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SYSTEMATIC REVIEW ARTICLE

Systematic Review of Food Addiction as Measured with the Yale Food Addiction Scale: Implications for the Food Addiction Construct

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Abstract: ***Background*:** The concept of food addiction attracts much interest in the scientific community. Research is mainly based on the Yale Food Addiction Scale (YFAS), a tool developed to assess food addiction. Substance use disorder criteria have been used to develop this scale.

***Objective*:** The aim of this paper was to review the clinical significance of food addiction diagnoses made with the YFAS and to discuss the results in light of the current debate on behavioral addictions.

***Methods*:** We performed a systematic review of the studies that assessed food addiction with the YFAS published between January 2014 and July 2017 by searching the electronic databases PsycINFO, MEDLINE, and PsycARTICLES.

***Results*:** Sixty publications were included in the analysis. Thirty-three studies examined nonclinical samples and 27 examined clinical samples. All studies used YFAS scoring results to define food addiction. The prevalence of food addiction according to the YFAS varied largely by the studied samples. In general, a higher body mass index and the presence of eating disorders (EDs), especially binge eating disorder (BED), were associated with higher YFAS scores.

***Conclusion*:** The concept of food addiction has not been established to this day although it can be grouped with other EDs such as BED. More research is needed to understand this behavior and the differences between food addiction and other EDs. The criteria for food addiction should be revisited in light of the concepts currently used to examine behavioral addictions.

Keywords: Addictive disorders, behavioral addiction, binge eating disorder, eating disorders, food addiction, obesity, yale food addiction scale, YFAS.

1. INTRODUCTION

Obesity and eating disorders (EDs) such as binge eating disorder (BED) are an important health concern in our society. Possible similarities between overeating and substance use disorder (SUD) have been discussed for decades, with the first mention of the term "food addiction" given by Theron Randolph in 1956 [1]. In the last 3 years, in the midst of important debates related to behavioral addictions, numerous articles have been published on this topic [2].

The concept of food addiction (FA) was introduced to describe patterns of specific eating behaviors and excessive consumption based on the hypothesis of similarities between such patterns and addictive behaviors [3].

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The definition for FA proposed by Gearhardt *et al*. [3] emerged by mapping the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) diagnostic criteria for substance dependence to eating behaviors [4]. These include tolerance, withdrawal symptoms, larger amounts consumed than intended, persistent desire or unsuccessful attempts to cut down, much time spent using or recovering from a substance, continual use despite knowledge of consequences, and activities given up due to use of a substance. As in the case of substance use disorder, the presence of 3 of 7 symptoms has been suggested as necessary to define FA, as well as to show clinically significant impairment or distress (Table **1**). To date, FA is not a clinically recognized disorder, but it has been suggested that addictive-like consumption of processed, hyper-palatable, and energy-dense foods could influence weight gain and obesity [5].

The most commonly used and well-known tool to measure so-called FA is the Yale Food Addiction Scale (YFAS).

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Table 1. DSM-IV-TR substance dependence criteria.

1. Substance taken in larger amount and for longer period than intended
2. Persistent desire or repeated unsuccessful attempt to quit
3. Much time/activity to obtain, use, recover
4. Important social, occupational, or recreational activities given up or reduced
5. Use continues despite knowledge of adverse consequences (*e.g.*, failure to fulfill role obligation, use when physically hazardous)
6. Tolerance (marked increase in amount, marked decrease in effect)
7. Characteristic withdrawal symptoms; substance taken to relieve withdrawal
Presence of clinical impairment or significant distress

The first scale was developed in 2009 [3], consisting of a self-report questionnaire that examines eating behaviors during the past 12 months. The YFAS has good clinical validity [6] and has been translated into different languages. It also has good internal consistency, as well as convergent, discriminant, and incremental validity [3, 7]. Elevated scores on this scale have been linked to obesity, EDs, and binge eating [8]. Criteria for substance dependence according to the text revision of the DSM-IV (DSM-IV-TR [9] (Table **1**) were used to develop the items for the questionnaire in the YFAS (Table **2**) and adapted to consumption of high fat and sugar foods [3]. This means that the questions were formulated to specifically fit these criteria. However, following diagnostic changes in the fifth edition of the DSM (DSM-5) [10] that introduced measures for a continuum of severity and craving, a new version of the YFAS, the YFAS 2.0, was developed in 2016 that added these new criteria for SUD (Tables **2** and **3**). The YFAS has 25 questions that measure 7 SUD criteria and the YFAS 2.0 has 35 questions that measure 11 SUD criteria. A short form of each scale was also developed: the modified YFAS (mYFAS) in 2014 [11] and the mYFAS 2.0 in 2017 [12]. If clinical impairment or distress is not present, the "diagnosis" of FA is not retained in all scales even if other symptoms are present. Scoring is computed according to the explanations reported in Table **4**.

Several reviews have been published on FA. Prevalence varied between 16.2% [13] and 19.9% [14] and was higher in overweight patients [14] and patients seeking weight loss [13]. Burrows [13] found a relationship between the presence of FA and binge eating, as well as between FA and depression and anxiety. Another review examined FA in patients seeking bariatric surgery [15]. The prevalence for this group of patients ranged from 14% to 57.8%. The presence of presurgical FA seems not to be associated with presurgical weight or postsurgical weight outcomes, yet presurgical FA was related to broad levels of psychopathology.

Most reviews assessed the published papers in relation to the results obtained with the YFAS in different populations. However, they did not explore the pertinence of the YFAS for the assessment of so-called FA. In the same way as the developers of the YFAS, other authors used the recommended cut-off of the YFAS to measure the existence of FA in different groups. Possible limitations of such reviews are that the conclusions were based on results of studies without assessment of the meaning of FA. For example, prevalence rates were drawn from the number of persons reaching a given cut-off. However, cut-offs were based on experts' consensus on the number of symptoms. The pertinence of the YFAS symptom count for the assessment of so-called FA was not explored.

