Appetite 190 (2023) 107037

Contents lists available at ScienceDirect

Appetite

journal homepage: www.elsevier.com/locate/appet

The relationship of food addiction with binge eating disorder and obesity: A network analysis study

Elvira Anna Carbone [a], Matteo Aloi [b,c], Marianna Rania [d], Renato de Filippis [c], Daria Quirino [a], Teresa Vanessa Fiorentino [a], Cristina Segura-Garcia [a,d,*]

[a] Department of Medical and Surgical Sciences, University Magna Graecia of Catanzaro, 88100, Catanzaro, Italy
[b] Department of Clinical and Experimental Medicine, University of Messina, 98125, Messina, Italy
[c] Department of Health Sciences, University Magna Graecia of Catanzaro, 88100, Catanzaro, Italy
[d] Center for Clinical Research and Treatment of Eating Disorders, University Hospital Mater Domini, 88100, Catanzaro, Italy

ARTICLE INFO

Keywords:
Food addiction
Network analysis
Binge eating disorder
Obesity
Depression
Eating behaviours

ABSTRACT

Food addiction (FA) has been associated with binge eating disorder (BED) and obesity at varying levels of severity and treatment outcomes. Despite much debate and scientific interest in FA, the mechanisms that underlie its co-occurrence with both conditions are not yet well understood. In order to understand this relationship, this study explores FA in a clinical sample of individuals with BED and obesity using network analysis (NA). A total of 303 patients (151 with BED and 152 with obesity) completed a battery of tests that investigated eating psychopathology, eating behaviours, emotional dysregulation, depression and FA. Two different NAs were conducted to investigate the interaction between these variables and FA. The BED and obesity groups were comparable in age (38 ± 14 vs. 42 ± 13 years), body mass index (38.8 ± 8.5 vs 42.4 ± 7.8), sex and demographics. According to the expected influence values, binge eating severity and depression were identified as the central nodes in both networks. In the BED group, binge eating severity was the central node and showed strong connections to both FA and grazing. In contrast, in the obesity group, depression was the central node, but its connections were weak, with only marginal associations to FA. These results suggest that FA represents an important and distinct construct of the two populations. In patients with BED, FA is intimately connected to other loss-of-control-related eating behaviours, such as binge eating and grazing. Conversely, in those with obesity, depression explains the relationship of FA with pathological eating behaviours. The presence of FA seems to be a distinguishing characteristic in the psychopathology of patients suffering from obesity with and without BED, and this could have implications for the prevention, treatment and management of these disorders.

1. Introduction

Food addiction (FA) was first proffered in 1956 as "*a common pattern of symptoms descriptively similar to those of other addictive processes*" (Randolph, 1956), referring to the conceptualization that foods, particularly highly palatable ones, may be the subject of addiction. In this light, the consumption of palatable foods and the addictive psychological and behavioural symptoms are characteristics of FA, including cravings, tolerance, limited control of substance intake and "withdrawal-like" physiological effects if food intake is stopped or reduced (Gordon et al., 2018). The concept of FA has been widely discussed and is currently gaining greater scientific attention as researchers work towards a more accurate classification and understanding of it.

Distinguishing FA from other pathologies can be challenging. Recently, studies have pointed towards frequent comorbidities, not only between FA and eating disorders such as binge eating disorder (BED) (Piccinni et al., 2021) but also between FA and obesity. Indeed, according to studies, 25% of individuals suffering from obesity report FA symptoms that are clinically severe compared to 11% of healthy-weight individuals (Pursey et al., 2014). Similarly, the prevalence of FA in BED is higher than in other eating disorders (di Giacomo et al., 2022): it was suggested that approximately 57% of individuals with BED report clinically significant symptoms (Pursey et al., 2014). Studies have reported that there is a direct relationship between the severity of FA and the associated eating and general psychopathology symptoms in individuals with both BED and obesity (Granero et al., 2014). FA has been observed

* Corresponding author. Department of Medical and Surgical Sciences, University Magna Graecia of Catanzaro, 88100, Catanzaro, Italy.
E-mail address: segura@unicz.it (C. Segura-Garcia).

https://doi.org/10.1016/j.appet.2023.107037
Received 12 April 2023; Received in revised form 5 September 2023; Accepted 7 September 2023
Available online 14 September 2023

to have associations with various altered eating behaviours, including binge eating, grazing and night eating, which are commonly reported by individuals who suffer from BED and obesity (Davis et al., 2011; Gearhardt et al., 2012a; 2014). In terms of predicting binge eating frequency, FA may be a more reliable indicator than other factors related to eating psychopathology (Gearhardt et al., 2012a; Sommer et al., 2021). Furthermore, research has shown a strong positive correlation between continual daytime consumption (grazing) and the severity of FA symptoms, as well as between night eating behaviour and FA (Bonder et al., 2018). Higher levels of night eating behaviour have been predicted by the repeated use of food despite negative consequences and increased food tolerance (Nolan & Geliebter, 2016). Individuals who describe evening hyperphagia and nocturnal food intake are more likely to exhibit symptoms of FA (Echeverri et al., 2023). Additionally, FA can help to identify distinct clusters among patients with obesity and BED, including individuals with varying levels of FA severity. Patients with BED experience greater eating disorder psychopathology and display more dysfunctional personality traits compared to individuals with obesity alone and no BED (Jiménez-Murcia et al., 2019). When FA is reported among patients with BED and obesity, this appears to represent a more disturbed variant characterized by higher levels of depression, negative affect, stress, emotion dysregulation and lower self-esteem (Gearhardt et al., 2012a; Sommer et al., 2021).

On the other hand, the differences are not only in the symptomatology and psychopathology but also in the neurobiology (Gordon et al., 2018): an increasing number of studies have produced evidence of biological and behavioural changes in response to highly palatable foods, the consequent loss of control (LOC), the way patients eat, the increase in impulsiveness and the inability to change eating habits despite the detrimental effects of overweight and obesity (Milano et al., 2022). Thus, FA is associated with dysfunctions in the reward circuit, such as hyperresponsiveness during exposure to high-calorie flavours, and there is also an impairment of self-regulatory control supported by deregulation of the fronto-striatal circuit (Florio et al., 2022).

Moreover, it is well demonstrated that FA is associated with lower rates of full remission, higher rates of dropout (Munguía et al., 2022) and poorer weight loss, eating and lifestyle behaviours in patients undergoing bariatric surgery (Ben-Porat et al., 2021, 2022). Thus, a systematic assessment of FA in BED, or obesity alone, or when they co-occur as often happens (Keski-Rahkonen, 2021), is recommended for the appropriate management, treatment and improvement of patients' quality of life (Agüera et al., 2021).

Because of a frequent overlap of FA with both conditions, it was erroneously conceptualized as either obesity or binge eating (Riva et al., 2006; Volkow et al., 2013). Recently, the evidence indicated that these are distinct and defined constructs and not synonymous (Burrows et al., 2017; Davis, 2017); nevertheless, the relationships that explain the co-occurrence of FA in BED and obesity are not well understood. In this regard, the network analysis (NA) approach has become more usual for examining the interactions among symptoms of comorbid conditions (Fried et al., 2017). The networks are made up of *nodes*, which represent the evaluated symptoms of a psychiatric syndrome, and *edges*, which are the connections between the nodes. NA is a useful tool for identifying the "bridge symptoms" underlying the connection between two syndromic clusters that are closely related (Jones et al., 2021).

Therefore, this study aims at analysing the underlying relationship between FA, BED and obesity through the NA approach. In line with previous research, our NA includes measures of depression, emotion regulation and symptoms related to eating behaviours, specifically focusing on their relationship with FA. Given the exploratory nature of this study, we do not formulate a priori hypotheses.

