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Food Addiction and Bariatric Surgery: A Systematic Review of the Literature

Valentina Ivezaj, Ph.D.¹, Ashley A. Wiedemann, Ph.D.¹, and Carlos M. Grilo, Ph.D.^{1,2}

¹Yale University School of Medicine, Department of Psychiatry, USA

²Yale University, Department of Psychology, USA

Abstract

Emerging research suggests that rates of food addiction are high among individuals seeking bariatric surgery, but little is known about associated features and the prognostic significance of pre-operative food addiction. Thus, this article provides a systematic review and synthesis of the literature on food addiction and bariatric surgery. Articles were identified through PubMed and SCOPUS databases, resulting in a total of 19 studies which assessed food addiction among pre-and/or post-bariatric surgery patients using the Yale Food Addiction Scale. Most studies were cross-sectional and only two studies prospectively measured food addiction both pre-and post-operatively. The presence of pre-surgical food addiction was not associated with pre-surgical weight or post-surgical weight outcomes, yet pre-surgical food addiction was related to broad levels of psychopathology. The relationship between food addiction and substance misuse among individuals undergoing bariatric surgery is mixed. In addition, very few studies have attempted to validate the construct of food addiction among bariatric surgery patients. Results should be interpreted with caution due to the methodological limitations and small sample sizes reported in most studies. Future rigorous research with larger and more diverse samples should prospectively examine the clinical utility and validity of the food addiction construct following bariatric surgery.

Keywords

bariatric surgery; review; food addiction; weight; obesity

Obesity is a prevalent¹ and costly² public health crisis associated with significant morbidity and mortality³ in the United States¹ and globally^{4, 5}. The disease and economic burden of obesity markedly worsens with increasing severity levels^{3, 6}. Despite the relative stabilization of less severe types of obesity, rates of severe obesity continue to rise⁷, along with increasing numbers of individuals seeking bariatric surgery, currently the most effective treatment for severe obesity and associated comorbidities^{8, 9}. Although bariatric surgery is generally effective, a substantial proportion of individuals who undergo bariatric surgery have suboptimal weight losses and continue to struggle with obesity^{8, 10}, highlighting the need to understand better modifiable prognostic indicators for post-operative weight

Correspondence: Valentina Ivezaj, Ph.D., Yale University School of Medicine, Program for Obesity, Weight, and Eating Research, 301 Cedar Street, 2nd Floor New Haven, CT 06519; Phone: (203) 785-7807; Fax: (203) 785-7855; valentina.ivezaj@yale.edu.

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outcomes. Research has begun to examine a diverse range of factors that appear to influence post-operative outcomes including various problematic eating behaviors including, for example, various forms of disordered eating, such as binge-eating disorder¹¹, loss-of-control eating^{12, 13}, and picking/nibbling¹⁴. More recently, researchers have also begun to investigate “addictive-type” eating or “food addiction” among individuals undergoing bariatric surgery.

Food addiction, a controversial concept¹⁵, posits that a subgroup of individuals are susceptible to highly palatable foods, resulting in eating behaviors that mirror addictions (i.e., consuming larger amounts than intended despite adverse consequences or repeated failed attempts to quit)¹⁶. Food addiction, as most often conceptualized and measured by the Yale Food Addiction Scale (YFAS)¹⁷, has been found to be strongly associated with obesity and with greater psychosocial impairment including, for example, depression, impulsivity, eating-disorder psychopathology and binge-eating, and poorer self-control^{18–20}. Preliminary evidence examining the relationship between food addiction and weight loss treatment outcomes in non-surgical populations is mixed^{21, 22}. Since 2013, an emerging literature has examined rates and correlates of pre- and post-operative food addiction among bariatric surgery patients. We aimed to systematically review and synthesize research on food addiction among individuals undergoing bariatric surgery to help guide future research efforts in this area.