The present paper is an attempt to explore the significance of the studies that used the YFAS in relation to the concept of FA. We discuss the results in light of the current debate on behavioral addictions. Due to recent changes in the field (introduction of the YFAS 2.0, the mYFAS, and the DSM-5, as well as the behavioral addiction debate), we focus on the three most recent years (2014-2017).

2. METHODS

A systematic literature review was undertaken in accordance with the guidelines outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [16] (Table **7**).

2.1. Search strategy

The electronic databases PsycINFO, MEDLINE, and PsycARTICLES were searched for empirical studies published between January 2014 and July 2017. The following keywords were used: ("yale food addiction scale" OR "YFAS") AND ("food addiction" OR "behavioral addiction" OR "behavioral addiction" OR "eating behavior" OR "eating behavior" OR "obesity" OR "food" OR "eat" OR "feeding behavior" OR "feeding behavior" OR "food preferences" OR "food habits" OR "body mass index" OR "overeating" OR "hyperphagia" OR "substance-related disorders" OR "binge eating" OR "hedonic eating").

2.2. Screen for Eligibility

The titles and abstracts of the studies from the initial search results were screened by two reviewers (LP and YK) independently. After excluding duplicates, articles deemed relevant were downloaded and LP and YK screened the full texts independently to determine eligibility. Articles that were dismissed by only one of the reviewers were downloaded together with articles deemed relevant by both reviewers. Eligibility criteria consisted of (1) adult participants over the age of 18 years and (2) the YFAS used to measure

Table 2. Substance use disorder criteria paired with YFAS questions.

Substance use Disorder Criteria (DSM-IV and DSM-5)	YFAS - # Questions in Red in mYFAS	YFAS 2.0 - Questions in Red in mYFAS 2.0
Loss of control	1. I find that when I start eating certain foods, I end up eating much more than planned. 2. I find myself continuing to consume certain foods even though I am no longer hungry. 3. I eat to the point where I feel physically ill.	1. When I started to eat certain foods, I ate much more than planned. 2. I continued to eat certain foods even though I was no longer hungry. 3. I ate to the point where I felt physically ill.
Persistent desire or repeated unsuccessful attempts to cut down	4. Not eating certain types of food or cutting down on certain types of food is something I worry about. 22. I want to cut down or stop eating certain kinds of food. 24. I have been successful at cutting down or not eating these kinds of food. 25. How many times in the past year did you try to cut down or stop eating certain foods altogether?	4. I worried a lot about cutting down on certain types of food, but I ate them anyway. 25. I really wanted to cut down on or stop eating certain kinds of foods, but I just couldn't. 31. I tried to cut down on or not eat certain kinds of food, but I wasn't successful. 32. I tried and failed to cut down on or stop eating certain foods.
Much time spent to obtain, use, recover	5. I spend a lot of time feeling sluggish or fatigued from overeating. 6. I find myself constantly eating certain foods throughout the day. 7. I find that when certain foods are not available, I will go out of my way to obtain them. For example, I will drive to the store to purchase certain foods even though I have other options available to me at home.	5. I spent a lot of time feeling sluggish or tired from overeating. 6. I spent a lot of time eating certain foods throughout the day. 7. When certain foods were not available, I went out of my way to get them. For example, I went to the store to get certain foods even though I had other things to eat at home.
Important activities given up	8. There have been times when I consumed certain foods so often or in such large quantities that I started to eat food instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy. 9. There have been times when I consumed certain foods so often or in such large quantities that I spent time dealing with negative feelings from overeating instead of working, spending time with my family or friends, or engaging in other important activities or recreational activities I enjoy. 10. There have been times when I avoided professional or social situations where certain foods were available because I was afraid I would overeat. 11. There have been times when I avoided professional or social situations because I was not able to consume certain foods there.	8. I ate certain foods so often or in such large amounts that I stopped doing other important things. These things may have been working or spending time with family or friends. 10. I avoided work, school, or social activities because I was afraid I would overeat there. 18. I felt so bad about overeating that I didn't do other important things. These things may have been working or spending time with family or friends. 20. I avoided work, school, or social functions because I could not eat certain foods there.
Use despite knowledge of adverse consequences	19. I kept consuming the same types of food or the same amount of food even though I was having emotional and/or physical problems.	22. I kept eating in the same way even though my eating caused emotional problems 23. I kept eating the same way even though my eating caused physical problems
Tolerance	20. Over time, I have found that I need to eat more and more to get the feeling I want, such as reduced negative emotions or increased pleasure. 21. I have found that eating the same amount of food does not reduce my negative emotions or increase pleasurable feelings the way it used to.	24. Eating the same amount of food did not give me as much enjoyment as it used to. 26. I needed to eat more and more to get the feelings I wanted from eating. This included reducing negative emotions like sadness or increasing pleasure.
Withdrawal symptoms	12. I have had withdrawal symptoms such as agitation, anxiety, or other physical symptoms when I cut down or stopped eating certain foods. (Please do NOT include withdrawal symptoms caused by cutting down on caffeinated beverages such as soda pop, coffee, tea, energy drinks, *etc*.) 13. I have consumed certain foods to prevent feelings of anxiety, agitation, or other physical symptoms that were developing. (Please do NOT include consumption of caffeinated beverages such as soda pop, coffee, tea, energy drinks, *etc*.) 14. I have found that I have elevated desire for or urges to consume certain foods when I cut down or stop eating them.	11. When I cut down on or stopped eating certain foods, I felt irritable, nervous, or sad. 12. If I had physical symptoms because I hadn't eaten certain foods, I would eat those foods to feel better. 13. If I had emotional problems because I hadn't eaten certain foods, I would eat those foods to feel better. 14. When I cut down on or stopped eating certain foods, I had physical symptoms. For example, I had headaches or fatigue. 15. When I cut down or stopped eating certain foods, I had strong cravings for them.