2. Methods

2.1. Participants

In this cross-sectional study, participants were consecutively recruited at the University Hospital "Mater Domini" of Catanzaro (Italy) from May 2021 to February 2023. Individuals were considered eligible with body mass index (BMI) $\geq$ 30 kg/m^2, age 18–64 years and the ability to answer self-report questionnaires and give valid informed consent. Patients were not eligible if they had a disease affecting the nervous system (i.e. epilepsy, dementia), a major psychiatric diagnosis (i.e. neurodevelopmental, schizophrenia spectrum, substance-related and neurocognitive disorders), medical conditions that influenced eating/weight (i.e. diagnosis of diabetes mellitus), history of malignant disease or were taking medications that could alter the ability to complete psychometric assessment or that could influence eating habits or pregnancy and breastfeeding over the previous 12 months. Each individual was duly informed about the procedures of the study in order to obtain the written informed consent. The researchers recruited 303 patients who fulfilled the inclusion criteria in the study. The Ethical Committee of "Regione Calabria, sezione Area Centro" approved the study protocol (Identifier: 162/April 22, 2021), which followed the ethical principles set out in the revised version of the Declaration of Helsinki (World Medical Association, 2018).

2.2. Procedures

Information about physical health, nutritional status, anthropometric data (i.e. height, weight and BMI) and previous and current eating history was collected for each participant. Height and weight when wearing light indoor clothing and no shoes were evaluated using a portable stadiometer (Seca 220; Seca GmbH & Co., Hamburg, Germany) and a balance scale (Seca 761), respectively; subsequently, the BMI (kg/m^2) was calculated. Trained psychiatrists interviewed each participant to confirm or exclude the diagnosis of BED through a face-to-face clinical interview and then using the Structured Clinical Interview for the DSM-5 (SCID-5-CV) (First et al., 2016). According to the diagnosis of BED, the sample was divided into two groups: (1) patients with obesity and comorbid BED (the BED group); and (2) patients with obesity who did not meet the criteria for a BED diagnosis (the obesity group).

2.3. Measures

Participants in the study were asked to complete the following tools:

- The Yale Food Addiction Scale (Y-FAS 2.0) was developed in 2016 (Gearhardt et al., 2016) to provide a validated measure of addictive-like eating behaviour based on the diagnostic criteria for substance dependence. The scale is widely used and translated into several languages. The Y-FAS 2.0 Italian version (Aloi, Rania, Rodríguez Muñoz, et al., 2017) was used in this study to assess addiction-like eating behaviour over the past 12 months. The Y-FAS 2.0 is a self-report tool that comprises 35 items. This scale assesses both the 11 DSM-5 diagnostic criteria for substance-related and addictive disorder (SRAD) and the impairment and/or distress related to food. Each item is scored on an eight-point Likert-type scale ranging from 0 (*never*) to 7 (*every day*). According to the item-specific cut-off, each item is dichotomized (0 for "*non*-endorsed" vs. 1 for "endorsed") to obtain the final score. The presence or absence of each criterion is calculated via these thresholds (Gearhardt et al., 2016). Two different scoring options are provided. The first is the *symptom count score*: the number of FA symptoms experienced in the previous 12 months, ranging from 0 to 11; the impairment/distress criterion should not be counted in this scoring. The second is the *diagnostic score*: FA is diagnosed when the participant reports 2 or more symptoms plus clinically significant

impairment/distress. Based on the revised DSM-5 taxonomy, it is possible to establish FA severity cut-offs: *mild* (i.e. 2 or 3 symptoms and clinically significant impairment/distress); *moderate* (i.e. 4 or 5 symptoms and significant impairment/distress); and *severe* (i.e. 6 or more symptoms and significant impairment/distress). Kuder–Richardson's alpha for Y-FAS 2.0 was 0.86.

- The Eating Disorder Examination Questionnaire (EDE-Q 6.0; Fairburn & Beglin, 1994) assesses features of eating disorders and core eating disorder behaviours. It has four subscales – Eating Restraint, Eating Concern, Weight Concern and Shape Concern – that are used to calculate the EDE-Q total score. The internal consistency ranges from 0.830 to 0.920 in this study.
- The Eating Disorder Inventory-2 (EDI-2) (Garner et al., 1983; Segura-García et al., 2015) evaluates the psychopathology and symptomatology of eating disorders. The questionnaire provides 11 subscale scores; the sum of all the items (ranging from 0 to 273) is a global measure of eating disorder severity. Higher scores indicate more severe symptomatology. Cronbach's alpha in this study was 0.915.
- The Beck Depression Inventory (BDI-II) (Beck et al., 1961; Ghisi et al., 2022) investigates depressive symptoms through 21 items on a Likert scale (0–3); scores of 0–9, 10–16, 17–29 and $\geq$ 30 indicate minimal, mild, moderate and severe depression, respectively. Cronbach's alpha in the present study was 0.850.
- The Binge Eating Scale (BES) (Gormally et al., 1982; Ricca et al., 2000) measures the severity of behaviours, feelings and cognitions associated with binge eating by means of 16 items. Scores of >17 and > 27, respectively, indicate possible and probable diagnoses of BED. Reliability in this research was 0.910.
- The Night Eating Questionnaire (NEQ) (Aloi, Rania, de Fazio, & Segura-Garcia, 2017) consists of 14 items that assess nocturnal eating behaviour along four dimensions: morning anorexia, evening hyperphagia, mood/sleep and nocturnal ingestions. A score of 30 strongly indicates night eating syndrome. The NEQ total score had a reliability of 0.750 in this study.
- The Grazing Questionnaire (GQ) (Aloi, Rania, de Fazio, et al., 2017) is composed of eight items corresponding to two dimensions (i.e. grazing behaviour and controllability), with higher scores reflecting higher levels of grazing behaviour and cognitions. The reliability of the GQ total score was 0.830 in this research;
- The Difficulties in Emotion Regulation Scale (DERS) (Giromini et al., 2012) consists of 36 items and assesses emotional dysregulation in six subscales, which together give a total score (Giromini et al., 2012). For this study, we only examined the DERS total score, which had an internal consistency of 0.890 in the present study.

2.4. Data analysis

Data were analysed using the Social Sciences Statistical Package, Version 26.0 (SPSS Inc., Chicago, IL, USA). The equality of the analysed groups and the fit of the distributions of the variables with the normal distribution were checked using the Shapiro-Wilk test and the appropriate statistical analysis method was chosen. After determining that the sociodemographic variables were normally distributed, the EDE-Q, EDI-2 total score, BDI-II, DERS, NEQ, GQ, BES and Y-FAS 2.0 symptom count variables were not normally distributed. Therefore, the Mann-Whitney *U* test was used for group comparison. In addition, the effect size *r* was calculated for significant results. Values of 0.2, 0.5 and > 0.8 were classified as small, medium and large effect sizes, respectively (Cohen, 1977). NA was performed through the software R (R Core Team 2002) (Dessau & Pipper, 2008) using *qgraph* and *bootnet* packages in accordance with Epskamp (Epskamp et al., 2012). Two different NAs were run: one for the sample with BED and one for the group with obesity. The networks were inferred by means of Gaussian Markov random field estimation, applying "Least Absolute Shrinkage and Selection Operator" (LASSO) regularization: a penalty was applied to correlations that were close to zero to make small correlations automatically shrink to zero and retain only meaningful associations and limit the number of spurious associations (Albieri & Didelez, 2014). The Extended Bayesian Information Criterion (EBIC) (Chen & Chen, 2008), a parameter that sets the degree of regularization/penalty applied to sparse correlations, was set to 0.25 in these analyses (values between 0 and 0.5 are typically chosen). Network estimation was performed using the *estimate Network* routine of the *bootnet* package (Epskamp et al., 2017). The centrality of a node was used to infer its influence (i.e. structural importance) in the networks. The centrality Plot function in *qgraph* was used to estimate indices of centrality. The betweenness (how a node affects the average path between other pairs of nodes), closeness (how a node is indirectly associated to the other nodes), strength (how a node is directly connected to the other nodes) and expected influence (sum of a node's connections representing the relative importance of a node in a network) are the indices that estimate centrality. The correlation stability (CS) coefficient was calculated to assess the internal reliability of the networks (Epskamp et al., 2018). The CS is the maximum proportion of the population that can be dropped so that the correlation between the recalculated indices of the obtained networks and those of the original network is at least 0.7. A minimum cut-off of 0.25 is recommended for betweenness, closeness and expected influence in order to consider a network stable (Epskamp et al., 2018). The CS coefficient was calculated using case-drop bootstrapping (n_{boots} = 2000). The accuracy of edge-weights was estimated by drawing bootstrapped confidence intervals computed using non-parametric bootstrapping (n_{boots} = 2000). Both for case-drop and non-parametric bootstrapping, network stability analyses were executed using the *bootnet* function in the *bootnet* package. Visual inspection of the networks reveals the thickness of an edge that graphically represents the magnitude of the association: thicker edges indicate stronger associations between symptoms. The level of statistical significance was set at $p \leq 0.05$.

