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PREVALENCE OF FOOD ADDICTION AMONG PATIENTS UNDERGOING METABOLIC/BARIATRIC SURGERY: A SYSTEMATIC REVIEW AND META-ANALYSIS

ABSTRACT

Candidates for metabolic/bariatric surgery show a high prevalence of food addiction (FA). However, few studies have investigated FA prevalence after bariatric surgery, especially using longitudinal studies. This systematic review with a meta-analysis aimed to determine pre- and postoperative prevalence of FA among patients undergoing metabolic/bariatric surgery. It included both cross-sectional and longitudinal studies that used the Yale Food Addiction Scale (YFAS). The following databases were searched: MEDLINE, ScienceDirect, LILACS, PsycArticles, CENTRAL, greylit.org, and opengrey.eu. Studies that used the YFAS to evaluate FA in pre- or postoperative patients were included. A random-effects meta-analysis was performed with cross-sectional studies to calculate the weighted prevalence of FA at the pre- and postoperative moments. For longitudinal studies, which measured FA at both time points for the same individuals, absolute prevalence reduction (APR) was calculated. Of the 6,626 records, 40 studies were included in the meta-analysis. The preoperative weighted prevalence of FA was 32% (95% CI: 27–37%; 33 groups), while the postoperative prevalence was 15% (95% CI: 12–18%; 14 groups). Seven longitudinal studies showed a weighted APR of 26 p.p. (95% CI: 10–41 p.p.). Observational data

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suggest a reduction in the prevalence of FA among patients that undergo bariatric surgery. Interventional studies are needed to confirm these findings.

Keywords: Obesity; bariatric surgery; YFAS; food addiction

1. Introduction

Obesity is a complex and multifactorial disease and is currently considered a global public health problem that affects people of different ages and economic levels [1]. It is closely related to environmental factors, such as the high availability of energy-dense ultra-processed foods rich in sugars and fats [2-4], and is associated with an increased risk of morbidity and mortality and reduced life expectancy [1]. In addition, people with obesity may show a higher prevalence of mental health disorders, such as anxiety and depression [5,6] and disordered eating behaviors [7,8].

Bariatric surgery is the most effective treatment for weight loss in patients with severe obesity and associated comorbidities [9]. However, some patients who undergo these procedures may not experience satisfactory weight loss and may even present with weight regain [10,11], highlighting the need to understand the possible relationships that lead to these conditions in the postoperative period. With the growing interest in food addiction (FA), investigations of the relationships between bariatric surgery and addiction-like eating behaviors have also increased [12,13,14].

Although it is not formally recognized as a clinical condition, FA is defined as the excessive intake of highly processed, hyperpalatable, energy-dense foods with characteristics and effects similar to those of addictive substances [15]. FA is primarily assessed using the Yale Food Addiction Scale (YFAS), which applies the diagnostic criteria for substance use disorders to food intake [16]. Specifically, the YFAS identifies individuals with susceptibility to excessive consumption of ultra-processed and palatable foods that reflects addiction-like behaviors [17], such as loss of control over intake, intense cravings, continued use despite negative consequences, withdrawal, and tolerance. FA is higher in populations with obesity [18,19, 20] and among patients undergoing metabolic/bariatric surgery [21,13,22].

The validity of the concept of FA has been the target of intense discussions in the last decade [23]. Many argue that this and other concepts related to eating behavior and overeating investigated through questionnaires examine the same construct that could be defined as "uncontrolled eating" [24]. Furthermore, there is an overlap between FA and other eating disorders, such as overeating and binge eating [25]. However, some investigations suggest that half of the individuals demonstrating YFAS diagnostic criteria for FA do not present binge eating or bulimia nervosa [26]. Another important controversy refers to the diagnostic criteria for FA being intimately related to substance use disorders, since there is no known single agent/compound that acts through specific mechanisms of action to induce the disorder in susceptible individuals [27].

Despite these controversies, FA is a rapidly growing area of research, and the last systematic review that examined the prevalence of FA among patients undergoing metabolic/bariatric surgery was published in 2017 [28]. In addition, Koball et al. [13] discussed the possible effects of bariatric surgery on FA through a narrative review of the literature. They concluded that FA rates significantly decreased during the first postoperative year, and presurgical FA was not related to postsurgical weight outcomes during the first postoperative year [13]. However, neither review presented the overall prevalence of FA in the pre- and postoperative bariatric population. Considering the accelerated pace of publications on FA in the scientific literature [29], an update on the estimates is warranted. Hence, it is appropriate to systematically analyze how the YFAS has been applied to the bariatric population and what the possible effects of surgery are on the prevalence of FA. Thus, this systematic review aims to determine the pre- and postoperative prevalence of FA in studies that used the YFAS among patients undergoing metabolic/bariatric surgery.