(Table 2) contd….

Substance use Disorder Criteria (DSM-IV and DSM-5)	YFAS - # Questions in Red in mYFAS	YFAS 2.0 - Questions in Red in mYFAS 2.0
Continued use despite social or interpersonal problems	-	9. I had problems with my family or friends because of how much I overate. 21. I avoided social situations because people wouldn't approve of how much I ate. 35. My friends or family were worried about how much I overate.
Impaired daily functioning (work, school, home)	-	19. My overeating got in the way of me taking care of my family or doing household chores. 27. I didn't do well at work or school because I was eating too much.
Use in physically hazardous situations	-	28. I kept eating certain foods even though I knew it was physically dangerous. For example, I kept eating sweets even though I had diabetes. Or I kept eating fatty foods despite having heart disease. 33. I was so distracted by eating that I could have been hurt (*e.g.*, when driving a car, crossing the street, operating machinery). 34. I was so distracted by thinking about food that I could have been hurt (*e.g.*, when driving a car, crossing the street, operating machinery).
Craving	-	29. I had such strong urges to eat certain foods that I couldn't think of anything else. 30. I had such intense cravings for certain foods that I felt like I had to eat them right away.
Clinically significant impairment	15. My behavior with respect to food and eating causes significant distress. 16. I experience significant problems in my ability to function effectively (daily routine, job/school, social activities, family activities, health difficulties) because of food and eating.	16. My eating behavior caused me a lot of distress. 17. I had significant problems in my life because of food and eating. These may have been problems with my daily routine, work, school, friends, family, or health.
Questions not scored and not classed (primer questions)	17. My food consumption has caused significant psychological problems such as depression, anxiety, self-loathing, or guilt. 18. My food consumption has caused significant physical problems or made a physical problem worse. 23. I have tried to cut down or stop eating certain kinds of food.	-

Abbreviations: YFAS – Yale Food Addiction Scale; DSM-IV and DSM-5 – *Diagnostic and Statistical Manual of Mental Disorders,* 4th and 5th editions; YFAS 2.0 – Yale Food Addiction Scale Version 2.0; mYFAS – modified Yale Food Addiction Scale; mYFAS 2.0 – modified Yale Food Addiction Scale Version 2.0; ED – eating disorder; FA – food addiction.

Table 3. DSM-5 substance-related and addictive disorders.

1. Taking the substance in larger amounts or for longer than you're meant to
2. Wanting to cut down or stop using the substance but not managing to
3. Spending a lot of time getting, using, or recovering from use of the substance
4. Cravings and urges to use the substance
5. Not managing to do what you should at work, home, or school because of substance use
6. Continuing to use, even when it causes problems in relationships
7. Giving up important social, occupational, or recreational activities because of substance use
8. Using substances again and again, even when it puts you in danger
9. Continuing to use, even when you know you have a physical or psychological problem that could have been caused or made worse by the substance
10. Needing more of the substance to get the effect you want (tolerance)
11. Development of withdrawal symptoms, which can be relieved by taking more of the substance
Presence of clinical impairment or significant distress

Table 4. YFAS scoring guidelines.

The scoring of YFAS is continuous for the first 16 questions with measures 0 to 4 (0 – never, 1 – once per month, 2 – two or three times per month, 3 – two or three times per week, 4 – four or more times per week). Questions 17 to 25 are answered yes or no.
In YFAS 2.0, all 35 questions are continuous with measures 0 to 7 (0 – never, 1 – less than monthly, 2 – once per month, 3 – two or three times per month, 4 – once per week, 5 – two to three times per week, 6 – four to six times per week, 7 – every day).
Different cut-offs for each question:
Each criterion for SUD has several questions. If one question is positive, the criterion is rated as met and scored as 1. In YFAS, yes-no questions are scored 1 or 0.
Clinical impairment or distress is not added to this symptom count but must be present in all cases. If this is not present, the criteria for food addiction is not met even if other symptoms are present.
For diagnosis with YFAS, the symptom count must be ≥3 out of 7 food addiction criteria and show clinical impairment or distress.
For assessment with YFAS 2.0, the symptom count must be ≥2 out of 11 food addiction criteria and show clinical impairment or distress. (2-3 symptoms count as mild, 4-5 symptoms as moderate, and 6 or more as severe food addiction)

Abbreviations: YFAS – Yale Food Addiction Scale; YFAS 2.0 – Yale Food Addiction Scale Version 2.0; SUD – substance use disorder.

FA symptoms. Any discrepancies between reviewers concerning manuscript eligibility were resolved after a full analysis of the paper and discussion between the two reviewers.

2.3. Data Extraction and Summary

Data from the selected studies were tabulated in the following format: author and publication year, country, type of study, number of subjects, recruitment type, target population, inclusion criteria, participant characteristics, outcome measures, prevalence of FA, number of YFAS symptoms, YFAS outcomes in association with other variables, conclusions, and limitations. The extracted data were summarized by using a narrative approach.

3. RESULTS

3.1. Study Selection

The initial search yielded more than 189 publications. After eliminating duplicates, we screened 140 remaining papers, 10 of which were excluded because they did not treat the topic of FA. After applying the eligibility criteria to these 130 papers, we retained 60 in the final review. The most common reasons for exclusion were that the papers were review articles (Fig. **1**).

