food Addiction Scale. *Diagnostica* 2012; 58: 115-26.
70. Brunault P, Ballon N, Gaillard P, et al. 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.
71. Granero R, Hilker I, Agüera Z, et al. Food addiction in a Spanish sample of eating disorders: DSM-5 diagnostic subtype differentiation and validation data. *Eur Eat Disord Rev* 2014; 22: 389-96.
72. Flint AJ, Gearhardt AN, Corbin WR, Brownell KD, Field AE, Rimm EB. Food-addiction scale measurement in 2 cohorts of middle-aged and older women. *Am J Clin Nutr* 2014; 99: 578-86.
73. Gearhardt AN, Roberto CA, Seaman MJ, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale for children. *Eat Behav* 2013; 14: 508-12.
74. Pedram P, Wadden D, Amini P, et al. Food addiction: its prevalence and significant association with obesity in the general population. *PLoS One* 2013; 8: e74832.
75. Pelchat ML, Schaefer S. Dietary monotony and food cravings in young and elderly adults. *Physiol Behav* 2000; 68: 353-9.
76. Pelchat ML. Food cravings in young and elderly adults. *Appetite* 1997; 28: 103-13.
77. Lafay L, Thomas F, Mennen L, et al. Gender differences in the relation between food cravings and mood in an adult community: Results from the fleurbaix laventie ville sante study. *Int J Eat Disord* 2001; 29: 195-204.

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78. Cepeda-Benito A, Fernandez MC, Moreno S. Relationship of gender and eating disorder symptoms to reported cravings for food: construct validation of state and trait craving questionnaires in Spanish. *Appetite* 2003; 40: 47-54.
79. Moore DJ, Zhang L. Gender differences in food preferences: the role of emotional intensity, self-regulation, and appetitive craving. *Journal of Academy of Business and Economics* 2010; 10: 15-27.
80. Zellner DA, Garriga-Trillo A, Rohm E, Centeno S, Parker S. Food liking and craving: a cross-cultural approach. *Appetite* 1999; 33: 61-70.
81. Imperatori C, Innamorati M, Tamburello S, et al. Gender differences in food craving among overweight and obese patients attending low energy diet therapy: a matched case-control study. *Eat Weight Disord* 2013; 18: 297-303.
82. Geliebter A, Pantazatos SP, McOuatt H, Puma L, Gibson CD, Atalayer D. Sex-based fMRI differences in obese humans in response to high vs. low energy food cues. *Behav Brain Res* 2013; 243: 91-6.
83. Wang GJ, Volkow ND, Telang F, et al. Evidence of gender differences in the ability to inhibit brain activation elicited by food stimulation. *Proc Natl Acad Sci U S A* 2009; 106: 1249-54.
84. Hargrove JT, Abraham GE. The incidence of premenstrual tension in a gynecologic clinic. *J Reprod Med* 1982; 27: 721-4.
85. Rozin P, Levine E, Stoess C. Chocolate craving and liking. *Appetite* 1991; 17: 199-212.
86. Dye L, Warner P, Bancroft J. Food craving during the menstrual cycle and its relationship to stress, happiness of relationship and depression; a preliminary enquiry. *J Affect Disord* 1995; 34: 157-64.
87. Morgan JF, McCluskey SE, Brunton JN, Hubert Lacey J. Polycystic ovarian morphology and bulimia nervosa: a 9-year follow-up study. *Fertil Steril* 2002; 77: 928-31.
88. Jahanfar S, Eden JA, Nguyen TV. Bulimia nervosa and polycystic ovary syndrome. *Gynecol Endocrinol* 1995; 9: 113-7.
89. Michelmores KF, Balen AH, Dunger DB. Polycystic ovaries and eating disorders: are they related? *Hum Reprod* 2001; 16: 765-9.
90. Meule A. How Prevalent is "Food Addiction"? *Front Psychiatry* 2011; 2: 61.
91. Isganaitis E, Lustig RH. Fast food, central nervous system insulin resistance, and obesity. *Arterioscler Thromb Vasc Biol* 2005; 25: 2451-62.
92. 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.