3. Results

Nearly half of the total sample (N = 151) met the criteria and were diagnosed with BED (49.8% vs. 50.2%). The two subgroups were comparable in age (BED = 38.1 ± 14.1 years vs. obesity = 42.9 ± 13.4 years) and BMI (BED = 38.8 ± 8.5 kg/m^2 vs. obesity = 42.4 ± 7.9 kg/m^2). Over 50% of the sample were women, married, graduated and employed. Among the individuals with BED, 68% had a positive score on

Table 1
Sample description.

		BED *n* = *151*		OBESITY *n* = *152*	
		Mean	**SD**	**Mean**	**SD**
Age	(Years)	38.1	(14.1)	42.9	(13.4)
BMI	(kg/m^2)	38.8	(8.5)	42.4	(7.9)
		Fr	**%**	**Fr**	**%**
Sex	Female	136	(90.1)	106	(69.7)
	Male	15	(9.9)	46	(30.3)
Education	Elementary school	6	(4.0)	10	(6.5)
	Middle school I	41	(27.1)	46	(30.4)
	High school II	75	(49.7)	73	(48.0)
	University degree	29	(19.2)	23	(15.1)
Employment	Unpaid activity	25	(16.5)	29	(19.1)
	Employed	64	(42.4)	69	(45.4)
	Unemployed	25	(16.5)	32	(21.0)
	Student	32	(21.3)	18	(11.8)
	On pension	5	(3.3)	4	(2.7)
Civil status	Single	63	(41.7)	39	(25.6)
	Married	76	(50.3)	98	(64.6)
	Divorced	11	(7.3)	12	(7.9)
	Widowed	1	(0.7)	3	(1.9)
Food addiction	Positive	103	(68.2)	32	(21.0)
	Negative	48	(31.8)	120	(79.0)

BED: *binge eating disorder*; BMI: *body mass index*; Fr: *frequency*; %: *percentage*; SD: *standard deviation*.

the Y-FAS 2.0, whereas only 21% of those with obesity had a positive score on the Y-FAS 2.0. Tables 1 and 2 display the main characteristics of the participants and the median scores of the scales, respectively.

3.1. Network analysis

The expected influence values indicated that binge eating severity (BES) and depression (BDI-II) were the nodes with the highest centrality in the networks ($M = 1.098$; $M = 2.215$). The CS coefficients for expected influence were above the recommended cut-off value (i.e. 0.25) and the CS coefficients for betweenness and closeness were below 0.25. Despite this, the expected influence index was chosen as the main CS coefficient, considering that the interpretation of betweenness and closeness in networks is somewhat unclear (Forbes et al., 2017) and the expected influence index is considered a more stable centrality index than the others (Epskamp & Fried, 2018). Fig. 1 displays the expected influence centrality index of the variables included in the networks.

3.1.1. Network analysis in patients with BED

Fig. 2 illustrates the network for patients with BED. In the BED group, binge eating severity ($M = 1.098$) represented the central node. This node exhibited the highest bridge strength, strongly connected to FA (0.27) and grazing (0.28). The associations between the BES and the EDE-Q total score were moderately strong (0.14). Furthermore, the BES node had a direct connection with the EDI-2 (0.10). The depression node connected both with the DERS (0.27) and the EDI-2 score (0.37). The CS coefficient for this network analysis was 0.36 for expected influence, which is above the recommended cut-off value (i.e. 0.25). See the Supplementary Material for the accuracy of the CS indices (Fig. S1), the bootstrapped confidence intervals of the estimated edge-weights (Fig. S2) and the estimated centrality indices (Fig. S3).

3.1.2. Network analysis in patients with obesity

In the obesity group, depression was the central node ($M = 2.215$), weakly connected to FA, which appeared marginal (Fig. 3). The strongest connections of the BDI-II were with the DERS (0.511) and the EDI-2 (0.43). The node was moderately associated with the EDE-Q (0.22), the NEQ (0.2) and directly to the BES (0.28). The CS coefficient for this second network analysis was 0.52 for expected influence, which is above the recommended cut-off value (i.e. 0.25). See the Supplementary Material for the accuracy of the CS indices (Fig. S4), the bootstrapped confidence intervals of the estimated edge-weights (Fig. S5) and the estimated centrality indices (Fig. S6).

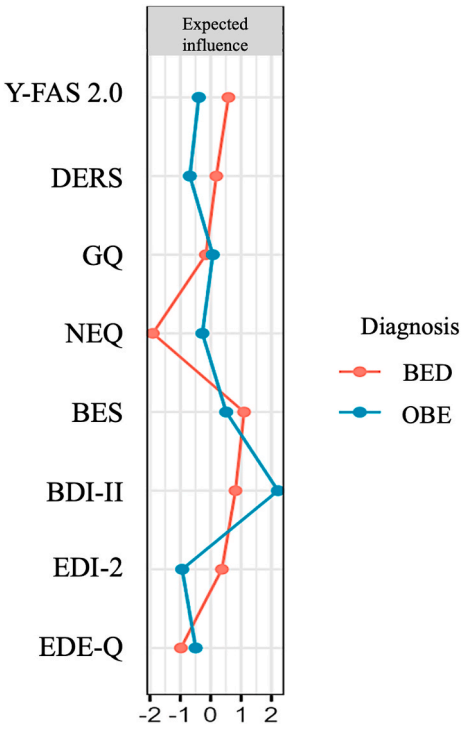

Fig. 1. Plot of expected influence index for each node of the two networks.
BDI-II: Beck Depression Inventory; BES: Binge eating scale; DERS: Difficulties in Emotion Regulation Scale; EDE-Q: Eating Disorder Examination Questionnaire; EDI-2: Eating Disorders Inventory-2; GQ: Grazing Questionnaire; NEQ: night eating questionnaire; p: statistical significance; Y-FAS 2.0: Yale Food Addiction Scale Version 2.0.

4. Discussion

Although this is not the first study that has investigated the FA construct in patients diagnosed with BED and obesity, this is the first evaluating FA in relation to specific eating behaviours and eating psychopathology through a NA approach. Understanding the multidimensional structure and underlying characteristics of FA and its potential associations with other constructs is crucial. This may not only facilitate the development of research on FA, which is still considered a relatively new construct, but also would enable the accurate targeting of FA within therapeutic programmes.

Table 2
Comparison between groups on psychopathological scales.

		BED	OBESITY				
		Median	Median	*U*	*Z*	*p*[a]	*r*
EDE-Q	*Restraint*	2.0	1.8	10557.5	−.333	.739	
	Eating concern	3.2	1.2	3271.5	−10.347	**<.001**	0.6
	Shape concern	5.3	4.3	6393.5	−6.055	**<.001**	0.4
	Weight concern	4.4	2.8	5577.0	−7.178	**<.001**	0.4
	Total score	3.8	2.8	5622.5	−7.105	**<.001**	0.4
EDI-2	*Total score*	101.0	61.0	2524.5	−7.063	**<.001**	0.4
BDI-II	*Total score*	26.0	10.5	835.5	−5.693	**<.001**	0.3
DERS	*Total score*	99.5	64.5	2313.5	−8.393	**<.001**	0.5
NEQ	*Total score*	17.0	12.0	5306.0	−7.302	**<.001**	0.4
GQ	*Total score*	15.0	6.0	2539.5	−11.087	**<.001**	0.6
BES	*Total score*	26.0	8.0	1741.0	−12.552	**<.001**	0.7
Y-FAS 2.0	*Symptom count*	6.0	0.0	5247.5	−8.976	**<.001**	0.5

BDI-II: *Beck Depression Inventory*; BES: *Binge eating scale;* DERS: *Difficulties in Emotion Regulation Scale*; EDE-Q: *Eating Disorder Examination Questionnaire*; EDI-2: *Eating Disorders Inventory-2; GQ: Grazing Questionnaire; NEQ: night eating questionnaire;* p*: statistical significance; r: Cohen's effect size;* SD: *Standard deviation;* Y-FAS 2.0*: Yale Food Addiction Scale Version 2.0.*

[a] The bold *p* values indicated the statistical significance.