Methods

We identified articles by conducting a literature search through PubMed and SCOPUS databases. The inclusion criteria for this review included quantitative studies that used the Yale Food Addiction Scale among bariatric surgery patients. The authors agreed on search terms ("bariatric surgery," "weight loss surgery," "sleeve gastrectomy," "gastric bypass," "RYGB," "lap-band," "LAGB," "VSG," "Roux-en-Y," "adjustable gastric banding," and "food addiction," "eating addiction," or "addictive eating") which generated a total of 209 results. Author AW conducted the search, screened the databases, and abstracted the information from the articles for inclusion. Duplicate articles were identified independently and removed from the total records screened by AW, resulting in 188 full text articles that were assessed for eligibility. Any articles assessing the concept of food addiction and bariatric surgery were reviewed by all authors. Consensus among authors was made regarding decisions to exclude articles (i.e., qualitative studies discussing the notion of food addiction). We also excluded any articles in a non-English language. Figure 1 is a PRISMA Flow Diagram²³ depicting the process for which studies were identified for inclusion in this review. The original search ended on 10/3/2016 and a follow-up search was conducted on 7/20/2017 to incorporate any articles published during the review process, which resulted in three new published articles using our search terms

Results

Of the 191 articles, a total of 19 (10%) studies met the inclusion criteria (assessment of food addiction among pre- or post-bariatric surgery patients). All studies used the Yale Food Addiction Scale (YFAS) to measure food addiction. The YFAS was used in seven (36.8%)

cross-sectional studies at the pre-operative stage^{24–30} and four cross-sectional studies at the post-operative stage^{31–34}. Three prospective studies were conducted^{35–37}, however, only two prospective studies assessed food addiction pre- and post-operatively^{36, 37}. Two of the prospective studies examined patients at 6- and 12-months after surgery^{35, 37}, and one study examined patients within 9 months after surgery³⁶. Finally, five (26.3%) studies examined the psychometric properties the YFAS in bariatric surgery patients^{38–42}. Table 1 provides a detailed summary of the 19 studies including designs and major findings.

YFAS Rates and Associated Features

YFAS food addiction rates were reported in a total of eleven (57.9 studies^{24, 27–29, 35–39, 41, 42}, the majority of which (n= 7; 63.6%) were conducted only during the pre-surgical period^{24, 27–29, 39, 41, 42}. Pre-surgical rates of food addiction ranged from 14%–57.8%; Koball et al.³⁵ found similar food addiction rates among pre-surgical candidates who did and did not go on to undergo bariatric surgery (13% and 14%, respectively). Only two (10.5%) of the 19 studies reported rates of meeting food addiction criteria post-operatively^{36, 37}; reported rates post-operatively were much lower than pre-operatively, ranging from 2%–13.7%.

Two studies prospectively examined the rate of food addiction before and after bariatric surgery^{36, 37}. Pepino et al.³⁶ found that a total of 14 (31.8%) of 44 surgical candidates met food addiction criteria and only one continued to meet food addiction criteria within 9 months after surgery, with no new cases identified postoperatively. Overall, patients meeting criteria for food addiction before surgery did not endorse significantly more symptoms post-operatively than patients not meeting criteria pre-operatively, and the rate of food addiction decreased from 32% to 2%. Similarly, Servincer et al.³⁷ reported that rates of food addiction decreased significantly from pre-surgery (57.8%) to 6- (7.2%) and 12- (13.7%) months post-operatively. We emphasize, however that these findings must be viewed cautiously in light of the extremely high attrition rates and missing data (63% at 6-month and 76% at 12-month). In both studies, rates of patients meeting food addiction criteria did not differ significantly by surgery type, although these finding must be viewed cautiously given the limited power to detect differences.

YFAS, BMI, and Weight Outcomes in Bariatric Surgery

Nine (47.4%) studies examined the relationship between the YFAS and either current weight, or post-operative weight-loss outcomes^{27–29, 34–38, 41}. All studies conducted with bariatric surgery candidates (n=7; 36.8%) found no relationship between food addiction and current BMI^{27–29, 35–37, 41}. Additionally, one study²⁷ found no significant differences between patients meeting criteria for food addiction in their reported previous maximal BMI, duration of obesity, or age of onset of obesity. Fewer studies have examined the relationship between food addiction and post-surgical weight-loss outcomes^{34–38}. Yanos and colleagues³⁴ examined predictors of weight regain after surgery and found that post-surgical scores on the YFAS were associated with weight regain. However, when examining several variables associated with weight regain in stepwise linear regression and logistic regression analyses, they found that the YFAS was no longer significantly related to weight regain. Studies have also examined whether pre-surgical rates of food addiction predict postsurgical

