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REVIEW

Prevalence of food addiction determined by the Yale Food Addiction Scale and associated factors: A systematic review with meta-analysis

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Abstract

Objective: To determine, through a systematic review with meta-analysis, the prevalence of food addiction (FA) using the Yale Food Addiction Scale (YFAS) and its derivatives exploring possible factors associated with the prevalence of FA in several contexts.

Methods: The following databases were searched: MEDLINE, ScienceDirect, LILACS, PsycArticles, CENTRAL, Greylit.org, and OpenGrey.eu. Studies that assessed FA using YFAS were included. Two independent reviewers assessed the eligibility of each report. Random-effects meta-analysis was performed to calculate the weighted prevalence of FA. Subgroup analyses and meta-regression were conducted to explore sources of heterogeneity.

Results: Of the 6425 abstracts reviewed, 272 studies were included. The weighted mean prevalence of FA diagnosis was 20% (95% CI: 18%; 21%). The prevalence of FA was higher in individuals with clinical diagnosis of binge eating (55%; 95% CI 34%; 75%). The prevalence in clinical samples was higher compared to non-clinical samples. Two studies included children only and no studies included only elderly people.

Conclusions: Food addiction is a topic in which there has been a significant growth in studies. The highest prevalence was found in the group of

Abbreviations: ADHD, attention-deficit hyperactivity disorder; BED, binge eating disorder; BMI, body mass index; BN, bulimia nervosa; CAPES, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior; CENTRAL, Cochrane Central Register of Controlled Trials; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders IV; DSM-V, Diagnostic and Statistical Manual of Mental Disorders V; dYFAS-C 2.0, dimensional Yale Food Addiction Scale for Children 2.0; ED, eating disorders; FA, food addiction; LILACS, Latin American and Caribbean Health Sciences Literature; mYFAS 2.0, Modified Yale Food Addiction Scale 2.0; mYFAS, modified Yale Food Addiction Scale; mYFAS-C, modified Yale Food Addiction Scale for Children and Adolescents; NA, Not applicable; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement; RTI-IB, Research Triangle Institute Item Bank; RYGB, Roux-en-Y Gastric Bypass; SD, standard deviation; SG, Sleeve Gastrectomy; USA, United States of America; WD, weight disorders; YFAS 2.0, Yale Food Addiction Scale 2.0; YFAS, Yale Food Addiction Scale; YFAS-C, Yale Food Addiction Scale for Children and Adolescents.

participants with eating disorders and weight disorders. More studies with children and the elderly are needed.

KEYWORDS
addiction, compulsive eating, YFAS

Highlights

- There was an exponential increase in the number of scientific publications related to food addiction.
- The overall prevalence of food addiction was 20%.
- The highest prevalence of food addiction was found in the group with a clinical diagnosis of binge eating.
- Studies conducted in clinical settings in general also showed high prevalence of food addiction.

1 | INTRODUCTION

Food addiction (FA) has been a topic that has attracted the interest of the scientific community in recent years. There has been an exponential increase in the number of scientific publications related to this topic since 2010 (Figure 1). It is believed that much of the research in this area is motivated by concerns about the worldwide increase in obesity (Gordon et al., 2018) and by the need to understand eating habits disturbances, such as eating disorders (ED) (Wiss et al., 2018). The increased interest in FA was driven in part by the increase in neuroimaging studies and further elucidation that both obesity and binge eating were associated with changes in dopaminergic signaling and that some specific foods stimulated hyperactivation of brain areas related to reward systems, a process comparable to that observed in drug users (Tang et al., 2012). These findings were further complemented by studies with animal models that showed addiction-like behaviours and neuronal changes in rodents with intermittent access to sugar (Ahmed et al., 2013).

There are strong arguments that discuss the relationship between drug addiction and FA, since are commonly involved with reward behaviour. In the case of FA this situation happens when, even after the needs for food are met and regardless of the physical consequences and negative psychological effects arising from uncontrolled food intake, the individual continue to eat (Marks, 1990; Schulte & Gearhardt, 2018). It is believed that this addiction-like behaviour may explain the relative failure of clinical behavioural therapies for weight loss, based on energy restriction and physical exercise, which induce an average weight loss of 2 kg in 2 years in primary care (Booth et al., 2014). In addition, other implications are related to FA such as a higher prevalence of depressive and anxiety symptoms (Burrows, Skinner, et al., 2017; Gearhardt et al., 2009; Meule & Gearhardt, 2014), increased visceral adiposity and links to ED such as binge eating disorder (BED) and bulimia nervosa (BN) (Burrows et al., 2018; Burrows, Hides, et al., 2017; Meule & Gearhardt, 2014), substance use disorders (Canan et al., 2017), as well as a worse quality of life (Minhas et al., 2021; Nunes-Neto et al., 2018; Zhao et al., 2018) and increased impulsivity (Minhas et al., 2021).

