



Craving in eating disorders: Mapping the concept through a systematic review

A. Cornil^{a,b,c,1}, C. Lakritz^{d,e,1}, S. Iceta^{d,e}, V. Flaudias^{b,f,g,*}

^a Adaptation, Resilience and Change (ARCh), Faculty of Psychology, Speech and language therapy and Education (FPLSE), ULiège, Liège 4000, Belgium

^b Nantes Université, Laboratoire de Psychologie des Pays de la Loire (LPPL UR 4638), Nantes F-44000, France

^c Psychological Sciences Research Institute, UCLouvain, Louvain-la-Neuve 1348, Belgium

^d Département de Psychiatrie et de Neurosciences, Université Laval, Québec, QC, Canada

^e Centre de Recherche de l'Institut Universitaire de Cardiologie et de Pneumologie de Québec, Québec City, QC, Canada

^f Université Clermont Auvergne, LAPSCO (UMR CNRS 6024), Clermont-Ferrand 63000, France

^g CHU Clermont-Ferrand, Pôle Psychiatrie B, Clermont-Ferrand F-63001, France

ARTICLE INFO

Keywords:

Eating disorders
Craving
Bulimia nervosa
Binge eating disorder
Anorexia nervosa
Assessment
Intervention

ABSTRACT

Purpose: Craving, long considered a hallmark of addictive disorders, has increasingly been recognized as a clinically significant phenomenon in eating disorders (ED). Yet, its conceptualization, measurement, and role in ED pathology remain inconsistent and fragmented. This review aimed to map existing knowledge through a systematic review.

Methods: Searches were conducted in July 2025 in Embase, PsycInfo, and Web of Science. Eligible records were peer-reviewed studies including adults clinically diagnosed with ED. Fifty studies and fifteen reviews met the inclusion criteria.

Results: Most studies examined bulimia nervosa (BN) and binge-eating disorder (BED), while anorexia nervosa (AN) and non-food-related cravings (e.g., exercise, vomiting, purging) were rarely addressed. Definitions of craving varied, sometimes conflating strong desire with loss of control or subsequent behaviors. Theoretical models were inconsistent, often borrowed from addiction research, and rarely integrated neurobiological findings. Craving assessment relied mainly on visual analogue scales (VAS) and the Food Cravings Questionnaire (FCQ), with limited use of qualitative, psychophysiological, or neurocognitive methods. Interventions specifically targeting craving were scarce. Cue exposure therapy (including virtual reality), neurofeedback, and non-invasive brain stimulation—repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS)—showed encouraging but mixed effects. Across ED, craving was consistently associated with binge eating, with trait craving emerging as a stronger predictor than state craving.

Conclusions: Craving is central yet conceptually elusive in ED. Establishing a consensual definition, developing theory-driven and transdiagnostic assessment tools, and expanding research beyond food and binge-related disorders are priorities to advance understanding and improve interventions.

1. Introduction

Eating disorders (ED) are characterized by the Diagnostic and Statistical Manual of Mental Health Disorders, Fifth Edition, Text Revision (DSM-5-TR) as "a persistent disturbance of eating or eating-related behavior that results in altered consumption or absorption of food, significantly impairing physical health or psychosocial functioning"

(American Psychiatric Association, 2022). For decades, ED have been compared to addictive disorders due to their similarities (Davis and Claridge, 1998; Vaz-Leal et al., 2017; Wilson, 2010). For example, both ED and addictive disorders involve intense preoccupations with the substance in question, repeated unsuccessful attempts to cease harmful behaviors, denial, and a noticeable impairment in the individual's physical and social functioning as a result of these behaviors (Davis,

* Corresponding author at: Nantes Université, Laboratoire de Psychologie des Pays de la Loire (LPPL UR 4638), Nantes F-44000, France.

E-mail addresses: Aurelien.Cornil@uliege.be (A. Cornil), clara.lakritz.1@ulaval.ca (C. Lakritz), sylvain.iceta.1@ulaval.ca (S. Iceta), valentin.flaudias@uca.fr (V. Flaudias).

¹ CA and LC both share the position of first author in view of their contribution to the proposed work.

2013; Vaz-Leal et al., 2017; Wilson, 2010). Neurobiological similarities have also been noted in brain responses to food and addictive substances, involving reward, motivation, and impulse control systems (Kaye et al., 2013; Kessler et al., 2016; Schulte et al., 2016). The co-occurrence of ED and substance use disorders, estimated between 8 % and 43 % (Nøkleby, 2012), further supports the link between these conditions. However, differences remain; ED typically do not involve tolerance or withdrawal symptoms, which are characteristic of addictive disorders (Rogers, 2017; Wilson, 2010). Due to these similarities and differences, the debate regarding whether ED should be considered as addictive disorders continues to generate significant academic interest (Domingo-Rodriguez et al., 2020; Macía et al., 2023).

Craving, a core component of addictive disorders, was only recently introduced as an explicit criterion for addictive disorders in the DSM-5 (American Psychiatric Association, 2013). Defined as "a strong desire or urge to use the substance" (American Psychiatric Association, 2013), craving is a multidimensional experience involving cognitive, emotional, behavioral, and physiological aspects (Meule, 2020). It can pertain to specific substances (e.g., alcohol, certain foods) or behaviors (e.g., gambling, physical activity). The inclusion of craving in the DSM-5 for addictive disorders has not increased diagnoses significantly but has enhanced diagnostic information and was argued to potentially be a target for future treatments (Hasin et al., 2012; Hormes, 2017). However, the concept of craving has raised questions about its transient or stable nature and how to quantify it (Weingarten and Elston, 1990). Measures have been developed, such as self-report questionnaires, psychophysiological and cognitive measures, but uncertainty remains, notably regarding their capacity to quantitatively measure the notion of craving (Ray et al., 2013; Weingarten and Elston, 1990).

Literature suggests that craving is also a transversal concept in ED (Cinelli et al., 2020; Rancourt et al., 2019). Food craving, specifically, is associated with various ED and is part of the concept of food addiction (El Archi et al., 2020). Measures like the Food Craving Inventory (White et al., 2002) and Food Cravings Questionnaires (FCQ; Cepeda-Benito et al., 2000) have shown strong correlations with bulimia nervosa (BN), binge eating disorder (BED), and anorexia nervosa (AN) binge/purge subtype (Chao et al., 2016; Moreno et al., 2008). For the restrictive subtype of AN, some argue that food cravings are downregulated, leading to better control overeating, while others suggest an absence of craving (Iceta and Bégin, 2024). Moreover, craving in ED seems not to be limited to food; it can also pertain to behaviors, such as physical activity (Vansteelandt et al., 2007).

Several models have been proposed to explain the development of craving in ED, though no consensus exists. Among the most cited models, the starvation of dietary restraint model suggests that excessive dietary restriction leads to craving and an inability to regulate consumption, resulting in binge-eating episodes (Herman and Polivy, 1980). The dual-process model differentiates between impulsive processes that contribute to craving development, operating quickly and automatically, and reflective control processes, which are slower and more deliberate (Bechara, 2005; Wiers et al., 2013). Other models include the conditioning model (Jansen, 1998), which posits that when a person frequently eats in response to specific stimuli (e.g., the sight, smell, or thought of food), those stimuli become conditioned cues, and over time, simply encountering these cues can elicit a conditioned craving response. The existence of multiple models highlights the ongoing debate regarding the conceptualization of craving. Some authors view it as a momentary state (Mercer and Holder, 1997; Pla-Sanjuanelo et al., 2015a) that can trigger binge eating episodes (Ferrer-García et al., 2017b), while others see it as a specific trait (Adler et al., 2022). Cepeda-Benito and colleagues (2000) incorporated both features in their conceptualization and assessment of craving. However, a consensus on this issue remains elusive.

Despite its association with ED, craving is not mentioned in any diagnostic criteria for ED, and its role remains uncertain (Iceta and Bégin, 2024). A literature review examined the determinants of food

craving in ED, how it was measured, and its influence on behaviors and treatment responses (de Oliveira and Cordàs, 2020). This review identified food craving as a key factor exacerbating dysfunctional eating behaviors in ED, such as overeating and binge-eating. The review pointed out that food craving was associated with physiological, cognitive, and emotional elements and was also influenced by the external environment. It also showed that food craving was linked to the specific psychopathology of each ED type and may affect responses to psychological and pharmacological treatments.

However, to date, there has not been a review that examines all types of cravings in ED (i.e., food-related or not), including how they are conceptualized and measured. The aim of this review is to synthesize existing knowledge on cravings in clinical populations living with ED, focusing on the following research questions: What conceptual frameworks exist for understanding cravings in ED? Which assessment tools are available to measure cravings? What interventions have been implemented to address cravings in clinical populations with ED, and what results have been observed from these interventions?

Our approach comprised a systematic review of (i) primary studies and (ii) existing reviews.

2. Method

2.1. Eligibility criteria

Papers included had to be peer-reviewed empirical research, reviews, and case studies in English. Participants had to be adults from the clinical population (i.e., recruited in clinical facilities or diagnosed by a trained professional) with a diagnosis of ED. In addition, both their craving and ED symptomatology had to be evaluated with a validated questionnaire or a clinical evaluation.

The papers were excluded if they were not peer-reviewed or did not involve a human population. We also excluded studies with a non-clinical population (i.e., recruited in the general population without a proper diagnosis), or with a population with ED mixed with a non-clinical population or population with other pathologies (i.e., undifferentiated in the analyses), or a clinical population without ED.

2.2. Search strategy

To select keywords, we first considered craving and synonyms used in the literature (Hormes and Rozin, 2010). Besides "craving", we selected "urge" as it is frequently used interchangeably, while other words (e.g., desire, need, hunger) refer to different concepts and would lead to false positives. To ensure that craving and urge were the center of the search results, we decided to search for them only in the title and the keywords fields. Regarding the "eating" field, we chose "food disorder", "eating disorder", "anorexia", "bulimia", or "binge eating". Those were searched in the title, keywords, and abstract fields. The following databases were used: Embase, PsycInfo, and Web of Science (for equations, see [Supplementary Material Table S1](#)). The search was conducted in November 2023, updated in September 2024, and last updated in July 2025.

2.3. Study selection and synthesis procedure

Articles were screened and selected according to the updated version of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). [Fig. 1](#) presents the selection process of the articles. Titles and abstracts were screened by AC and VF separately, then discussed in case of disagreement to reach consensus. The remaining articles were read in full by CL, and the selection was checked by AC. Eventually, the following data were extracted by CL and checked by AC and CL: aim(s) of the study, hypotheses, definition, conceptualization or model of craving, object of craving, type of study, population details, diagnosis of the sample,

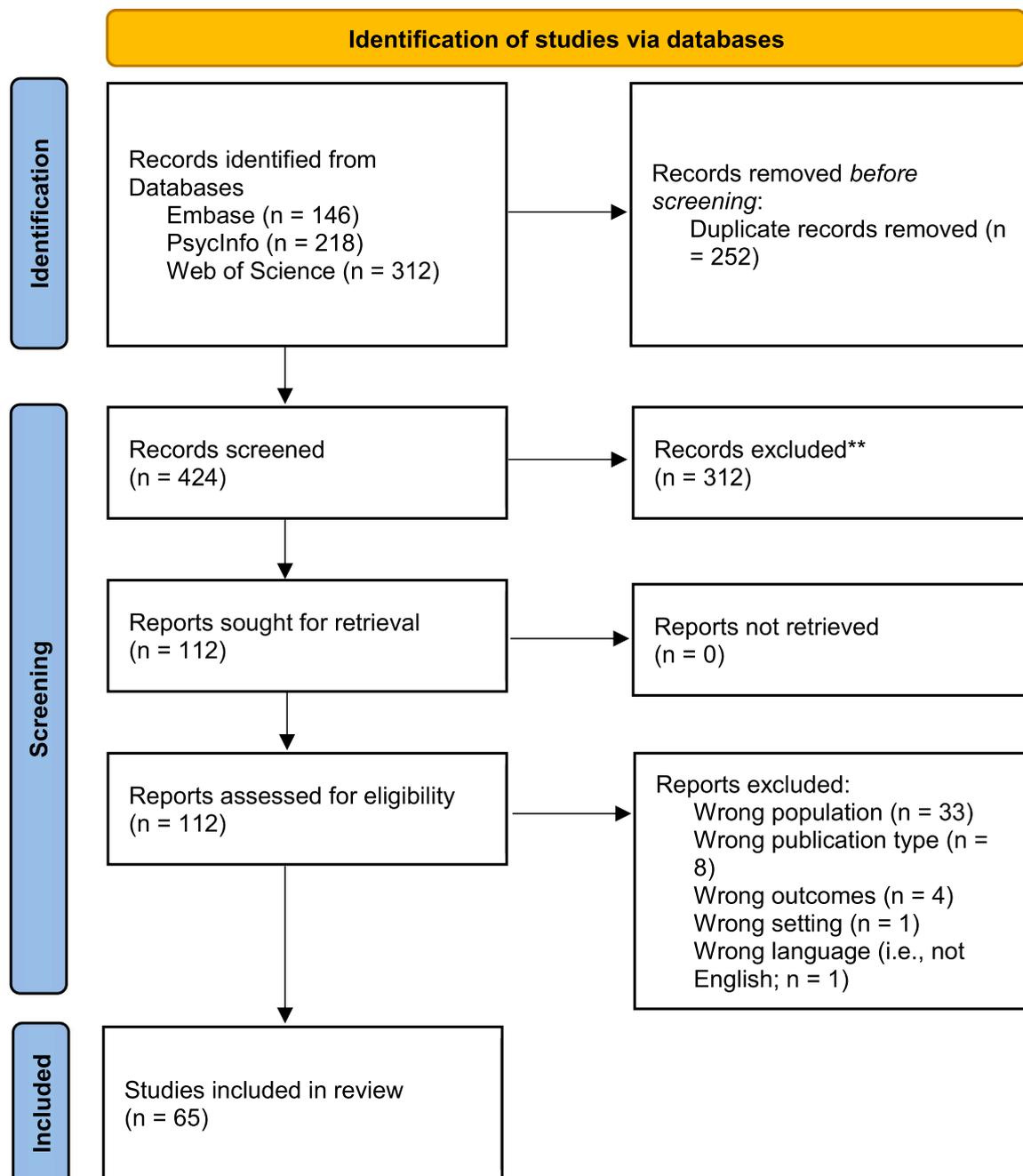


Fig. 1. PRISMA 2020 Flow Diagram: Overview of the Article Search and Selection Process.

assessment, results, implications, limitations, and perspectives. Full text selection and data extraction were performed with Covidence (Covidence systematic review software, 2024).

We conducted a narrative synthesis approach (Davis et al., 2009) to address the objectives of this review, critiquing and identifying key themes. In our analysis, we distinguished between the primary studies included and the reviews.

2.4. Quality assessment

Quality of the papers was assessed with the Critical Appraisal Skills Programme (Critical Appraisal Skills Programme, 2024), which is a flexible tool that can be adapted to the variety of methodologies and designs of the articles included. A score was assigned to each study based on its quality, with 1 point awarded for each question that received a

unanimous "yes" from the authors. These scores were then standardized to create a score out of 10 for each study, enabling direct comparisons (see Supplementary Material Table S2 and S3).