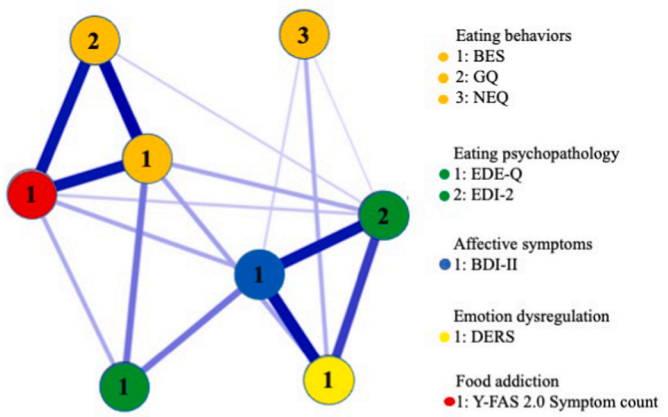

Fig. 2. Network analysis in patients with BED.
The network structure estimated from the graphical EBIC-LASSO in patients with binge eating disorder. Blue lines represent positive correlations. Thicker edges represent stronger correlations. BDI-II: Beck Depression Inventory; BES: Binge eating scale; DERS: Difficulties in Emotion Regulation Scale; EDE-Q: Eating Disorder Examination Questionnaire; EDI-2: Eating Disorders Inventory-2; GQ: Grazing Questionnaire; NEQ: night eating questionnaire; p: statistical significance; Y-FAS 2.0: Yale Food Addiction Scale Version 2.0.

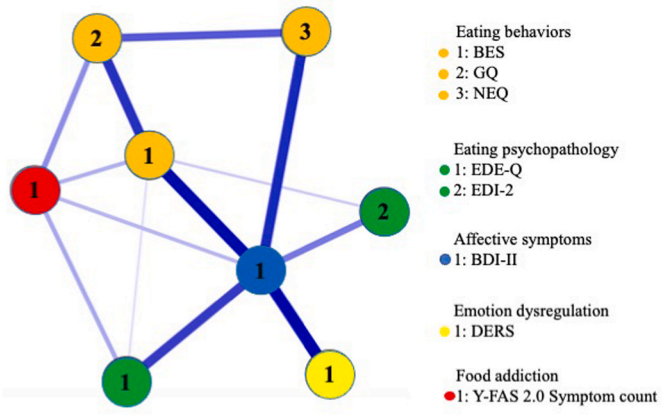

Fig. 3. Network analysis in patients with obesity
The network structure estimated from the graphical EBIC-LASSO in patients with obesity. Blue lines represent positive correlations. Thicker edges represent stronger correlations. BDI-II: Beck Depression Inventory; BES: Binge eating scale; DERS: Difficulties in Emotion Regulation Scale; EDE-Q: Eating Disorder Examination Questionnaire; EDI-2: Eating Disorders Inventory-2; GQ: Grazing Questionnaire; NEQ: night eating questionnaire; p: statistical significance; Y-FAS 2.0: Yale Food Addiction Scale Version 2.0.

Our finding supports previous research that had identified a frequent overlap of FA in both BED (di Giacomo et al., 2022) and obesity (Pursey et al., 2014). Additionally, this study has found evidence to suggest that FA is an important and distinct construct with different meanings in these two populations (Burrows et al., 2017; Davis, 2017).

In the first NA, as expected, binge eating severity emerged as the central node for patients with BED; interestingly, it was closely connected to both FA and grazing behaviour. The high centrality of binge eating and grazing behaviour is consistent with previous studies demonstrating that binge eating and grazing are highly prevalent in patients with obesity and BED compared to those without BED (Masheb et al., 2011). This is not surprising as both grazing and binge eating exhibit LOC overeating, despite differences in the amount and duration of food intake (Conceição et al., 2017; Heriseanu et al., 2017; Succurro et al., 2015). Patients often report that the experience of LOC and the perception of overeating, even when trying to stop, are the core defining characteristics (Berner et al., 2020), as prioritized in the ICD-11. The fear of LOC was associated with more frequent binge-eating episodes (Perelman et al., 2023) and greater LOC was linked to a greater global eating-disorder psychopathology but independently associated with binge size (Bruzas et al., 2022). It was demonstrated that individuals with subjectively large LOC episodes experience levels of distress, associated psychopathology and impairment comparable to those with objectively large LOC episodes (Brownstone et al., 2013; Palavras et al., 2013). On the other hand, research has shown that the addiction to palatable foods can promote both compulsive overeating (Davis, 2017) and compulsive grazing (Bonder et al., 2018). Grazing is considered "compulsive" if the LOC overeating feature prevails over the "non--compulsive" pattern (Conceição et al., 2018) and represents a good predictor of FA symptoms (Bonder et al., 2018).

As noted, definitions of binge eating and food addiction share similar clinical features, such as LOC overeating (Gearhardt et al., 2012a). Thus, from this perspective, food addiction, grazing and binge eating could be lumped together as "loss-of-control-related eating behaviours". By contrast, depressive symptoms were weakly linked to FA, binge eating or grazing, but strongly associated with emotional dysregulation (DERS) and eating psychopathology (EDI-2). Studies have shown that patients with BED report more depressive symptoms (Araujo et al., 2010; Caldas et al., 2022), greater eating psychopathology (Dingemans & van Furth, 2012), particularly in shape and weight concern, and overvaluation of weight and shape (Grilo, 2013; Grilo et al., 2010). Furthermore, they are more emotionally dysfunctional than those with obesity without BED (Wiedemann et al., 2018), suggesting that these symptoms constitute another core feature of the disorder. In a previous NA study in patients with BED that considered different variables, the central nodes were emotional dysregulation measured on the DERS-Impulse subscale and metacognition on the Metacognition Self-Assessment Scale (MSAS--Self-Monitoring domain), whereas depression and eating psychopathology were marginal (Aloi et al., 2021). This result might appear to contradict the current study; however, the spatial associations between BDI-II, EDI-2, BES and DERS in both studies show a similar pattern. Rather, the current study looks for the association between pathological eating behaviours in two different groups and highlights the psychopathological centrality of LOC-related eating behaviours in BED.

Conversely, in the second network that analysed the obesity group, depression was the central node. In this case, depression was weakly linked to FA, which appeared to be marginal. The BDI-II was directly linked to binge and night eating behaviour, as well as the EDE-Q and EDI-2. It may be hypothesized that the patients in our sample exhibit atypical depressive features, thus explaining the strong and close association between depression and eating behaviours (Benazzi, 2002; Maj et al., 2020). Indeed, the literature reports that atypical features are present in 25–30% of patients suffering from depression (Thase, 2007) and seem to be more associated with overweight and obesity (Lamers et al., 2016; Pistis et al., 2021). A recent review and meta-analysis demonstrated that patients with atypical depression presented a 2.55-point higher BMI score than individuals with melancholic depression (Silva et al., 2020). The depression rate has been linked to weight and shape concerns and body image: adults with obesity and relevant depressive symptoms and lower self-esteem reported greater weight and shape concerns compared to patients without these symptoms (Brytek-Matera, 2011; Darby et al., 2007; Felske et al., 2021). Another study emphasizes the role of emotion dysregulation and deficits in interoceptive awareness as underlying mechanisms initiating and maintaining emotional eating in obesity (Willem et al., 2019). In these patients, depressive symptoms are related to a lower ability to cope with negative emotions. Consequently, patients may exhibit an altered response to palatable and high-fat food, which can result in weight gain and decreased motivation for treating obesity (Albano et al., 2019). In our sample, the BMI in this group was higher than that of the BED group. Overall, this NA supports a large umbrella review that found depression to be one of the few risk factors with strong evidence for the

development of obesity (Solmi et al., 2018) and underscores the significant interplay between depression, body image, emotion dysregulation and eating behaviours in obesity (Micanti et al., 2017; Willem et al., 2020).

