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Food addiction, eating addiction and eating disorders

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The concept of food addiction is currently a highly debated subject within both the general public and the scientific communities. The term food addiction suggests that individuals may experience addictive-like responses to food, similar to those seen with classic substances of abuse. An increasing number of studies have established the prevalence and correlates of food addiction. Moreover, food addiction may be associated with obesity and disordered eating. Thus, intervening on food addiction may be helpful in the prevention and therapy of obesity and eating disorders. However, controversy exists about if this phenomenon is best defined through paradigms reflective of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) substance-related disorders (e.g. food addiction) or non-substance-related disorders (e.g. eating addiction) criteria. This review paper will give a brief summarisation of the current state of research on food addiction, a more precise definition of its classification, its differentiation from eating addiction and an overview on potential overlaps with eating disorders. Based on this review, there is evidence that food addiction may represent a distinct phenomenon from established eating disorders such as bulimia nervosa or binge-eating disorder. Future studies are needed to further examine and establish orthogonal diagnostic criteria specific to food addiction. Such criteria must differentiate the patterns of eating and symptoms that may be similar to those of eating disorders to further characterise food addiction and develop therapy options. To date, it is too premature to draw conclusions about the clinical significance of the concept of food addiction.

Food addiction: YFAS 2-0: Eating disorders: DSM-5: Eating addiction

Quantifying maladaptive or potentially dysregulated patterns of eating as a food addiction, eating addiction or an eating disorder is an emerging topic of interest that, if supported, may have relevance for a variety of areas of health⁽¹⁾. However, controversy and criticism exist in how to define maladaptive patterns of eating that are commonly referred to as food addiction, the distinction from other associated conditions (e.g. eating addiction,

eating disorders, etc.), and the role such phenomenon may play in health problems such as obesity^(2–8).

For example, media coverage and clinical work with people with morbid obesity have promoted the concept of food addiction. While this term seems to be widely accepted in the general population, it is not as universally accepted within the scientific community. Scientifically sound research is necessary in order to be able to clarify the

Abbreviations: BED, binge-eating disorder; BN, bulimia nervosa; DSM-5, Diagnostic and Statistical Manual of Mental Disorders; YFAS, Yale food addiction scale.

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still open questions regarding the association between food and addiction.

Therefore, the purpose of the present paper was 3-fold: First, the current state of research on food addiction was reviewed; secondly, evidence for established criteria and concepts for addiction to food/eating is presented; thirdly, the potential relationships and distinctions between food addiction and recognised eating disorders were reviewed.

Current state of research on food addiction

The concept of food addiction refers to specific food-related behaviours characterised by excessive and dysregulated consumption of high-energy food⁽⁹⁾. Research on food addiction began in 1956⁽¹⁰⁾. However, much attention has been given to this concept in recent years as new methods, knowledge and an increasing number of studies have been carried out on both animal models and in human subjects in recent decades⁽¹¹⁾. Preliminary findings suggest an association between overweight/obesity, food and addiction⁽¹⁾ which has recently led to some researchers^(1,2) to put forward a concept of addictive-like eating as a potential explanation for overweight and obesity. Two main concepts have been used to quantify the addictive-like potential of food. First, research has focused on the chemical constituency of the food itself. This contention is based on similarities in patterns of food intake and consumption of drugs of abuse⁽¹²⁾ (e.g. in dopamine pathways^(13,14) and in eating patterns^(2,15)). Specifically, individuals labelled as having food addiction frequently consuming processed foods that are energy dense and high in sugar, fat and salt^(16,17). Biological evidence suggests that the salt, sugars and fats contained within such highly palatable foods may have addictive potential via activating dopamine reward systems in the brain⁽²⁾. To this end, several different variables that may indicate the molecular, cellular and systems-level mechanisms⁽¹⁸⁾, reward mechanisms^(19–23), specific components of food^(17,24,25) or diagnostic criteria for substance dependence in relation to eating behaviours^(26–28) as an addiction have been recently examined. The alternative contention has focused on eating behaviours, rather than food. This has led to the concept of maladaptive or dysregulated eating being more like an eating addiction^(29,30). However, this view has been criticised as it does not clearly distinguish such behavioural patterns from other eating disorders, notably bulimia nervosa (BN) or binge-eating disorder (BED)⁽⁴⁾. Given the consternation surrounding the validity and quantification of this phenomenon, some have questioned the clinical and scientific relevance of the concept of food addiction^(5–8). To date, there is insufficient evidence to fully support or refute either contention. Given the rapidly growing body of evidence for both contentions and the potential clinical relevance of understanding how dysregulated patterns of eating contribute to adverse health outcomes, it stands that all interpretations of these data must take the preliminary nature of research on the