All the studies and reviews were evaluated using the adequate version (randomized control trial, cohort study, review) of the Critical Appraisal Skills Programme quality assessment tool. All the primary studies provided a clear, focused issue and used an appropriate method to answer their question. Overall, the quality assessment indicated that the studies included were of good quality, with a mean score of $M = 8.83 \pm 0.9$ (out of 10), ranging from 6.9 to 10. Each review addressed a clearly defined issue and employed suitable methods to answer its respective questions. The overall quality assessment showed that the reviews included were of good quality, with an average score of $M = 8.93 \pm 0.8$ (out of 10), ranging from 7.3 to 10.

In general, lower quality of the studies and reviews was related to

criteria that could not be assessed due to imprecision or lack of information rather than criteria not met. More specifically, the recruitment of the control (21/41 papers) and the consideration of potential confounding factors (16/47 papers) were unclear, and the estimates of the effect were not precise enough (15/49 papers). When considering only the reviews, the evaluation pointed out weaknesses in the quality assessment of the included studies (7/15 unclear and 4/15 not adequately assessed) and the precision of the results (6/15 unclear and 3/15 not precise).

Despite these few weaknesses and given the acceptable quality of the results, no primary study or review was excluded from the results.

2.5. Registration

The protocol was registered on Prospero, the international prospective register of systematic reviews of the National Institute for Health Research (<https://www.crd.york.ac.uk/PROSPERO/view/CRD42023467681>).

See the PRISMA Flow Diagram Fig. 1.

3. Results

3.1. Overview

The search yielded 676 articles. After excluding duplicates and applying the inclusion criteria, the total corpus consisted of a total of 65 articles. Accordingly, we report findings in two complementary analyses: the 50 primary studies and the 15 reviews. In each part, we have detailed the findings related to cravings in populations with ED, covering the conceptual frameworks of cravings, the methods used to evaluate cravings, and the outcomes reported about cravings in ED.

3.2. Findings from the primary studies

3.2.1. Overview of the studies included

Among the 50 included studies, 21 were non-randomized experimental studies, 8 were cross-sectional studies, and 6 were randomized controlled trials. Additionally, we identified 4 case reports and 3 randomized controlled trial study protocols. Other study types included ecological momentary assessment design (3 studies), a case control study (1 study), a cohort study (1 study), a case series (1 study), the development and validation of a questionnaire (1 study), and a longitudinal study conducted over a period of 7–29 days (1 study).

These 50 studies included a total of 3786 participants, ranging from 1 (Mehra et al., 2018; Pla-Sanjuanelo et al., 2016) to 208 (Van den Eynde et al., 2012). The majority of papers ($n = 29$, 58 %) recruited women participants only, while 18 studies included both men and women (with the percentage of women ranging from 67 % to 96 %), one study involved a single man (Mehra et al., 2018), and the three last ones were study protocols (Brockmeyer et al., 2016; Halbeisen et al., 2025; Maranhão et al., 2015). The average age across all participants was 25.1 ± 10.6 . Publication dates spanned from 1994 (Kennedy et al., 1994; Van der Wallin et al., 1994) to 2025 (Boltri et al., 2025; Grilo et al., 2025; Halbeisen et al., 2025).

Most studies ($n = 32$) were conducted in Europe, led by Germany with 14 studies and the United Kingdom with 6 studies (1 of which was carried out in both Germany and the United Kingdom). Spain followed with 11 studies, and 9 studies took place in Italy (8 of which were carried out in both Spain and Italy). Additional European contributors included Belgium with 2 studies, and both the Netherlands and Sweden, each with 1 study. In North America, there were 9 studies, with 5 conducted in Canada and 4 in the United States of America. South America had 1 study conducted in Brazil. Asia had 2 studies (one in Japan and one in Israel). One study took place in New Zealand. Two studies did not specify the country of recruitment. Overall, most studies were conducted in Western cultures.

All the studies are presented in Table 1.

3.2.2. Diagnosis of the participants

Out of the 50 studies, 33 involved participants diagnosed with BN, BED, or Eating Disorder Not Otherwise Specified (EDNOS). Among them, 16 studies included both individuals with BN and those with BED or EDNOS, 9 studies focused solely on participants with BN, while 8 studies exclusively examined participants with BED. In addition to the 33 studies, 4 studies included individuals with either AN or BN, and 9 studies focused on participants with AN. Furthermore, 3 studies involved participants with all types of ED, and one case study featured a participant with Pica disorder.

3.2.3. Object of craving

In 42 out of 50 studies, the primary focus of craving was on food. Among these, in addition to craving for food, 9 studies also examined cravings for specific behaviors, including binge eating (Christian et al., 2024; Engelberg et al., 2005; Kennedy et al., 1994; Leenaerts et al., 2023; Steiger et al., 1999; Tasca et al., 2009), vomiting (Kennedy et al., 1994; Tasca et al., 2009), and cravings related to restraint, physical activity, purging, or laxative abuse (Christian et al., 2024; Tasca et al., 2009). These 9 studies focused on individuals with AN or BN, and one also included individuals with EDNOS (Steiger et al., 1999). Beyond these 42 studies on food cravings, the remaining 8 studies explored other objects of craving: 7 focused on cravings related to physical activity, including 3 case reports on individuals with AN (Boltri et al., 2025; Graap et al., 2018; Pieters et al., 2006) and 4 studies involving individuals with AN, BN, or unspecified eating disorders (Amin et al., 2023; Halbeisen et al., 2025, 2024; Paslakis et al., 2017). The eighth study centered on craving for a non-nutritive item: ice, as addressed in a case report on an individual with pica disorder (Mehra et al., 2018).

3.2.4. Definition of craving

A total of 28 studies out of 50 provided definitions of craving. The most common definition described craving as "an urge to" in 9 studies involving participants with all types of ED (Amin et al., 2023; Engelberg et al., 2005; Ferrer-García et al., 2017a; Graap et al., 2018; Halbeisen et al., 2025, 2024; Mehra et al., 2018; Paslakis et al., 2017; Sutoh et al., 2016), while 7 studies referred to it as a strong or intense "desire", also observed across all types of ED (Arend et al., 2024; Leenaerts et al., 2023; Mallorquí-Bagué et al., 2020; Meule et al., 2018; Moreno et al., 2008; Pla-Sanjuanelo et al., 2015b; Wolz et al., 2017). Additionally, 4 studies combined these terms, defining craving as a "desire or urge" in participants with either BN or BED (Chami et al., 2021; Neudeck et al., 2001; Waters et al., 2001a, 2001b). Beyond mere expressions of desire, craving was also characterized as a "motivational state" in 4 studies, with 2 specifying "an appetitive motivational state" in participants with BN or BED (Ferrer-García et al., 2017b; Pla-Sanjuanelo et al., 2019) and 2 incorporating an emotional dimension: "an appetitive motivational-emotional state" in participants with BN or BED (Pla-Sanjuanelo et al., 2015a) and "an affectively charged motivational state" in participants with all types of ED (Amin et al., 2023). Mallorquí-Bagué et al. (2020) also described it as "an affective state." Less frequently cited definitions included "uncontrollable approach tendencies toward" (Brockmeyer et al., 2016) and "a driving force toward" (Alpers and Tuschén-Caffier, 2004), each mentioned in one study involving participants with BN or BED. The notion of a lack of control was highlighted in three studies involving participants with BN or BED, which defined craving as an "irresistible desire" (Wolz et al., 2017), an "almost compelling urge to eat" (Ferrer-García et al., 2017a), and "uncontrollable approach tendencies toward" (Brockmeyer et al., 2016). Moreover, some definitions emphasized the involvement of cognitive, emotional, and behavioral systems in craving, describing it as "characterized by changes in the cognitive, emotional, and behavioral/motor levels" across all types of ED (Amin et al., 2023), "an affectively charged momentary state to engage in physical activity" (Halbeisen et al., 2024),

Table 1
Description of the fifty research studies.

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Adler et al., (2022)	Cross-sectional study	To test whether individuals with AN restrictive subtype can separate self-perceived actual control over eating versus the feeling of loss of control in the context of eating, and compare it with individuals with BN and healthy controls.	AN restrictive subtype; BN; HC; Source of diagnosis: DSM-5	113 (100 %)	22.3 (3.6)	G1 AN-R; W = 26 M = 0 G2 BN; W = 28 M = 0 G3 HC; W = 59 M = 0		Food	Model: Not specified; Conceptualization: Trait	Lack of control over eating (subscale of the FCQ-T) is higher among BN than AN and HC.	A sample of women only.
Alpers and Tuschen-Caffier, (2004)	Cross-sectional study	3 goals: - to examine the energy consumption during non-binge meals and binge-eating episodes separately. - to assess the macronutrient composition of meals and whether they provide evidence for malnutrition in patients with BN. - to examine whether the macronutrient composition of binge-eating episodes is characterized by a larger proportion of carbohydrates.	BN or Panic Disorder (PD, anxiety disorders); HC; Source of diagnosis: DSM-III-R	120 (100 %)	28.0 (4.3)	G1 BN; W = 40 M = 0 G2 Panic Disorder; W = 40 M = 0 G3 HC; W = 40 M = 0	"A driving force towards binge eating because carbohydrates may have a mood-lifting effect"	Food	Model: The starvation/dietary model; Conceptualization: Not specified	No evidence supporting the hypothesis that carbohydrate craving triggers binge-eating in BN.	Self-report or monitoring.
Amin et al., (2023)	Other: Development and validation of a questionnaire	2 goals: - to develop an instrument to assess the acute urge ("state") to be physically active in patients with ED - to test the psychometric properties and validate the instrument in patients with ED.	ED patients: AN, BN, UED (unspecified eating disorder), Others; HC; Source of diagnosis: ICD-10	126 (92.9 %)	26.3 (9.5)	G1 AN; W = 63 M = 2 G2 BN; W = 40 M = 2 G3 Unspecified Eating Disorder; W = 10 M = 1 G4 Others; W = 4 M = 0	"we refer to the urge for physical activity as an intense "affectively charged motivation state" [...] that is characterized by changes in the cognitive, emotional, and behavioral/motor levels."	Other: physical activity	Model: Not specified; Conceptualization: State that explain physical activity and affective experiences	The State Urge to be Physically Active- Questionnaire measures acute activity urges as a state and is valid in patients with ED. It has four factors: cognitive aspects, emotional aspects, motor aspects, and burden.	Self-report or monitoring; validation on a single site.
Arend et al., (2024)	Other: Ecological Momentary Assessment	2 goals: - to examine the links between emotional states and food craving of patients with AN restrictive, AN binge-purge, BN, BED, and a	ED patients: AN restrictive, AN binge purge, BN, BED; HC; Source of diagnosis: DSM-5	204 (100 %)	28.5 (10.6)	G1 AN restrictive; W = 29 M = 0 G2 AN binge-purge; W = 26 M = 0 G3 BN; W = 50 M = 0 G4 BED;	"momentary [...] desire to eat something tasty"	Food	Model: Affect regulation model; Conceptualization: State; Predictor and mediator of eating behaviours; high food craving could predict	Associations between emotion and food cravings are specific to each ED group when compared to HC: - AN restrictive: lower craving and less arousing negative emotions; higher	A sample of women only.

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Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
		control group - to compare food craving across the group with ED and the control group				W = 41 M = 0 G5 HC; W = 58 M = 0			binge eating, and low food craving could predict restriction.	craving in high positive emotions - AN binge-purge: lower craving and less arousing negative emotions, but higher craving when high arousal negative emotions; higher craving in high positive emotions - BN: higher food craving with arousing negative emotions - BED: no difference regarding negative emotion-related craving; lower craving in high positive emotions	
Boltri et al., (2025)	Case series	To test de feasibility of a virtual reality-based running exposure protocol designed to target the urge to be physically active in AN in patients	AN; Source of diagnosis: Not specified	3 (100 %)	23.3 (2.5)		"multifaceted, momentary condition encompassing motor (e.g., physical restlessness, akathisia, increased drive for activity), emotional (e.g., heightened anxiety, inner tension, agitation), and cognitive (e.g., intrusive thoughts about movement, preoccupation with activity) components"	Other: physical activity	Model: Not specified; Conceptualization: State, trigger, and reinforcing factor for compulsive tendencies towards physical exercise	Reduction of the urge to be physically active after each virtual reality-based running exposure, but a habituation trend over sessions, suggesting a short-term effect. Potential of virtual reality to address the urge to be physically active in AN.	Small sample size (single case study design), therefore, no generalizability of the results; lack of a control group, difficulty in isolating the effect of the protocol into a broader care approach; short follow-up period; no causal inferences possible.
Brockmeyer et al., (2016)	Randomised controlled trial (study protocol)	3 goals: -to examine whether a tailored, brief (10 sessions), computerised Cognitive Bias Modification (CBM) training (approach bias modification versus sham) is able to reduce binge-eating episodes in patients with BN and BED -to investigate whether this CBM programme reduces global ED psychopathology, trait	BN or BED; Source of diagnosis: DSM-5	54 (NA)	NA	G1 real Cognitive Bias Modification; n = 27 G2 sham Cognitive Bias Modification; n = 27	"uncontrollable approach tendencies towards excessive consumption of food despite negative consequences"	Food	Model: Dual-process models; Conceptualization: The addiction-like features in BN and BED is highlighted as uncontrollable approach tendencies towards binge food despite significant negative psychological and physical consequences.	(NA because study protocol)	

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Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Bruce et al., (2009)	Non-randomised experimental study	and cue-elicited food craving, food intake, and approach and attentional bias towards visual food stimuli in patients with BN and BED from pre- to post-treatment. -to assess treatment acceptance. To explore the biochemical, mood and eating-related effects of acute tryptophan depletion in women with and without BN who were or were not using serotonin reuptake inhibitors.	BN or Bulimia-spectrum ED; HC; Source of diagnosis: DSM-IV-TR	64 (100 %)	24.5 (5.2)	G1 Unmedicated BN; W = 26 M = 0 G2 Medicated BN; W = 13 M = 0 G3 Healthy controls; W = 25 M = 0		Food	Model: Not specified; Conceptualization: Neurobiological hypothesis involving alterations in the function of the serotonin system.	Women with BN who were using serotonin reuptake inhibitors, but not the other groups, also reported an increased urge to binge eat in the tryptophan-depleted condition.	Lack of information on the history of medication; small sample size.
Chami et al., (2021)	Non-randomised experimental study	2 goals: - to characterize binge eating days by examining the frequency of specific emotions, food cravings, meal skipping, and dietary restrictions. - to explore individual changes in these factors during an intervention to reduce binge-eating frequency, considering different intervention types (food-specific vs. general) and patient groups (with BN vs. with BED).	BN or BED; Source of diagnosis: DSM-5	77 (92.2 %)	33.6 (12.6)	G1 BN; W = 36 M = 3 G2 BED; W = 35 M = 3	"the intense desire or urge to eat a particular type of food"	Food	Model: Conditioning model; Conceptualization: State and trait; Facilitator of binge-purge cycle	No reduction of food craving, reduction of binge-eating	Lack of information on the temporal nature and the causality between mood and binge; potential influence of the mood by previous binge; self-report or monitoring; difference between types of negative affect, or positive affect not considered
Christian et al., (2024)	Non-randomised experimental study	3 goals: - to characterize the frequency of fear-based processes during partial AN remission - to investigate associations between fear-based processes and AN behavioral urges (restriction, purging, compensatory exercise, binge eating) - to test if these associations vary with different feared stimuli	AN both subtypes; Source of diagnosis: DSM-5	41 (100 %)	29.9 (8.9)			Food; Other: restrict, purging, exercise, binge	Model: An anxiety-based model of AN; Conceptualization: Not specified	Fear, avoidance, and distress were positively related to cravings for restraint, binge eating, purging, and physical exercise. Avoidance behaviours predicted craving to binge eat and to exercise, and approach behaviours were related to restriction. Approaching feared stimuli may increase craving in the short term.	Small sample size; homogeneity of the sample (i.e., stage of partial remission); Association investigated within a timeframe that might not be optimal; Other relevant symptoms (e.g., distress tolerance, expectancy violation, physiological response to feared situation) not considered; No pre-registration