93. Imperatori C, Innamorati M, Contardi A, et al. The association among food addiction, binge eating severity and psychopathology in obese and overweight patients attending low-energy-diet therapy. *Compr Psychiatry* 2014; 55: 1358-62.
94. Khantzian EJ. The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. *Harv Rev Psychiatry* 1997; 4: 231-44.
95. Khantzian EJ. The self-medication hypothesis of addictive disorders: focus on heroin and cocaine dependence. *Am J Psychiatry* 1985; 142: 1259-64.
96. Blume AW, Schmalzing KB, Marlatt GA. Revisiting the self-medication hypothesis from a behavioral perspective. *Cogn Behav Pract* 2000; 7: 379-84.
97. Cheetham A, Allen NB, Yücel M, Yücel M, Lubman DI. The role of affective dysregulation in drug addiction. *Clin Psychol Rev* 2010; 30: 621-34.
98. Dallman MF, Pecoraro N, Akana SF, et al. Chronic stress and obesity: a new view of "comfort food". *Proc Natl Acad Sci U S A* 2003; 100: 11696-701.
99. Dallman MF, Pecoraro NC, la Fleur SE. Chronic stress and comfort foods: self-medication and abdominal obesity. *Brain Behav Immun* 2005; 19: 275-80.
100. Paxton SJ, Diggins J. Avoidance coping, binge eating, and depression: an examination of the escape theory of binge eating. *Int J Eat Disord* 1997; 22: 83-7.
101. Heatherton TF, Baumeister RF. Binge eating as escape from self-awareness. *Psychol Bull* 1991; 110: 86-108.
102. Adam TC, Epel ES. Stress, eating and the reward system. *Physiol Behav* 2007; 91: 449-58.
103. Dallman MF. Stress-induced obesity and the emotional nervous system. *Trends Endocrinol Metab* 2010; 21: 159-65.
104. Yau YC, Potenza MN. Stress and eating behaviors. *Minerva Endocrinol* 2013; 38: 255-67.
105. Meule A, Gearhardt AN. Five years of the Yale Food Addiction Scale: taking stock and moving forward. *Curr Addict Rep* 2014; 1: 193-205.
106. Osman JL, Sobal J. Chocolate cravings in American and Spanish individuals: biological and cultural influences. *Appetite* 2006; 47: 290-301.
107. Pretlow RA. Addiction to highly pleasurable food as a cause of the childhood obesity epidemic: a qualitative Internet study. *Eat Disord* 2011; 19: 295-307.
108. Gearhardt AN, White MA, Masheb RM, Grilo CM. An examination of food addiction in a racially diverse sample of obese patients with binge eating disorder in primary care settings. *Compr Psychiatry* 2013; 54: 500-5.
109. Eichen DM, Lent MR, Goldbacher E, Foster GD. Exploration of "food addiction" in overweight and obese treatment-seeking adults. *Appetite* 2013; 67: 22-4.
110. Clark SM, Saules KK. Validation of the Yale Food Addiction Scale among a weight-loss surgery population. *Eat Behav* 2013; 14: 216-9.
111. Cassin SE, von Ranson KM. Is binge eating experienced as an addiction? *Appetite* 2007; 49: 687-90.
112. Goodman A. Addiction: definition and implications. *Br J Addict* 1990; 85: 1403-8.
113. Davis C. From passive overeating to "food addiction": a spectrum of compulsion and severity. *ISRN Obes* 2013; 2013: 435027.
114. Davis C. Compulsive overeating as an addictive behavior: overlap between Food Addiction and Binge Eating Disorder. *Curr Obes Rep* 2013; 2: 171-8.
115. Speranza M, Revah-Levy A, Giquel L, et al. An investigation of Goodman's addictive disorder criteria in eating disorders. *Eur Eat Disord Rev* 2012; 20: 182-9.
116. Dehghani-Arani F, Rostami R, Nadali H. Neurofeedback training for opiate addiction: improvement of mental health and craving. *Appl Psychophysiol Biofeedback* 2013; 38: 133-41.
117. Ross SM. Neurofeedback: an integrative treatment of substance use disorders. *Holist Nurs Pract* 2013; 27: 246-50.