Given the complex nature of FA, for a long-time its measurement had been carried out using instruments that assess several isolated aspects related to addiction, such as craving, compulsion, reward, and others (Pursey et al., 2014). Only in 2009, with the advent of the Yale Food Addiction Scale (YFAS), which takes into account the items proposed by the Diagnostic and Statistical Manual of Mental Disorders 4 (DSM-IV) the construct 'food addiction' began to be studied as a whole (Gearhardt et al., 2009). Currently, YFAS has been the main tool for assessing FA, with versions validated for adults, children and adolescents in several languages.

The YFAS contains 25 items and uses two types of classification, one that provides a food addiction symptom score from 0 to 7 and the other that proposes a 'diagnosis' of FA, given to those participants who have 3 or more symptoms and satisfy the criterion of clinical impairment, in line with that proposed by the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV (Gearhardt et al., 2012). In 2014, a short version of the YFAS was developed and validated for faster evaluation in epidemiological studies (Flint et al., 2014). The modified Yale Food Addiction Scale (mYFAS) is composed of 9 items and follows the same rating system as the original YFAS. Years later, with the new version of the DSM-V, the YFAS and mYFAS were updated to ensure that the

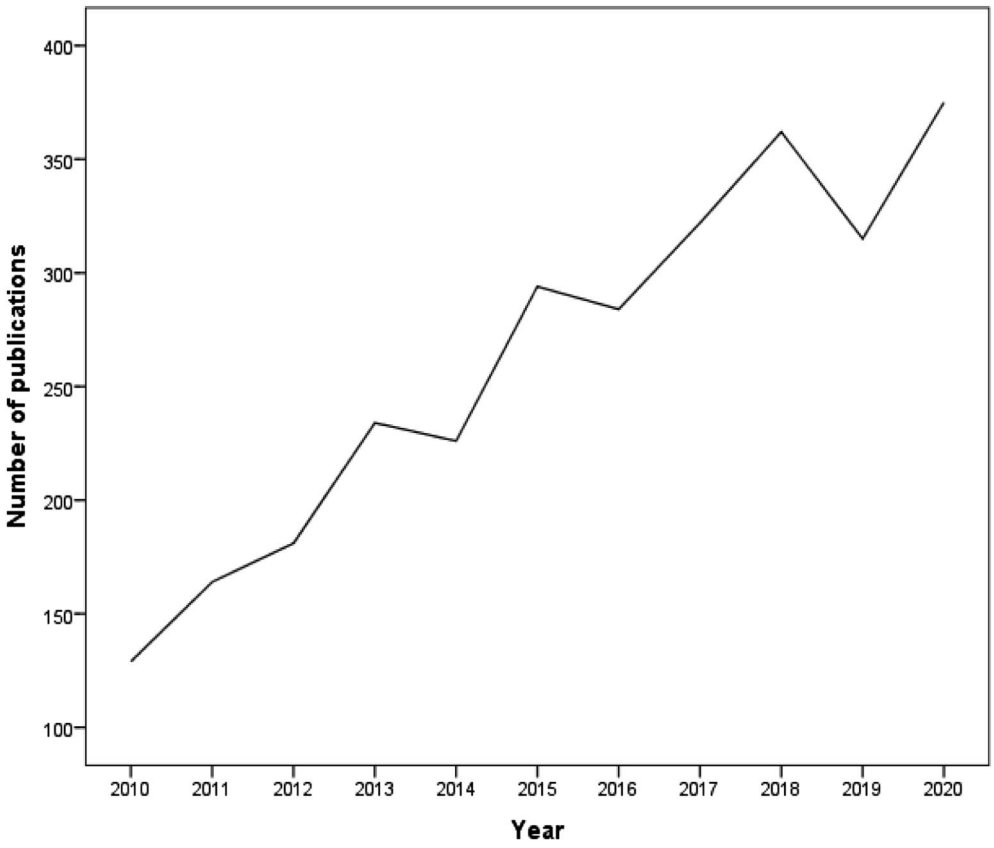

FIGURE 1 Number of scientific publications on food addiction in the years 2010–2020. Values represent the number of hits based on a Web of Science search conducted for each year separately, using the search term 'food addiction'