aetiology of food addiction into account. That stated, the term food addiction has received the majority of research and clinical focus. Therefore, we have used this terminology as the preferred nomenclature throughout this review.

Assessment of food addiction

Fixed criteria to assess food addiction have been defined⁽¹²⁾ to more uniformly assess the concept and to ensure that the results among studies are comparable. This criterion is based on the concept that food addiction may represent an addiction; similar to addictions defined by the substance-related and addictive disorder criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)⁽³¹⁾. Thus, the substance-related and addictive disorder criteria have been applied to food and a research instrument, the Yale food addiction scale (YFAS) was developed⁽¹²⁾. The YFAS version 2.0 is a thirty-five-item questionnaire with an eight-point response scale⁽³²⁾. The YFAS 2.0 measures the eleven substance-related and addictive disorder criteria according to food and eating⁽³²⁾. For the potential ‘diagnosis’ of a food addiction, at least two of the eleven substance-related and addictive disorder criteria must be fulfilled, and significant impairment needs to be present⁽³¹⁾. The YFAS also measures impairment from eating behaviour⁽¹²⁾. The YFAS has been translated and validated in English⁽¹²⁾, German⁽³³⁾, Italian⁽³⁴⁾, Spanish⁽³⁵⁾ and Japanese⁽³⁶⁾. The YFAS is the most commonly used tool to assess food addiction^(3,37). For this reason, the results of the YFAS are presented in this article. The validation study demonstrated internal reliability ($\alpha = 0.90$) and convergent validity with other measures of problematic eating⁽³²⁾.

Prevalence and correlates of food addiction assessed by the YFAS

Three systematic reviews of studies that have assessed food addiction using the YFAS have been conducted. These reviews revealed between twenty-five and sixty studies using human samples have been published between 2009 and July 2017^(3,4,26). These studies have reported prevalence from 0 to 25.7 % in non-clinical samples (e.g. adult general population, student samples)^(3,4) and prevalence from 6.7 to 100 % in samples recruited from clinical settings⁽³⁾. The definition of a clinical sample includes, e.g. individual with a current diagnosis of an eating disorder (prevalence: 57.6–100 %^(3,4,26)), or clinical prebariatric surgery sample (prevalence: 14–57.8 %⁽³⁸⁾). Compared to men, women showed significantly higher prevalence (3.0–14.0 v. 6.7–21.3 %)^(26,39,40). In men, sexual minority orientation (e.g. gay, bisexual) was significantly associated with higher YFAS scores (prevalence: 1.83 v. 1.27 %)⁽⁴¹⁾. Inconsistent results were found for food addiction prevalence and age^(26,42,43). Higher prevalence has been reported in samples of black persons than in Hispanics or white individuals^(39,44). Additionally, a positive association with BMI has been reported⁽³⁾. Evidence suggests that food addiction may be comorbid with eating disorders, especially BED and BN⁽³⁾.



Specifically, positive associations have been reported among binge-eating scores, difficulties in emotional eating regulation, restraint, disinhibition and hunger, night-eating scores, craving, impulsivity, reward sensitivity, depressive symptoms, anxiety, post-traumatic stress disorder and food addiction overall scores⁽³⁾.