2. Methods

This systematic review with a meta-analysis is part of a larger review that aims to assess the prevalence of FA in different contexts [29]. It is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline [30]. The protocol used in this study was previously published in the PROSPERO database (https://www.crd.york.ac.uk/prospero/) under the registration identification of CRD42020193902.

2.1 Eligibility criteria

Cross-sectional studies, cohorts, and clinical trials performed with preoperative and postoperative bariatric surgery populations were included, regardless of age group, clinical condition, or other related variables. Studies that used any of the versions of the YFAS (i.e., YFAS, YFAS 2.0, dYFAS-C 2.0, mYFAS, mYFAS 2.0, YFAS-C, and mYFAS-C) and reported the prevalence of FA were included. All versions of the YFAS apply diagnostic criteria for substance use disorders to the intake of ultra-processed and palatable foods, but the different iterations of the YFAS have been developed to provide updates on diagnostic criteria (YFAS vs YFAS 2.0), briefer versions (mYFAS and mYFAS 2.0), and developmentally appropriate measures for children/adolescents (YFAS-C, mYFAS-C, and dYFAS-C 2.0). Duplicate publications of studies were excluded.

2.2 Search strategy

The following electronic bibliographic databases were searched for appropriate studies: Medical Literature Analysis and Retrieval System Online (MEDLINE), ScienceDirect, Latin American and Caribbean Health Sciences Literature (LILACS), American Psychological Association (PsycArticles), and Cochrane Central Register of Controlled Trials (CENTRAL). Likewise, the following gray literature databases were included: Grey Literature Report (Greylit.org) and the System for Information on Grey Literature in Europe (opengrey.eu). In addition, the reference lists of articles included in the full-text reading were also analyzed to select items that were not retrieved by the search strategy.

The search strategy included terms related to the outcome (FA) and was adapted for each electronic database. The following keywords were used for searching all databases: "Food addiction," "Eating Addiction," "Yale Food Addiction Scale," and "YFAS," separated by the Boolean operator "OR". A date restriction (2008–2022), from the year of validation of the first version of YFAS to the current year, but no language restriction, was applied. Before the final analysis, a final search was performed to identify new studies for inclusion in this review. The last database search was conducted on March 27, 2022.

2.3 Identification and selection of studies

Mendeley v1.19.5® software (Elsevier, Netherlands) was used to help manage the references. Three authors (DRP, AESJ, and MLM) who had access to authors and journal titles independently assessed the titles and abstracts of the retrieved articles. Disagreements were resolved in consultation with a senior researcher (NBB). This schematization was repeated in the assessment of the risk of bias. Full-text versions of potentially eligible articles were retrieved for further evaluation.

2.4 Data extraction

The following variables were collected as exploratory variables: type of study, the country in which it was carried out, whether it was a validation study, presence or absence of clinical conditions/comorbidities, age group of the sample, gender, the time of surgery evaluated (preoperative, postoperatively, or both), type of surgery, the YFAS version used, the scoring method for YFAS, and the prevalence, if any, of bulimia, anorexia nervosa, binge eating, loss of eating control, and depression. Data were independently extracted by the review authors, and differences were resolved by consensus with a senior researcher (NBB). The necessary information was extracted from published articles, protocols, and comments related to each study.

2.5 Risk of bias assessment

A risk of bias assessment was performed for all the studies included in the meta-analysis. Three authors independently assessed the potential risk of bias in each study using the Research Triangle Institute Item Bank (RTI-IB) [31] since most of the studies in this review were observational. The RTI-IB tool was developed to identify sources of distortion and confounding in observational studies; it provides a comprehensive list of 29 questions covering a variety of categories of bias that assesses trends in selection, performance, detection, attrition, confounding, selective reporting of results, and overall study quality. This procedure was used to classify how confident the study was (low, medium, or high) about the proximity of observed effects to actual effects. The score for each study was calculated by dividing the number of completed items by the number of applicable items and later classified using the following cut-off points: 0–0.40 indicating high risk of bias; 0.41–0.70 indicating medium risk of bias, and 0.71–1.00 indicating low risk of bias.