construct contemplates the changes, giving rise to the Yale Food Addiction Scale 2.0 (YFAS 2.0) with 35 items and the modified Yale Food Addiction Scale (mYFAS 2.0) with 11 items (Gearhardt et al., 2016; Schulte & Gearhardt, 2017). Likewise, the Yale Food Addiction Scale for Children and Adolescents (YFAS-C) was developed to assess food addiction among paediatric populations (Gearhardt et al., 2013).

In 2014, a systematic review noted that the average prevalence of FA measured by the YFAS was around 20%, ranging from 5% to 57% and this diagnosis affected more women, individuals older than 35 years, and clinical samples (i.e., those who are seeking some type of medical/professional assistance) (Pursey et al., 2014). However, with the explosive increase over the years in the number of studies evaluating FA using YFAS, in several contexts, and around the globe, no systematic review has been proposed to comprehensively assess this topic since the publication of Pursey et al. (2014). The most current systematic reviews are aimed at specific population groups (Skinner et al., 2021; Yekaninejad et al., 2021), specific clinical contexts (Burrows et al., 2018; Leary et al., 2021), with data from only one of the YFAS versions (Oliveira et al., 2021) or just intended to explore the construct of FA (Penzenstadler et al., 2019). Thus, this study aims to determine, through a systematic review with meta-analysis, the prevalence of FA using the YFAS and its derivatives exploring possible factors associated with the prevalence of FA in several contexts.

2 | METHODS

This meta-analysis is reported according to the items of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) (Moher et al., 2009). A protocol was previously published in the PROSPERO database (https://www.crd.york.ac.uk/prospero/), under registration protocol CRD42020193902.

2.1 | Search strategy

Searches were performed in the following electronic bibliographic databases: MEDLINE, ScienceDirect, Latin American and Caribbean Health Sciences Literature (LILACS), PsycArticles, and Cochrane Central Register of Controlled Trials (CENTRAL). Likewise, the following

grey literature databases were included: Greylit.org and OpenGrey.eu. Furthermore, the reference lists of the articles included in the full-text reading were also analyzed to select the articles that were not retrieved by the search strategy. The search strategy included terms related to the outcome (food addiction) and was adapted for each electronic database. There was a date restriction (2008–2021), from the year the first YFAS version was validated to the current year, and there was no language restriction. A final search was performed before the final analysis to identify new studies with potential for inclusion in this review. In all databases, the following keywords were used: 'Food addiction'; 'Eating Addiction'; 'Yale Food Addiction Scale' and 'YFAS' separated by the Boolean operator 'OR'. The last search in the databases was carried out on 19 October 2021.

2.2 | Eligibility criteria

Cross-sectional studies, cohorts, and clinical trials conducted with all populations, regardless of age group, clinical condition, or another related variable, were included. The use of any of the versions of the YFAS (YFAS, YFAS 2.0, dYFAS-C 2.0 mYFAS, mYFAS 2.0, YFAS-C, mYFAS-C) was the primary inclusion criteria, as well as the presentation of the scale's results. Duplicate publications of included studies were excluded.

2.3 | Data extraction

Three authors who had access to the authors and titles of the journals independently evaluated the titles and abstracts of the retrieved articles. DRP and AESJ were the researchers responsible for reading all records, independently. Furthermore, four junior researchers (ADS, KSC, LN and MLM) read a quarter of all titles and abstracts each. Hence, at least three researchers, being the two responsible researchers (DRP and AESJ) and one of the four junior researchers, read all the titles and abstracts. Disagreements were solved by asking a senior researcher (NBB). This schematization was repeated in the bias risk assessment. Full-text versions of potentially eligible articles were retrieved for further evaluation.