Taken together, our findings suggest that FA appears to be frequent, especially among patients with BED but also among those with obesity. The psychopathological variables included in the analysis permitted different facets of the psychopathological features of FA to be displayed in patients with obesity with and without BED, the extent to which variables belonging to the same construct (i.e. LOC) are connected and how different constructs mutually interact and reinforce each other (Borsboom, 2017; Fried & Cramer, 2017; Jones et al., 2021). Although other studies focused on the network structure of psychological features in obesity (Calugi & Dalle Grave, 2020) and psychopathological features in BED (Aloi et al., 2021; Monteleone et al., 2023; Wang et al., 2019), no studies included FA with direct comparison of high-weight patients with and without BED. The correct identification of central symptoms is critical for more targeted clinical interventions. Indeed, core symptoms are suggested to be the potential and specific treatment targets (Borsboom, 2017). To date, a considerable proportion of patients do not achieve remission from binge eating or regaining weight, even after bariatric interventions (Brownley et al., 2016; Chao et al., 2016). The different centrality of FA in the two groups evaluated in this study provides additional evidence of new features that need greater consideration in the diagnosis and treatment of patients with BED and obesity (Carbone et al., 2021). The knowledge of these features may be a useful guide for clinicians, in order to suggest interventions aiming to improve LOC-related eating symptoms, including FA in high-weight patients with BED and depression in high-weight patients without BED. Further longitudinal and intervention clinical trials should be conducted to explore the effectiveness of different strategies in the two groups.

The limitations of the current study also need to be acknowledged. First, the cross-sectional design does not allow causality to be inferred regarding the connections identified in the networks or their state or trait nature to be distinguished. Second, self-report questionnaires, although consistent with previous literature, may be affected by recall bias, leading to underestimation of eating behaviours or affective symptoms. Third, the lack of assessment of personality traits and other measures of general psychopathology, such as anxiety, stress or sleep alterations, which are frequent in patents with BED or obesity, prevents a complete assessment of the connections between FA and the whole psychopathology in our sample. Indeed, psychiatric comorbid syndromes could have affected psychopathology expression because people with obesity, BED and other comorbid major psychiatric disorders exhibit worse eating psychopathology than those without (de Fátima Benato Fusco et al., 2020; Duarte-Guerra et al., 2022; Klatzkin et al., 2018).

The main strength is that the study allowed the associations between FA, eating behaviours and eating psychopathology to be explored in people with obesity with and without BED. If replicated, the current data suggest that FA, when present, may characterize more specific phenotypes of patients with obesity and BED who may require targeted therapies.

In conclusion, these results suggest that FA represents an important and distinct construct in the two populations. In patients with BED, FA is intimately connected to other pathological eating behaviours (e.g. binge eating and grazing), whereas in patients with obesity, depression explains the relationship with pathological eating behaviours. Thus, FA appears as a differential feature in the psychopathology of patients suffering from obesity with and without BED, which could have different implications for development, maintenance, prevention and treatment.

Author contributions

CSG and MA contributed to the design of the study. EAC, MA, MR, RdF and DQ collected the data and created the dataset. CSG and MA conducted the data analyses. EAC wrote the first draft of the manuscript. MA, TVF and CSG reviewed and edited the manuscript. All authors approved the final version of the manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical statement

The Ethical Committee of "Regione Calabria, sezione Area Centro" approved the study protocol (identifier: 162/April 22, 2021)., which followed the ethical principles set out in the revised version of Helsinki Declaration.

Declaration of competing interest

Authors declare they have no competing interest.

Data availability

Data will be made available on request.

Acknowledgements

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.107037.

References

Agüera, Z., Lozano-Madrid, M., Mallorquí-Bagué, N., Jiménez-Murcia, S., Menchón, J. M., & Fernández-Aranda, F. (2021). A review of binge eating disorder and obesity. *Neuropsychiatrie, 35*(2), 57–67. https://doi.org/10.1007/S40211-020-00346-W/TABLES/1

Albano, G., Rowlands, K., Baciadonna, L., Coco, G. L., & Cardi, V. (2019). Interpersonal difficulties in obesity: A systematic review and meta-analysis to inform a rejection sensitivity-based model. *Neuroscience & Biobehavioral Reviews, 107*, 846–861. https://doi.org/10.1016/J.NEUBIOREV.2019.09.039

Albieri, V., & Didelez, V. (2014). Comparison of statistical methods for finding network motifs. *Statistical Applications in Genetics and Molecular Biology, 13*(4), 403–422. https://doi.org/10.1515/SAGMB-2013-0017

Aloi, M., Rania, M., Carbone, E. A., Caroleo, M., Calabrò, G., Zaffino, P., Nicolò, G., Carcione, A., Coco, G. L., Cosentino, C., & Segura-Garcia, C. (2021). Metacognition and emotion regulation as treatment targets in binge eating disorder: A network analysis study. *Journal of Eating Disorders, 9*(1). https://doi.org/10.1186/S40337-021-00376-X

Aloi, M., Rania, M., de Fazio, P., & Segura-Garcia, C. (2017). Italian validation of the Grazing Questionnaire: Analysis of psychometric properties. *Minerva Psichiatrica, 58*(4), 196–202. https://doi.org/10.23736/S0391-1772.17.01948-3

Aloi, M., Rania, M., de Fazio, P., Vinai, P., Tagliabue, A., Allison, K. C., Segura-Garcia, C., & Segura-García, C. (2017). Validation of the Italian version of the night eating questionnaire (I-NEQ). *Journal of Psychopathology, 23*, 137–144.

Aloi, M., Rania, M., Rodríguez Muñoz, R. C., Jiménez Murcia, S., Fernández-Aranda, F., De Fazio, P., & Segura-Garcia, C. (2017). Validation of the Italian version of the Yale food addiction scale 2.0 (I-YFAS 2.0) in a sample of undergraduate students. *Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity, 22*(3), 527–533. https://doi.org/10.1007/s40519-017-0421-x

Araujo, D. M. R., Santos, G. F. D. S., & Nardi, A. E. (2010). Binge eating disorder and depression: A systematic review. *World Journal of Biological Psychiatry: The Official Journal of the World Federation of Societies of Biological Psychiatry, 11*(2 Pt 2), 199–207. https://doi.org/10.3109/15622970802563171

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*, 561–571.

Ben-Porat, T., Košir, U., Peretz, S., Sherf-Dagan, S., Stojanovic, J., & Sakran, N. (2022). Food addiction and binge eating impact on weight loss outcomes two years following sleeve gastrectomy surgery. *Obesity Surgery, 32*(4), 1193–1200. https://doi.org/10.1007/S11695-022-05917-0

Ben-Porat, T., Weiss, R., Sherf-Dagan, S., Rottenstreich, A., Kaluti, D., Khalaileh, A., Abu Gazala, M., Zaken Ben-Anat, T., Mintz, Y., Sakran, N., & Elazary, R. (2021). Food addiction and binge eating during one year following sleeve gastrectomy: Prevalence

and implications for postoperative outcomes. *Obesity Surgery, 31*(2), 603–611. https://doi.org/10.1007/S11695-020-05010-4

Benazzi, F. (2002). Can only reversed vegetative symptoms define atypical depression? *European Archives of Psychiatry and Clinical Neuroscience, 252*(6), 288–293. https://doi.org/10.1007/S00406-002-0395-0

Berner, L. A., Sysko, R., Rebello, T. J., Roberto, C. A., & Pike, K. M. (2020). Patient descriptions of loss of control and eating episode size interact to influence expert diagnosis of ICD-11 binge-eating disorder. *Journal of Eating Disorders, 8*(1), 71. https://doi.org/10.1186/s40337-020-00342-z, 2020.