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Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Claudino et al., (2011)	Randomised controlled trial	(e.g., food, social situations). To investigate the effect of one session of real high-frequency repetitive transcranial magnetic stimulation (rTMS) applied to the left dorsolateral prefrontal cortex (DLPFC) on salivary cortisol concentrations in individuals with BN, and indirectly on food craving.	BN or Eating Disorder Not Otherwise Specified-bulimic type (including BED); Source of diagnosis: DSM-IV	22 (100 %)	28.6 (8.7)	G1 real rTMS (BN = 7; ENDOS = 4); W = 11 M = 0 G2 sham rTMS (BN = 7; ENDOS = 4); W = 11 M = 0		Food	Model: Not specified; Conceptualization: Not specified	Only a trend of a reduction of food craving, no correlation between levels of stress, GSQ-S, and VAS urge to eat	No control group; Between-subject design
Engelberg et al., (2005)	Other: Longitudinal study (over 7–29 days)	The study aimed to characterize the natural course of events linking dietary restraint to urges to binge and actual binge episodes.	BN or Eating Disorder Not Otherwise Specified; Source of diagnosis: DSM-IV	39 (100 %)	24.1 (12.7)	G1 BN; W = 29 M = 0 G2 BN nonpurging type; W = 1 M = 0 G3 EDNOS; W = 9 M = 0	"the urge to binge"	Food; Other: binge	Model: The starvation/dietary model; Conceptualization: Not specified	Actual binge eating was not directly preceded by restraint, but restraint was systematically observed before the increase in the urge to binge.	Self-report or monitoring with ecological momentary assessment; Smaller number of recordings of restraint before binge cravings than for other analyses; Different time intervals
8 Ferrer-García et al., (2014)	Cross-sectional study	The main aims were to identify contexts and cues triggering binge eating in Spanish and Italian patients, assess transcultural differences in food craving, and develop valid virtual-reality environments for cue-exposure therapy.	BED, BN purging subtype; Source of diagnosis: DSM-5	101 (88.1 %)	30.1 (8.0)	G1 Spanish sample G2 Italian sample		Food	Model: Not specified; Conceptualization: Not specified	The presence of palatable food, along with hunger and negative mood, was strongly associated with craving.	
Ferrer-García, et al., (2017a)	Randomised controlled trial	The study aims to compare the effectiveness of six virtual reality-cue exposure therapy (VR-CET) sessions as a second-level treatment for patients with BN or BED, who did not respond to initial structured cognitive-behavioural therapy (CBT), against six additional CBT sessions.	BN or BED; Source of diagnosis: DSM-5	64 (70.3 %)	34.7 (9.5)	G1 Additional Cognitive Behavioural Treatment; W = 24 M = 8 G2 VR-Cue Exposure Therapy; W = 21 M = 1	"an almost irresistible urge to eat"	Food	Model: Conditioning model; Conceptualization: Craving increases the potential occurrence of bingeing.	Reduction of food cravings, and to a greater extent in the VR condition Food craving + anxiety-induced binge eating.	Fewer cue exposure therapy sessions than usual; Potential placebo effect of a new intervention compared to control subjects who continued with their usual treatment; General anxiety tool instead of food-related anxiety; No supervision of first-level treatment; No consideration of age or illness onset; No evaluation of the long-term impact

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Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Ferrer-García, et al., (2017b)	Non-randomised experimental study	2 goals: - to analyze the relationship between eating style (emotional, restrictive, or external) and psychophysiological responses to food-related virtual-reality environments (specifically, food craving and anxiety) - to evaluate whether this relationship was different in patients with BN or BED to that in healthy participants.	BN or BED; HC; Source of diagnosis: DSM-5	193 (86.5 %)	26.6 (8.5)	G1 ED; W = 45 M = 13 G2 HC; W = 122 M = 13	"an appetitive motivational state that promotes the ingestion of desired foods"	Food	Model: Conditioning model; Conceptualization: State, Trigger of binge eating.	A positive link was found between external eating style and food craving in virtual reality environments for both healthy and clinical groups, with a stronger association in those with BN or BED compared to healthy controls. External eating style was the key predictor of cue-elicited craving in both groups.	Small sample size; Age difference between groups (10 years); Mainly a sample of women; No causal conclusion
Forester et al., (2024)	Other: Ecological Momentary Assessment	To evaluate the relationships between anticipatory processes (binge planning and binge inevitability), shame, and binge-eating episodes in BED	BED; Source of diagnosis: DSM-5	43 (90.7 %)	33.8 (13.7)			Food	Model: Not specified; Conceptualization: Precipitant of binge eating in BED, part of the anticipatory processes	Anticipatory processes, which include craving, likely precede and explain affective changes (e.g., guilt) that precipitate binge-eating episodes, contrary to the traditional view that considers negative emotions to be the primary trigger.	Small sample size; Low binge eating frequency; Narrow demographics; Use of single-item assessments; Lack of causal inference; Lack of consideration for contextual factors
Gendall et al., (1997)	Other: Case control	To determine the prevalence and characteristics of food cravings among women with a history of AN	AN; Source of diagnosis: DSM-III-R	165 (100 %)		G1 AN; W = 64 M = 0 G2 HC; W = 101 M = 0	"body attempts to correct [...] biological, psychological, and sensory deficits" created by "intense dietary restriction"	Food	Model: Not specified; Conceptualization: Common immediate trigger of binge eating in women with BN	No difference between women with AN history and control women in experiencing (occurrence and recency) food cravings, but more intense craving, greater difficulty to resist, anxiety if unavailable, and more frequent among women with AN history. More intense and frequent craving is related to lifetime BN.	Sample size; Retrospective study
Graap et al., (2018)	Case report	To test the effect of dronabinol in a male patient with AN suffering from a severe acute urge to be physically active.	AN; Source of diagnosis: Not specified	1 (0 %)	27.0 (NA)		an "acute urge" to engage in physical activity: "a momentary condition in terms of a "state" that is attended by changes in cognitive, emotional and behavioral aspects. Mostly, this urge is experienced as an increased inner	Other: physical activity	Model: Not specified; Conceptualization: State; Involvement of changes in cognitions (compulsive thoughts), emotions, and behaviours (agitation).	Reduction of craving for physical activity	

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Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Grilo et al., (2025)	Randomised control trial	To test and compare the effectiveness of cognitive-behavioural therapy (CBT), lisdexamfetamine (LDX), and their combination on BED	BED; Source of diagnosis: DSM-5; Eating disorder examination interview	141 (83.7 %)	43.6 (11.5)	G1 CBT; n = 47 G2 LDX; n = 47 G3 CBT + LDX; n = 47	agitation along with compulsive thoughts of physical activity"	Food	Model: Not specified; Conceptualization: General and specific food craving	Reduction of food craving in the 3 conditions but greater in the combined condition	No control group; Concerns regarding the generalizability (e.g., settings, sociodemographics, not treatment-seeking population); Short-term outcomes; Unadjusted p-values
Halbeisen et al., (2024)	Cohort study	To investigate the prognostic role of activity urges on predicting early weight gain among patients with AN during the first two weeks of treatment	AN restrictive, binge purge, and atypical; Source of diagnosis: ICD-10	53 (96.2 %)	25.2 (9.7)		physical activity urge: "an affectively charged momentary state to engage in (any) physical activity"	Other: physical activity	Model: Not specified; Conceptualization: State	Higher physical activity urges at admission predict lower early weight gain and lower discharge weights	Lack of objective physical activity measurement; Single assessment of activity urges; Homogeneity of the sample; Unassessed comorbidities; short-term weight changes
Halbeisen et al., (2025)	Randomised controlled trial (study protocol)	To evaluate the feasibility of virtual reality-based interventions to reduce the urge to be physically active in patients with AN	AN both subtypes; Source of diagnosis: ICD-11	42 (not 100 %, but the exact % was not provided)		G1 intervention G2 control	urge	Other: physical activity	Model: Not specified; Conceptualization: Physical activity urge develops gradually in patients with AN	(NA because study protocol)	
Kennedy et al., (1994)	Non-randomised experimental study	To compare perceptions and emotional responses in patients with AN (both subtypes) and control subjects before and after a daily standard meal (lunch).	AN; HC; Source of diagnosis: DSM-III-R	26 (100 %)	24.0 (7.4)	G1 AN-R; W = 9 M = 0 G2 AN-B; W = 10 M = 0 G3 HC; W = 7 M = 0		Food; Other: binge and vomit	Model: Not specified; Conceptualization: Not specified	No change in craving either before or after measures between baseline and after 6 weeks of supervised hospital treatment.	Small sample size
Leenaerts et al., (2023)	Non-randomised experimental study	To explore the relations between negative affect, craving, rash action, and binge eating in daily life, and to investigate whether craving and rash action mediate the relationship between negative affect and binge eating.	BN; HC; Source of diagnosis: DSM-5	146 (100 %)	21.8 (3.5)	G1 BN; W = 70 M = 0 G2 HC; W = 76 M = 0	"an intense desire for a binge-eating episode"	Food; Other: binge-eating episode	Model: An addiction model; Conceptualization: Craving as a construct with both a motivational component (i.e., the desire for a substance) and an inhibitory component (i.e., the attempt to abstain). When it comes to food, specific food targeting and satisfaction through consumption.	Negative affect is a stronger predictor of craving in individuals with BN compared to controls. Negative affect can induce binge eating in patients with BN via craving (and rash action), yet it may also result in food avoidance.	Mainly a sample of women; Short illness duration and sample not seeking treatment; Self-report or monitoring with ecological momentary assessment; No assessment of negative emotions nor dietary restriction; Decreased compliance resulting in missing data; Investigation on only 3 days of the week.
Mallorquí-Bagué et al., (2020)	Non-randomised	3 goals: - to examine the clinical	AN both subtypes; HC;	40 (100 %)	21.9 (5.8)	G1 AN; W = 20 M = 0 G2 HC; W = 20 M = 0	"intense desire for specific food";	Food	Model: Not specified; Conceptualization:	The prevalence of food addiction was significantly	

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Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
	experimental study	and electrophysiological features of emotion and food craving regulation in patients with AN - to identify differences in event-related potentials (ERP) during the down-regulation of emotions or cravings between groups. - to analyze the correlation between self-reported emotion regulation strategies and ERP (specifically P300 and Late Positive Potential) during down-regulation of cravings or negative emotions.	Source of diagnosis: DSM-5				"food craving [...] is considered a hallmark of food addiction, [and] has been recently proposed as an affective state involving behavioural and physiological changes"		State; Hallmark of food addiction; Potential regulation of craving	higher in the AN group than in the control group. Among AN subtypes, the AN-BP subtype had higher YFAS total scores and met most criteria except for "withdrawal symptoms." In a food craving regulation task, both AN and control groups allocated more attention to food stimuli, successfully regulating food cravings, despite patients with AN reporting greater food addiction symptoms. Patients with AN tended to use more maladaptive suppression strategies for negative emotions.	
Maranhão et al., (2015)	Randomised controlled trial (study protocol)	3 goals: - to investigate the effects of repetitive transcranial magnetic stimulation (rTMS) on food cravings and binge eating behavior, - to investigate its impact on ED-related psychopathology (depression, anxiety, stress), anthropometric measures, cognition, brain structure and function, hormones, and inflammatory biomarkers - to evaluate the tolerability and safety of rTMS.	BED; HC; Source of diagnosis: DSM-5	90 (100 %)				Food	Model: Not specified; Conceptualization: Increase of behaviour frequency, salience of cues, ambivalence, and relapse.	(NA because study protocol)	
Max et al., (2023)	Randomised controlled trial	The study aims to investigate the manual interaction with food in a virtual reality in patients with BED, and the effect of a computer-based inhibitory control training programme enhanced by transcranial direct current stimulation	BED; Source of diagnosis: DSM-5	31 (77.42 %)	36.3 (Not provided)	G1 tDCS; n = 15 G2 sham stimulation; n = 16		Food	Model: Dual-process models; Conceptualization: Not specified	No reduction of food craving.	Small sample size; Mismatch in the assessment of impulsivity

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Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Mehra et al., (2018)	Case report	(tDCS) on the manual interaction with food. To present the association of pagophagia (compulsive ice chewing) with sadness in a patient with recurrent depressive disorder.	Pica; Source of diagnosis: Not specified	1 (100 %)	44.0 (NA)		"strong urge to consume the substance due to its taste or consistency"	Other: non-nutritive items (ice)	Model: Not specified; Conceptualization: Not specified	Pagophagia, characterized by intense ice craving, diminished after addressing the underlying depression in a single case.	
Meule et al., (2018)	Non-randomised experimental study	To test whether individuals with BN or BED report greater momentary food craving when exposed to induction than individuals without ED.	BN or BED; HC; Source of diagnosis: DSM-5	46 (89.1 %)	27.7 (9.4)	G1 BE (BN = 14; BED = 13); W = 24 M = 3 G2 HC (with no ED and low food craving trait); W = 17 M = 2	"a subjective experience of an intense desire to eat the food"	Food	Model: Not specified; Conceptualization: Not specified	No significant difference in food cravings before exposure. Both groups showed an increase in food craving during the induction in the binge-eating group, but the increase in food craving was stronger for the binge-eating group compared to the control group.	Sample composed of women without obesity; BN and BED were regrouped.; No control group with high food craving trait and without problematic eating
Moreno et al., (2008)	Cross-sectional study	To test the factor structure of the FCQ-T and FCQ-S in a clinical sample, and to evaluate the association between those measures and ED symptoms.	AN (both subtypes), BN (purging or non-purging), Eating Disorder Not Otherwise Specified; Source of diagnosis: DSM-IV	177 (100 %)	20.4 (5.2)		"strong desires that, arising from either physiological or psychological underlying states, promote drug and food consumption"	Food	Model: Not specified; Conceptualization: State and Trait. Emergence from and expression through several psychological processes.	Replication of the factor structures of the FCQ-Trait and State. Food craving (FCQ-T more than FCQ-S) predicts binge eating symptoms more than body dissatisfaction. Both FCQ-T and FCQ-S scales have good validity to assess craving in ED. The use of one or the other depends on whether the focus is on the circumstances (state) or not (trait).	High interfactor correlations of the FCQ-T
Nederkorn et al., (2004)	Non-randomised experimental study	To test the conditioning model of binge eating.	BN; HC; Source of diagnosis: DSM-IV	71 (100 %)		G1 BN; W = 51 M = 0 G2 Control; W = 20 M = 0		Food	Model: Conditioning model; Conceptualization: Not specified	Food exposure triggers physiological and subjective responses in participants with BN and in controls. Smaller finger pulse amplitude increases and higher food intake are related to stronger eating cravings.	Potential induction of negative emotions by the methodology, which can prevent craving from occurring
Neudeck et al., (2001)	Non-randomised experimental study	This study aims to explore the psychological and physiological reactions of patients with BN to repeated exposure to	BN; HC; Source of diagnosis: DSM-IV	72 (100 %)	26.6 (10.4)	G1 BN; W = 48 M = 0 G2 Control; W = 24 M = 0	"urge to binge" defined as "an increased desire to binge"	Food	Model: An addiction model; Conceptualization: Not specified	On the first, but not on the second day, exposure to high-caloric food cues led to increases in urge to binge and physiological stress in women with BN. Blood sugar	