The software Mendeley v 1.19.5 (Elsevier, Netherlands) was used to aid in the management of the references and extract the data of interest from the included studies. The primary outcome sought in the studies was the prevalence of the diagnosis of FA, according to YFAS. The following variables were collected as secondary outcomes: type of study, the country in which it was conducted, whether it was a validation study, the presence or not of clinical conditions/comorbidities, age group of the sample, sex, weight status of the sample, study population, whether the collection of the study data was face-to-face or online, the YFAS version used, the scoring method for YFAS, and, if any, the prevalence of BN, anorexia nervosa (AN), BED, and depression. For intervention studies, data from the baseline moment were considered for extraction. Data were extracted by the review authors independently and differences were resolved in consensus with a senior researcher (NBB).

Studies were stratified into the following subgroups: country, sex, age group of the sample, data collection (face-to-face or online), studies with university students, with bariatric surgery patients, risk of bias assessment, YFAS version used, and according to the clinical status of the sample (clinical or non-clinical sample). Studies were characterized as having a clinical sample when the sample was recruited in specific settings with the aid to treat a clinical condition (such as self-help groups) and/or was looking for some medical/professional help. Studies with non-clinical sample were those studies conducted in the general population. We also stratified studies by the eating and weight disorders characteristics of the sample. Regarding weight disorders (WD), studies were classified as samples without WD, with overweight, and with obesity. Regarding ED, studies were stratified into a group without ED and groups with ED according to the diagnosis method. If the sample was already under treatment in a specialized health center for the ED, it was considered a 'clinical diagnosis'. On the other hand, if the study used scales and questionnaires to assess ED of the sample, it was considered as 'non-clinical diagnosis'. We stratified the ED studies in the following subgroups: anorexia (non-clinical diagnosis); anorexia (clinical diagnosis); bulimia (non-clinical diagnosis); bulimia (clinical diagnosis); binge eating (non-clinical diagnosis); binge eating (clinical diagnosis). All necessary information was extracted from published articles, protocols, and comments related to each study.

2.4 | Bias risk assessment

Risk of bias assessment was performed with all included studies. Three authors independently assessed the areas of potential risk of bias in each study using the Research Triangle Institute Item Bank (RTI-IB) (Viswanathan & Berkman, 2012), since most studies in this review are from observational nature. The RTI-IB tool was developed to identify sources of distortion and confusion in observational studies, providing a comprehensive list of 29 questions covering a variety of bias categories.

Assesses trends in selection, performance, detection and attrition, confusion, selective reporting of results, and overall quality of a study. This procedure aims to classify how confident the study is (low, medium, or high) about the proximity between the observed effect and the true effect. The score for each study was calculated by dividing the number of items completed by the number of applicable items and further classified with the following cutoff point: 0–0.40 high risk of bias; 0.41–0.70 medium risk of bias and 0.71–1.00 low risk of bias.

2.5 | Data analysis

Data analysis was based on a quantitative study of the variables. Stata v.12 software (StataCorp) was used for this investigation, through the metaprop command (Nyaga et al., 2014), with a DerSimonian and Laird random-effects model using the Freeman–Tukey transformation to stabilize variances. The data analyzed were the prevalence found through the YFAS versions in the different studies. Studies that did not report an overall prevalence of FA in the sample were excluded from the quantitative analysis. The weighted prevalence of FA was calculated for all studies at once and in several subgroups within the clinical and methodological characteristics of the included studies. Metaregression analyses were conducted to explore the differences in FA prevalence in the subgroups, using the metareg command in Stata.

3 | RESULTS

At total, 6425 records were identified by database searching. After removing duplicate references and further evaluation with the previously defined inclusion criteria, 429 full texts were selected for evaluation. One hundred fifty-three were excluded after analysis of the full text for the following reasons: YFAS results not shown ($n = 36$), YFAS use not reported ($n = 3$), no YFAS prevalence ($n = 65$) and repeated results ($n = 49$). Thus, 272 full texts were included for qualitative analysis and quantitative analysis (Table S1). Figure 2 contains the flowchart that illustrates the search and selection of studies.

A total of 269,050 participants were evaluated in the studies. Studies included predominantly females, with 21 studies using an exclusively female sample. Table 1 presents a summary of the total number of studies stratified into categories according to type of scale used; characteristics of the included sample, type of collection and risk of bias. The specific characteristics of each study are described in Table S1.

The results of the critical assessment of the risk of bias of each included studies are described in Table S2. One hundred seventy of the 272 studies were considered as low risk of bias, 93 studies were considered as moderate risk of bias, nine studies were considered as high risk of bias. For studies with high risk, the most frequent biases were selection bias, confusion, and general quality. Overall, they presented problems around the clarity of the inclusion/exclusion criteria and they lacked reporting details on the tools used to measure exposures.