Bonder, R., Davis, C., Kuk, J. L., & Loxton, N. J. (2018). Compulsive "grazing" and addictive tendencies towards food. *European Eating Disorders Review, 26*(6), 569–573. https://doi.org/10.1002/erv.2642

Borsboom, D. (2017). A network theory of mental disorders. *World Psychiatry:Official Journal of the World Psychiatric Association (WPA), 16*(1), 5–13. https://doi.org/10.1002/WPS.20375

Brownley, K. A., Berkman, N. D., Peat, C. M., Lohr, K. N., Cullen, K. E., Bann, C. M., & Bulik, C. M. (2016). Binge-eating disorder in adults: A systematic review and meta-analysis. *Annals of Internal Medicine, 165*(6), 409–420. https://doi.org/10.7326/M15-2455

Brownstone, L. M., Bardone-Cone, A. M., Fitzsimmons-Craft, E. E., Printz, K. S., Le Grange, D., Mitchell, J. E., Crow, S. J., Peterson, C. B., Crosby, R. D., Klein, M. H., Wonderlich, S. A., & Joiner, T. E. (2013). Subjective and objective binge eating in relation to eating disorder symptomatology, negative affect, and personality dimensions. *International Journal of Eating Disorders, 46*(1), 66–76. https://doi.org/10.1002/EAT.22066

Bruzas, M. B., Tronieri, J. S., Chao, A. M., Jones, E., McAllister, C., Gruber, K., McCuen-Wurst, C., Berkowitz, R. I., Wadden, T. A., & Allison, K. C. (2022). Binge size and loss of control as correlates of eating behavior and psychopathology among individuals with binge eating disorder and higher weight. *Journal of Behavioral Medicine, 45*(4), 603–612. https://doi.org/10.1007/S10865-022-00312-7

Brytek-Matera, A. (2011). Exploring the factors related to body image dissatisfaction in the context of obesity. *Archives of Psychiatry and Psychotherapy, 13*(1), 63–70. https://www.archivespp.pl/Exploring-the-factors-related-to-body-image-dissatisfaction-in-the-context-of-obesity, 153299,0,2.html.

Burrows, T., Skinner, J., McKenna, R., & Rollo, M. (2017). Food addiction, binge eating disorder, and obesity: Is there a relationship? *Behavioral Sciences, 7*(3). https://doi.org/10.3390/BS7030054

Caldas, N. D. R., Braulio, V. B., Brasil, M. A. A., Furtado, V. C. S., de Carvalho, D. P., Cotrik, E. M., Dantas, J. R., & Zajdenverg, L. (2022). Binge eating disorder, frequency of depression, and systemic inflammatory state in individuals with obesity - a cross sectional study. *Archives of Endocrinology and Metabolism, 66*(4), 489–497. https://doi.org/10.20945/2359-3997000000489

Calugi, S., & Dalle Grave, R. (2020). Psychological features in obesity: A network analysis. *International Journal of Eating Disorders, 53*(2), 248–255. https://doi.org/10.1002/EAT.23190

Carbone, E. A., Caroleo, M., Rania, M., Calabrò, G., Staltari, F. A., de Filippis, R., Aloi, M., Condoleo, F., Arturi, F., & Segura-Garcia, C. (2021). An open-label trial on the efficacy and tolerability of naltrexone/bupropion SR for treating altered eating behaviours and weight loss in binge eating disorder. *Eating and Weight Disorders, 26*(3), 779–788. https://doi.org/10.1007/S40519-020-00910-X

Chao, A. M., Wadden, T. A., Faulconbridge, L. F., Sarwer, D. B., Webb, V. L., Shaw, J. A., Thomas, J. G., Hopkins, C. M., Bakizada, Z. M., Alamuddin, N., & Williams, N. N. (2016). Binge-eating disorder and the outcome of bariatric surgery in a prospective, observational study: Two-year results. *Obesity, 24*(11), 2327–2333. https://doi.org/10.1002/oby.21648

Chen, J., & Chen, Z. (2008). Extended Bayesian information criteria for model selection with large model spaces. *Biometrika, 95*(3), 759–771. https://doi.org/10.1093/BIOMET/ASN034

Cohen, J. (1977). *Statistical power for the behaviour sciences*. Hillsdale, NJ: Laurence Erlbaum and Associates.

Conceição, E. M., de Lourdes, M., Pinto-Bastos, A., Vaz, A. R., Brandão, I., & Ramalho, S. (2018). Problematic eating behaviors and psychopathology in patients undergoing bariatric surgery: The mediating role of loss of control eating. *International Journal of Eating Disorders, 51*(6), 507–517. https://doi.org/10.1002/EAT.22862

Conceição, E. M., Mitchell, J. E., Machado, P. P. P., Vaz, A. R., Pinto-Bastos, A., Ramalho, S., Brandão, I., Simões, J. B., de Lourdes, M., & Freitas, A. C. (2017). Repetitive eating questionnaire [Rep(eat)-Q]: Enlightening the concept of grazing and psychometric properties in a Portuguese sample. *Appetite, 117*, 351–358. https://doi.org/10.1016/J.APPET.2017.07.012

Darby, A., Hay, P., Mond, J., Rodgers, B., & Owen, C. (2007). Disordered eating behaviours and cognitions in young women with obesity: Relationship with psychological status. *International Journal of Obesity, 31*(5), 876–882. https://doi.org/10.1038/SJ.IJO.0803501

Davis, C. (2017). A commentary on the associations among "food addiction". *Binge Eating Disorder, and Obesity: Overlapping conditions with idiosyncratic clinical features. Appetite, 115*, 3–8. https://doi.org/10.1016/J.APPET.2016.11.001

Davis, C., Curtis, C., Levitan, R. D., Carter, J. C., Kaplan, A. S., & Kennedy, J. L. (2011). Evidence that "food addiction" is a valid phenotype of obesity. *Appetite, 57*(3), 711–717. https://doi.org/10.1016/J.APPET.2011.08.017

Dessau, R. B., & Pipper, C. B. (2008). ''R"–project for statistical computing. *Ugeskr Laeger, 170*(5), 328–330. PMID: 18252159.

Dingemans, A. E., & van Furth, E. F. (2012). Binge Eating Disorder psychopathology in normal weight and obese individuals. *International Journal of Eating Disorders, 45*(1), 135–138. https://doi.org/10.1002/EAT.20905

Duarte-Guerra, L. S., Kortchmar, E., Maraviglia, E. C. S., Costa, T. da S., Lasmar, C. M., Morin, R. M. R., Grossi, I. O., Villares, J. F., Cremonesi, M. C., Watanuki, H. M., Santo, M. A., Lotufo-Neto, F., & Wang, Y. P. (2022). Longitudinal patterns of comorbidity between anxiety, depression and binge eating symptoms among patients with obesity: A path analysis. *Journal of Affective Disorders, 303*, 255–263. https://doi.org/10.1016/J.JAD.2022.02.030

Echeverri, B., Kozak, A. T., Gildner, D. J., & Pickett, S. M. (2023). Night eating syndrome subtypes: Differences in binge eating and food addiction symptoms. *Eating and Weight Disorders, 28*(1). https://doi.org/10.1007/S40519-023-01534-7

Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods, 50*(1), 195–212. https://doi.org/10.3758/S13428-017-0862-1

Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software, 48*, 1–18. https://doi.org/10.18637/JSS.V048.I04

Epskamp, S., & Fried, E. I. (2018). *A Tutorial on Regularized Partial Correlation Networks*. https://doi.org/10.1037/met0000167.supp

Epskamp, S., Maris, G., Waldorp, L. J., & Borsboom, D. (2017). Network psychometrics. *The Wiley Handbook of Psychometric Testing: A Multidisciplinary Reference on Survey, Scale and Test Development, 2–2*, 953–986. https://doi.org/10.1002/9781118489772.CH30

Fairburn, C. G., & Beglin, S. J. (1994). Assessment of eating disorder psychopathology: Interview or self-report questionnaire. *International Journal of Eating Disorders, 16*(4), 363–370.

de Fátima Benato Fusco, S., Amancio, S. C. P., Pancieri, A. P., Alves, M. V. M. F. F., Spiri, W. C., & Braga, E. M. (2020). Anxiety, sleep quality, and binge eating in overweight or obese adults. *Revista da Escola de Enfermagem da USP, 54*, 1–8. https://doi.org/10.1590/S1980-220X2019013903656

Felske, A. N., Williamson, T. M., Scurrey, S. R. M., Telfer, J. A., Campbell, T. S., & Rash, J. A. (2021). The influence of weight-related self-esteem and symptoms of depression on shape and weight concerns and weight-loss 12 Months after bariatric surgery. *Obesity Surgery, 31*(3), 1062–1072. https://doi.org/10.1007/S11695-020-05097-9

First, M. B., Williams, J. B. W., Karg, R. S., & Spitzer, R. L. (2016). *Structured clinical interview for DSM-5 disorders – clinician version (SCID-5-CV)*. American Psychiatric Association.