Eating cognitions in food addiction

Eating cognitions common in food addiction may reflect a form of impulsive eating⁽⁴⁵⁾, which may be related to addictive-like eating⁽⁴⁶⁾. For example, rigid control has been associated with higher BMI and disordered eating behaviour^(47,48). Furthermore, binge eating is related to overweight and obesity⁽⁴⁹⁾. Accordingly, the amount of binge symptoms have also been examined in relation to food addiction⁽³¹⁾. Specifically, binges are defined as (1) consuming a quantity of food that is larger than what is considered normal in a discrete period of time, (2) a sense of lack of control, (3) eating faster than normal, (4) continuing to eat despite feeling uncomfortably full, (5) eating despite not being hungry, (6) eating alone and (7) feeling disgusted with oneself, depressed or very guilty afterwards⁽³¹⁾. Further research is needed to elucidate this potential relationship, distinguishing if food addiction is orthogonal from other disorders that include binges, and if the binges observed in food addiction are distinct from objective and subjective binge episodes as part of BN or BED. In addition, morbid obesity is associated with reduced quality of life⁽⁵⁰⁾. Future research is needed to further elucidate if food addiction is specifically related to the mental well-being component of quality of life in individuals with morbid obesity. If such a finding is supported, this may be of clinical importance and should be taken into account in prevention and therapy.

Two examples of studies conducted in Germany

YFAS 2-0 food addiction in a representative study in Germany. The first nationwide, representative study of the prevalence of food addiction was recently conducted in Germany⁽⁴²⁾. Point prevalence of food addiction was 7.9% within Germans, with higher rates in underweight (15.0%) and obese participants (17.2%) (Fig. 1).

Results of this nationwide study are similar to other research. For example, the prevalence of food addiction was comparable to previously reported rates within community samples collected from general populations worldwide^(3,4,26). Moreover, the overall point prevalence was also similar to the prevalence of alcohol use disorder (e.g. an established substance use disorder) in Europe (8.8%) and Germany specifically (6.8%)⁽⁵¹⁾. Additionally, the highest prevalence rates in individuals with obesity are consistent with previous research^(3,4,26,52). Finally, the elevated prevalence in underweight individuals was interesting. However, previous studies have also found a higher risk for food addiction in people with eating disorders, including the binge-purge subtype of anorexia nervosa^(53,54). Thus, the elevated food addiction prevalence in underweight individuals may be due to an underlying eating disorder or other forms

of disordered eating. This nationwide study adds much needed context to understanding that food addiction may be a contributor to overeating⁽⁴²⁾, but it is not synonymous with obesity and not exclusively found in overweight/obese individuals. Therefore, food addiction may reflect a distinct phenotype of problematic eating behaviour⁽⁴²⁾.

Food addiction in German-speaking endurance athletes. A recent study of amateur endurance athletes^(55,56) examined comorbidity of food addiction, eating disorders and exercise dependence (e.g. another proposed behavioural addiction). The prevalence of food addiction was 6.2%, of exercise dependence 30.5% and of eating disorders 6.5%. The highest prevalence of food addiction was found in underweight (9.8%) and obese (23.1%) subjects (see Fig. 1). Food addiction and exercise dependence were associated, thus suggesting potential overlap in underlying mechanisms for behavioural addictions^(55,56).

Transferability of criteria of addiction to food and/or eating addiction

The second purpose of this review was to examine whether established criteria for addiction⁽³¹⁾ may be used to quantify food addiction and/or eating addiction⁽³²⁾. Table 1 shows the original DSM-5 substance dependence/addiction criteria⁽³¹⁾. Using the DSM-5 paradigm as a mode for creating a food-specific criteria has been proposed^(32,52) and a subsequent corresponding assessment has been created⁽⁵⁷⁾.