Two hundred and seventy-two studies were included in a meta-analysis (Table 2). The prevalence of FA among the studies ranged from 1.11% to 94.7%. Thirty-five of the 272 studies had a prevalence ≥50%. The pooled prevalence in all studies was 20% (95% CI: 18%; 21%, $I^2 = 98.46\%$). Furthermore, the prevalence of FA stratified by subgroups are shown in Table 2. The highest prevalence was seen in the subgroup of studies with binge eating clinical diagnosis (55%, 95% CI: 35%; 75%; $I^2 = 95.49\%$). The subgroup of studies that used mYFAS 2.0 had a prevalence three times higher than those that used mYFAS (18%, 95% CI: 9%; 23%; $I^2 = 99.15\%$). Furthermore, the subgroup of studies that used mYFAS exhibited the lowest prevalence in this review (7%, 95% CI: 6%; 8%; $I^2 = 86.83\%$). The YFAS version subgroup also showed different prevalences in studies that used YFAS 2.0 (21%, 95% CI: 18%; 23%; $I^2 = 97.83\%$) and in studies with YFAS (24%, 95% CI: 21%; 28%; $I^2 = 97.92\%$). Also noteworthy are the differences found in studies between age groups, in which the subgroup of studies with adults had the highest prevalence (24%, 95% CI: 20%; 29%; $I^2 = 98.59\%$).

Table 3 shows the metaregression analysis. There were significant differences between the subgroups of studies with clinical versus non-clinical samples ($p < 0.001$), between studies with samples with weight disorders versus without weight disorders ($p = 0.001$) and between studies with samples with eating versus without eating disorders ($p = 0.004$). Although the prevalence of FA in studies that used YFAS 2.0 scale was higher than that of studies that used the YFAS scale, this difference was not significant in the metaregression analysis ($p = 0.26$). The analysis also revealed no differences among studies with different age group in the samples. At last, the difference in the prevalence between studies that used mYFAS versus mYFAS 2.0 was significant in the main analysis ($p = 0.03$) and this difference remained significant even after including the covariates 'sample' ($p = 0.03$), 'WD' ($p = 0.04$), or 'ED' ($p = 0.02$) in the metaregression model. However, when including the 'age group' covariate in the metaregression model, the difference did not remain significant ($p = 0.16$).