Florio, L., Lassi, D. L. S., de Azevedo-Marques Perico, C., Vignoli, N. G., Torales, J., Ventriglio, A., & Castaldelli-Maia, J. M. (2022). Food addiction: A comprehensive review. *The Journal of Nervous and Mental Disease, 210*(11), 874–879. https://doi.org/10.1097/NMD.0000000000001555

Forbes, M. K., Wright, A. G. C., Markon, K. E., & Krueger, R. F. (2017). Evidence that psychopathology symptom networks have limited replicability. *Journal of Abnormal Psychology, 126*(7), 969–988. https://doi.org/10.1037/ABN0000276

Fried, E. I., & Cramer, A. O. J. (2017). Moving forward: Challenges and directions for psychopathological network theory and methodology. *Perspectives on Psychological Science:A Journal of the Association for Psychological Science, 12*(6), 999–1020. https://doi.org/10.1177/1745691617705892

Fried, E. I., van Borkulo, C. D., Cramer, A. O. J., Boschloo, L., Schoevers, R. A., & Borsboom, D. (2017). Mental disorders as networks of problems: A review of recent insights. *Social Psychiatry and Psychiatric Epidemiology, 52*(1). https://doi.org/10.1007/S00127-016-1319-Z

Garner, D. M., Olmstead, M. P., & Polivy, J. (1983). Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *International Journal of Eating Disorders, 2*(2), 15–34. https://doi.org/10.1002/1098-108X(198321)2:2<15:AID-EAT2260020203>3.0.CO, 2-6.

Gearhardt, A. N., Boswell, R. G., & White, M. A. (2014). The association of "food addiction" with disordered eating and body mass index. *Eating Behaviors, 15*(3), 427–433. https://doi.org/10.1016/j.eatbeh.2014.05.001

Gearhardt, A. N., Corbin, W. R., & Brownell, K. D. (2016). Development of the Yale food addiction scale version 2.0. *Psychology of Addictive Behaviors:Journal of the Society of Psychologists in Addictive Behaviors, 30*(1), 113–121. https://doi.org/10.1037/ADB0000136

Gearhardt, A. N., White, M. A., Masheb, R. M., Morgan, P. T., Crosby, R. D., & Grilo, C. M. (2012a). An examination of the food addiction construct in obese patients with binge eating disorder. *International Journal of Eating Disorders, 45*(5), 657–663. https://doi.org/10.1002/EAT.20957

Ghisi, M., Flebus, G. B., Montano, A., Sanavio, E., & Sica, C. (2022). Beck depression inventory. In*Adattamento italiano*. Manuale. Second Edition.

di Giacomo, E., Aliberti, F., Pescatore, F., Santorelli, M., Pessina, R., Placenti, V., Colmegna, F., & Clerici, M. (2022). Disentangling binge eating disorder and food addiction: A systematic review and meta-analysis, 27(6. In *Eating and weight disorders* (p. 1963). https://doi.org/10.1007/S40519-021-01354-7, 330.

Giromini, L., Velotti, P., de Campora, G., Bonalume, L., & Cesare Zavattini, G. (2012). Cultural adaptation of the difficulties in emotion regulation scale: Reliability and validity of an Italian version. *Journal of Clinical Psychology, 68*(9), 989–1007. https://doi.org/10.1002/JCLP.21876

Gordon, E. L., Ariel-Donges, A. H., Bauman, V., & Merlo, L. J. (2018). What is the evidence for "food addiction?" A systematic review. *Nutrients, 10*(4). https://doi.org/10.3390/NU10040477

Gormally, J., Black, S., Daston, S., & Rardin, D. (1982). The assessment of binge eating severity among obese persons. *Addictive Behaviors, 7*(1), 47–55. https://doi.org/10.1016/0306-4603(82)90024-7

Granero, R., Hilker, I., Agüera, Z., Jiménez-Murcia, S., Sauchelli, S., Islam, M. A., Fagundo, A. B., Sánchez, I., Riesco, N., Dieguez, C., Soriano, J., Salcedo-Sánchez, C., Casanueva, F. F., de La Torre, R., Menchõn, J. M., Gearhardt, A. N., & Fernández-Aranda, F. (2014). Food addiction in a Spanish sample of eating disorders: DSM-5 diagnostic subtype differentiation and validation data. *European Eating Disorders*

Review:The Journal of the Eating Disorders Association, 22(6), 389–396. https://doi.org/10.1002/ERV.2311

Grilo, C. M. (2013). Why no cognitive body image feature such as overvaluation of shape/weight in the binge eating disorder diagnosis? *International Journal of Eating Disorders, 46*(3), 208–211. https://doi.org/10.1002/EAT.22082

Grilo, C. M., Masheb, R. M., & White, M. A. (2010). Significance of overvaluation of shape/weight in binge-eating disorder: Comparative study with overweight and bulimia nervosa. *Obesity, 18*(3), 499–504. https://doi.org/10.1038/OBY.2009.280

Heriseanu, A. I., Hay, P., Corbit, L., & Touyz, S. (2017). Grazing in adults with obesity and eating disorders: A systematic review of associated clinical features and meta-analysis of prevalence. *Clinical Psychology Review, 58*, 16–32. https://doi.org/10.1016/J.CPR.2017.09.004

Jiménez-Murcia, S., Agüera, Z., Paslakis, G., Munguia, L., Granero, R., Sánchez-González, J., Sánchez, I., Riesco, N., Gearhardt, A. N., Dieguez, C., Fazia, G., Segura-García, C., Baenas, I., Menchón, J. M., & Fernández-Aranda, F. (2019). Food addiction in eating disorders and obesity: Analysis of clusters and implications for treatment. *Nutrients, 11*(11). https://doi.org/10.3390/NU11112633

Jones, P. J., Ma, R., & McNally, R. J. (2021). Bridge centrality: A network approach to understanding comorbidity. *Multivariate Behavioral Research, 56*(2), 353–367. https://doi.org/10.1080/00273171.2019.1614898

Keski-Rahkonen, A. (2021). Epidemiology of binge eating disorder: Prevalence, course, comorbidity, and risk factors. *Current Opinion in Psychiatry, 34*(6), 525–531. https://doi.org/10.1097/YCO.0000000000000750

Klatzkin, R. R., Gaffney, S., Cyrus, K., Bigus, E., & Brownley, K. A. (2018). Stress-induced eating in women with binge-eating disorder and obesity. *Biological Psychology, 131*, 96–106. https://doi.org/10.1016/J.BIOPSYCHO.2016.11.002

Lamers, F., Beekman, A. T. F., Van Hemert, A. M., Schoevers, R. A., & Penninx, B. W. J. H. (2016). Six-year longitudinal course and outcomes of subtypes of depression. *The British Journal of Psychiatry, 208*(1), 62–68. https://doi.org/10.1192/BJP.BP.114.153098

Maj, M., Stein, D. J., Parker, G., Zimmerman, M., Fava, G. A., De Hert, M., Demyttenaere, K., McIntyre, R. S., Widiger, T., & Wittchen, H. U. (2020). The clinical characterization of the adult patient with depression aimed at personalization of management. *World Psychiatry : Official Journal of the World Psychiatric Association (WPA), 19*(3), 269–293. https://doi.org/10.1002/WPS.20771

Masheb, R. M., Grilo, C. M., & White, M. A. (2011). An examination of eating patterns in community women with bulimia nervosa and binge eating disorder. *International Journal of Eating Disorders, 44*(7), 618–624. https://doi.org/10.1002/EAT.20853