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Table 1 (continued)

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		high-calorie and low-calorie foods. It will assess stress levels and binge urges as psychological responses and measure cortisol as a physiological stress indicator. Additionally, based on Jansen's addiction model, the study will examine how blood sugar levels may affect these responses to food exposure.								levels did not have any influence on the response to the confrontation.	
Paslakis et al., (2017)	Non-randomised experimental study	To test the impact of virtual reality jogging exposure on the acute urge to be physically active in patients with ED.	AN, BN; Source of diagnosis: DSM-5	30 (100 %)		G1 AN; W = 20 M = 0 G2 BN; W = 10 M = 0	"acute urge to engage in physical activity"	Other: physical activity	Model: Not specified; Conceptualization: Increase of agitation with compulsive thoughts.	Reduction of craving for physical activity	Small sample size; Single exposure
Pieters et al., (2006)	Case report	To explore how experience-sampling methodology (ESM) can reveal individual differences in hyperactivity, emotions, and cognitions, and to discuss its clinical and therapeutic relevance.	AN restrictive subtype; Source of diagnosis: Not specified	2 (100 %)	19.5 (NA)			Other: physical activity	Model: Not specified; Conceptualization: Not specified	Both patients had a tendency to be hyperactive, which was linked to their preoccupation with weight and negative emotions. However, only one patient showed a significant connection between the urge to move and the absence of positive emotions.	Artificial environment; Limitations of the quantity of exercise; Self-report or monitoring (reluctance to admit or unawareness)
Pla-Sanjuanelo et al., (2015b)	Non-randomised experimental study	The study aims to determine if virtual reality (VR) exposure to food cues induces craving levels consistent with state-craving and trait-craving, assessed by the Spanish and Italian versions of the Food Craving Questionnaire.	BN or BED; HC; Source of diagnosis: DSM-5	118 (83.9 %)	26.3 (7.9)	G1 ED (BED and BN); W = 30 M = 10 G2 Control; W = 69 M = 9	"strong desire to eat"	Food	Model: Not specified; Conceptualization: State and Trait	Patients with BED or BN with elevated state and trait craving showed greater mean craving experience (to consume virtual food) in 3D environments, compared to controls. State craving was the factor explaining the craving best during virtual reality exposure in both patients and controls.	
Pla-Sanjuanelo et al., (2015a)	Non-randomised experimental study	3 goals: - to create virtual scenarios for cue exposure therapy (CET) in patients with BN and BED. - to examine variations in craving levels based on gender, age, BMI, DSM-V diagnosis,	BN or BED; HC; Source of diagnosis: DSM-5	164 (87.2 %)	27.2 (8.2)	G1 ED; W = 89 M = 12 G2 HC; W = 54 M = 9	"an appetitive motivational-emotional state that triggers the search for food and the consequent intake behaviors"	Food	Model: Not specified; Conceptualization: State	Binge cravings in individuals with BN or BED were highest alone at home, especially during meals and in certain rooms. Women had stronger cravings than men, but no key differences between ED subtypes were noted. Patients with BN or BED	Few participants used open items of the inventory; A Large number of items with a potential impact on response accuracy; Self-report or monitoring; Mainly a sample of women

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Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
		bulimic symptom severity, weight concerns, and affective issues. - to assess differences in binge craving contexts and cues among patients with BN or BED compared to controls without an eating disorder.								craved more than controls, except when feeling positive.	
Pla-Sanjuanelo et al., (2016)	Case report	To test the effectiveness of virtual reality-based cue-exposure therapy (VR-CET) for a patient with BN who is resistant to conventional cognitive behavioral therapy (CBT) treatment.	BN purging subtype; Source of diagnosis: DSM-5	1 (100 %)	44.0 (NA)			Food	Model: Not specified; Conceptualization: Not specified	Reduction of food craving in BN.	Not provided
Pla-Sanjuanelo et al., (2017)	Non-randomised experimental study	To compare the efficacy of virtual reality-based cue-exposure therapy (VR-CET) alone or with pharmacotherapy in patients with BN and BED who were resistant to cognitive behavioral therapy (CBT).	BN or BED; Source of diagnosis: DSM-5	32 (Not provided)		G1 VR-Cue Exposure Therapy + pharmacotherapy; n = 17 G2 VR-Cue Exposure Therapy alone; n = 15		Food	Model: Not specified; Conceptualization: Not specified	Reduction of food craving in both interventions, without a difference between interventions.	Small sample size; No randomization; Lack of control group
Pla-Sanjuanelo et al., (2019)	Non-randomised experimental study	To assess the virtual reality software's ability to elicit anxiety and craving responses in patients with ED and healthy controls, and determine which response better discriminates between the groups. 4 specific goals: - to determine if food-related virtual cues trigger higher craving and anxiety in patients with BN or BED versus healthy controls - to test if virtual-reality effects are stronger in patients compared to healthy controls - to explore whether anxiety or craving	BN or BED; HC; Source of diagnosis: DSM-5	193 (86.5 %)	26.6 (8.4)	G1 ED; W = 45 M = 13 G2 HC; W = 122 M = 13	"an appetitive motivational state that triggers the search for food and promotes the ingestion of desired foods"	Food	Model: Conditioning model; Conceptualization: Greater ED pathology is related to higher craving.	Patients with BN or BED and controls showed greater craving and anxiety in food-related virtual environments (compared to neutral stimuli). The levels of these responses were significantly heightened across all scenarios in the patients with BN or BED. Time since the last meal (hunger indicator) was related to craving and anxiety in the control group but not among the patients. Food-related virtual reality environments are valid for patients with BN and BED. Anxiety and craving should be considered for treatment.	Lack of instructions on food intake prior to the experiment; Mainly a sample of women; No physiological measures

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Rosch et al., (2023)	Randomised controlled trial	responses better differentiate patients from healthy controls – to assess how variables like time without eating, BMI, and binge-eating episode frequency/severity impact craving and anxiety levels. To explore predictors of treatment success for neurofeedback (NF) in BED.	BED; Source of diagnosis: DSM-5	43 (83.7 %)	47,6 (13.3)	G1 real-time functional near-infrared spectroscopy neurofeedback; W = 18 M = 4 G2 EEG neurofeedback; W = 18 M = 3		Food	Model: Not specified; Conceptualization: Not specified	Lower food cravings before neurofeedback treatment (real-time functional near-infrared spectroscopy and electroencephalography), along with higher BMI and higher ED, predicted lower binge-eating frequency and lower ED among individuals with BED.	Reduction of the statistical power (spontaneous remissions lead to exclusion); Mainly a sample of white treatment-seeking women; Limitation of the generalizability of the intervention to non-targeted food cues
Rouach et al., (2007)	Non-randomised experimental study	To investigate how a standardized psychological challenge affects ghrelin levels and the urge to eat in individuals of varying weights, including individuals with BED.	BED with or without obesity; HC; Source of diagnosis: DSM IV-R	24 (66.7 %)	44.2 (9.5)	G1 BED+Obesity; W = 6 M = 2 G2 Obesity; W = 5 M = 3 G3 HC; W = 5 M = 3		Food	Model: Model based on the reward process; Conceptualization: Not specified	The VAS score for the urge for uncontrolled eating was higher in the group with BED compared to the groups with or without obesity at baseline. Increased ghrelin responses were linked to heightened psychological stress, but cravings after stress did not correlate with acute plasma ghrelin changes, even in patients with BED who associate binge episodes with stress.	Potential external confounding variables affected the craving; Variation of sensitivity to ghrelin stimulation (obese are more sensitive)
Sommer et al., (2021)	Cross sectional study	To examine eating-related symptoms, general psychopathology, and early life experiences and compare between patients with obesity and BED, patients with obesity without BED, and healthy, normal-weight controls.	BED with obesity; Individuals with obesity; HC; Source of diagnosis: DSM-5	131 (68.7 %)	42.7 (13.3)	G1 BED+Obesity; W = 27 M = 0 G2 Obesity; W = 33 M = 17 G3 HC; W = 30 M = 14		Food	Model: Not specified; Conceptualization: Not specified	Trait food craving was stronger for the group with obesity and BED than the group with obesity without BED, and helps distinguish between the two.	Cross-sectional design prevents the investigation of the transition between obesity and BED; Potential impact of the experience of treatment (i.e., naive versus experienced) on the answers; Control group potentially not equivalent
Steiger et al., (1999)	Cross sectional study	To evaluate the extent to which behavioral impulsivity moderates the association between episodic dietary overcontrol and binge	BN purging and nonpurging subtypes, Eating Disorder Not Otherwise Specified;	51 (100 %)	27.4 (7.5)			Food; Other: binge	Model: The starvation/dietary model; Conceptualization: Not specified	In BN spectrum eating disorders: - the urge to binge was higher on binge days. - impulsivity had an influence on the relation	

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Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
		eating in bulimia-spectrum disorders using a naturalistic experience-sampling methodology.	Source of diagnosis: DSM-IV							between dietary control and the urge to binge: for women with low Impulsivity, the urge to binge increased significantly with dietary control. For those with average Impulsivity, the increase was modest. In contrast, high Impulsivity weakened the link, showing minimal effect.	
Sutoh et al., (2016)	Non-randomised experimental study	To assess changes in cerebral oxygenation with rTMS and the short-term effects of high-frequency rTMS on food craving and bulimic symptoms in patients with BN.	BN; Source of diagnosis: DSM-IV-TR	8 (100 %)	24.8 (2.5)		"urge to eat"	Food	Model: Not specified; Conceptualization: Not specified	Reduction of food craving but only with high-calorie food pictures.	Small sample size and weak recruitment justification; Lack of control group and sham rTMS; Assumed stimulation of the left dorsolateral prefrontal cortex; Uncertain relevance of Near-infrared spectroscopy to evaluate brain-directed treatment of ED
Tasca et al., (2009)	Other: Ecological Momentary Assessment	To examine the psychometric properties of an ecological momentary assessment (EMA) method for assessing eating disorder urges.	AN (both subtypes), BN purging subtype; Source of diagnosis: DSM-IV	139 (100 %)	26.1 (8.9)	G1 ANR; W = 21 M = 0 G2 ANB; W = 43 M = 0 G3 BNP; W = 75 M = 0		Food; Other: binge, vomit, over-exercise, restrict, and/or abuse laxatives	Model: Not specified; Conceptualization: Triggering by dietary restraint and/or negative emotion. Precursor of the characteristic symptoms of ED.	Ecological momentary assessment diary showed construct, predictive, and criterion validity, as well as stability in assessing ED cravings. EMA reliably indicates ED behaviours and attitudes, potentially predicting outcomes for ED patients.	Mainly a sample of Caucasian treatment-seeking women from moderate-income families; No assessment of cravings between meals due to event-contingent ecological momentary assessment
Van den Eynde et al., (2012)	Cross-sectional study	To assess a direct comparison of trait (Study 1) and state (Study 2) food craving levels between HC and people with bulimic eating disorders (BD).	BN or Eating Disorder Not Otherwise Specified-bulimic type; HC; Source of diagnosis: DSM-IV-TR	Study 1: 139 (100 %) Study 2: 69 (100 %)	27.0 (7.1)	Study 1-G1 BD; W = 70 M = 0 Study 1-G2 HC; W = 69 M = 0 Study 2-G1 BD; W = 40 M = 0 Study 2-G2 HC; W = 29 M = 0		Food	Model: Not specified; Conceptualization: State and Trait	State and trait food craving dimensions are higher among participants with bulimic disorders than controls, even after controlling for ED symptomatology. Food preoccupation and potential loss of control are characteristics differentiating the group with BN or EDNOS and the control group. The group with BN or EDNOS reported higher craving in relation to increased eating and weight concerns, but not to restraint or shape concerns as opposed to controls.	Only a sample of women; Acutely ill BD patients (no data about premorbid or recovery periods); No assessment of mood and emotional states as potential mediators between craving and bingeing

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Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Van den Eynde et al., (2013)	Non-randomised experimental study	To investigate brain activation patterns associated with the processing of food stimuli and body image.	BN; HC; Source of diagnosis: DSM-IV-TR	42 (100 %)	27.7 (6.1)	G1 BN; W = 21 M = 0 G2 HC; W = 21 M = 0		Food	Model: Not specified; Conceptualization: State and Trait	Women with BN (compared to controls) experience higher anxiety when processing visual food stimuli and comparing themselves to slim women, but they do not experience higher craving. They use the insula more and the fusiform gyrus less.	Lack of DSM Axis II assessment; Use of various food types rather than tailored stimuli; No consideration of the difference between high and low calorie foods; Food intake not standardized prior to the evaluation; Menstrual cycle not standardized but controlled; Potential partial coverage of the cerebellum in the fMRI; No difference between "state" and "trait" findings
Van der Wallin et al., (1994)	Cross-sectional study	The aim was to evaluate the differences in food selection, energy sources, and macronutrient distribution between purged and non-purged diets in patients with BN.	BN, both diagnoses AN/BN; Source of diagnosis: DSM-III-R	47 (100 %)	28.0 (7.0)			Food	Model: Not specified; Conceptualization: Not specified	Patients identified their binge eating as driven by strong cravings or irresistible urges for specific foods, such as bread, cakes, pasta, and sweets. This focus on cravings was evident in the significant differences in carbohydrate intake during binges, where high amounts of bread and sugar products were consumed compared to non-binge periods.	
Waters et al., (2001a)	Non-randomised experimental study	To investigate the roles of hunger, food cravings, and mood in the subjective binge-eating episodes of patients with BN, and to identify the critical factors involved in the processes surrounding binge-eating episodes that occur after cravings.	BN; Source of diagnosis: DSM-IV	15 (100 %)	24.8 (0.7)		"a strong urge or desire for a particular food"	Food	Model: The starvation/dietary model; Conceptualization: Manifestation of restriction between binge episodes and the cause of the interruption of restriction.	In patients with BN, cravings leading to bingeing were associated with lower mood, higher tension, and reduced energy, with further deterioration in mood post-binge. Conversely, cravings that do not lead to bingeing can improve mood. Bingeing correlates with lower hunger and higher tension, which are also linked to binge-inducing cravings.	
Waters et al., (2001b)	Non-randomised experimental study	To identify the key environmental, situational, and food-related factors that contribute to binge eating episodes in women with BN during moments of craving. It	BN; Source of diagnosis: DSM-IV	15 (100 %)	24.8 (0.7)		"a strong urge or desire for a particular food"	Food	Model: Not specified; Conceptualization: Internal and external factors triggering binge eating episodes.	In patients with BN, time of the day (morning more than evening) and social context (being alone) were critical in determining the transition from food craving to binge eating, as well as consuming the craving food.	