2.6 Certainty of evidence

The quality of the evidence was analyzed using adaptations of the method proposed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) [32]. In the present analysis, this method was adapted for cross-sectional studies. The quality of evidence was classified into three categories—high, moderate, and low—based on criteria such as type of study, methodological limitations, inconsistent results, indirect evidence, imprecision, and publication bias. The quality of the evidence determined by the GRADE system allows the analysis of aggregated results by considering the design and results of the studies included and the pooled effect estimate obtained by the meta-analysis.

2.7 Data analysis

The "metaprop" command in Stata v.12 software (StataCorp, College Station, Texas) was used for the meta-analysis [33]. According to the YFAS, the primary outcome sought in the studies was the prevalence of FA. The weighted prevalence of FA was calculated separately for preoperative and postoperative studies. A DerSimonian and Laird random-effects model was used with the Freeman–Tukey transformation to stabilize variances. The data analyzed were prevalence evaluated in the other studies using different versions of the YFAS. Longitudinal studies that evaluated the pre- and postsurgery prevalence of FA in the same sample were analyzed in two ways: first, the pre- and postoperative FA prevalence found in these studies was included separately in each meta-analysis of pre- and postoperative studies; second, we analyzed the absolute prevalence reduction (APR) of FA in these longitudinal studies, considering the within-study variation in the FA prevalence data (i.e., the absolute difference in FA prevalence between each study's postoperative and preoperative moment, associated with its confidence interval). For the meta-analyses of the APR, we used the "metan" command with a DerSimonian and Laird random-effects model. Finally, meta-regression analysis was also performed to explore differences in the prevalence of FA between the pre- and postoperative groups, using the "metareg" command in Stata.

3. Results

3.1 Search results

A total of 6,626 records were identified through the search strategy. With the removal of duplicates and subsequent application of inclusion criteria, 43 studies were selected for full-text screening. After a complete reading, three articles were excluded for the following reasons: prevalence was not exclusive to the bariatric sample (n = 1); and repeated results from a study were already included (n = 2). Figure 1 shows a flowchart that illustrates the search and selection of studies.

3.2 Characteristics of the studies included in the analysis

Of the selected studies, 28 (68.3%) used the original YFAS to assess FA, 12 (29.3%) used YFAS 2.0, and 1 (2.4%) used mYFAS 2.0. No study used the iterations of the YFAS developed specifically for children. Tables 1, 2, and 3 show the general characteristics of the 40 articles, separated according to the time of data collection (preoperative, postoperative, or both). Twenty-six studies presented preoperative data (Table 1), seven studies presented postoperative data (Table 2), and seven studies performed a longitudinal analysis of both preoperative and postoperative data for the same sample (Table 3). One study evaluated a sample of women only, while the others evaluated both sexes, although the samples were primarily female.

The prevalence of FA among the 26 preoperative studies ranged from 6.3% to 69% (Table 1), while it ranged from 0% to 32% in the postoperative studies (Table 2). The APR of the seven prospective studies with preoperative and postoperative measurements of the same sample ranged from 1 p.p. to 59 p.p. (Table 3). Of the seven prospective studies, two evaluated the presence of FA at 24 months after surgery; the others evaluated it at six months (n = 1), nine months (n = 1), or 12 months (n = 3).

3.3 Risk of bias

The assessment of the risk of bias classified 17 studies as having a low risk of bias, 22 studies as having a moderate risk of bias, and only one study as having a high risk of bias. The most frequent biases in studies with high and moderate risk were selection bias and confounding. The individual classification of the studies is shown in Tables 1, 2, and 3.

3.4 Results of meta-analysis

Figure 2 shows the weighted prevalence of FA in the 33 groups evaluated preoperatively, involving the 26 studies that were evaluated exclusively at the preoperative moment and the seven longitudinal studies. The data set included 8,304 participants, of whom 2,074 presented a positive diagnosis for FA. A pooled FA prevalence of 32% (95% CI: 27–37%, I^2 = 95.22%) was found for the preoperative period.

In the case of the 14 groups of individuals with an evaluation at the postoperative moment (7 studies that exclusively measured FA at the postoperative moment and the seven longitudinal studies with measurements at both moments), the pooled FA prevalence was 15% (95% CI: 12–18%, $I^2 = 71.29\%$) (Figure 3). A total of 1,754 individuals were evaluated, with 272 positives for FA.