weight loss. Clark and colleagues³⁸, in their study which assessed pre-surgical scores retrospectively, found no significant differences in weight loss outcomes by food addiction groups. None of the three prospective studies conducted found a relationship between pre-surgical food addiction and post-surgical weight outcomes at 6 and 12 months post-surgery^{35, 37} or up to 9 months post-surgery³⁶. The two studies which examined patients at 6-month and 12-month follow-up found no differences in the total percent weight lost³⁵ or percent of excess BMI lost between those meeting criteria for food addiction and those not meeting criteria³⁵, and no differences in BMI were found in those who dropped out at all time points assessed³⁷.

YFAS and Substance Use

Six (31.6%) studies examined the relationship between the YFAS and substance use^{28, 31–33, 35, 38}. Two studies examined food addiction and substance use among individuals seeking bariatric surgery^{28, 35} and found no relationship between food addiction and problematic alcohol use^{28, 35}, drug, or tobacco use³⁵. Four (21.1%) studies have examined substance use and food addiction during the postoperative period and overall the findings are mixed^{31–33, 38}. Two studies retrospectively assessed pre-surgical food addiction using the YFAS^{32, 38}. Reslan and colleagues³² categorized those with and without substance misuse and found that those in the post-operative substance misuse group had higher pre-surgical YFAS scores. Clark and colleagues³⁸ reported there were no differences in problematic substance use after surgery between those who met criteria for food addiction and those who did not. Fowler and colleagues³¹ examined participants with and without reported new onset substance use disorders after bariatric surgery and found that the new onset participants endorsed more pre-surgical problematic foods high in sugar and low in fat on the YFAS problematic food list. Finally, one study³³ found that marijuana use during the previous year and increased marijuana use were both associated with scores on the YFAS. However, they found that scores on the YFAS were unrelated to reported marijuana use during the past month.

YFAS and Other Psychosocial and Behavioral Outcomes

The YFAS has also been examined in bariatric patients in relation to other outcomes, such as eating behavior, psychopathology, and quality of life. A total of nine (47.4%) studies have evaluated the YFAS and other forms of disordered eating, such as binge eating, emotional eating, and night eating^{24, 26–29, 35, 36, 38, 41}. Among bariatric candidates, patients who met food addiction criteria were more likely to report binge-eating episodes^{28, 35, 41} with greater severity^{27, 38} compared to those who did not meet food addiction criteria. YFAS scores were also a significant predictor of binge eating when controlling for other measures of eating pathology such as disordered and emotional eating³⁸. The presence of pre-surgical food addiction was also associated with higher levels of emotional eating among pre-surgical bariatric patients^{29, 36, 41} and post-bariatric patients when assessed retrospectively for the pre-surgical period³⁸. Similarly, among individuals seeking bariatric surgery, food addiction was associated with a host of problematic eating behaviors and psychopathology including higher levels of external eating³⁶, night eating syndrome^{26, 35}, food cravings^{28, 36}, restraint²⁸, shape and weight concerns^{28, 41}, depression^{27–29, 35}, anxiety^{29, 35}, and impulsivity^{28, 30}, poorer quality of life²⁷, and lower levels of eating self-efficacy^{24, 35}. When

examining overall demographic factors, one study found that those who met criteria for food addiction were more likely to be single²⁷, and that food addiction negatively correlates with age²⁸, while other studies found no differences in age, race, education, or income based on food addiction status^{35, 36}.

Validation and Psychometric Studies of the YFAS in Bariatric Patients

Studies of various aspects of the psychometric properties of the YFAS, including validity and reliability, have been conducted in five samples of bariatric patients^{38–42}, including three studies with bariatric candidates^{39, 41, 42}. Meule and colleagues³⁹, in their study of the German version of the YFAS, reported an internal consistency of 0.82, and when conducting an exploratory factor analysis, they found a uni-dimensional one-factor structure. A more recent investigation examining psychometric properties of the German version of the YFAS 2.0 measure reported a high internal consistency of 0.87⁴¹ which was similar to the Cronbach alpha of 0.93 reported recently for the Portuguese version of the YFAS. Torres et al.⁴² examined the test-retest of the YFAS among bariatric candidates and found no differences at 6–8 weeks after initial screening or at 3–8 months later in a subset of participants (n=30). Additionally, the YFAS demonstrated good convergent validity with other measures of disordered eating, including power of food, and external-, emotional-, and binge-eating, and divergent validity with a measure of restrained eating. Torres et al.⁴² also examined discriminant validity by comparing bariatric candidates to a non-clinical sample of students and found that the bariatric candidates were more likely to meet criteria for a food addiction diagnosis.