(continued on next page)

Table 1 (continued)

Study	Type of research	Aim	ED diagnosis and source of the diagnosis	Sample Size N (% of women)	Age Mean (SD)	Group description	Definition of craving	Object of craving	Model and conceptualization of craving	Outcomes related to craving	Limitations provided by the authors
Werle et al., (2024)	Randomised controlled trial	focuses on understanding both individual factors and the interaction between internal and external cues that can trigger these episodes. To investigate food-related attentional processes in individuals with BED using electrophysiological data (P300, late positive potential amplitudes, N2pc) with a spatial Go/no-Go paradigm using food and nonfood images	BED; Source of diagnosis: DSM-IV	118 (78.8 %)	34.1 (12.5)	G1 BED; W = 50 M = 10 G2 Overweight; W = 19 M = 9 G3 Normal Weight; W = 24 M = 6	"(classically conditioned) response" to "dopamine increase [...] at the emotional level"	Food	Model: Incentive sensitization theory; Conceptualization: State, Food stimuli induce a dopaminergic activation that makes the stimuli strongly desired.	Those factors interacted (e.g., alone more frequently in the morning). Internal and environmental factors must be considered as antecedents of eating episodes to understand BN. Craving is higher in the group with BED than in the group with overweight and the group with normal weight, which do not differ. Craving was higher after the experiment compared to before.	Moderate sample size; Imbalance in group size; Specific aspects of the design (e.g., stimulus duration, trial balance); difficulty in disentangling attentional processes
Wolz et al., (2017)	Non-randomised experimental study	3 goals: - to compare individuals with BN or BED to healthy controls in terms of their cravings and neurophysiological reactions to visual chocolate stimuli - to examine the impact of chocolate odor on the processing of these visual chocolate cues - to determine whether there are differences between groups in their response to chocolate odor alone	BN or BED; HC; Source of diagnosis: DSM-5	39 (100 %)	32.4 (9.5)	G1 BED (BN+BED); W = 19 M = 0 G2 HC; W = 20 M = 0	"a strong and irresistible desire to consume a specific substance and often leads to loss of control over food intake"	Food	Model: Not specified; Conceptualization: Sight and smell are triggers that are more powerful when combined. Repeated binge eating is supposed to lead to a sensitized dopaminergic system, resulting in higher craving.	Chocolate imagery is linked to enhanced cognitive control and motivated attention compared to neutral imagery. Patients with BN or BED showed a greater response to chocolate cues than controls. Both groups experienced greater craving for chocolate, but there was no difference in responses to chocolate stimuli. Olfactory stimulation from chocolate odor improved craving responses more significantly in patients with BN or BED.	Small sample size of mixed BN and BED; Increase in alpha activity may be related to theta activity because participants had their eyes closed; Underestimation of the "supralinearity" effect due to exposure to olfactory and visual stimuli separately

Note. AN = Anorexia Nervosa; AN-R = Anorexia Nervosa, Restrictive Subtype; AN-B = Anorexia Nervosa, Binge-Purge Subtype; BN = Bulimia Nervosa; BED = Binge Eating Disorder; ED = Eating Disorder; UED = Unspecified Eating Disorder; EDNOS = Eating Disorder Not Otherwise Specified; HC = Healthy Controls; DSM-5 = Diagnostic and Statistical Manual of Mental Disorders, 5th Edition; DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th Edition; DSM-IV-TR = Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision; ICD-10 = International Classification of Diseases, 10th Revision; ICD-11 = International Classification of Diseases, 11th Revision; G1 = Group 1; G2 = Group 2; G3 = Group 3; W = Women; M = Men; N = Sample Size; SD = Standard Deviation; FCQ-T = Food Cravings Questionnaire-Trait; FCQ-S = Food Cravings Questionnaire-State; CBM = Cognitive Bias Modification; VR-CET = Virtual Reality-Cue Exposure Therapy; rTMS = Repetitive Transcranial Magnetic Stimulation; tDCS = Transcranial Direct Current Stimulation; ESM = Experience-Sampling Methodology; EMA = Ecological Momentary Assessment; CBT = Cognitive Behavioral Therapy; LDX = Lisdexamfetamine; NF = Neurofeedback; ATD = Acute Tryptophan Depletion; MAIA = Multidimensional Assessment of Interoceptive Awareness; BSQ = Body Shape Questionnaire; YFAS = Yale Food Addiction Scale; VAS = Visual Analog Scale; NA = Non applicable; Empty cells in the table indicate that the information was not provided in the original article.

Table 2

Number of studies using each type of measure to assess craving across the 50 studies.

Assessments of craving	Frequency
Visual Analogue Scale (VAS)	26
Food Cravings Questionnaire - State and Trait	8 (including 1 in short version)
Food Cravings Questionnaire - Trait	4 (including 1 in short version)
Food Cravings Questionnaire - State	4 (including 1 modified version)
State Urge to be Physically Active-Questionnaire	4
Food diary	2
Craving Record	2
Yale Food Addiction Scale 2.0	1
Food Chocolate Craving Questionnaire - State and Trait	1
Precipitating Binge Eating Behavior Inventory	1
Self-report questionnaire to measure acute urge to be physically active (smQ)	1

"body attempt to correct biological, psychological, and sensory deficits" (Gendall et al., 1997) and "attended by changes in cognitive, emotional, and behavioral aspects" in participants with AN (Graap et al., 2018). Others also noted the involvement of physiological, psychological, or behavioral aspects, stating it "arises from either physiological or psychological underlying states" across all types of ED (Moreno et al., 2008) or it "encompasses motor, emotional, and cognitive components" in AN cases (Boltri et al., 2025) and "involves behavioral and physiological changes" in participants with AN (Mallorquí-Bagué et al., 2020).

3.2.5. Models and conceptualization of craving

Out of the 50 studies, a large majority of 33 studies did not apply any specific framework for craving. Among those that did, 17 studies referred to theoretical frameworks explaining the development of food craving, 15 involving participants with BN, BED, or both, one involving participants with AN, and one involving AN, BN, and unspecified ED. Notably, no theory was used to account for other types of craving (e.g., restraint, physical activity). The conditioning model (Jansen, 1998) was the most cited, appearing in 5 studies. It describes how cue reactivity related to specific stimuli triggers physiological responses that are experienced as craving. Four of these 5 studies involved individuals with BN or BED, with Chami et al. (2021) conceptualizing craving as both a trait and a state, 2 studies (Ferrer-García et al., 2017b, 2017a) as a trigger for binge-eating, and 1 study (Pla-Sanjuanelo et al., 2019) as a state alone. The fifth study (Nederkoorn et al., 2004) focused solely on individuals with BN and did not provide a conceptualization for craving. The starvation/dietary restraint model (Herman and Polivy, 1980), which posits that restrictive attitudes and behaviors regarding eating enhance craving and binge eating, was used in 4 studies involving individuals with BN alongside those with EDNOS or panic disorders (Alpers and Tuschen-Caffier, 2004; Engelberg et al., 2005; Steiger et al., 1999; Waters et al., 2001a), none of which provided a specific conceptualization of craving. The dual-process model (Bechara, 2005; Wiers et al., 2013), which suggests two distinct processes in craving and its regulation: a rapid and automatic impulsive system, and a slower and deliberate reflective system, was noted in 2 studies in BN or BED (Brockmeyer et al., 2016; Max et al., 2023), but neither specified a conceptualization. Other models included the addictive appetite model in individuals with BN (Leenaerts et al., 2023), which highlights negative affect as a trigger of craving which promotes binge eating, an addiction model in individuals with BN (Neudeck et al., 2001), the affect regulation model, where craving is a response to negative affect that leads to eating behaviors, providing temporary relief (Arend et al., 2024), a neurobiological model of the reward system in individuals with BED (Rouach et al., 2007), and an anxiety-based model in individuals with AN (Christian et al., 2024), which posits that AN-related behaviors result from pairing food or weight gain with aversive consequences,

reinforced through avoidance of feared outcomes. None of these last models provided a specific conceptualization of craving.

In addition, 7 studies mentioned neurobiological systems involved in craving, each shedding light on different aspects of brain function and physiological interactions (Amin et al., 2023; Bruce et al., 2009; Claudino et al., 2011; Maranhão et al., 2015; Sutoh et al., 2016; Werle et al., 2024; Wolz et al., 2017). Wolz et al. (2017) highlighted the involvement of the orbitofrontal cortex in craving among participants with BN or BED, a focus shared by Sutoh et al. (2016), who mentioned the hyperactivity in both the anterior cingulate and orbitofrontal brain circuits in participants with BN. Amin et al. (2023) expanded this understanding by discussing the association with peripheral leptin levels in participants with AN, BN, or unspecified eating disorders, suggesting a broader physiological context. Meanwhile, Claudino et al. (2011) highlighted the interaction between stress, glucocorticoids, and the dopamine system in participants with BN or EDNOS, emphasizing the role of stress in craving mechanisms. Werle et al. (2024) explain that, according to the incentive sensitization theory, craving is a conditioned emotional response driven by a sensitized dopaminergic system. Maranhão et al. (2015) pointed out the cognitive dimension by explaining the involvement of reward pathways and cognitive functions in participants with BED. Lastly, Bruce et al. (2009) focused on the relation with serotonin system alteration in participants with BN, providing insights into the neurochemical underpinnings of craving.

3.2.6. Assessment of craving

The different methods for craving assessments are presented Table 2. The references for each questionnaire used in the study are listed in Supplementary Material Table S2 and their properties are presented in Supplementary Material Table S4.

A total of 26 studies used visual analogue scales (VAS) to measure cravings, with 3 studies employing 2 or 3 VAS, while the remaining studies employed 1 VAS. Among the VAS, 18 were continuous scales, either ranging from 0 to 100 or presented as 10 cm lines, while 10 were discrete scales using Likert-type formats with 5, 7, or 11 points. Two studies did not specify the type of scale used. The specific measures of craving assessed with the VAS varied widely across the studies. These included: the level of food craving (n = 6), the urge to binge (n = 4), the urge to eat (n = 4), desire to binge (n = 3), the acute urge to be physically active (n = 2), general craving (n = 2), craving for sweet foods (n = 1), desire to eat (n = 2), unspecified behavioral urges (n = 1), urge for uncontrolled eating (n = 1), urge to move (n = 1), urge to vomit (n = 1), anticipation of binge (n = 1), and want to eat (n = 1). Notably, only eight of the VAS provided the exact questions posed to participants.

Besides the VAS, the most used questionnaires were the Food Cravings Questionnaire - State and Trait (Cepeda-Benito et al., 2000), appearing in 16 studies. Four studies focused solely on the State version, and 4 studies on the Trait version.

Among the 7 studies examining cravings related to physical activity, the State Urge to be Physically Active-Questionnaire was used in 4 studies (Amin et al., 2023; Boltri et al., 2025; Halbeisen et al., 2025, 2024), and the 3 remaining studies used different tools (Graap et al., 2018; Pasklakis et al., 2017; Pieters et al., 2006).

3.2.7. Outcomes of the studies

Out of the 50 studies, 33 studies explored factors related to cravings and binge-eating symptoms, sometimes comparing these between ED patients and control groups. This category contained 2 case reports, 7 cross-sectional studies, 17 non-randomized experimental studies, 3 ecological momentary assessment studies, 1 cohort study, 1 randomized controlled trial, 1 case-control study, and 1 longitudinal study. In addition to these 33 studies, 15 other studies focused on interventions assessing the effects of specific interventions on cravings and binge-eating behaviors in individuals with ED. This included 2 case reports, 4 non-randomized experimental studies, 8 randomized controlled trials (including 3 study protocols that do not provide any results), and 1 case

Table 3
Description of the fifteen reviews.

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
Bou Khalil and El Hachem, (2014)	Comprehensive review	To review the relevant studies that support the hypothesis that rTMS may be efficient in the treatment of obesity through its direct efficacy in reducing food craving.	BN or obesity, with or without addiction	“irresistible urge to consume”	Food; Drugs; Alcohol	Role in substance and food overconsumption		Some studies suggest that rTMS may help reduce food cravings in patients with BN, but other research shows that rTMS is not more effective than a placebo. The relationship between rTMS and cravings remains uncertain.	Need for more studies and larger samples
Casper, (2022)	Narrative review	To explore how restlessness and an increased urge to move in AN may strengthen personal motivation to maintain caloric restriction and augment body awareness and proprioception. The review specifically looks at the potential effects of leptin administration in AN to gain insights into these relationships.			Other: physical activity	Urge to move, in the context of AN, maintains the will to pursue restriction, counters the discomforts of underfeeding, and increases body awareness, which may lead to body size overestimation.		The studies did not provide clear evidence that the increased urge to move and physical restlessness enhance proprioception and body awareness and thereby counterbalance awareness of the emaciated body, and may contribute to body size overestimation in AN. There is some evidence that the increased urge to move ought to improve along with other symptoms in AN through treatment with leptin.	
Chmiel et al., (2024)	Systematic review	To analyze the effectiveness of tDCS in treating BED, examine its effects on BED and cognitive aspects, explore potential mechanisms, propose new therapy targets, and assess safety.	BED		Food			Different results of tDCS on food craving are reported: reduction of food craving after tDCS, potential moderating role of hunger, intensity of food craving positively related to BMI and BED scores, and greater susceptibility of men (compared to women) to tDCS-induced decreases of food cravings.	Heterogeneity in methods, inconsistency of outcome evaluations, limited sample size and diversity, lack of long-term results, potential sex-specific effects, expectation bias of the participants, and genetic influence. No strict adherence to PRISMA guidelines
Gay et al., (2022)	Meta-analysis	2 goals: - to evaluate the effects of rTMS versus sham stimulation (shamTMS) on cravings in substance-related and behavioral addictions, and to clarify indications based on addiction type - to define optimal stimulation settings regarding target location,	Substance use disorders, Behavioral addictions	“Craving is defined as a pressing, urgent, and irrepressible desire to give way to an addictive behavior, motivated by internal and external cues, resulting in loss of control in most cases. It also includes the expectation of	Food; Drugs; Alcohol; Other: gambling	Experience including expectation of positive effects and/or relief from negative aspects; Core symptom of addiction		No effect of rTMS on the reduction of craving among people with an ED was found.	Variability in stimulation parameters, small sample size (number of studies), different assessment of craving, and variability in the rigor of randomized control trials.