Finally, in the case of the only seven longitudinal studies with measures of FA at both moments for the same set of individuals, the prevalence of FA at the preoperative moment was 34% (95% CI: 20–50%), while it was 9% (95% CI: 6–13%) at the postoperative moment, leading to a weighted APR of 26 p.p. (95% CI: 10–41 p.p., $I^2 = 95.8\%$) (Figure 4).

3.5 Meta-regression

Meta-regression analysis performed for the prevalence between preoperative and postoperative groups showed a significant difference in FA ($\beta = -16\%$; 95% CI: -25% to -7%; $p = 0.001$).

3.6 Certainty of evidence

Considering the limitations of the studies included in this review and the inconsistencies in the results, the quality of the evidence was deemed to be very low (Table 4). This classification was based on two criteria: limitations of the studies (quality assessment) and inconsistency in results (heterogeneity). Only these criteria were used due to the inadequacy of the analysis of the traditional criteria "indirect evidence," "inaccuracy," and "publication bias," given the nature of the studies included in the meta-analysis.

4. Discussion

4.1 Summary of the results

The present study provides the results of a systematic review and meta-analysis of the prevalence of FA among individuals undergoing metabolic/bariatric surgery. The analysis included 40 studies, of which 26 presented the cross-sectional prevalence of FA at the preoperative moment and seven at the postoperative moment, while seven longitudinal studies assessed prevalence at both the preoperative and postoperative moments for the same individuals. Most studies evaluated FA using the original YFAS (67.5%). The meta-analysis identified a high weighted prevalence of FA in preoperative samples (32%), while in postoperative samples it was reduced to less than half (15%) that of the preoperative samples. Of the seven studies that prospectively measured preoperative and preoperative FA in the same sample, all showed a reduction in FA after surgery, which ranged from 1% to 59%, with a weighted APR of 26 p.p.

4.2 Comparison with the literature and interpretation of data

The prevalence of FA at the preoperative moment (32%) of individuals was slightly higher than that observed in individuals with obesity but who are not necessarily candidates for bariatric surgery (28%) [29]. This is consistent with findings in the literature, as there is evidence that individuals with obesity are more likely to meet the YFAS criteria for FA [34]. Nevertheless, it is worth noting that not all individuals with obesity show FA and that other pathways involving physical inactivity, genetics, and the dietary environment may be involved in the genesis and prolongation of obesity [35]. The weighted prevalence of FA after bariatric surgery (15%) was similar to that in individuals without body weight disorders (16%) and was slightly higher than that in non-clinical samples (13%) [29].

The meta-regression showed that the difference in FA prevalence between the pre- and postoperative groups was statistically significant. This leads us to assume that bariatric surgery may result in a reduction in FA in this population. Nevertheless, the comparison of prevalence at preoperative and postoperative moments of cross-sectional studies using different samples strongly decreases our ability to infer any causality. Longitudinal studies are better at determining the possible causal effects of bariatric surgery on FA prevalence. In this sense, the present review also evaluated seven longitudinal prospective studies, which indicated a reasonable weighted APR of 26 p.p. for FA. Such effects were observed as early as after six months of postoperative follow-up. However, there was marked variability in the APR; for example, a study with 12 months of follow-up showed an APR of only 1 p.p. [36]. This probably occurred due to the discrepant sample size evaluated preoperatively and postoperatively. Of the 923 individuals included in the preoperative evaluation, which resulted in a low prevalence of FA (15%), only 170 individuals were evaluated in the postoperative period, indicating a significant sample loss and possible generation of selection bias in the sample, given that only the individuals most affected by FA may have returned for the second evaluation. On the other hand, the 24-month study showed an APR of 59 p.p. [37], illustrating the potential beneficial effects of bariatric surgery on FA.

The presence of FA is associated with an extra burden in individuals with obesity, such as a lower quality of life [38], impulsivity [38], dysregulation of emotions

[38], reward dysfunction [35], and a higher likelihood of co-occurring mental health conditions [38]. After bariatric surgery, several biological, physiological, and metabolic changes occur, for example in neural transmission [39,40], in the regulation of hunger/satiety [41,42], on the palate [43,44], in food preferences or intolerances, [45,46] and in the desire to eat [47]. The observed reduction in the prevalence of FA in the postoperative period may be related to such metabolic changes promoted by bariatric surgery, as they are also associated with FA. Evidence shows that bariatric surgery also decreases other eating disorders, such as loss of eating control and binge eating disorders [48,49].