Two studies tested the psychometric properties of the YFAS in post-bariatric patients^{38, 40} although one of these³⁸ used YFAS data that was retrospectively assessed for the pre-surgical period and thus must be viewed cautiously. Clark and colleagues³⁸ reported that the YFAS classification of food addiction demonstrated convergent validity with measures of binge eating and emotional eating, although the YFAS symptom count only showed convergent validity with the assessment of disordered eating (assessed via the EAT-26). The YFAS displayed discriminant validity with measures of problematic substance use, behavioral activation, and behavioral inhibition, and incremental validity of the YFAS was found in predicting binge-eating behavior above and beyond the contribution by disordered eating. Servincer and colleagues⁴⁰, in their psychometric study of the Turkish version of the YFAS with post-bariatric patients, obtained a Cronbach alpha of 0.859, and found no differences between three and six months (examining past month, instead of past year symptom endorsement for the YFAS) when examining test re-test with respect to the dichotomous assessment of the YFAS. Contrary to the study by Meule and colleagues³⁹, Servincer et al.⁴⁰ found a six-factor structure instead of one-factor structure for the YFAS when conducting an exploratory factor analysis.

Discussion

To our knowledge, this is the first paper to systematically review the literature on the construct of food addiction among bariatric surgery patients. Overall, the emerging literature in this area is methodologically limited with relatively small samples and limited measures.

Within this context, our review yielded four primary findings. First, a total of 19 studies have examined food addiction among bariatric surgery patients; of these, only two studies prospectively measured food addiction both pre- and post-operatively. Both studies found high levels of food addiction before surgery, which significantly reduced post-surgery. Second, the presence of pre-surgical food addiction was not associated with pre-surgical weight or post-surgical weight outcomes up to 12 months post-surgery; yet, the presence of pre-surgical food addiction was linked to greater pre-operative eating-disorder psychopathology, problematic eating behaviors, and broad levels of psychopathology. Third, the relationship between food addiction and substance misuse among bariatric surgery patients is mixed. Fourth, all studies, except for one⁴¹, used the original YFAS (based on DSM-IV-TR criteria) to assess food addiction, and very few studies (n = 5) (38–42) examined the psychometric properties of the YFAS among bariatric surgery patients.

Of note, the current literature is limited by cross-sectional designs and retrospective accounts of food addiction and lack of long-term prospective follow-up beyond 12 months post-surgery, which is when weight regain often occurs⁸. Of the two prospective studies, the first had a small sample size (n=44)³⁶ and the second had high attrition³⁷. Additionally, many of the post-operative studies (n=4)^{31, 32, 34, 35} included primarily Roux-en-Y gastric bypass surgeries. Sleeve gastrectomy surgery, however, is now the most commonly performed bariatric surgery in the United States⁴³. Only four studies included more than one bariatric surgery^{33, 36–38}; two of which had particularly small sample sizes (n=44³⁶; and n=50³³), making surgical comparisons difficult. Moreover, the studies lacked racial and ethnic diversity as the majority of the samples with reported race were primarily White^{24, 31, 32, 34, 35, 38}. Finally, it is possible there was incomplete retrieval of all possible articles despite the comprehensiveness of the search.