Alternatively, focusing on the behaviour of eating suggests that patterns described as food addiction may in fact be more similar to a behavioural eating addiction⁽⁵⁸⁻⁶¹⁾. That is, fundamental differences exist between drugs and food⁽²⁹⁾ and there is a lack of evidence that foods contain any addictive substance at all⁽³⁰⁾. Rather, an eating addiction denotes a set of behaviours and cognitions that represent maladaptive addiction-like patterns of eating⁽³⁰⁾. This paradigm has led to the development of the addiction-like eating behaviour scale. The addiction-like eating behaviour scale is a valid and reliable ($\alpha > 0.83$) instrument to quantify the behavioural features of an eating addiction⁽³⁰⁾. It is a fifteen-item scale with responds on a five-point Likert scale that has a two-factor structure: increased appetite drive and low dietary control⁽³⁰⁾. However, few scientists favour the concept of eating addiction, and consequently, there are currently few publications available^(29,30). Evidence for the non-substance-related disorder criteria from the DSM-5⁽³¹⁾ and its transferability to addictive-like eating behaviour is shown in Table 2.

Potential relationships and distinctions between food addiction and eating disorders

The third purpose of the article was to examine the potential relationships and distinctions between food addiction and eating disorders.

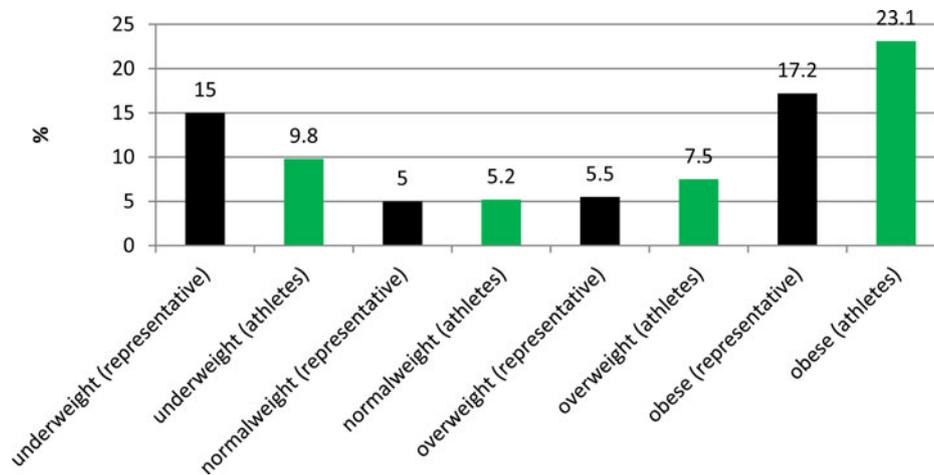


Fig. 1. (Colour online) Prevalence of food addiction in three studies, according to BMI category (representative = study representative for the German population, athletes = German amateur endurance athletes).

Overlapping prevalence rates

Genetic similarities between compulsive overeating and substance addictions have been established^(62–64), e.g. variants in genes encoding dopamine D2 receptor (e.g. Taq1 (rs1800497) allele of the ANKK1 gene)⁽⁶³⁾ and transporter (e.g. SLC6A3, DAT1), and opioid receptor genes (OPRM1 gene)⁽⁶⁴⁾. Additionally, several studies have reported food addiction prevalence between 86 and 100% in BN^(53,54,65), 26 and 77% in BED^(53,66) and 50% in the binge-purging subtype of anorexia nervosa⁽⁵³⁾, measured by Eating Disorder Diagnostic Scale, Eating Disorder Examination Questionnaire, Questionnaire for Eating and Weight Patterns - Revised and Eating Disorder Inventory-2. Despite such overwhelming overlaps with BN, BED and anorexia nervosa, however, there are not always complete overlaps with eating disorders. Another study found some overlap between the symptoms of food addiction and BED, however only when addictive traits in binge-type eating disorders are present⁽⁶⁷⁾. This has been described as an addictive appetite model of binge-eating behaviour⁽⁶⁸⁾. The research today suggests that addictive-like aspects of eating may be present in some eating disorder variants. This is similar to the well-established overlaps of other addictions and eating disorders⁽⁶⁹⁾. Thus, further research is needed to further understand potential relationships among food addiction and binge-related symptoms of eating disorders.