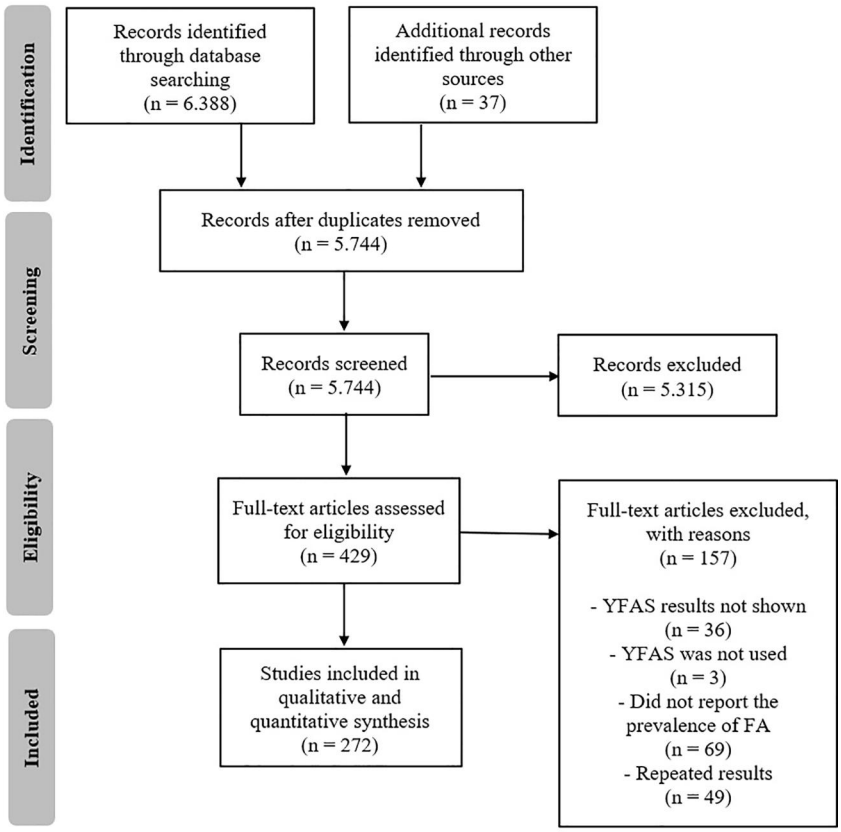

FIGURE 2 Flow diagram of studies included in the review

4 | DISCUSSION

This review systematically evaluated 272 studies that used YFAS and its derivatives to verify the prevalence of FA diagnosis in any population. The meta-analysis identified that the prevalence in samples with overweight and obese. All studies were meta-analyzed and the weighted prevalence for the diagnosis of FA was 20%. Individuals were 24% and 28%, respectively. The mean prevalence was higher in the meta-analysis carried out with studies in clinical samples, being more than double compared to non-clinical samples (31% and 14%, respectively). As for sex, the prevalence was higher for males (27%), however only two studies assessed only males. Furthermore, in populations with eating disorders, the highest prevalence of FA were among individuals with a clinical diagnosis of Anorexia (44%), Bulimia (48%) and Binge Eating (55%). It is noteworthy that the samples of the studies were predominantly composed by women. The risk of bias was low in 62% of the studies and this subgroup of studies had a lower prevalence of FA (19%) than the moderate/high risk of bias subgroup (21%).

Although this review contains a significant number of studies, the overall prevalence of FA was similar to that found by Pursey et al. (2014), who reported a prevalence of 19% evaluating 20 studies. The prevalence of FA observed here (20%) was slightly higher than the prevalence of tobacco and alcohol use, which are 19.2% and 18.2%, respectively (World Health Organization, 2019a, 2019b). Even when considering the prevalence of FA in non-clinical samples (14%) found in our analysis, it is still similar to the prevalence of the use of these substances. This indicates that FA is as prevalent as common addictions, such as alcohol and tobacco. It is noteworthy that the prevalence of FA in non-clinical samples was higher than the worldwide prevalence of obesity (13%) (World Health Organization, 2021) and much higher than the lifetime prevalence of ED (0.91%) (Qian et al., 2021). Thus, the prevalence of FA has been higher in the general population than the prevalence of obesity and ED, and although all these clinical conditions are associated with a pattern of excessive food consumption, FA may be characterized as a distinct clinical phenomenon.

The prevalence of FA in children and adolescents, which ranged from 13% to 18%, was much higher than the overall prevalence of BED in this age group, which ranges from 1.32% to 3% for subclinical BED (Kjeldbjerg & Clausen, 2021). Among the different age groups evaluated in our study, it is possible to observe a progression in the prevalence of FA according to age, with a

TABLE 1 Summary of characteristics of selected studies ($n = 272$)

	N	%
YFAS version		
YFAS	158	58.08
YFAS 2.0	70	25.73
YFAS-C	20	7.35
mYFAS version		
mYFAS	11	4.04
mYFAS 2.0	15	5.51
mYFAS-C 2.0	01	0.36
Clinical conditions		
Anorexia	21	7.72
Bulimia	32	11.76
Binge eating	08	2.94
Depression	07	2.57
Bariatric surgery	38	13.97
Overweight	41	15.07
Obesity	57	20.95
Malnutrition	01	0.36
Insomnia	02	0.73
Heart disease	01	0.36
Diabetes	06	2.20
Chemical dependency	03	1.10
Gambling disorder	01	0.36
Pre-menopausal	02	0.73
Bipolar disorder	01	0.36
Nomophobia	01	0.36
Schizophrenic	01	0.36
ADHD	01	0.36
Age group		
Children	4	1.47
Children and adolescent	4	1.47
Adolescent	20	7.35
Adolescent and adult	86	31.61
Adult	41	15.07
Adult and elderly	22	8.08
Type of collection		
Face-to-face	219	80.51
Online	53	19.48
Risk of bias assessment		
Low	170	62.50
Moderate/high	102	37.50

Abbreviations: ADHD, Attention-deficit Hyperactivity Disorder; mYFAS 2.0, Modified Yale Food Addiction Scale 2.0; mYFAS, Modified Yale Food Addiction Scale; mYFAS-C 2.0, Modified Yale Food Addiction Scale for Children; YFAS 2.0, Yale Food Addiction Scale 2.0; YFAS, Yale Food Addiction Scale; YFAS-C, Yale Food Addiction Scale for Children.