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Table 3 (continued)

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
Grall-Bronnec and Sauvaget, (2014)	Narrative review	To critically review the progress in the use of rTMS since its inception to treat addiction and related disorders (gambling, ED), and in particular, the developments in its therapeutic efficacy.		previously experienced effects of a psychoactive drug, whether these are its positive effects or the relief of its negative effects, or both." "Craving is defined as a pressing, urgent, and irrepensible desire to give in to an addictive behaviour, and results in the loss of control in most cases [...] craving also includes the expectation of positive effects and the relief of negative effects as a result."	Food; Drugs; Alcohol	Experience, including expectation of positive effects and/or relief from negative aspects		Four of the seven studies listed concluded that rTMS is effective in reducing induced food craving in BN or EDNOS.	Use of visual analog scale, variation of the craving induction procedures, small sample sizes (in the studies), potential interference of other psychiatric conditions, lack of consideration for handedness, ethnicity, and factors influencing cortical excitability, variability of the protocols (e.g., stimulation site, number of sessions).
Hall et al., (2018)	Narrative review	To investigate recent advancements in non-invasive brain stimulation (NIBS) techniques for understanding food cravings and consumption, as well as for treating eating-related clinical conditions like obesity, BED, BN, and AN. The goal is to enhance therapeutic approaches for these conditions.			Food			Non-invasive brain stimulation methods reliably impact craving strength with a single session, and rTMS seems to be more effective than tDCS. Despite encouraging studies, the randomized trials of multi-session non-invasive brain stimulation remain too scarce to draw conclusions about their efficacy, especially in AN.	Lack of consistent effect of tDCS, lack of consideration for context (presence of facilitators or inhibitors), lack of details about the instructions before the consumption opportunity, self-report or monitoring (e.g., social desirability bias), lack of adequate control conditions, research mainly on the dorsolateral prefrontal cortex but less on the parietal lobe, and other cortical and subcortical regions, ideal dose of non-invasive brain stimulation (intensity, frequency and number of sessions) not established.
Ince et al., (2021)	Systematic review	To review impulsivity treatment approaches for binge eating behavior, evaluating their effectiveness and offering recommendations for		"food craving, i.e. an intense desire to eat particular foods as they perceive food and related stimuli highly rewarding"	Food			Cue exposure therapy in virtual reality reduces food craving among BN and BED patients to a greater extent than additional cognitive	Lack of adequate control conditions, small sample size (number of studies), heterogeneity of methodologies,

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Table 3 (continued)

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
		future research and practice, specifically focusing on interventions using food stimuli, as they directly address impulsive eating.						behavioural therapy, which was already effective. Both interventions also decrease binge eating and purging frequency and increase abstinence rate. Intensive behaviour therapy, with or without liraglutide, and multicomponent therapy (intensive behaviour therapy, liraglutide, and diet) reduce food craving at 24 and 52 weeks. Computer-assisted approach bias modification training does not reduce trait food craving compared to a sham program. EEG-neurofeedback with cue exposure and tDCS (interventions using a direct neuromodulation approach) demonstrate their potential for reducing food craving. The effect of rTMS is less clear.	paradigms, and treatment intensity, no approach improved all the components of food-related impulsivity.
Kober and Boswell, (2018)	Comprehensive review	To review diagnostic features and socio-demographic features of BED; to discuss comorbidity between obesity and BED, to review four psychological processes that may be involved in BED, as well as their neural substrates: emotion reactivity, food cue reactivity, food craving, and cognitive control (including the regulation of emotion and craving); to discuss how some existing treatments for BED do, or do not, target these specific processes.		"a strong desire to use/eat"	Food	Diagnostic criteria for Substance Use Disorders in DSM-5		Individuals with obesity and individuals with BED exhibit greater food cue reactivity and craving compared to controls. Craving is viewed as a causal factor in overeating and binge eating, and it interferes with weight loss. In BED, deficits in craving regulation may be linked to broader impairments in cognitive control. Craving can be reduced and regulated through cognitive control strategies. BED is associated with increased craving, impaired regulation of craving, and cognitive control deficits. AN and BN are associated with both intensified food	Small and preliminary studies.
Mercer and Holder, (1997)	Narrative review	To establish a connection between endogenous		"a distinct state characterized by an	Food	State			

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Table 3 (continued)

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
		opioid peptides (EOPs) and food cravings.		intense urge to obtain a substance."				cravings and altered endogenous opioid peptide activity. Abnormally elevated beta-endorphin levels are observed in BN, with low levels in plasma and cerebrospinal fluid and high levels in those who vomit. The stress of the binge-vomiting cycle may elevate beta-endorphin levels, inducing cravings, especially for sweets. Treatments with opioid antagonists have reduced binge eating and made bingeing and purging less pleasurable. AN may involve an atypical opioid system, leading to a self-perpetuating addiction to dieting. Opioid antagonists have been used to treat AN, with mixed results.	
de Oliveira and Cordàs, (2020)	Systematic review	To examine how food cravings are measured in individuals with ED.	ED sample	"as an intense desire or an urge for the consumption of a specific food"	Food	Craving is influenced by cognitions, emotions, physiology, and external components (e.g., eating environment, advertisements); a physiological component of eating behaviour (hunger/energy need) and elements that generate obsessive thoughts; Intensification due to a restrictive diet that induces stress by emotional deprivation and energy needs; craving is associated with impairment of inhibitory control.	- The conditioning model : craving is an automatic response to conditioning - the Theory of social learning : a psychosocial and cognitive perspective in which craving is based on the effect of expectation - Neurobiological model with the implication of the re	Food craving exacerbates dysfunctional eating behaviours like overeating and binge eating. It is influenced by internal factors (physiological, cognitive, and emotional factors), as well as external environmental stimuli. The intense desire for food is a physiological reaction to self-imposed food restrictions in both behavioural and attitudinal contexts.	
Rachid, (2018)	Comprehensive review	To review the safety and efficacy of repetitive transcranial magnetic stimulation (TNS), including deep TMS and theta-burst stimulation, for treating ED, and discuss findings and future research directions in this area.	AN, BN, BED		Food; Other: exercise, restrict, binge			Slightly more controlled studies of rTMS (with active stimulation more than sham) for BN and BED showed positive results on craving and eating behaviour. In BN and BED, reduction of craving for food or to purge was reported, along with feelings of	Small sample sizes (number of studies and in the studies), comorbidities in several studies, heterogeneity of stimulation parameters, use of the 5 cm rule as a target area in some studies, placebo effect in some studies, lack of

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Table 3 (continued)

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
Stramba-Badiale et al., (2020)	Narrative review	To discuss the integration of transcranial magnetic stimulation (TMS) with virtual reality (VR) exposure as a therapeutic approach for treating food addiction.	BN, BED	"a physiological condition which, despite a state of satiety, determines food intake of desired food"	Food			fullness, hunger, and purge frequency, but not for craving to restrict or binge frequency. In AN, the results were mixed, with one study showing only a trend for increased urge to eat with active versus sham rTMS, and another study showing a slight decrease in the urge to restrict in post-rTMS compared to pre-rTMS. Studies underscore TMS effectiveness on craving reduction and also the exposure of BN and BED patients to craved virtual food that can reduce craving. The authors discussed the combination of TMS with virtual reality cue exposure therapy, which should reduce food craving and the craving to eat in individuals with food addiction. The integration of both interventions would address cognitive and emotional aspects and brain mechanisms associated with ED. It would improve control and decision making (TMS) and the ability to recognize and regulate physiological activity (virtual reality exposure therapy), leading to decreased food craving.	adequate control/sham conditions, poor assessments (e.g., VAS, no objective measure of ED symptoms), heterogeneous results, lack of investigation of long-term effect and potential on remission Dropouts due to cybersickness or TMS-induced headache, the effectiveness of the integrated approach is influenced by a lack of knowledge on the ED neural mechanism and the effects of TMS on ED.
Taylor, (2019)	Systematic review	To summarize and evaluate self-report measures of food craving, suggest future directions for the field, and provide guidance on selecting a food craving measure.	BN, EDNOS bulimia type	"intense desires or urges for a particular type of food"	Food	Components: intrusive thoughts and multi-sensory imagery, motivation to search and consume particular food, poor perceived self-control, anticipation of pleasure and/or relief.		Different assessments exist to measure state, past, and habitual food craving; the authors elaborated a decision-making tree for food craving measures. State measures should be used to evaluate the effectiveness of an intervention in the lab, or for ecological-	Limited data on the predictive validity of food craving measures on the clinical course of ED, self-report or monitoring (social desirability bias and demand characteristics), questionnaires items are subject to interpretation, (continued on next page)

Table 3 (continued)

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
Verzijl et al., (2022)	Narrative review	To synthesize current literature on food cravings, discussing three applicable models of craving: Elaborated Intrusion Theory, the Cognitive Processing Model, and the Ambivalence Model, and exploring how these models can apply to disordered eating behaviors in research and clinical contexts.		"both an intense desire for a substance and a psychological or physiological motivational state that prompts the consumption of a desired substance"	Food; Alcohol	Antecedent and consequence to physiological or mental health conditions (e.g., mood disorder, addiction, premenstrual disorder); not necessary nor sufficient for food addiction labelling, not a core symptom of ED, but a transdiagnostic feature.	Three models to understand motivational processes, guide craving assessment, and argue for targeting craving in treatment: - the Elaborated Intrusion Theory - the Cognitive Processing Model - the Ambivalence Model of Craving	momentary assessment to investigate the impact of fluctuating variables (context, hunger, mood, etc.). Trait assessment should be preferred to analyse usual patterns, as health professionals can do. Past assessments, over a timeframe, should be used to capture an individual's experience over a specific period. The target of the craving must also be defined: a specific food, a tasty food, or a variety of foods. Research on food craving dimensions, such as approach and avoidance, is crucial for understanding clinical intervention outcomes in ED. Theories from substance use literature, like the Elaboration Intrusion theory and the Cognitive Processing Model, emphasize the cognitive and motivational conflicts in food cravings. The ambivalence model of craving (AMC) highlights the need to assess both approach and avoidance inclinations in food cravings. Interventions like functional imagery training and exposure techniques have proven effective in reducing these cravings. The AMC suggests that different food craving profiles may indicate maladaptive eating behaviors that don't meet clinical diagnosis criteria but still require attention. By using a transdiagnostic approach, the AMC focuses on redefining problematic behaviors	retrospective recall, food craving assessments are mostly tested on young college students and not on individuals with ED, lack of diversity in samples (e.g., education, income, race, ethnicity).

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Table 3 (continued)

Review	Type of research	Aim(s)	Diagnosis of participants	Definition of craving	Object(s) of craving	Conceptualization of craving	Model(s) to describe craving	Outcomes related to craving	Limitations provided by the authors
Whatnall et al., (2022)	Narrative review	This review explores craving and loss of control (LOC) symptoms, highlighting their similarities to substance use and eating disorders in recent research.		"the powerful or strong desire for something"	Food; Other: substance			instead of sticking to categorical diagnoses, which could enhance treatment outcomes. Recognizing the motivational conflicts in food consumption and restriction can lead to more customized interventions for disordered eating. Craving is prevalent in both eating disorders (such as BN and BED) and substance use disorders (SUD), where it acts as an indirect prompt for overeating in ED and a direct factor in relapse for SUDs. In food addiction (FA), cravings often focus on ultra-processed foods and are more closely associated with loss of control than binge size. FA shares characteristics with SUDs, including tolerance, and both activate dopamine pathways in the brain. Neuromodulation interventions can effectively reduce cravings in both types of disorders, while exposure to related cues can elevate cravings and impact consumption. Additionally, metabolic responses to certain foods may influence cravings and their addictive potential.	

Note. BN = Bulimia Nervosa; BED = Binge Eating Disorder; ED = Eating Disorder; EDNOS = Eating Disorder Not Otherwise Specified; HC = Healthy Controls; rTMS = Repetitive Transcranial Magnetic Stimulation; tDCS = Transcranial Direct Current Stimulation; TNS = Transcranial Nervous Stimulation; NIBS = Non-Invasive Brain Stimulation; EOPs = Endogenous Opioid Peptides; VR = Virtual Reality; CET = Cue Exposure Therapy; CBT = Cognitive Behavioral Therapy; EEG = Electroencephalography; VAS = Visual Analog Scale; FCQ-T = Food Cravings Questionnaire-Trait; FCQ-S = Food Cravings Questionnaire-State; EMA = Ecological Momentary Assessment; SUD = Substance Use Disorder; FA = Food Addiction; LOC = Loss of Control; Empty cells in the table indicate that the information was not provided in the original article.

Table 4
Number of reviews reporting each type of measure to assess cravings.

Assessments of craving	Frequency
Visual Analogue Scales (VAS)	5
Food Cravings Questionnaire - State	2
Food Cravings Questionnaire - State and Trait	1
Control of Eating Questionnaire	1
Craving Experience Questionnaire	1
Food Craving Inventory	1
Food craving questionnaire	1
General Craving Scale	1
General Food Craving Questionnaire - State	1
Leeds Food Preference Questionnaire	1
Palatable Eating Motives Scale	1

series. Finally, 2 studies also aimed to develop or experiment with a tool for assessing cravings. [Amin and colleagues \(2023\)](#) validated the State Urge to be Physically Active-Questionnaire, and [Tasca et al. \(2009\)](#) highlighted the relevance of using an ecological momentary assessment diary to evaluate craving in ED.

3.3. Craving-related factors

3.3.1. Food exposure and environmental triggers

Food exposure and environmental triggers significantly influenced food cravings. Studies showed that food exposure ([Nederkoorn et al., 2004](#); [Neudeck et al., 2001](#); [Pla-Sanjuanelo et al., 2019, 2015a](#)), particularly palatable food ([Ferrer-García et al., 2014](#); [Meule et al., 2018](#); [Pla-Sanjuanelo et al., 2019](#)), and odors (e.g., chocolate odors;

[Wolz et al., 2017](#)) heighten cravings in BN and BED, especially when patients are alone at home and during certain times of day, morning or evening ([Pla-Sanjuanelo et al., 2015a](#); [Waters et al., 2001b](#)). In line with these findings, external eating style—defined as eating triggered by external stimuli—was identified as a key predictor of food cravings in both healthy individuals and those with BN or BED, with a notably stronger association in the clinical groups ([Ferrer-García et al., 2017b](#)). In addition, one study ([Pla-Sanjuanelo et al., 2015b](#)) reported that state craving was the best factor explaining cravings during food exposure in BN and BED. Trait food craving was found to be significantly stronger in individuals with both obesity and BED compared to those with obesity alone, suggesting its potential as a distinguishing marker between these groups ([Sommer et al., 2021](#)). Craving was higher in the BED group than in the overweight or normal weight groups, which do not differ ([Werle et al., 2024](#)).