Thus, the data from the present review indicate that individuals with FA undergoing bariatric surgery may experience a reduction in the symptoms of this condition, which in turn could contribute to the control of obesity in this population. However, more longitudinal studies, preferably with an experimental design with control groups, are needed to assess the negative causal effects of bariatric surgery on FA, especially after 12 months, since weight regain after this period is common [50,51]. We also highlight the need for longer longitudinal studies to assess whether the effect of bariatric surgery on FA is enduring or transient. This is of great importance from the perspective of treatment of obesity and the recurrence of this condition after surgical intervention.

4.3 Limitations

A possible limitation of this study is that it did not conduct a specific search for YFAS in bariatric surgery. However, the search strategy found all studies that used any version of the YFAS (regardless of sample type), suggesting that all studies that evaluated FA in the bariatric population were also included. Another limitation is that the YFAS is a self-report measure, which can be affected by participants' subjective interpretation. Some patients undergoing bariatric surgery may be prone to under- or overreporting of FA due to concerns about how it may influence their access to bariatric surgery. However, the YFAS has been found to have strong psychometric properties in several contexts [52,53,54,55], which does increase confidence in the findings.

In addition, the YFAS was the only instrument used to assess FA, which better enables comparison between studies (rather than collate various measures). However, caution should be exercised in the interpretation and applicability of the data since the prevalence of FA reported in the studies showed wide variation, and more than half the studies showed a moderate risk of bias. It is noteworthy that the overall quality of the evidence, as assessed by GRADE [32], was low, mainly due to limitations of the studies and inconsistency in the results. Therefore, future research should seek to increase the quality of performance and reporting of the studies.

In addition, most of the studies included in the present review are cross-sectional, making it impossible to determine a causal effect of bariatric surgery on the reduction of FA prevalence. We included a few longitudinal studies, which, although not experiments, could contribute to the inference of a possible causal effect of bariatric surgery. Nevertheless, such longitudinal studies showed a critical sample loss in the postoperative period, which also introduced bias to our analysis, thereby reinforcing the need for cautious interpretation of our data.

5. Conclusion

The prevalence of FA was high in the preoperative period among individuals undergoing bariatric surgery. The meta-analysis identified a reduction in the prevalence of FA among patients after metabolic/bariatric surgery, and the difference in prevalence was significant, as shown by the meta-regression analysis. Although this review comprised 40 studies, only seven were longitudinal studies that evaluated the prevalence of FA before and after bariatric surgery. Therefore, further longitudinal studies are needed, especially with an experimental design with control groups, to determine the efficacy of surgical interventions for improving FA outcomes and their effects on long-term obesity control.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest for all authors.

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TABLE AND FIGURE LEGENDS

Figure 1. Flowchart of studies included in the review.

Figure 2. Forest plot for the prevalence of food addiction in preoperative samples.

Figure 3. Forest plot for the prevalence of food addiction in postoperative samples.