3.2. Study Methods and Scale Used

Most of the studies were cross-sectional without controls, but six were cross-sectional case-control studies [17-22]. Most studies used the older version of the YFAS, seven used the YFAS 2.0 [6, 12, 23-26], and three used the shorter mYFAS, which has only nine questions [11, 27, 28]. Nine studies aimed to validate the YFAS [6, 12, 17, 19, 24, 29-32], and two used it to validate another eating scale: the Obsessive Compulsive Eating Scale [33] and the Weight Efficacy Lifestyle Scale [34].

The Italian studies used an Italian version of the YFAS that included 16 questions instead of 25 [19, 30, 35-37]. Although this version is shorter, it includes a question on each FA criterion, as in the YFAS. This scale's validity has been tested [19]. We do not discuss this scale in detail in this analysis.

The studies all used auto-questionnaires. Half of the studies were done online or on paper without an interviewer present, and the other half were done in clinics or laboratories.

3.3. Included Samples

Thirty-three studies examined nonclinical samples (27 used the YFAS and 6 used the YFAS 2.0) and 27 (one of which used the YFAS 2.0) examined clinical samples. Among the clinical studies, 11 analyzed patients who were seeking bariatric surgery [17, 29, 34, 38-45], one of which used the YFAS 2.0 [29]. One study included a nonclinical control sample [17], and one study included a follow-up examination [45]. Nine studies evaluated overweight or obese patients; all but two of these studies [46, 47] included patients who were in weight-loss programs [19, 27, 30, 35, 36, 48, 49]. Three of these studies examined women only [27, 36, 46], one of which used the YFAS 2.0 [23]. Overall, 18 studies that used the original YFAS and 2 that used the YFAS 2.0 analyzed overweight or obese patients.

In four studies, only patients with EDs were analyzed [50], three of which included only women [20, 51, 52]. One study examined men with heroin addiction [18] and another patients with type 2 diabetes [53]. One study included only patients with schizophrenia who were mainly being treated with clozapine or quetiapine [54].

More studies investigated female-only samples [11, 46, 51, 55-58] (three groups used the same National Health Service cohort of female participants: Flint *et al*. [14], Cornelis *et al*. [56], Mason *et al*. [57]) than male-only samples [18, 59]. A large number of studies (15) examined young participants (students or young adults) [22, 24, 26, 28, 29, 32, 33, 46, 55, 60-65], two of these using the YFAS 2.0 [24, 29].

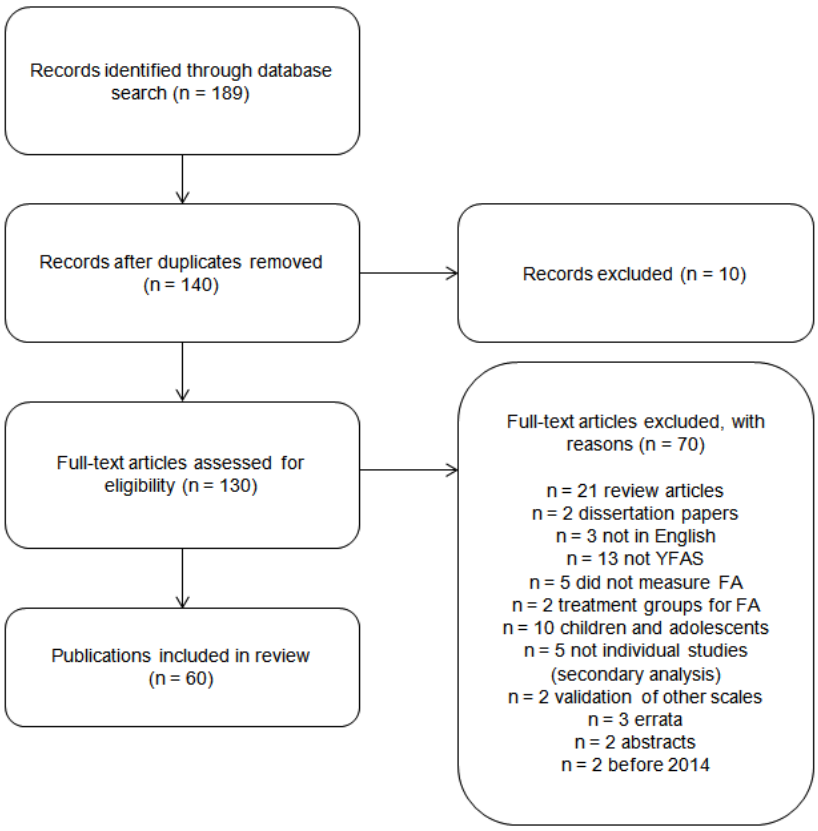

Fig. (1). Flowchart for study selection. YFAS – Yale Food Addiction Scale; FA – Food addiction.

3.4. Definition of FA

All studies used the YFAS or YFAS 2.0 scoring results (Table **4**) to define FA. The criteria for FA were determined by a consensus of experts from the substance dependence criteria in the DSM-IV [3, 9]. For the YFAS 2.0, following diagnostic changes in the DSM-5 [10], measures for a continuum of severity and craving were added. For an FA diagnosis to be retained, individuals had to show clinical impairment or distress.

One-third of the articles reported the percentages of different symptoms measured on the scale, which varied between analyses. As Pursey *et al*. and Burrows *et al*. found, the highest scored symptom was generally unsuccessful attempts to cut down [13, 14]. Tolerance and use despite knowledge of adverse consequences were also frequent, followed by activities given up and withdrawal symptoms.