3.3.2. Emotional and psychological influences

Emotional and psychological factors were also closely linked to food cravings. An ecological momentary assessment study ([Forester et al., 2024](#)) indicated that anticipatory processes, encompassing craving, may precede and elucidate affective changes that lead to binge-eating episodes in patients with BED, challenging the conventional perspective that prioritizes negative emotions as the main trigger. Multiple studies, involving patients with BN ([Ferrer-García et al., 2014](#); [Leenaerts et al., 2023](#); [Van den Eynde et al., 2012](#); [Waters et al., 2001a](#)) or patients with AN ([Christian et al., 2024](#)), found that negative affect, weight concerns, and lower mood were associated with heightened cravings. These results were also supported by [Pieters et al. \(2006\)](#) regarding craving related to

Box 1

General results synthesis from the studies and reviews.

Studies predominantly focused on craving in individuals diagnosed with BN, BED, and EDNOS (33 studies out of 50), with a notable lack of studies involving individuals with AN. Most of the studies and reviews (42 out of 50 studies and 14 out of 15 reviews) focused on the craving for food.

Regarding the theoretical framework of craving, only about half of the studies provided a definition of craving, whereas almost all reviews included one. Craving was often defined by synonyms (e.g., urge, desire) accompanied by terms expressing intensity (e.g., intense, strong, irresistible). It was conceptualized either as a state, a trait, or both. The motivational, emotional, cognitive, physiological, and behavioral dimensions are sometimes mentioned. A few studies and reviews also included the notion of loss of control in the definition of craving. Reference to models was frequently omitted, and the models mentioned primarily focused on BN and BED, while only one addressed AN. Most theories did not focus on craving but were either applied to it, or craving was only a component of the model, except in the three models presented in one review ([Verzijl et al., 2022](#)), where craving was the main focus: the elaborated intrusion theory of desire ([Kavanagh et al., 2005](#)), the cognitive-process model ([Tiffany, 1990](#)), and the ambivalence model of craving ([Breiner et al., 1999](#); [Stritzke et al., 2007](#)). No model was presented to account for objects of craving other than food within the context of ED, such as physical activity, bingeing, vomiting, purging, or using laxatives. Neurobiological findings underscore the multifaceted neurobiological basis of craving in ED, involving interactions between cortical and subcortical regions, neurochemical systems (dopamine, serotonin, opioids), hormonal signals (e.g., leptin), and stress-related pathways

Regarding assessment, craving was mainly assessed using VAS (in 26 studies out of 42), with the format of VAS varying across studies (18 continuous scales, 10 discrete scales, 2 did not provide the type of scale). The FCQ was also frequently used in its trait and/or in its state form. Regarding factors related to craving, external stimuli (e.g., visual or olfactory exposure to food, odours, contexts) and internal cues (e.g., negative affect, concerns) were identified as recurrent antecedents for cravings. Binge eating episodes, particularly in BN, BED, and AN binge-eating subtype, either directly, through impulsivity or dietary restraint, was identified of being precipitating by craving. While research globally agreed on the role of craving in promoting binge eating, some authors framed it as an indirect contributor. Trait-craving, more than state craving, has been identified as a predictor of binge eating, with impulsivity and dietary restraint acting as mediators. On a physiological level, craving was also related to changes in ghrelin levels and the alterations of opioid and dopamine systems.

Only two studies had compared craving between ED types or subtypes; the only comparison available was between the AN-bulimic subtype and the AN-restrictive subtype. Patients with AN-bulimic subtype had a greater craving to vomit and higher scores of food craving than those with restrictive AN.

Regarding the effect of interventions on cravings, besides one pharmaceutical intervention (case study), cue exposure therapy (also in virtual reality) in BN and BED, and neurofeedback showed encouraging results. Non-invasive brain stimulations were also reported as potential interventions for craving in ED, especially in the reviews. The effectiveness of both rTMS and tDCS varies across studies and reviews.

physical activity in participants with AN, where the urge for physical activity was associated with the preoccupation with weight and negative emotions. In a single case study, treating depression reduced pagophagia, which is characterized by intense ice craving (Mehra et al., 2018). Women with BN show higher anxiety than controls when viewing food or comparing themselves to slim women, but not stronger cravings. They activate the insula more and the fusiform gyrus less (Van den Eynde et al., 2013).

3.3.3. Gender differences in craving

One study (Pla-Sanjuanelo et al., 2015b) explored the impact of gender on food craving and found that women generally had stronger cravings than men in participants with BN or BED.

3.3.4. Physiological responses to craving

Rouach et al. (2007) explored physiological responses to food cravings in participants with BED and noted that stress-related cravings did not correlate with ghrelin changes in participants with BED, while elevated ghrelin responses were linked to psychological stress.

3.3.5. Craving as a predictor of binge eating

Some studies provided evidence that food craving could trigger binge-eating episodes. In the context of BN or EDNOS, Moreno et al. (2008) found that particularly trait craving, more than state craving, predicted binge-eating symptoms. Steiger et al. (1999) identified the urge to binge as a predictor of binge eating in BN or EDNOS, noting that impulsivity influences the connection between dietary control and the urge. Also, Engelberg et al. (2005) noted that while an increase in the urge to binge often follows periods of dietary restraint in BN or EDNOS, this does not always lead to actual binge-eating incidents. According to Waters et al. (2001a), cravings leading to binges in participants with BN were associated with lower mood, heightened tension, and diminished energy levels, with further declines in mood and energy following a binge, whereas cravings that did not result in binges could enhance mood. Another study by Waters et al. (2001b) emphasized the importance of the environment in the transition from craving to binge in BN, including the social context, such as being alone, which played a critical role in the transition from food craving to binge eating. Unlike previous studies, Alpers and Tuschen-Caffier (2004) found no evidence that carbohydrate cravings trigger binge eating episodes in BN patients.

3.3.6. Craving in anorexia nervosa

In patients with AN, Van der Wallin et al. (1994) found that individuals with the binge-eating subtype reported strong cravings for specific foods, including bread, cakes, pasta, and sweets, which prompted binge-eating episodes. This was corroborated by Moreno et al. (2008), who stated that food cravings could predict binge-eating symptoms in those with AN, regardless of whether cravings were perceived as a trait or a state. However, in a food craving regulation task, Mallorquí-Bagué et al. (2020) found that patients with AN (both subtypes) were successful at down-regulated food craving, but they used maladaptive emotion regulation strategies, such as suppression (inhibition of the behavioral expression of emotional responses to stressors, which can lead to increased emotional distress) during food craving, reflecting their tendency to adopt dysfunctional behaviors to manage negative emotions. Increased physical activity at admission of AN patients correlates with reduced early weight gain and lower discharge weights (Halbeisen et al., 2024). There were no differences in food cravings between women with a history of anorexia nervosa (AN) and control women; however, the former exhibited more intense cravings, greater resistance difficulties, and increased anxiety when food was unavailable (Gendall et al., 1997).

3.3.7. Craving across eating disorders

Some studies have compared cravings between the different ED types or subtypes. Kennedy et al. (1994) showed that patients with

AN-bulimic subtype had a greater craving to vomit than those with restrictive AN, though there were no significant differences in other cravings or changes after six weeks of treatment. Adler et al. (2022) compared AN, BN, and controls and demonstrated that BN have a higher lack of control over eating (as a component of food craving-trait). Mallorquí-Bagué and colleagues (2020) found that the AN-bulimic subtype scored significantly higher on the Yale Food Addiction Scale (YFAS) compared to other AN subtypes, except for “withdrawal symptoms”. The study by Arend and colleagues (2024) showed that the association between emotions (high vs low arousing and negative vs positive) and food cravings was specific to each ED. Other studies often fail to make clear comparisons across the bulimic symptom spectrum, generally mixing BN, BED, or EDNOS.

3.4. Interventions on craving

Twelve articles reported the outcomes of various interventions designed to reduce cravings and manage symptoms in patients with ED, revealing mixed results.

3.4.1. Interventions involving pharmacology

One pharmacological intervention, a single case study, investigated the effect of dronabinol in a participant with AN (Graap et al., 2018) and showed a reduction of craving for physical activity.

The other interventions focused on participants with BN or BED. A randomized control trial with a sample of patients with BED demonstrated that cognitive-behavioural therapy and lisdexamfetamine reduced food cravings with a larger effect when combined (Grilo et al., 2025). Another research (Bruce et al., 2009) demonstrated that women with BN or bulimia-spectrum ED under serotonin reuptake inhibitors felt stronger binge craving when their serotonin levels were lowered by acute tryptophan depletion.

3.4.2. Psychological interventions and neurofeedback

Cue-exposure therapy (i.e., a therapeutic behavioral approach where individuals are exposed to relevant cues (here craving-related) to diminish conditioned responses) was consistently effective in reducing cravings in participants with BN or BED (Ferrer-García et al., 2017b; Paskalis et al., 2017; Pla-Sanjuanelo et al., 2016). In addition, virtual reality cue-exposure therapy, whether or not combined with pharmacotherapy, significantly reduced food craving in participants with BN or BED, without difference between interventions (Pla-Sanjuanelo et al., 2017). However, other cognitive interventions on participants with BN or BED such as inhibitory control training and implementation intentions, as examined by Chami et al. (2021), did not demonstrate a reduction in outcomes. Virtual-reality exposure to running reduced the urge to be physically active in three AN patients, but with a short-term effect (Boltri et al., 2025).

Neurofeedback, as studied by Rosch et al. (2023) in participants with BED using either real-time functional near-infrared spectroscopy neurofeedback, targeting individual prefrontal cortex, or electroencephalography neurofeedback, targeting fronto-central activity, was found to be more effective in reducing food cravings when participants initially reported low cravings.

3.4.3. Neuromodulation

The results of Repetitive Transcranial Magnetic Stimulation (rTMS) were inconsistent. Sutoh et al. (2016) identified rTMS as effective in reducing food cravings through a non-randomized experimental study in participants with BN. However, Claudino et al. (2011) observed only a trend towards reduction in cravings in a randomized control trial in participants with BN or EDNOS, raising questions about the overall effectiveness of rTMS for treating food cravings. Finally, Transcranial Direct Current Stimulation (tDCS), as investigated by Max et al. (2023) in participants with BED, did not show a significant reduction in symptoms.

3.5. Findings from the reviews

3.5.1. Overview of the reviews included

Among the 15 reviews included, there were 7 narrative reviews, 4 systematic reviews, 3 comprehensive reviews, and 1 meta-analysis. Of the 15 reviews, 8 focused on the effects of interventions (e.g., repetitive transcranial magnetic stimulation) on cravings: 1 meta-analysis (Gay et al., 2022), 2 systematic reviews (Chmiel et al., 2024; Ince et al., 2021), 2 comprehensive reviews (Bou Khalil and El Hachem, 2014; Rachid, 2018), and 3 narrative reviews (Grall-Bronnec and Sauvaget, 2014; Hall et al., 2018; Stramba-Badiale et al., 2020). Additionally, 2 systematic reviews examined measures of food cravings (de Oliveira and Cordàs, 2020; Taylor, 2019). Furthermore, 3 narrative reviews discussed the development and symptoms of food cravings (Mercer and Holder, 1997; Verzijl et al., 2022; Whatnall et al., 2022), while one narrative review explored the impact of craving for physical activity in individuals with AN on the motivation for caloric restriction (Casper, 2022). Lastly, a comprehensive review investigated the psychological processes surrounding cravings in binge eating disorder (Kober and Boswell, 2018).

All the reviews are presented in Table 3.

3.5.2. Object of craving

In 14 out of 15 reviews, the focus of craving was for food, while the 15th review centered on craving for physical activity (Casper, 2022). Among the 14 reviews that addressed food craving, one discussed craving for both food and alcohol (Verzijl et al., 2022), 2 covered craving for food, alcohol, and drugs (Bou Khalil and El Hachem, 2014; Grall-Bronnec and Sauvaget, 2014), one examined craving for food, alcohol, drugs, and gambling (Gay et al., 2022), one focused on craving for food alongside exercise, restriction, and binge eating (Rachid, 2018), and one addressed craving for food and other substances (Whatnall et al., 2022).

3.5.3. Definition of craving

Eleven reviews provided definitions of craving, with the most common being a strong, intense, or irresistible "desire" to consume, mentioned in 8 reviews (de Oliveira and Cordàs, 2020; Gay et al., 2022; Grall-Bronnec and Sauvaget, 2014; Ince et al., 2021; Kober and Boswell, 2018; Taylor, 2019; Verzijl et al., 2022; Whatnall et al., 2022). Two of these 8 reviews included the word "urge," defining craving as the "desire or urge to" consume (de Oliveira and Cordàs, 2020; Taylor, 2019). One of the 8 reviews described craving as both a "desire" and "a motivational state" (Verzijl et al., 2022). Additionally, 2 reviews (Bou Khalil and El Hachem, 2014; Mercer and Holder, 1997) defined craving specifically as an "urge to" consume, with one of these stating that it is also a "state" (Mercer and Holder, 1997). Lastly, one review characterized craving as "a physiological condition" (Stramba-Badiale et al., 2020). The concept of a lack of control was emphasized in 3 reviews: "irresistible urge" (Bou Khalil and El Hachem, 2014) and "an irrepressible desire" (Gay et al., 2022; Grall-Bronnec and Sauvaget, 2014).

3.5.4. Models and conceptualization of craving

Only 2 reviews have provided models or theories to explain the development of craving (de Oliveira and Cordàs, 2020; Verzijl et al., 2022). de Oliveira and Cordàs (2020) presented three distinct models. The first one is the *conditioning model* (Jansen, 1998), which was previously presented in the studies section. The second is the *theory of social learning* (Bandura, 1977), which adopts a psychosocial and cognitive perspective, suggesting that craving arises from the expectation of an effect, influenced by social and environmental factors. The third one is a *neurobiological model* (Araujo et al., 2008), emphasizing the role of the brain's reward system in the experience of craving. de Oliveira and Cordàs (2020) used the three models to build their objective and hypothesis, each model contributing to an aspect of craving. Verzijl et al. (2022) presented three other models to understand craving. The *elaborated intrusion theory of desire* (Kavanagh et al., 2005) proposes that

cravings (or desires, as the authors make no qualitative difference between both constructs) emerge from the elaboration of intrusive thoughts, requiring voluntary cognitive processes, making them more intense and difficult to resist. The *cognitive-process model* (Tiffany, 1990) explains that craving can be triggered by both internal factors (e.g., negative emotions) and external cues (e.g., driving past a fast food restaurant) when a barrier (e.g., fast food restaurant is closed or attempting to restrict calorie intake) prevents the automatic execution of the behavior (e.g., eating a juicy burger). These barriers bring cravings to conscious awareness and generate an individual's experience of craving. Lastly, the *ambivalence model of craving* (Breiner et al., 1999; Stritzke et al., 2007) suggests that craving arises from the interaction between the desire to indulge and the desire to resist, creating a state of ambivalence. The decision to consume a substance is influenced by the strength of these competing inclinations, shaped by historical factors like family history, life stressors, and personality traits. Verzijl et al. (2022) argued that the ambivalence model of craving is preferable as it provides a more transdiagnostic view of the link between food craving and disordered eating behaviors, including food consumption habits, whereas the elaborated intrusion theory and the cognitive-process model only explain the emergence of craving.