Within the context of these limitations, we cautiously offer the following summary and research recommendations. The current data suggest that rates of food addiction decrease during the first post-operative year. Pre-surgical food addiction is unrelated to pre-surgical BMI and post-surgical weight loss^{27–29, 35–37, 41}. No study, however, has prospectively examined whether the emergence or re-emergence of post-operative food addiction is related to poorer long-term weight outcomes. For instance, recent research suggests that post-operative, and not pre-operative, loss-of-control eating and binge-eating disorder are related to poorer weight outcomes following sleeve gastrectomy and Roux-en-Y gastric bypass surgeries^{11–13}. Given the overlapping features of food addiction and binge eating^{12, 44}, it is possible that post-operative food addiction will also be related to poorer long-term weight outcomes following bariatric surgery. Future research should examine the prognostic significance of post-operative food addiction and whether the presence of both post-operative food addiction and binge eating represents a more severe subgroup with elevated psychopathology, as has been observed in non-surgical treatment-seeking populations^{45, 46}. Additionally, the current research, although limited, suggests that pre-operative food addiction is related to a broad spectrum of psychopathology such as depression, anxiety, and disordered eating. Future research should examine the relationship between post-operative food addiction and comorbid psychopathology to help identify treatment needs and care following bariatric surgery.

Almost one-third of the studies examined the relationship between food addiction and substance use among bariatric patients, in part, due to similar behavioral and neurobiological manifestations of “addictive-type” eating and substance misuse. Preliminary findings from two studies suggest that pre-operative food addiction is not associated with pre-operative substance use^{28, 35}. Three studies^{31, 32, 38} examined the relationship between post-operative substance misuse and retrospective accounts of pre-operative food addiction; results were mixed, which may be due to varying assessments of substance use and limited samples sizes. One study examined the relationship between post-surgical YFAS scores and marijuana use³³. Recent, but not current, marijuana use was associated with food addiction. None of the studies prospectively measured changes in food addiction and substance use pre- and post-operatively.

It is also important to note that this literature is largely dependent on one self-report measure, the YFAS¹⁵, and only one study used the YFAS 2.0 (Gearhardt, Corbin, Brownell, 2016), which was revised according to changes in the diagnostic criteria for alcohol and substance use disorders in the most recent version of the Diagnostic and Statistical Manual of Mental Disorders (DSM 5). The YFAS has received little psychometric attention either in terms of research examining either basic psychometric aspects (internal consistency, factor structure, etc) or different aspects of “validity” among bariatric patients. The self-report YFAS has not been compared to any interview of clinician-based rating of the concept (a typical approach) because none exists. Of the five studies that have assessed the psychometric properties of the YFAS among bariatric surgery patients, different factor structures emerged ranging from one to six^{39, 40}. While these differences may have represented cultural differences in samples (i.e., German³⁹ versus Turkish versions⁴⁰) and/or differences in pre-surgical stage³⁹ versus post-surgery⁴⁰, future research is needed to better understand the clinical utility and validity of the YFAS and the concept of food addiction among bariatric surgery patients.

Conclusion

The presence of food addiction assessed by the YFAS is common among individuals seeking bariatric surgery and is associated with disordered-eating behavior and broad psychopathology. Rates of food addiction decrease significantly during the first post-operative year. Pre-surgical food addiction does not seem to be related to post-surgical weight outcomes during the first post-operative year. Future research should examine the relationship between post-surgical food addiction, associated features, and longer-term weight outcomes. More rigorous research methods with larger and more diverse patients are needed to better understand the clinical utility and validity of food addiction following bariatric surgery.