Differences

Other researchers however argue that food addiction and eating disorders are two different constructs^(70–72). That is, cognitive control and disinhibition of eating behaviour have been established in the aetiology of eating disorders^(47,73); however these cognitions are not evidenced in food addiction⁽³³⁾. In addition, support for distinct behavioural and neurobiological evidence for food addiction phenotype has been found, thereby suggesting an addictive disorder rather than a subset of eating disorders⁽⁷⁰⁾. Thus, BED has been proposed as a psycho-behavioural disorder

and food addiction as a biological-based disorder⁽⁷²⁾. Moreover, grazing patterns of overconsumption in individuals with food addiction has been reported⁽⁷⁴⁾, which indicates that overeating does not only occur as a binge, such as those in the diagnostic criteria for both BN and BED. Furthermore, food addiction has been reported after bariatric surgery^(74,75) when binges are not physiologically possible, but grazing is common.

The evidence for food addiction's overlap with eating disorders

Some evidence exists to suggest that food addiction may overlap with the DSM-5 criteria for eating disorders⁽³¹⁾ (see Table 3). That is, Table 3 summarises evidence for similarities of food addiction and each eating disorder variant. The extant literature suggests little evidence for the overlap with anorexia nervosa and food addiction. However, the tolerance, loss of control, consequences and problems subscales of the YFAS 2.0 may in fact be assessing several key aspects of DSM-5 criteria for BED. Finally, some evidence suggests that tolerance and loss of control aspects of food addiction may reflect DSM-5 criteria for BN^(3,31,32,52).

Discussion

Food addiction is an emerging area of both clinical and research interest. The current review discussed several definitional and conceptual categorisations that have been put forth to quantify food addiction. However, the YFAS 2.0 concept predominates the literature. Similarly, evidence shows some similarities of food addiction with established eating disorders, particularly BED. Thus, the current review supports two main areas of contention that warrant much more research; considering food addiction as a substance-related addiction or a behavioural-related addiction and if food addiction is distinct from established eating disorders. Further research is

Table 1. Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria for substance dependence, possible food addiction equivalents and plausibility of a transfer to food addiction

DSM-5 criteria for substance dependence ⁽³¹⁾	General definition ⁽³¹⁾	Possible food addiction equivalents ^(32,52)	Plausibility for food addiction ⁽⁵⁷⁾
Impaired control			
Amount	Substance often taken in larger amounts or over a longer period than was intended.	Food often consumed in larger amounts or over a longer period than was intended.	Yes. Empirically supported.
Attempts	Persistent desire or unsuccessful efforts to cut down or control substance use.	Persistent desire or unsuccessful efforts to cut down or control food intake.	Yes. Empirically supported.
Time spent	Great deal of time is spent in activities necessary to obtain or use the substance or recover from its effects.	Great deal of time is spent in activities necessary to obtain or overeat on foods or recover from its effects.	Yes. Plausible.
Craving	Craving, or a strong desire or urge to use the substance.	Craving, or a strong desire or urge to eat specific foods.	Yes. Empirically supported.
Social impairment			
Activities	Important social, occupational or recreational activities are given up or reduced because of substance use.	Important social, occupational or recreational activities are given up or reduced because of overeating on foods.	Yes. Plausible.
Obligations	Recurrent substance use resulting in a failure to fulfil major role obligations at work, school or home.	Recurrent overeating resulting in a failure to fulfil major role obligations at work, school or home.	Yes. Plausible.
Problems	Continued use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.	Continued overeating despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of specific foods.	Yes. Plausible.
Risky use			
Situations	Recurrent substance use in situations in which it is physically hazardous.	Recurrent overeating in situations in which it is physically hazardous.	Yes. Plausible in the context of certain health conditions, but less relevant.
Consequences	Substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance.	Overeating is continued despite knowledge of having a persistent or recurrent physical (e.g. presence of diabetes mellitus or excessive consumption of unsuitable foods after bariatric surgery) or psychological problem that is likely to have been caused or exacerbated by overeating on foods.	Yes. Empirically supported.
Pharmacological criteria			
Tolerance	Need for markedly increased amounts of the substance to achieve intoxication or desired effect OR Markedly diminished effect with continued use of the same amount of the substance	Need for markedly increased amounts of food to achieve desired effect OR Markedly diminished effect with continued use of the same amount of food	Yes. Plausible.
Withdrawal	Withdrawal syndrome (differs by substance) OR Substance is taken to relieve or avoid withdrawal symptoms	Withdrawal syndrome when refraining from eating specific foods OR Specific foods are eaten to relieve or avoid withdrawal symptoms	Yes. Plausible, but hard to distinguish from human energy needs.
Intoxication		–	–