3.5.5. Neurobiological mechanisms involved in craving

Three reviews have highlighted neurobiological models related to craving. Gay et al. (2022) discussed the activation of reward and motivation circuits in cravings involved in substance or behavioral (including eating disorders) addictions. Mercer and Holder (1997) proposed the opiodergic theory of food cravings, which suggests that food craving mediates the link between opioid peptides and food consumption. According to this theory, the activity of endogenous opioid peptides triggers cravings, which then lead to food ingestion. Finally, Bou Khalil and El Hachem (2014) discussed the role of irregularities in frontostriatal pathways in the development of food cravings.

3.5.6. Methods of assessment

Five reviews reported the use of VAS to evaluate cravings, 2 used the Food Cravings Questionnaire – State, and one analyzed both the Food Cravings Questionnaire – State and Trait. The other scales were each mentioned in a single review. The assessments can be seen in Table 4. The references for each questionnaire mentioned in the reviews are listed in Supplementary Material Table S3 and their properties are presented in Supplementary Material Table S4.

3.5.7. Outcomes of the reviews

3.5.7.1. Craving-related factors. Seven reviews explored the factors and mechanisms related to cravings, particularly in the context of ED.

3.5.7.1.1. Food exposure and environmental triggers. Three reviews (de Oliveira and Cordàs, 2020; Taylor, 2019; Whatnall et al., 2022) emphasized the importance of considering both internal and external contextual factors that may trigger or sustain food cravings in BN and BED. Additionally, de Oliveira and Cordàs (2020) highlighted the significance of evaluating state, past, and habitual food cravings.

3.5.7.2. Craving as a predictor of binge eating. The link between craving and binge eating in BN or BED was discussed in 3 reviews (de Oliveira and Cordàs, 2020; Kober and Boswell, 2018; Whatnall et al., 2022). The review by Kober and Boswell (2018) and the one by de Oliveira and Cordàs (2020) highlighted that food craving in BN and BED was either a causal factor or exacerbated binge eating. Whatnall et al. (2022) were more nuanced and considered craving not a direct cause but an indirect contributor to overeating behaviors.

3.5.7.2.1. Craving in Anorexia Nervosa. In AN, the review of Casper (2022) argued that the urge to move was associated with physical restlessness and is enhanced by self-confidence, self-control, and

increased body perception, which maintain the individual in AN.

3.5.8. Interventions on craving

3.5.8.1. Psychological interventions and neurofeedback. Reviews by [Ince et al. \(2021\)](#) and the one by [Stramba-Badiale et al. \(2020\)](#) investigated the impact of cue exposure therapy in virtual reality. The systematic review by [Ince et al. \(2021\)](#) showed that this approach reduced food cravings in BN and BED patients more effectively than additional cognitive behavioral therapy. The narrative review by [Stramba-Badiale et al. \(2020\)](#) suggested that combining cue exposure therapy in virtual reality with EEG-neurofeedback and tDCS could enhance effectiveness, although it did not provide experimental evidence to support this claim.

3.5.8.2. Neuromodulation. The review of [Verzija et al. \(2022\)](#) proposed that interventions targeting approach and avoidance inclinations in food cravings could improve treatment outcomes for ED, drawing on substance use literature. Two reviews ([Mercer and Holder, 1997](#); [Whatnall et al., 2022](#)) highlighted neural mechanisms for the development of craving, with [Mercer and Holder \(1997\)](#) focusing on altered opioid activity in AN and BN and [Whatnall et al. \(2022\)](#) discussing dopamine-based reward pathways and the potential of excitatory neuromodulation to reduce cravings and consumption in BN and BED.

The effectiveness of rTMS in reducing cravings for individuals with BN, BED, or EDNOS varied across reviews. While [Grall-Bronnec and Sauvaget \(2014\)](#) and [Rachid \(2018\)](#) provided evidence supporting the effectiveness of rTMS in reducing cravings for individuals with BN and BED, the meta-analysis by [Gay et al. \(2022\)](#) found no effect of rTMS on craving reduction in participants with ED. Additionally, [Bou Khalil and El Hachem \(2014\)](#) reported mixed results, leaving the effectiveness of rTMS uncertain.

The reviews by [Chmiel et al. \(2024\)](#) and [Hall et al. \(2018\)](#) explored alternative non-invasive brain stimulation methods. The systematic review by [Chmiel et al. \(2024\)](#) found that tDCS reduced food cravings, with factors such as hunger, BMI, BED scores, and gender potentially influencing the results. The narrative review by [Hall et al. \(2018\)](#) compared rTMS and tDCS, revealing that both methods decreased craving strength in a single session, with rTMS appearing more effective. However, the scarcity of randomized trials involving multi-session non-invasive brain stimulation limits conclusions about their overall efficacy.

For an overview, the key findings are summarized in [Box 1](#).

4. Discussion

This systematic review provides a comprehensive synthesis of research on craving in ED. The analysis highlights the central role of craving in ED while underscoring the persistent conceptual ambiguity surrounding its definition and theoretical underpinnings. Craving is variably described as a transient state or a stable trait, and sometimes conflated with the sense of loss of control (e.g., “irresistible desire”). This heterogeneity makes it difficult to compare findings across studies and prevents the construction of integrative models. Moreover, most empirical work focuses on disorders characterized by binge eating, particularly BN and BED, with very limited attention given to AN or to non-food-related forms of craving such as vomiting, exercise, or laxative use (e.g., [Verzija et al., 2022](#)).

4.1. Models: borrowed frameworks and missing integration

Although multiple dimensions of craving have been examined separately, the conceptual landscape remains fragmented. Some authors include behaviors that follow craving, such as binge eating, purging, or excessive physical exercise, as part of the definition. In contrast, others distinguish between craving as a desire and the subsequent behaviors,

emphasizing that these behaviors do not always occur as a result of cravings ([Tiffany and Carter, 1998](#); [Whatnall et al., 2022](#)). More intricately, some authors integrate the notion of lack of control into the definition of craving (e.g., “irresistible desire”), whereas others separate it, claiming loss of control as a process of failed regulation distinct from the strong desire, and which can lead to behaviors. As a consequence of the lack of a clear definition, models addressing craving also show marked inconsistency, and in most cases, craving is not even central to these theories. Beyond the conditioning framework, the models identified in the primary studies and the reviews diverge, likely due to differences in clinical populations or review objectives. Rather than reflecting a convergence of knowledge, this heterogeneity illustrates the dispersion of research and the conceptual ambiguity surrounding craving in ED. In parallel, neurobiological findings, while advancing, continue to be studied in isolation and have yet to be integrated into comprehensive explanatory models. The lack of a clear definition, the discrepancy of models, and the complexities of neurobiological mechanisms all underscore the need for a unified, operational conceptualization of craving in ED research or, even better, in a transdiagnostic way. Craving is indeed a construct that can be found across ED, even though its object is not always food. While the clinical significance of craving in ED is already documented ([Hormes, 2017](#)); future multimodal studies (e.g., neuroimaging, endocrinology, computational modeling) should test whether distinct craving types engage shared neural circuits, thereby validating a transdiagnostic framework.

A coherent transdiagnostic theory of craving would need to capture its cognitive, emotional, and neurobiological dimensions. One promising attempt is the metacognitive hub model ([Flaudias et al., 2019](#)), which conceptualizes craving as arising from the interaction of reflective, automatic, interoceptive, and metacognitive systems, each associated with distinct neural substrates. The model also accounts for implicit and explicit aspects of craving, linked via metacognitive abilities. Although further empirical validation is required, such integrative frameworks highlight the potential to unify fragmented findings and to inform both assessment tools and therapeutic strategies.

4.2. Assessment: practical but theoretically weak tools

Most studies have assessed craving using VAS with some variability in format (continuous vs. discrete), or through the FCQ ([Cepeda-Benito et al., 2000](#); [Meule, 2020](#)). The FCQ provides a multidimensional picture of food craving, covering aspects such as physiological responses, potential triggers, anticipation of pleasure or relief, and perceived lack of control. Other instruments, such as the YFAS, include craving items that are embedded in a broader context (e.g., food addiction) that is essential to their interpretation. Any tool without a proper subscale (i.e., established by a confirmatory factor analysis) for craving should not be used to measure it. Qualitative approaches (e.g., diaries) remain less frequently used despite their capacity to capture the phenomenology of craving. The FCQ focused on food as the object of craving, which limits the scope of the measure. Psychophysiological and neurocognitive measures ([Ray et al., 2013](#); [Rosenberg, 2013](#); [Sayette et al., 2000](#)) also represent valuable complementary approaches, although their implementation is often limited by feasibility issues. The lack of a shared definition continues to drive methodological inconsistencies. Developing a unified framework would not only refine current assessment tools but also extend their applicability to diverse craving targets such as food, exercise, and purging.

4.3. Clinical implications and interventions

Although craving is widely acknowledged to be closely linked with maladaptive eating behaviors, targeted interventions remain limited. Encouraging results have been reported for cue exposure therapy, including virtual reality adaptations (e.g., [Whatnall et al., 2022](#)), as well as neurofeedback approaches. Non-invasive brain stimulation

techniques such as rTMS and tDCS also show potential (as seen in reviews), though findings remain inconsistent. The scarcity of intervention studies may reflect the lack of a robust theoretical framework, yet addressing craving directly could have substantial clinical benefits given its predictive role in binge episodes (Meule et al., 2018).

4.4. Transdiagnostic perspective and parallels with addictions

Craving appears to cut across ED diagnoses, with evidence that trait craving, more than state craving, predicts binge eating, often via mediators such as impulsivity or dietary restraint (Arend et al., 2024). Only two studies directly compared ED subtypes, suggesting higher food and vomiting cravings in AN binge-purging type versus AN restrictive type. Although craving is reported in major eating disorders, its nature must be considered in relation to its object. While there seems to be agreement that food-related desire involves an intense motivational state with affective and cognitive components (i.e., craving; Hormes, 2017), is the phenomenon the same for physical activity and restriction? Is it more of an obsession involving persistent intrusive thoughts that seek satisfaction and anxiety reduction through compulsion (Amianto et al., 2022), as in obsessive-compulsive disorders? Or are craving and obsession ultimately a single transdiagnostic phenomenon, as implied by some widely used scales (e.g., Anton, 2000)? This review does not resolve the conceptual ambiguity surrounding craving and obsession in ED (Collombat et al., 2024) but offers several avenues for further research in the following section.

More generally, craving in ED shares striking similarities with craving in addictions, both in terms of antecedents (e.g., visual/olfactory cues, negative affect) and mechanisms (e.g., involvement of dopamine and opioid systems; Hormes, 2017; Kober and Mell, 2015). As in substance use disorders, craving may act both directly and indirectly (via impulsivity) on problematic behaviors such as binge eating, alcohol use, or gambling (Lopez-Guerrero et al., 2023). These convergences support a transdiagnostic framework linking ED and addictions and revive debates around the concept of “food addiction” (Hormes and Rozin, 2010; Zeganadin et al., 2024).

4.5. Limitations and directions for research

The findings of this review should be interpreted in light of several limitations. First, the vast majority of studies included were conducted in Western populations, which inevitably restricts the cross-cultural generalizability of the conclusions. Cultural factors play a key role in shaping both the expression of craving and the meanings attributed to it (see for example Osman and Sobal, 2006); therefore, extending research to non-Western contexts and including studies published in other languages is essential to broaden the scope of current knowledge.

Methodological issues also limit the robustness of available evidence. Many studies relied on relatively small samples, and designs varied widely in terms of diagnostic groups, assessment tools, and experimental paradigms. This heterogeneity hinders direct comparisons and contributes to the dispersion of findings. Future research would benefit from systematic and well-powered investigations, including direct comparisons between ED types and subtypes, rather than collapsing heterogeneous groups into broad categories.

Another important gap concerns the broad perspective of food craving, without specifying the type of food, except for some studies that mention palatable food (Ferrer-García et al., 2014; Meule et al., 2018; Pla-Sanjuanelo et al., 2019). While there is a growing body of literature focusing on ultraprocessed foods in eating disorders (for a review, see Pereira et al., 2024), there is a lack of evidence regarding their influence on craving in clinical population as only one review (Whatnall et al., 2022) mentions a link. Moreover, food is the most frequently studied target, and research neglects other forms of craving—such as those related to exercise, purging, or laxative misuse—even though they are clinically relevant. Addressing these underexplored dimensions would

allow for a more comprehensive understanding of craving as a transdiagnostic construct.

While this review tends to indicate the presence of craving across ED, highlighting its relevance, it is nevertheless biased by the lack of research on obsession. In order to clarify this field, a consensual and differential definition of craving and obsession would help to establish the presence of one and/or the other in eating disorders. Interventions targeting craving in ED remain limited, particularly in the pharmacological domain, where only dronabinol has been tested. Topiramate, for example, has shown promising results in BED (Nouredine et al., 2021a, 2021b) and its specific effect on craving warrants further investigation.

Finally, advancing the field will require the adoption of longitudinal, multimodal, and integrative methodologies, combining neuroimaging, endocrinological measures, and computational modeling to capture the multiple levels at which craving operates. Above all, however, progress depends on establishing a consensual and operational definition of craving, which could serve as a foundation for both the refinement of assessment tools and the development of targeted interventions.

5. Conclusion

Craving occupies a paradoxical position in the study of ED: it is central to clinical experience yet remains conceptually elusive. Existing frameworks, largely borrowed from addiction research (e.g., Kavanagh et al., 2005; Tiffany and Carter, 1998), offer valuable insights but often fail to capture the specificity of craving in ED—particularly outside BN and BED, and beyond food-related phenomena.

The field continues to lack theoretical consensus and reliable, theory-driven assessment tools. Without conceptual clarity, interventions remain tentative. Promising approaches such as cue exposure, neurofeedback, or non-invasive brain stimulation require further validation within a sound theoretical framework. What is urgently needed is not another list of techniques but a cohesive model that reframes craving as a transdiagnostic process, bridging biological, cognitive, and contextual dimensions. The metacognitive hub model (Flaudias et al., 2019) offers such potential, aligning disparate findings and opening new avenues for targeted, meaningful interventions.

Finally, craving in ED mirrors addictive processes closely enough to justify the comparison—at least symptomatically (Hormes, 2017; Hormes and Rozin, 2010). Yet rather than collapsing categories, future research should embrace the nuance: clarifying what craving is, what it reflects, and how it can be transformed.

Funding and acknowledgements

AC was funded by a postdoctoral fellowship obtained by VF and funded by the Conseil regional des Pays-de-la-Loire and Nantes University (Project: METABOU).

SI is supported by the Fonds de Recherche en Santé du Québec (FRQS Junior 1; grant number 312066; <https://doi.org/10.69777/312066>).

This research was funded, in whole or in part, by the Conseil regional des Pays-de-la-Loire, Grant “Etoiles Montantes”. A CC-BY public copyright license has been applied by the authors to the present document and will be applied to all subsequent versions up to the Author Accepted Manuscript arising from this submission, in accordance with the grant’s open access conditions.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.neubiorev.2025.106515](https://doi.org/10.1016/j.neubiorev.2025.106515).

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