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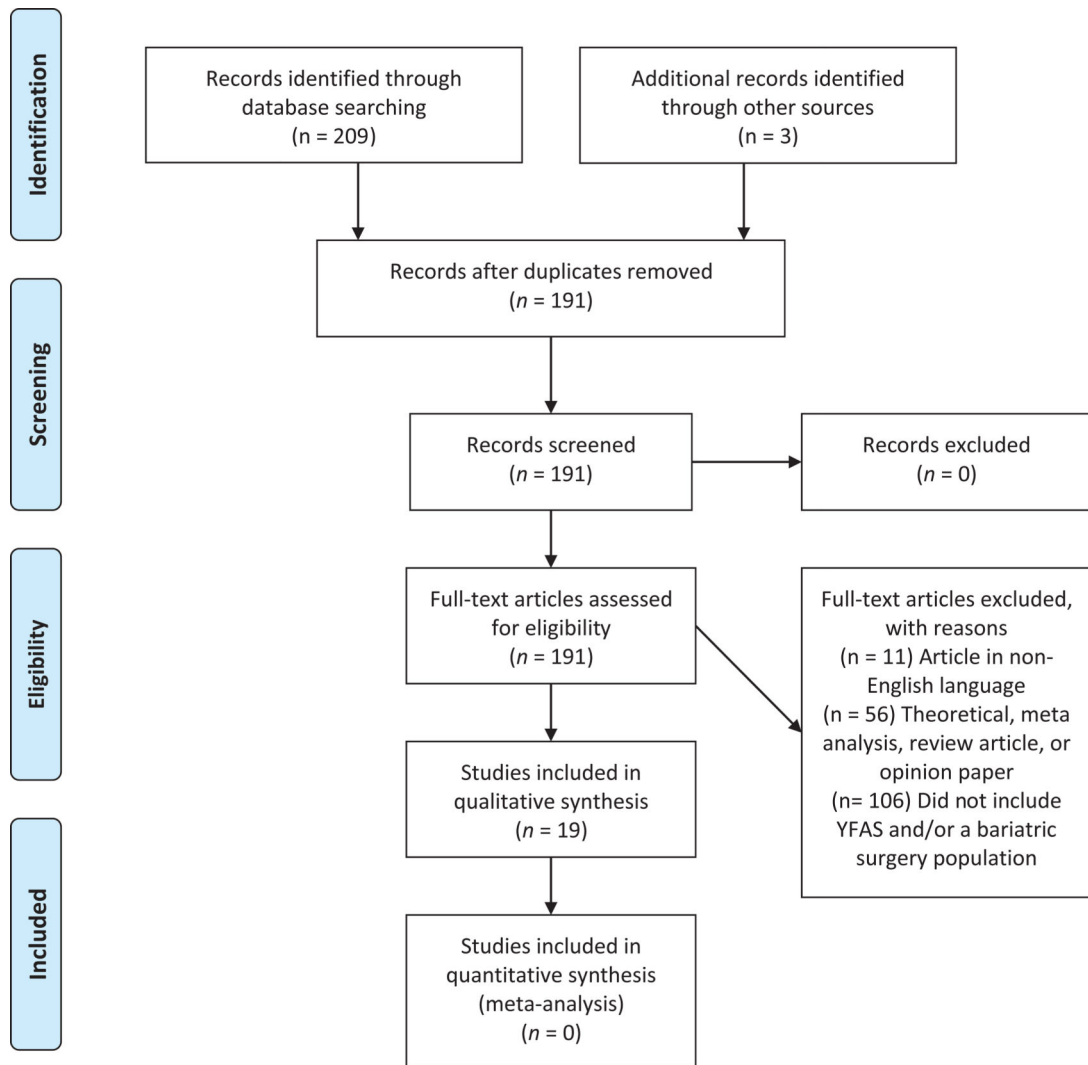
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Figure 1.
PRISMA 2009 Flow Diagram

| | | Author | Sample Characteristics | Purpose | Design | Surgery Type | Candidates, Post-bariatric, or Both | YFAS Rates | Food Addiction Main Outcomes |
|---|---|---------------------------------|--|---|-----------------|--------------|-------------------------------------|------------|--|
| Preoperative Studies (YFAS + Primary Weight Outcomes) | 1 | Brunault et al. 2016 | Final: n=188 Age: 40.8 (SD=12.3) BMI: 46 (SD=7.3) WT: 124.9 (SD=24.9) kg Maximal BMI: 48.8 (SD=7.9) Women: 84% Men: NI Race: NI Marital: 69.1% married | Examining food addiction in bariatric surgery candidates; rates and risk factors | Cross-sectional | NA | Candidates | 16.5% | No differences in BMI by FA groups, previous maximal BMI, duration of maximal BMI, duration of obesity, or age of obesity onset. FA group > BE symptoms than non-FA group. Significant BES score: FA group (64.5%) > non-FA group (7.6%). FA group were more likely to be single than non-FA group ($P<.05$). FA group reported lower physical, psycho-social and sexual QoL, and higher rates and levels of depression, than non-FA group |
| | 2 | Miller-Mateo et al. 2014 | N=142 Age: 46.26 (SD=11.7) BMI: 49.05 (SD=9.56) WT: NI Women: 81% Men: 19% Race: 53.5% Caucasian; 39.4% AA; 7% Multi-racial Marital: NI | Prevalence of and relationships of problematic eating behaviors and BMI in bariatric candidates | Cross-sectional | NA | Candidates | 16.9% | No differences in BMI by FA vs. non-FA group. FA sx correlated with emotional eating subscales and total score. FA sx correlated with depression and anxiety scores. FA group > non-FA group in anxiety and depression scores |
| | 3 | Meule et al. 2014 | N=96 Age: 39.92 (SD=11.51) BMI: 50.64 (SD=8.99) WT: NI Women: 65.6% Men: 34.4% Race: NI Marital: NI | FA in obese persons seeking bariatric surgery | Cross-sectional | NA | Candidates | 40% | No differences in BMI in FA and non-FA groups. FA sx unrelated to BMI. FA group > FCQ-T scores than non-FA. No differences in FCQ-S scores. FA group > EDE-Q total score, eating concerns, weight and shape concerns, more BE days, higher restraint. FA sx correlated with FCQ, EDE-Q subscales, BE days. No differences in AUDIT by FA groups. FA sx unrelated to AUDIT. FA sx negatively correlated with age. FA group > depression scores than non-FA group. |