3.5. Reported Prevalence of FA

Most studies (26) were done in the United States [6, 11, 12, 26, 27, 32, 38, 41, 42, 45, 47-49, 56-59; 63, 66-72], 3 of which used the YFAS 2.0 [6, 12, 26].

For studies that used the original YFAS, the prevalence of FA was as follows. In nonclinical samples, the reported prevalence of FA, according to the criteria defined in Table **4**, ranged from 0% to 25.7%. In the clinical samples, the prevalence ranged from 6.7% to 100% (100% was a sample of patients with bulimia nervosa [BN]). Most studies on patients with ED analyzed for this review were conducted in clinics in Spain, with the prevalence of FA varying from 72.3% to 90.6%.

For studies that used the YFAS 2.0, the prevalence of FA was as follows. In nonclinical samples, the reported prevalence of FA, according to the criteria defined in Table **4**, ranged from 8.2% to 22.2%. In the clinical prebariatric surgery sample, the prevalence was 47.4% (23). The YFAS 2.0 allows a continuum of severity. The studies that used this measure found mild FA (2 or 3 symptoms) in 0.7% to 1.7% in nonclinical populations, moderate FA (4 or 5 symptoms) in 1.8% to 4.2%, and severe FA (6 or more symptoms) in 6.6% to 18.9%.

Two studies done in the United States showed differences in race: Berenson *et al*. found higher YFAS scores in black women than in Hispanic women [56] and Carr *et al*. reported higher YFAS 2.0 scores in black persons than in white [26]. More analyses were done with female-only samples, but in studies with both sexes, one using the YFAS 2.0 showed a link between FA and female gender [25], and one reported that women had more YFAS symptoms than did men [26]. In addition, gay and bisexual men showed more YFAS symptoms than did heterosexual men [59].

3.6. Association with Body Mass Index (BMI)

Other measures taken simultaneously with the YFAS varied widely. The BMI was most frequently recorded by using self-reported data to calculate the score. The number of YFAS symptoms were positively associated with BMI in a

majority (10) of the studies that used the original YFAS [11, 23, 29, 53, 57, 62, 63, 66, 68-70, 73] and in 2 studies that used the YFAS 2.0 [23, 29]. Only three studies did not find this correlation [30, 47, 56], although one [47] analyzed an obese sample. One study found that the YFAS symptom score was associated with a higher visceral fat level [46].

3.7. Association with Comorbid EDs

EDs were assessed in 12 studies that used the original YFAS [17, 20, 43-45, 50-52; 59, 69, 70, 72] and in 4 that used the YFAS 2.0 [6, 12, 24, 29]. In two studies, a link was shown more frequently than in other studies between FA and BN, as well as between FA and BED (Table **5**) [20, 70]. In several studies, a higher YFAS symptom score was associated with higher binge eating scores or binge eating days [31, 35, 38, 41, 69] and in 2 studies [24, 29], a higher YFAS 2.0 score was associated with the same. Interestingly, FA symptoms according to the YFAS were less frequent after treatment of BN. Hilker *et al*. [52] reported that FA symptoms according to the YFAS improved following a 6-week psychoeducational treatment program. Meule *et al*. [51] showed that patients with remitted BN (last episode at least 3 months ago) had a lower prevalence of FA symptoms according to the YFAS after being treated in a specialized center for ED.

Numerous studies included patients who were receiving bariatric surgery. In these patients, the prevalence of FA according to the YFAS reduced after surgery. Sevinçer *et al*. [40] showed a reduction in the prevalence of FA from 57.8% before surgery to 7.2% at 6-month follow-up after the intervention and 13.7% at 12-month follow-up. The weight loss did not differ in patients with or without FA after surgery. Pepino *et al*. [42] reported that 93% of patients with FA did not present the criteria after bariatric surgery. These results should be interpreted with caution, as the follow-up was short [15]. The prevalence of FA in prebariatric surgery samples seemed to differ across studies between the United States (14-36%) and Europe (21-57.8%).

3.8. Association with Scales Related to EDs

BED was commonly measured, with 11 studies [19, 24, 27, 29-31, 33, 35, 37, 39, 65] using the Binge Eating Scale or assessing binge days, 2 of which used the YFAS 2.0 [24, 29]. A higher YFAS 2.0 symptom score was associated with higher binge eating scores or binge eating days [24, 29]. The Three-Factor Eating Questionnaire, which measures restraint, disinhibition, and hunger, was administered in 3 studies that used the original YFAS [6, 12, 22, 24, 65, 66] and in 3 that used the YFAS 2.0 [6, 12, 24] and was generally but not always positively associated with YFAS scores. Eight studies used an emotional eating or emotional regulation scale [24, 27, 30, 37, 41, 44, 45, 72] one of which used the YFAS 2.0 [24]. Persons with higher YFAS scores showed more difficulties in emotional regulation in one analysis [37] and had higher emotional eating scores in two studies [41, 42]. Higher YFAS scores were associated with the experience of higher levels of craving in four studies [42, 43, 66, 69]. Higher night eating scores were also found in persons with higher YFAS scores [67].

Two studies reported high reward sensitivity associated with FA as diagnosed by YFAS scores [50, 55]. One study found that these individuals showed a more hedonic response to food [71].

3.9. Comorbid Psychiatric Disorders

Depression and/or anxiety was measured in 13 studies [25, 28, 34, 36, 39, 41, 43, 51, 53, 55, 56, 62, 67]. Higher YFAS scores were linked to more depressive symptoms in five analyses [25, 31, 38, 43, 56]. Persons who scored higher on the YFAS were found to have higher anxiety scores in

Table 5. Binge eating disorder (DSM-5).