* The last column of the table was taken from a publication by Meule⁽⁵⁷⁾. However, it should be pointed out that we only agree with these statements if the following three points are noticed: First, food, within the concept of food addiction, cannot be seen only as a single substance, but as a complex composition of ingredients. By this, the substance dependence definition of the DSM-5 would not fit properly. Secondly, the process of eating (behaviour) should be considered. Thirdly, the criterion 'withdrawal' in our opinion is not transferable by plausible means.

needed to continue to delineate and clarify controversies about similarities and differences in food addiction with other concepts and established disorders.

First, substantial debate exists whether food addiction is more similar to substance dependence or to behavioural addictions. The DSM-5 criteria for substance

dependence (Table 1) and for non-substance-related disorders (Table 2) were applied to food. Applying the DSM-5 criteria to addictive-like eating suggests that both concepts, the concept of substance dependence (food addiction) and the concept of non-substance dependence (eating addiction), may fit. Specifically,

Table 2. Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria for non-substance-related disorders, definitions of the criteria and plausibility in the context of eating addiction

DSM-5 criteria for non-substance related disorders ⁽³¹⁾	Definition of the criteria (using the example of gambling) ⁽³¹⁾	Possible eating addiction equivalents (based on ⁽³¹⁾)	Plausibility for eating addiction (based on ⁽²⁹⁻³¹⁾)
Amount	Needs to gamble with increasing amounts of money in order to achieve the desired excitement.	Needs to eat increasing amounts of food in order to achieve the desired excitement.	Plausible, but this would rather correspond to the concept of substance dependence.
Attempts	Has made repeated unsuccessful efforts to control, cut back, or stop gambling.	Has made repeated unsuccessful efforts to control, cut back, or stop eating.	Plausible, but for survival it is not possible not to eat.
Time spent	Is often preoccupied with gambling (e.g. having persistent thoughts of reliving past gambling experiences, handicapping or planning the next venture, thinking of ways to get money with which to gamble).	Is often preoccupied with eating.	Yes. Plausible.
Obligations	Has jeopardised or lost a significant relationship, job, or educational or career opportunity because of gambling.	Has jeopardised or lost a significant relationship, job, or educational or career opportunity because of eating.	Plausible, when eating is preferred to other activities/obligations and results in sequelae.
Withdrawal	Is restless or irritable when attempting to cut down or stop gambling.	Is restless or irritable when attempting to cut down or stop eating.	Plausible, but hard to distinguish from human energy needs.
Behaviour in response to distress	Often gambles when feeling distressed (e.g. helpless, guilty, anxious, depressed).	Often eats when feeling distressed (e.g. helpless, guilty, anxious, depressed).	Plausible as compensatory satisfaction.
Chasing losses	After losing money gambling, often returns another day to get even ('chasing' one's losses).	–	No. There are no negative consequences of eating that can be reversed.
Negation of the dimension of the behaviour	Lies to conceal the extent of involvement with gambling.	Lies to conceal the extent of involvement with eating.	Yes. Plausible to hide the amount eaten.
Dependent on others	Relies on others to provide money to relieve desperate financial situations caused by gambling.	Relies on others to provide food.	No. Food is mostly cheap and affordable.