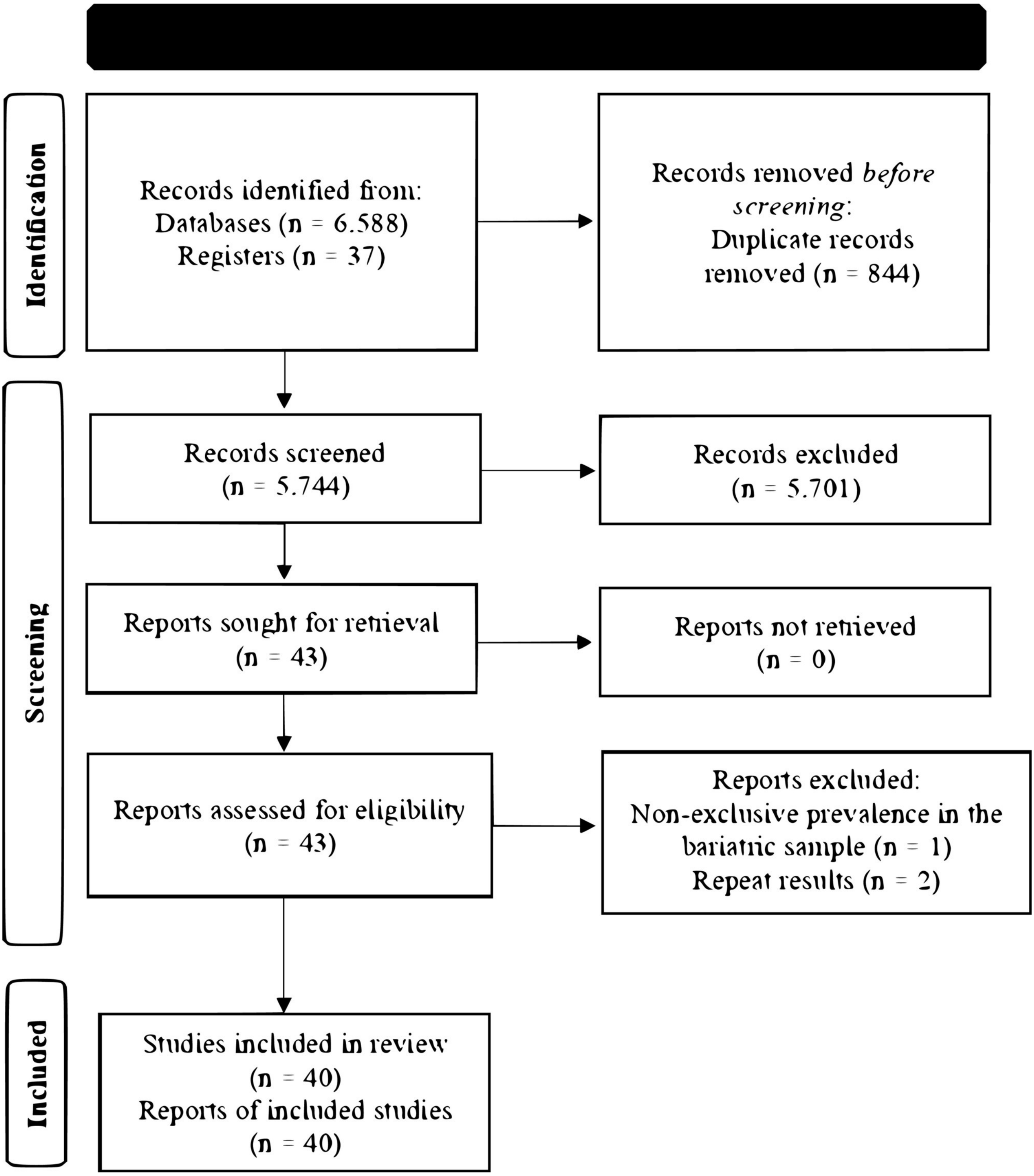
Figure 4. Forest plot for the weighted APR of longitudinal studies.

Table 1. Characteristics of included studies that assessed the prevalence of FA using the Yale Food Addiction Scale (YFAS) only in patients who were candidates for bariatric surgery (preoperative) (n=26).

Table 2. Characteristics of included studies that assessed the prevalence of FA using the Yale Food Addiction Scale (YFAS) only in postoperative bariatric surgery patients (n=7).

Table 3. Characteristics of the included longitudinal prospective studies that evaluated the prevalence of FA using the Yale Food Addiction Scale (YFAS) in the same subjects before and after bariatric surgery (n=7).

Table 4. Evidence quality assessment.