reduction only in the prevalence of the group of studies that included the elderly. However, after performing meta-regression analysis with this subgroup, there was no statistical significance in the age factor. Still, it is noteworthy the growing prevalence among age groups. The genesis of FA may be related to the repetition of the pattern of eating hyperpalatable foods that lead to neurobehavioral adaptations that favour the increase in the reward associated with this food profile and, consequently, favour the development of FA (Ulrich-Lai et al., 2015; Yau & Potenza, 2013). Considering the importance of repeating this eating pattern for neurobehavioral adaptations, the increasingly early introduction of hyperpalatable and/or ultra-processed foods in children's diets can be an important factor in the development of FA, and could be associated with the progressive increase in FA observed from the youngest to the oldest age groups. Few studies have reported the diagnosis of FA in children and exclusively in the elderly, so the results for these age groups should be interpreted with caution.

Individuals with clinically diagnosed eating disorders were been shown to have a higher prevalence of FA compared to non-clinical samples and this difference was significant in the meta-regression analysis. It is plausible that high prevalence in some eating disorders subgroups (particularly AN) may be increased by the occurrence of false positives for FA, as assessed by the YFAS. One possibility is that individuals with restrictive eating disorders, like AN, may subjectively interpret their eating behaviour to be excessive despite eating very little food. The phenomena of subjective binge eating episodes (where individuals subjectively report losing control of their eating despite not consuming an objectively large amount of food) is well-documented in eating disorders and subjective binge eating episodes are still associated with more severe pathology and worse treatment outcomes (Brownstone & Bardone-Cone, 2021). It is plausible that a subjective form of FA (i.e. still clinically relevant) may be occurring in some forms of eating disorders. The consequences of a dietary restriction, food

TABLE 2 Meta-analysis results on the prevalence of general food addiction, clinical and non-clinical sample, clinical conditions, gender, pandemic COVID-19, age group, YFAS version, type of collection and risk of bias ($n = 272$)

	Articles	*n*	*N*	Pooled prevalence	Lower 95% CI	Upper 95% CI	I^2
Total	272	25,879	256,936	20	18	21	98.46
Country/economic level							
Upper income country	220	24,116	212,432	20	18	22	98.35
Upper middle income country	40	3441	29,009	20	16	23	98.42
Low middle income country	9	612	3253	15	12	18	89.96
Sample							
Non-clinical	161	19,639	234,796	14	13	15	98.12
Clinical	111	6025	23,142	31	27	35	97.75
University student	55	11,862	174,034	11	10	13	97.33
Weight disorders							
No weight disorders	174	20,659	232,335	17	16	19	98.51
Overweight	41	2518	14,768	24	19	29	97.85
Obesity	58	3233	13,948	28	24	32	96.87
Bariatric surgery	39	2177	9605	28	24	32	94.90
Eating disorder							
Anorexia (non-clinical diagnosis)	10	788	7331	12	6	19	98.59
Anorexia (clinical diagnosis)	11	828	1965	44	26	62	98.57
Bulimia (non-clinical diagnosis)	14	1313	9353	16	09	25	99.17
Bulimia (clinical diagnosis)	18	1221	3070	48	35	62	98.20
Binge eating (non-clinical diagnosis)	3	199	1130	18	4	38	98.73
Binge eating (clinical diagnosis)	5	308	521	55	34	75	95.49
Sex							
Female	22	8791	138,554	24	16	34	98.87
Male	2	47	212	27	10	49	87.29
Both	247	16,600	114,394	19	18	21	98.06
Age group							
Children	4	160	1979	13	06	24	95.97
Children and adolescent	4	53	249	17	4	35	90.53
Adolescent	20	938	6191	18	14	23	94.23
Adolescent and adult	86	6903	51,395	20	17	23	98.46
Adult	42	10,039	147,175	24	20	29	98.59
Adult and elderly	20	1251	9759	17	12	22	97.88
YFAS version							
YFAS	158	9464	59,209	21	18	23	97.83
YFAS 2.0	71	5099	27,852	24	21	28	97.92
YFAS-C	20	862	9869	14	10	18	96.06
mYFAS version							
mYFAS	11	8624	145,963	7	6	8	86.83
mYFAS 2.0	15	1796	14,658	18	9	23	99.15

TABLE 2 (Continued)

	Articles	*n*	*N*	Pooled prevalence	Lower 95% CI	Upper 95% CI	I^2
Risk of bias assessment							
Low	171	11,756	77,660	19	17	21	97.76
Moderate/high	102	14,102	180,428	21	19	24	98.73

Note: The 'age group' subgroup did not include the 254 studies, as part of the studies did not inform the age group of the studied population.