Table 3. Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria for eating disorders and potential fit to Yale food addiction scale (YFAS) food addiction criteria

DSM-5 criteria for eating disorders ⁽³¹⁾	Possible fit to YFAS food addiction criteria (based on ^(3,31,32,52))
Anorexia nervosa	
A. Restriction of energy intake relative to requirements, leading to a significantly low body weight in the context of age, sex, developmental trajectory and physical health. Significantly low weight is defined as a weight that is less than minimally normal or, for children and adolescents, less than that minimally expected.	Not seen in YFAS food addiction.
B. Intense fear of gaining weight or of becoming fat, or persistent behaviour that interferes with weight gain, even though at a significantly low weight.	Not seen in YFAS food addiction.
C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or persistent lack of recognition of the seriousness of the current low body weight.	Appears in the YFAS food addiction criterion: risky use.
Binge eating disorder	
A. Recurrent episodes of binge eating. An episode of binge eating is characterised by both of the following:	(3)
1. Eating, in a discrete period of time (e.g. within any 2-h period), an amount of food that is definitely larger than what most people would eat in a similar period of time under similar circumstances.	1. Appears in the YFAS food addiction criterion: tolerance
2. A sense of lack of control over eating during the episode (e.g. a feeling that one cannot stop eating or control what or how much one is eating).	2. Appears in the YFAS food addiction criterion: loss of control
B. The binge-eating episodes are associated with three (or more) of the following:	
1. Eating much more rapidly than normal.	1. & 3. Appears in the YFAS food addiction criterion: tolerance
2. Eating until feeling uncomfortably full.	2. & 5. Appears in the YFAS food addiction criterion: use despite knowledge of adverse consequences
3. Eating large amounts of food when not feeling physically hungry.	4. Appears in the YFAS food addiction criterion: continued use despite social or interpersonal problems
4. Eating alone because of feeling embarrassed by how much one is eating.	Appears in the YFAS food addiction criterion: clinically significant impairment
5. Feeling disgusted with oneself, depressed, or very guilty afterward.	Not seen in YFAS food addiction.
C. Marked distress regarding binge eating is present.	Not seen in YFAS food addiction.
D. The binge eating occurs, on average, at least once weekly for 3 months.	
E. The binge eating is not associated with the recurrent use of inappropriate compensatory behaviour as in bulimia nervosa and does not occur exclusively during the course of bulimia nervosa or anorexia nervosa.	
Bulimia nervosa	
A. Recurrent episodes of binge eating. An episode of binge eating is characterised by both of the following:	
1. Eating, in a discrete period of time (e.g. within any 2-h period), an amount of food that is definitely larger than what most individuals would eat in a similar period of time under similar circumstances.	1. Appears in the YFAS food addiction criterion: tolerance
2. A sense of lack of control over eating during the episode (e.g. a feeling that one cannot stop eating or control what or how much one is eating).	2. Appears in the YFAS food addiction criterion: loss of control
B. Recurrent inappropriate compensatory behaviours in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics or other medications; fasting; or excessive exercise.	Not seen in YFAS food addiction.
C. The binge eating and inappropriate compensatory behaviours both occur, on average, at least once weekly for 3 months.	Not seen in YFAS food addiction.
D. Self-evaluation is unduly influenced by body shape and weight.	Not seen in YFAS food addiction.
E. The disturbance does not occur exclusively during episodes of anorexia nervosa.	Not seen in YFAS food addiction.