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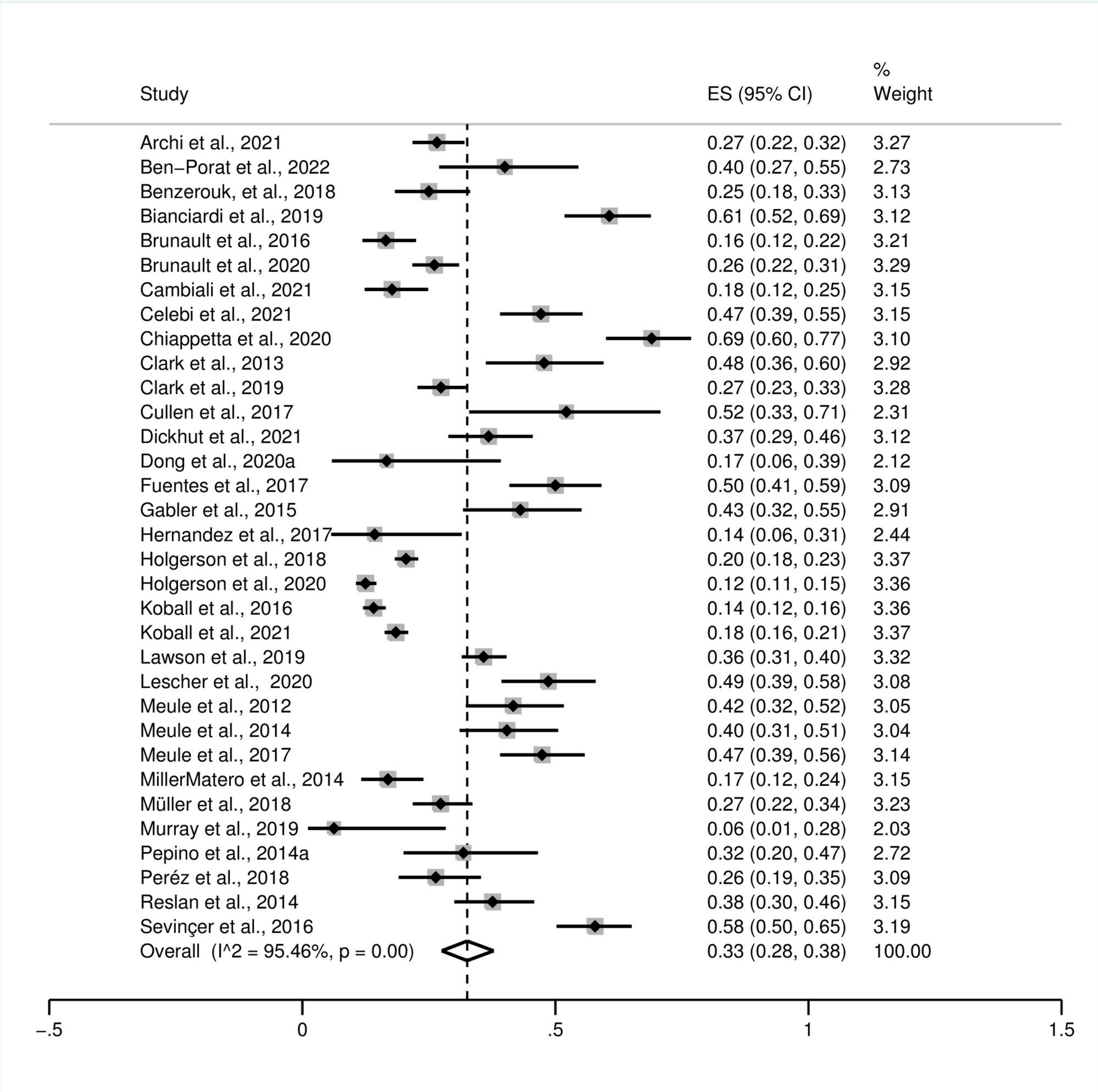