Criterion 1	Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following: 1. Eating, in a discrete period of time (*e.g*., within any 2-hour period), an amount of food that is definitely larger than most people would eat in a similar period of time under similar circumstances 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)
Criterion 2	Binge-eating episodes are associated with three (or more) of the following: 1. Eating much more rapidly than normal 2. Eating until feeling uncomfortably full 3. Eating large amounts of food when not feeling physically hungry 4. Eating alone because of being embarrassed by how much one is eating 5. Feeling disgusted with oneself, depressed, or very guilty after overeating
Criterion 3	Marked distress regarding binge eating is present
Criterion 4	The binge eating occurs, on average, at least 1 day a week for 3 months (DSM-5 frequency and duration criteria)
Criterion 5	The binge eating is not associated with the regular use of inappropriate compensatory behavior (*e.g*., purging, fasting, excessive exercise) and does not occur exclusively during the course of anorexia nervosa or bulimia nervosa

Abbreviations: DSM-5 – Diagnostic and Statistical Manual of Mental Disorders, 5th edition.

two studies [25, 38]. One study found a higher prevalence of FA according to the YFAS in patients with symptoms of post-traumatic stress disorder [58].

3.10. Craving

Food craving was analyzed in eight studies [29, 33, 42, 47, 64, 69], one of which used the YFAS 2.0 [29], and higher scores were found in individuals with positive results for FA according to the YFAS. One article [64] reported that individuals with lower inhibitory performance to food pictures had higher food craving scores.

3.11. Impulsiveness

Impulsiveness was examined in 11 studies [18, 29, 30, 33, 43, 50, 53, 55, 63, 64, 68], one of which used the YFAS 2.0 [29], by administering the Barratt Impulsiveness Scale or the UPPS-P Impulsivity Scale. Three studies [50, 63, 68] reported correlations between impulsivity on the UPPS-P Impulsivity Scale and higher rates of negative urgency in patients with FA as diagnosed by the YFAS. Four studies [53], one of which used the YFAS 2.0 [29], found correlations between impulsiveness measured with the Barratt Impulsiveness Scale and the YFAS score. Two studies [29, 43] found that higher YFAS symptoms and a diagnosis of FA were correlated with higher attentional impulsivity scores. One of these studies used the YFAS 2.0 [29] and one [43] included presurgery patients. Raymond and Lovell [53] reported a strong correlation between FA and non-planning impulsivity.

4. DISCUSSION

Sixty publications that examined FA with the YFAS were included in our analysis. Thirty-three studies examined nonclinical samples and 27 examined clinical samples. Prevalence rates of FA varied by clinical and nonclinical population, as well by country. In general, a higher symptom score was associated with a higher BMI [11, 23, 29, 53, 57, 62, 63, 66, 68, 69, 70, 73].

The studies that analyzed FA used the YFAS symptom score as a cut-off to define FA in groups of patients, as intended by the authors of the YFAS. Most studies used the YFAS scores, however, without providing information on scoring, with only about one-third of the studies explaining the scoring of the different criteria of the YFAS. Symptoms varied in these studies, but the most common was the inability to cut down or stop eating for studies that used the original YFAS. The YFAS 2.0 allows a continuum of severity and therefore different prevalence rates. It allows detection of mild FA, and, interestingly, severe FA with 6 or more symptoms is the most prevalent with rates between 6.6%and 18.9% in nonclinical populations. Most studies, however, use the predefined cut-off and do not further assess the pertinence of the YFAS symptom count for the assessment of so-called FA.

The studies that examined BED symptoms found a positive correlation between the number of BED symptoms, binge eating days, and higher YFAS scores [19, 24, 27, 29-31, 33, 35, 37, 39, 65]. Examination of the criteria of FA

Table 6. Criteria for food addiction according to YFAS paired with binge eating criteria.

FA Criteria According to YFAS Questions	Binge Eating Criteria
Loss of control	The 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)
Persistent desire or repeated unsuccessful attempts to cut down	-
Much time spent to obtain, use, recover	-
Important activities given up	-
Use despite knowledge of adverse consequences	Eating until feeling uncomfortably full Feeling disgusted with oneself, depressed, or very guilty after overeating
Tolerance	Eating, in a discrete period of time (*e.g.*, within any 2-hour period), an amount of food that is definitely larger than most people would eat in a similar period of time under similar circumstances Eating much more rapidly than normal Eating large amounts of food when not feeling physically hungry
Withdrawal symptoms	-
Continued use despite social or interpersonal problems	Eating alone because of being embarrassed by how much one is eating
Impaired daily functioning (work, school, home)	-
Use in physically hazardous situations	-
Craving	-
Clinically significant impairment	Marked distress regarding binge eating is present

Abbreviations: YFAS – Yale Food Addiction Scale; FA – food addiction.

Table 7. PRISMA-checklist.