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| Preoperative Studies (YFAS was a secondary outcome) | 4 | Baldofski et al. 2015 N=233 Age: 45.35 (SD=10.37) BMI: 48.72 (SD=7.64) WT: NI Women: 68% Men: NI Race: NI Marital: NI | Examining non-normative eating and psychopathology in bariatric candidates with and without BED and night eating syndrome | Cross-sectional | NA | Candidates | NI | FA group > BIS attentional impulsivity, no differences on motor impulsivity, and non-planning impulsivity, and total score. FA sx unrelated to motor, non-planning impulsivity. No differences in FA when compared those who met criteria for BED or night eating syndrome groups. Both BED and night eating syndrome groups had higher YFAS scores than participants without ED. |
| | 5 | Baldofski et al. 2016 N=240 Age: 45.08 (SD=10.43) BMI: 48.63 (SD=7.48) WT: NI Women: 68.75% Men: NI Race: NI Marital: NI | SEM study to examine weight bias internalization, emotion regulation, and non-normative eating behaviors | Cross-sectional | NA | Candidates | NI | Weight bias internalization positively predicted greater FA sx. Emotion regulation partially mediated the relationship between weight bias internalization and FA. Nonacceptance predicted higher FA sx. |
| | 6 | Ames et al. 2015 N=1740 Age: 48.7 (median) BMI: 44.9 (median) WT: NI Women: 71.1% Men: 28.85% Race: 90.8% Caucasian Marital: NI | Validation study of the WEL-SF | Cross-sectional | NA | Candidates | 21% | Lower scores on the WEL-SF were associated with FA severity and dependence ($p<.0001$). |

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| | 7 | Meule, de Zwaan, Müller, 2017 | N=138 Age: 39.5 (SD=10.7) BMI: 48.8 (SD=7.08) WT: NI Women: 78.3% Men: NI Race: NI Marital: NI | Secondary data analysis examining impulsivity as a predictor of FA in bariatric candidates | Cross-sectional | NA | Candidates | 47.4% | Attentional and motor impulsivity interactively predicted FA scores. Higher attentional impulsivity was associated with a higher likelihood of FA dx (for high scores, but not medium or low levels of impulsivity) |
| Preoperative Studies (Validation and Psychometric Studies of YFAS) | 8 | Meule, Müller, Gearhardt, Bleichert, 2017 | N=138 Age: 39.52 (SD=10.71) BMI: 48.80 (SD=7.08) WT: NI Women: 78.3% Men: NI Race: NI Marital: NI | Evaluate psychometric properties of the German version of the YFAS 2.0 | Cross-sectional | NA | Candidates | 47.4% | Internal consistency: .87. FA dx unrelated to current BMI. FA group > binge days, eating, weight, and shape concerns, but not related to restraint scores than non-FA group FA sx associated with number of binge days, eating, weight, and shape concerns, but not related to restraint scores. |
| | 9 | Torres et al. 2017 | N=190 Age: 43.21 (SD=10.39) BMI: 43.24 (SD=5.80) WT: NI Women: 87.4% Men: NI Race: NI Marital: NI | Examine the psychometric properties of the Portuguese version of the YFAS | Cross-sectional | NA | Candidates | 25.8% | Internal consistency: .93. Displayed good test-retest reliability after 6-8 weeks, and 3-8 months in a subsample of participants. Good convergent validity with FA sx count and power of food, external eating, emotional eating, binge eating, and divergent validity with restrained eating. FA sx count scores displayed discriminant validity when comparing bariatric candidates to a non-clinical student sample Bariatric candidates were more likely to meet criteria for an FA diagnosis compared to the non-clinical student sample ($p<.001$) |