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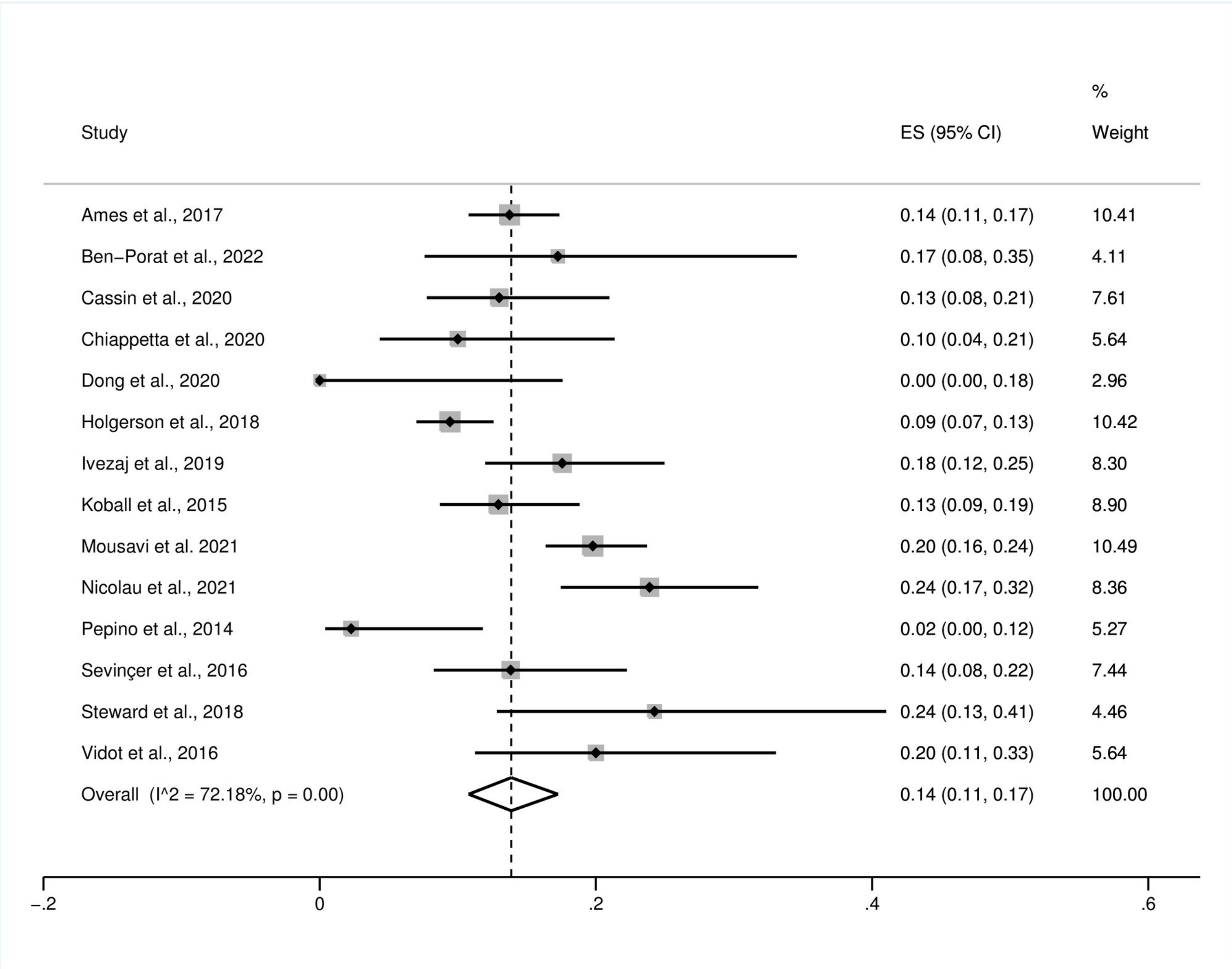

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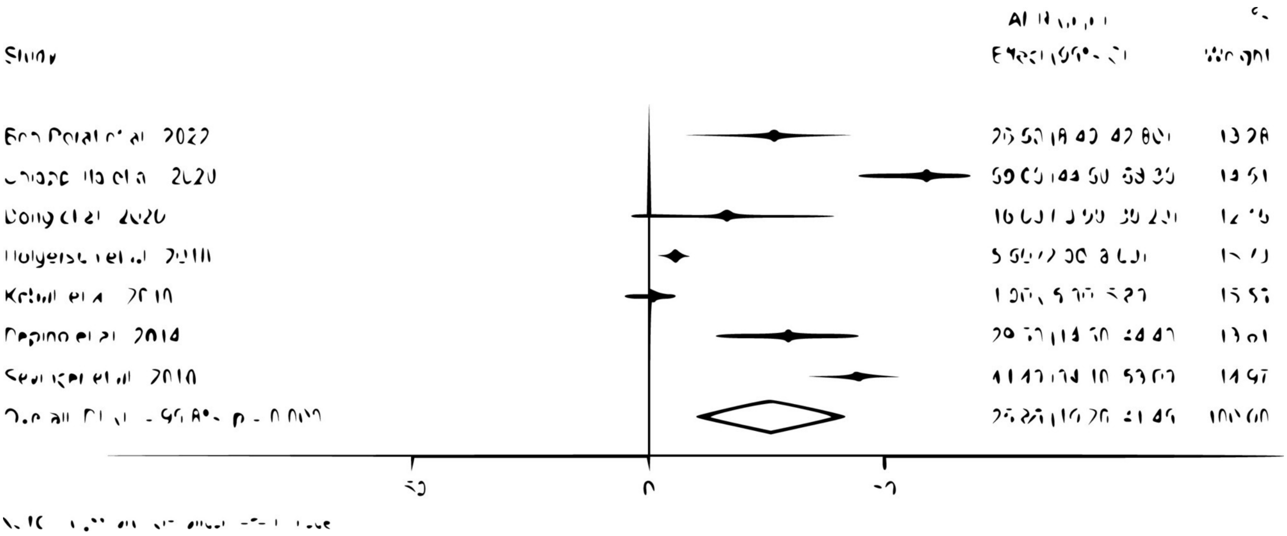

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