Abbreviations: mYFAS 2.0, Modified Yale Food Addiction Scale 2.0; mYFAS, Modified Yale Food Addiction Scale; mYFAS-C 2.0, Modified Yale Food Addiction Scale for Children; YFAS 2.0, Yale Food Addiction Scale 2.0; YFAS, Yale Food Addiction Scale; YFAS-C, Yale Food Addiction Scale for Children.

TABLE 3 Meta-regression analysis using the subgroups

Variable	Coefficient	95% CI	*p*
Sample[a]	0.16	0.12 to 0.20	<0.001
Country/economic level	0.01	−0.02 to 0.06	0.34
Weight disorders[b]	0.05	0.02 to 0.07	0.001
Eating disorder[c]	0.06	0.01 to 0.10	0.004
Age group	0.02	−0.00 to 0.06	0.11
YFAS version	0.03	−0.02 to 0.08	0.26
mYFAS version	0.09	0.00 to 0.18	0.03

Abbreviations: CI, Confidence Interval; mYFAS, Modified Yale Food Addiction Scale; YFAS, Yale Food Addiction Scale.

[a]The sample subgroup was composed of non-clinical and clinical samples.

[b]The weigh disorders subgroup was composed of no weight disorders, overweight and obesity.

[c]The eating disorder subgroup was composed of no eating disorder, non-clinical diagnosis and clinical diagnosis.

insufficiency or some form of deprivation or negligence related to eating may also lead to false positives for FA (Wiss & Brewerton, 2020). Thus, future research on the factors underlying FA in ED samples is needed.

As for the YFAS version subgroup, there is a higher prevalence in studies using YFAS 2.0, but this difference was not significant in the metaregression analysis. This difference might be expected since the YFAS 2.0 threshold is lower and has a higher number of symptoms, in addition to the fact that YFAS meets the criteria proposed by the DSM-IV (Gearhardt et al., 2012), while YFAS 2.0 meets DSM-V criteria (Gearhardt et al., 2016).

Few studies used mYFAS and mYFAS 2.0. Unlike YFAS, mYFAS is composed of only 9 items following the DSM-IV (Flint et al., 2014) and mYFAS contains 11 items following the DSM-V changes (Schulte & Gearhardt, 2017). Comparing the prevalence of mYFAS (7%) and mYFAS 2.0 (18%), there is a significant difference in the metaregression analysis ($p = 0.02$). This difference is possibly due both to the divergences in the diagnostic criteria between the scales and to the presence of the study by Flint et al. (2014), which used mYFAS and presented a very large sample. Furthermore, this difference remained significant in models adjusted for 'sample', WD or ED, indicating that these characteristics of the included studies did not play a role in the different prevalence between studies that used mYFAS and mYFAS 2.0. However, in the model adjusted for the 'age group', this difference did not remained significant. Thus, the difference found may be due to the different populations found in the studies.

This review has some limitations and should be considered when interpreting the data. First, there is a limitation inherent to YFAS, in which it uses self-reported measures, which implies the subjectivity of the responses, which can compromise the results. However, YFAS has been validated in different relevant contexts and has been the main tool for assessing FA. The studies included in this review are predominantly cross-sectional, which prevents the establishment of cause-and-effect inferences. The small number of studies reporting YFAS data exclusively with children and the absence of studies only with the elderly compromised the analyzes in these age groups. Furthermore, the samples were predominantly female, limiting the generalizability of the results.

Food addiction is a topic in which there has been a significant growth in studies. The meta-analysis identified a high prevalence of FA in clinical samples and in individuals with obesity and overweight, however the highest prevalence of FA was found in participants with eating disorders. The populations included in the studies may not be representative of the general population, as they were predominantly female and because of their different clinical contexts. More research is needed on the assessment of FA in children and the elderly, and using the mYFAS versions.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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