PRISMA-IPD Section/Topic	Item No.	Checklist Item	Reported on Page
Title			
Title	1	Identify the report as a systematic review and meta-analysis of individual participant data.	p. 1
Abstract			
Structured summary	2	Provide a structured summary including as applicable: **Background:** state research question and main objectives, with information on participants, interventions, comparators and outcomes. **Methods:** report eligibility criteria; data sources including dates of last bibliographic search or elicitation, noting that IPD were sought; methods of assessing risk of bias. **Results:** provide number and type of studies and participants identified and number (%) obtained; summary effect estimates for main outcomes (benefits and harms) with confidence intervals and measures of statistical heterogeneity. Describe the direction and size of summary effects in terms meaningful to those who would put findings into practice. **Discussion:** state main strengths and limitations of the evidence, general interpretation of the results and any important implications. **Other:** report primary funding source, registration number and registry name for the systematic review and IPD meta-analysis.	p. 1
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known.	p. 2-3
Objectives	4	Provide an explicit statement of the questions being addressed with reference, as applicable, to participants, interventions, comparisons, outcomes and study design (PICOS). Include any hypotheses that relate to particular types of participant-level subgroups.	p. 3
Methods			
Protocol and registration	5	Indicate if a protocol exists and where it can be accessed. If available, provide registration information including registration number and registry name. Provide publication details, if applicable.	
Eligibility criteria	6	Specify inclusion and exclusion criteria including those relating to participants, interventions, comparisons, outcomes, study design and characteristics (*e.g.* years when conducted, required minimum follow-up). Note whether these were applied at the study or individual level *i.e.* whether eligible participants were included (and ineligible participants excluded) from a study that included a wider population than specified by the review inclusion criteria. The rationale for criteria should be stated.	p. 11
Identifying studies - information sources	7	Describe all methods of identifying published and unpublished studies including, as applicable: which bibliographic databases were searched with dates of coverage; details of any hand searching including of conference proceedings; use of study registers and agency or company databases; contact with the original research team and experts in the field; open adverts and surveys. Give the date of last search or elicitation.	p. 11
Identifying studies - search	8	Present the full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	p. 11
Study selection processes	9	State the process for determining which studies were eligible for inclusion.	
Data collection processes	10	Describe how IPD were requested, collected and managed, including any processes for querying and confirming data with investigators. If IPD were not sought from any eligible study, the reason for this should be stated (for each such study). If applicable, describe how any studies for which IPD were not available were dealt with. This should include whether, how and what aggregate data were sought or extracted from study reports and publications (such as extracting data independently in duplicate) and any processes for obtaining and confirming these data with investigators.	p. 11
Data items	11	Describe how the information and variables to be collected were chosen. List and define all study level and participant level data that were sought, including baseline and follow-up information. If applicable, describe methods of standardising or translating variables within the IPD datasets to ensure common scales or measurements across studies.	
IPD integrity	A1	Describe what aspects of IPD were subject to data checking (such as sequence generation, data consistency and completeness, baseline imbalance) and how this was done.	
Risk of bias assessment in individual studies.	12	Describe methods used to assess risk of bias in the individual studies and whether this was applied separately for each outcome. If applicable, describe how findings of IPD checking were used to inform the assessment. Report if and how risk of bias assessment was used in any data synthesis.	
Specification of outcomes and effect measures	13	State all treatment comparisons of interests. State all outcomes addressed and define them in detail. State whether they were pre-specified for the review and, if applicable, whether they were primary/main or secondary/additional outcomes. Give the principal measures of effect (such as risk ratio, hazard ratio, difference in means) used for each outcome.	p. 11
Synthesis methods	14	Describe the meta-analysis methods used to synthesise IPD. Specify any statistical methods and models used. Issues should include (but are not restricted to): · Use of a one-stage or two-stage approach. · How effect estimates were generated separately within each study and combined across studies (where applicable). · Specification of one-stage models (where applicable) including how clustering of patients within studies was accounted for. · Use of fixed or random effects models and any other model assumptions, such as proportional hazards. · How (summary) survival curves were generated (where applicable). · Methods for quantifying statistical heterogeneity (such as I2 and t2). · How studies providing IPD and not providing IPD were analysed together (where applicable). · How missing data within the IPD were dealt with (where applicable).	
Exploration of variation in effects	A2	If applicable, describe any methods used to explore variation in effects by study or participant level characteristics (such as estimation of interactions between effect and covariates). State all participant-level characteristics that were analysed as potential effect modifiers, and whether these were pre-specified.	
Risk of bias across studies	15	Specify any assessment of risk of bias relating to the accumulated body of evidence, including any pertaining to not obtaining IPD for particular studies, outcomes or other variables.	
Additional analyses	16	Describe methods of any additional analyses, including sensitivity analyses. State which of these were pre-specified.	

(Table 7) contd….

PRISMA-IPD Section/Topic	Item No.	Checklist Item	Reported on Page
Results			
Study selection and IPD obtained	17	Give numbers of studies screened, assessed for eligibility, and included in the systematic review with reasons for exclusions at each stage. Indicate the number of studies and participants for which IPD were sought and for which IPD were obtained. For those studies where IPD were not available, give the numbers of studies and participants for which aggregate data were available. Report reasons for non-availability of IPD. Include a flow diagram.	p. 11-12
Study characteristics	18	For each study, present information on key study and participant characteristics (such as description of interventions, numbers of participants, demographic data, unavailability of outcomes, funding source, and if applicable duration of follow-up). Provide (main) citations for each study. Where applicable, also report similar study characteristics for any studies not providing IPD.	
IPD integrity	A3	Report any important issues identified in checking IPD or state that there were none.	
Risk of bias within studies	19	Present data on risk of bias assessments. If applicable, describe whether data checking led to the up-weighting or down-weighting of these assessments. Consider how any potential bias impacts on the robustness of meta-analysis conclusions.	
Results of individual studies	20	For each comparison and for each main outcome (benefit or harm), for each individual study report the number of eligible participants for which data were obtained and show simple summary data for each intervention group (including, where applicable, the number of events), effect estimates and confidence intervals. These may be tabulated or included on a forest plot.	
Results of syntheses	21	Present summary effects for each meta-analysis undertaken, including confidence intervals and measures of statistical heterogeneity. State whether the analysis was pre-specified, and report the numbers of studies and participants and, where applicable, the number of events on which it is based. When exploring variation in effects due to patient or study characteristics, present summary interaction estimates for each characteristic examined, including confidence intervals and measures of statistical heterogeneity. State whether the analysis was pre-specified. State whether any interaction is consistent across trials. Provide a description of the direction and size of effect in terms meaningful to those who would put findings into practice.	
Risk of bias across studies	22	Present results of any assessment of risk of bias relating to the accumulated body of evidence, including any pertaining to the availability and representativeness of available studies, outcomes or other variables.	
Additional analyses	23	Give results of any additional analyses (*e.g.* sensitivity analyses). If applicable, this should also include any analyses that incorporate aggregate data for studies that do not have IPD. If applicable, summarise the main meta-analysis results following the inclusion or exclusion of studies for which IPD were not available.	
Discussion			
Summary of evidence	24	Summarise the main findings, including the strength of evidence for each main outcome.	p. 16-17
Strengths and limitations	25	Discuss any important strengths and limitations of the evidence including the benefits of access to IPD and any limitations arising from IPD that were not available.	p. 17-18
Conclusions	26	Provide a general interpretation of the findings in the context of other evidence.	p. 17-18
Implications	A4	Consider relevance to key groups (such as policy makers, service providers and service users). Consider implications for future research.	p. 17-18
Funding Funding	27	Describe sources of funding and other support (such as supply of IPD), and the role in the systematic review of those providing such support.	p. 18