Micanti, F., Iasevoli, F., Cucciniello, C., Costabile, R., Loiarro, G., Pecoraro, G., Pasanisi, F., Rossetti, G. L., & Galletta, D. (2017). The relationship between emotional regulation and eating behaviour: A multidimensional analysis of obesity psychopathology. *Eating and Weight Disorders, 22*(1), 105–115. https://doi.org/10.1007/S40519-016-0275-7

Milano, W., Carizzone, F., de Biasio, V., Angela Mercorio, M., Francesca Milano, M., Saetta, B., & Capasso, A. (2022). Neurobiological correlates shared between obesity, BED and food addiction. *Endocrine, Metabolic & Immune Disorders - Drug Targets, 23*(3), 283–293. https://doi.org/10.2174/1871530322666220627125642

Monteleone, A. M., Cascino, G., Salerno, L., Albano, G., Barone, E., Cardi, V., & Lo Coco, G. (2023). The interplay between emotion regulation, interpersonal problems and eating symptoms in individuals with obesity: A network analysis study. *Journal of Affective Disorders, 324*, 61–67. https://doi.org/10.1016/J.JAD.2022.12.056

Munguía, L., Gaspar-Pérez, A., Jiménez-Murcia, S., Granero, R., Sánchez, I., Vintró-Alcaraz, C., Diéguez, C., Gearhardt, A. N., & Fernández-Aranda, F. (2022). Food addiction in eating disorders: A cluster analysis approach and treatment outcome. *Nutrients, 14*(5). https://doi.org/10.3390/NU14051084

Nolan, L. J., & Geliebter, A. (2016). "Food addiction" is associated with night eating severity. *Appetite, 98*, 89–94. https://doi.org/10.1016/J.APPET.2015.12.025

Palavras, M. A., Morgan, C. M., Borges, F. M. B., Claudino, A. M., & Hay, P. J. (2013). An investigation of objective and subjective types of binge eating episodes in a clinical sample of people with co-morbid obesity. *Journal of Eating Disorders, 1*(1). https://doi.org/10.1186/2050-2974-1-26

Perelman, H., Gilbert, K., Grilo, C. M., & Lydecker, J. A. (2023). Loss of control in binge-eating disorder: Fear and resignation. *International Journal of Eating Disorders*. https://doi.org/10.1002/EAT.23929

Piccinni, A., Bucchi, R., Fini, C., Vanelli, F., Mauri, M., Stallone, T., Cavallo, E. D., & Claudio, C. (2021). Food addiction and psychiatric comorbidities: A review of current evidence. *Eating and Weight Disorders, 26*(4), 1049–1056. https://doi.org/10.1007/S40519-020-01021-3

Pistis, G., Milaneschi, Y., Vandeleur, C. L., Lasserre, A. M., Penninx, B. W. J. H., Lamers, F., Boomsma, D. I., Hottenga, J. J., Marques-Vidal, P., Vollenweider, P., Waeber, G., Aubry, J. M., Preisig, M., & Kutalik, Z. (2021). Obesity and atypical depression symptoms: Findings from mendelian randomization in two European cohorts. *Translational Psychiatry, 11*(1). https://doi.org/10.1038/S41398-021-01236-7

Pursey, K. M., Stanwell, P., Gearhardt, A. N., Collins, C. E., & Burrows, T. L. (2014). The prevalence of food addiction as assessed by the Yale food addiction scale: A systematic review. *Nutrients, 6*(10), 4552–4590. https://doi.org/10.3390/NU6104552

Randolph, T. G. (1956). The descriptive features of food addiction; addictive eating and drinking - PubMed. *Quarterly Journal of Studies on Alcohol - Part A, 17*(2), 198–224.

Ricca, V., Mannucci, E., Moretti, S., Di Bernardo, M., Zucchi, T., Cabras, P. L., & Rotella, C. M. (2000). Screening for binge eating disorder in obese outpatients. *Comprehensive Psychiatry, 41*(2), 111–115. https://doi.org/10.1016/S0010-440X(00)90143-3

Riva, G., Bacchetta, M., Cesa, G., Conti, S., Castelnuovo, G., Mantovani, F., & Molinari, E. (2006). Is severe obesity a form of addiction? Rationale, clinical approach, and controlled clinical trial. *CyberPsychology and Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society, 9*(4), 457–479. https://doi.org/10.1089/CPB.2006.9.457

Segura-García, C., Aloi, M., Rania, M., Ciambrone, P., Palmieri, A., Pugliese, V., Ruiz Moruno, A. J., & de Fazio, P. (2015). Ability of EDI-2 and EDI-3 to correctly identify patients and subjects at risk for eating disorders. *Eating Behaviors, 19*, 20–23. https://doi.org/10.1016/j.eatbeh.2015.06.010

Silva, D. A., Coutinho, E. da S. F., Ferriani, L. O., & Viana, M. C. (2020). Depression subtypes and obesity in adults: A systematic review and meta-analysis. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity, 21*(3). https://doi.org/10.1111/OBR.12966

Solmi, M., Köhler, C. A., Stubbs, B., Koyanagi, A., Bortolato, B., Monaco, F., Vancampfort, D., Machado, M. O., Maes, M., Tzoulaki, I., Firth, J., Ioannidis, J. P. A., & Carvalho, A. F. (2018). Environmental risk factors and nonpharmacological and nonsurgical interventions for obesity: An umbrella review of meta-analyses of cohort studies and randomized controlled trials. *European Journal of Clinical Investigation, 48*(12). https://doi.org/10.1111/ECI.12982

Sommer, L. M., Halbeisen, G., Erim, Y., & Paslakis, G. (2021). Two of a kind? Mapping the psychopathological space between obesity with and without binge eating disorder. *Nutrients, 13*(11). https://doi.org/10.3390/NU13113813

Succurro, E., Segura-Garcia, C., Ruffo, M., Caroleo, M., Rania, M., Aloi, M., de Fazio, P., Sesti, G., & Arturi, F. (2015). Obese patients with a binge eating disorder have an unfavorable metabolic and inflammatory profile. *Medicine (United States), 94*(52), 1–7. https://doi.org/10.1097/MD.0000000000002098

Thase, M. E. (2007). Recognition and diagnosis of atypical depression. *The Journal of Clinical Psychiatry, 68*(SUPPL. 8), 11–16. Suppl 8 https://europepmc.org/article/med/17640153.

Volkow, N. D., Wang, G. J., Tomasi, D., & Baler, R. D. (2013). The addictive dimensionality of obesity. *Biological Psychiatry, 73*(9), 811–818. https://doi.org/10.1016/J.BIOPSYCH.2012.12.020

Wang, S. B., Jones, P. J., Dreier, M., Elliott, H., & Grilo, C. M. (2019). Core psychopathology of treatment-seeking patients with binge-eating disorder: A network analysis investigation. *Psychological Medicine, 49*(11), 1923–1928. https://doi.org/10.1017/S0033291718002702

Wiedemann, A. A., Ivezaj, V., & Barnes, R. D. (2018). Characterizing emotional overeating among patients with and without binge-eating disorder in primary care. *General Hospital Psychiatry, 55*, 38–43. https://doi.org/10.1016/J.GENHOSPPSYCH.2018.09.003

Willem, C., Gandolphe, M., Doba, K., Roussel, M., Verkindt, H., Pattou, F., & Nandrino, J. (2020). Eating in case of emotion dys-regulation, depression and anxiety: Different pathways to emotional eating in moderate and severe obesity. *Clinical Obesity, 10*(5). https://doi.org/10.1111/COB.12388

Willem, C., Gandolphe, M. C., Roussel, M., Verkindt, H., Pattou, F., & Nandrino, J. L. (2019). Difficulties in emotion regulation and deficits in interoceptive awareness in moderate and severe obesity. *Eating and Weight Disorders, 24*(4), 633–644. https://doi.org/10.1007/S40519-019-00738-0

World Medical Association, W. (2018). *WMA declaration of Helsinki – ethical principles for medical research involving human subjects*.