food addiction may reflect more criteria for substance dependence of the DSM-5 (Table 1) than eating addiction meets non-substance dependence criteria (Table 2). Recent systematic reviews also support a better fit for the concept of substance dependence, primarily due to the numerous studies that have established brain reward dysfunction and impaired control in food addiction^(24,58). Nevertheless, it should also be noted that some evidence suggests that it may be plausible for most of the DSM-5 criteria for non-substance dependence disorders to

quantify food addiction (Table 2). This is consistent with the behavioural addiction perspective of some researchers^(3,29). The plausibility of an eating addiction should be examined more closely in future studies.

Secondly, the current review of the literature also questions whether food addiction and eating disorders overlap or are distinct phenomena. After comparing the YFAS-derived criteria for food addiction and the criteria for eating disorders (see Table 3), food addiction and eating disorders seem to share several criteria, but do not

completely overlap^(3,31,32,52). Thus, the evidence to date may suggest that they may be distinct phenomena. Specifically, Table 3 shows that the criteria for the two eating disorders BED and BN correspond more closely to the criteria for food addiction, than do the criteria for anorexia nervosa. However, there are also fundamental differences between eating disorders and food addiction, such as the presence of compensatory behaviours in BN but not in BED or food addiction⁽⁶⁵⁾. Thus, eating disorders and food addiction may share similar traits but are not congruent. Further research is necessary to clarify ambiguities among food addiction and eating disorders. For example, applying research domain criteria⁽⁷⁶⁾ is necessary to examine if food addiction demonstrates key genetic, behavioural and physiological differences from each eating disorder variant in positive and negative valence systems, cognitive systems, social processes, arousal and regulatory systems, and sensorimotor systems domains. Establishing such differences would greatly inform a more precise definition of food addiction that may also contribute to an improved prevention and therapy options.

Conclusion

Addictive-like eating may manifest through repeated consumption of highly palatable, highly processed complex foods, typically containing high amounts of energy, sugar and fat. Evidence exists for this specific pattern of eating to be characterised as behavioural or substance dependence. While the evidence supporting a food addiction concept dominates the literature, it is currently premature to draw definitive conclusions for a better fit of the substance use disorder concept (food addiction, see Table 1) or the behavioural addiction concept (eating addiction, see Table 2). Superficial evidence suggests that food addiction may be associated with overweight and obesity, but causal inferences have not been established to date. Additionally, food addiction does not seem to match with the established eating disorders (see Table 3). Rather food addiction may represent a distinct pattern of disordered eating or a subtype of an already existing eating disorder, such as BED. Prevention and therapy concepts relevant to obesity and eating disorders may be able to be extended to food addiction. Specifically, such interventions guided by the addiction model of food and eating behaviour may offer novel, more individualised treatment approaches^(17,77). Future studies with clear definitions and classifications of food addiction and eating addiction, as well as similarities and differences between food addiction and eating disorders are needed.

Limitations

This review has summarised the current understanding of food addiction. However, this review is limited by several factors. First, the extant research is largely cross-sectional and therefore no aetiology of food addiction may be evidenced. Secondly, little evidence exists to

suggest appropriate and effective treatment techniques specific to food addiction. This further confuses the delineation of food addiction from other established disorders, such as BN and/or BED. Thirdly, the lack of scientifically established and agreed upon diagnostic criteria severely limits the ability of existing studies to provide adequate comparisons and insights into the phenomenon of food addiction. Finally, historical records are lacking to indicate the potential role of culture and/or the changing patterns of food processing and modern food production in the aetiology of food addiction. Further research and clinical work are needed to identify causal factors, treatment approaches and psychological, physical and social impacts of individuals with food addiction.

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Conflicts of Interest

None.

Authorship

C. H., B. C. and T. E. wrote and approved the manuscript. It is a summary of an invited presentation of C. H. to the International Early Research Championship in the Nutrition Society Winter Meeting 2018.

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