according to the YFAS and BED shows that there are some similarities (Table **6**). However, higher YFAS scores were able to predict weight above and beyond BED [6]. Craving was also often correlated with higher scores [29, 33, 42, 47, 64, 69]. Some studies paired the different items on other ED scales with the YFAS symptom count. However, none gave information on the association of each YFAS question with items measured on other scales. This omission is problematic, as most researchers are applying the criteria based on SUD to define FA by using a confirmatory approach.

With caution, the authors hypothesize that there may be some limitations related to the YFAS item formulation and some items may need to be interpreted differently. This needs to be investigated in further studies.

The questions used to measure the items taken from SUDs on the YFAS and the newer YFAS 2.0 are partly subjective and socially influenced (Table **2**). For example, the question "I avoided social situations because people wouldn't approve of how much I ate" is strongly influenced by society's view on eating behavior and obesity. The question "I worried a lot about cutting down on certain types of food, but I ate them anyways" can be considered as cognitive restraint and is a symptom of ED such as anorexia nervosa and BN. We examined each questionnaire topic, considering the differences between the YFAS and the YFAS 2.0, to determine whether the symptom that the scale intends to measure was assessed with the questions asked (Table **2**).

Some groups are more likely to be influenced by social standards about which kind of behavior is expected when considering nutrition and health. Typically, women are often more preoccupied with these topics and are more likely to feel guilty about their eating behaviors. More of the studies in this review were done with female populations (patients and students) than with male populations, which is likely to influence FA prevalence rates. An example of this possibility is that people who self-perceive themselves as having FA have higher rates of FA scores on the YFAS [61]. The endorsement of FA might influence the scale [22].

In one study, patients with schizophrenia who were taking clozapine, which is known to induce weight gain as a secondary effect, had a higher prevalence of FA according to the YFAS [54]. Again, in this case, the only difference ought to be a higher appetite and this is not specifically measured by the YFAS. Perhaps this means that the scale is biased when given to people with a stronger appetite and modification of satiety, without this necessarily being FA.

One of the main limitations of the presented studies is that the bias arising from self-report of questionnaires used in the individual studies limits the findings of this review. The data presented in the studies provide information on the prevalence of YFAS scores in different groups. As the studies use a predefined cut-off and as we do not have sufficient information we cannot form conclusions about the clinical significance of FA diagnoses made by using only the YFAS.

We suggest more research is needed in this field and suggest examining the psychological processes of pathological eating from the perspective of behavioral addictions. Kardefelt-Winther *et al*. [74] suggested focusing on two components when defining behavioral addictions: (a) significant functional impairment or distress as a direct consequence of the behavior and (b) persistence over time. Significant functional impairment and distress is a criterion in the YFAS. Like persistence over time, it is also a symptom in BED and other EDs. In order not to pathologize common behavior, it is important to use the exclusion criteria suggested to ensure the behavior is not due to other factors. These exclusion criteria are as follows: (a) The behavior is not explained by an underlying disorder (depression, *etc*.), (b) the functional impairment does not result from willful choice, and (c) the behavior is not a temporary coping strategy [75]. Not using exclusion criteria when analyzing FA, as was the case for various studies in this review, is one potential criticism of their design. The behaviors were not examined in depth and instead the YFAS criteria were used to define and measure FA. It will also be important to add assessments of other psychological measures such as impulsivity that some studies, but not all, analyzed. For example, structured interviews would be helpful to study other factors, as would other statistical analyses such as item response theory [76].

This review followed a strict systematic search protocol; however, it is not without limitations. Because strict eligibility criteria were applied in selecting relevant treatment studies, such as focusing on the last 3 years, they, therefore, represent only a sample of published studies on FA. The risk of bias in the individual studies was not assessed separately and this limits the findings of this review. Study populations were predominately female and overweight, limiting the generalizability of findings. More representative samples are needed to better understand the impact of FA symptoms in the general population.

CONCLUSION

The YFAS is a widely used evaluation tool in different populations, most often for patients with obesity who are searching for bariatric surgery. The prevalence of FA varies largely according to the population studied, which shows that it is dependent on sample recruitment methods. There is a clear association between elevated YFAS scores and ED, especially BED.

Rather than using the cut-off criteria of the YFAS, further studies should assess the individual items of the scale to examine the underlying mechanisms of this behavior from a clinical perspective. Analysis of behavioral addictions, as described earlier, could be helpful for establishing criteria to differentiate FA from other EDs.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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