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| 10 | Meule et al. 2012 | N=96 Age: 39.92 (SD=11.51) BMI: 50.64 (SD=8.99) WT: NI Women: 65.5% Men: 34.5% Race: NI Marital: NI | Factor structure and item analysis of the German version of the YFAS | Cross-sectional | NA | Candidates | 41.7% | Internal consistency: .82. |
| 11 | Yanos et al. 2015 | N=97 Age: 56.11 (SD=11.26) BMI: 35.75 (SD=9.96) Preoperative WT: 330.84 lbs (SD = 64.47) Women: 77.3% Men: NI Race: 92.8% Caucasian Marital: NI | Examining the relationship of relevant variables to weight nadir and weight regain after bariatric surgery | Cross-sectional | RYGB | Post-bariatric | NI | FA sx were correlated with weight regain after surgery. FA sx wasn't a significant predictor of weight regain in the final model, when included depression, night eating, protein intake, fluid consumption, physical activity, avoiding sweets, fruits and vegetables, post-surgical alcohol use, post-surgical comorbidities, and leisure time. |
| 12 | Fowler et al. 2014 | N=154 Age: 48.7 (SD=10.8) BMI: 32.3 (SD=6.7) WT: NI Women: 88.4% Men: NI Race: 94.2% White Marital: NI | Examining high-sugar/low-fat and high GI foods in relation to new onset SUDs *Note: YFAS assessed retrospectively | Cross-sectional | 92.98% RYGB | Post-bariatric | NI | Those who met criteria for new onset SUD endorsed consuming more problematic high GI foods and foods in high sugar/low fat combination on the YFAS compared to those who did not meet criteria. There were no differences in consumption of high sugar foods between groups. |
| 13 | Reslan et al. 2014 | N=141 Age: 53 (SD=10.33) BMI: NI | Examining factors associated with post-SUDs among post-RYGB patients | Cross-sectional | RYGB | Post-bariatric | NI | YFAS sx total correlated with night eating and disinhibition and hunger subscales on the TFEQ |

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| | | WT: NI Women: 79% Men: NI Race: 93% Caucasian Marital: 65% married | *Note: YFAS assessed retrospectively | | | | | The substance misuse group had higher FA sx. YFAS sx total was correlated with family history of substance misuse. |
| 14 | Vidot et al., 2016 | N=50 Age: 28.04 (SD=5.8) BMI: 35.2 (SD=10.4), WT: NI Women: 76% Men: 24% Race: 56% Hispanic; 24% Non-Hispanic, Black; 10% Non-Hispanic White Marital: 54.2% never married 41.6% married; 4.2% divorced | Examining association of marijuana use pattern, disordered, eating, and FA | Cross-sectional | 62% RYGB 26% SG 12% ABG | Post-bariatric | NI | FA sx associated with marijuana use during the previous year, and increased marijuana use after surgery. FA sx unrelated to marijuana use during the past month. Diagnosis of FA did not differ by marijuana use category. |
| 15 | Clark et al., 2013 | N=67 Age: 42.7 BMI: NI WT: NI Women: 62.7% Men: NI Race: 86.6% Caucasian Marital: NI | Validation of the YFAS in post-bariatric patients *Note: YFAS assessed retrospectively | Cross-sectional | 59.7% RYGB | Post-bariatric | 53.7% | No differences in weight loss outcomes by FA groups. FA group > emotional eating, BE symptoms, EDE-Q scores than non-FA group. FA sx associated with emotional eating, and BE sx. No relationship between FA and problematic substance use. Convergent validity of FA dx with BE and emotional eating. Convergent validity of FA sx with disordered eating. Discriminant validity of YFAS with substance use, BA, BIS. |
| 16 | Servinco et al., 2015 | n=133 (3 month) n=57 (6 month) Age: 36.13 (SD=10.10) BMI: 47.21 (SD=7.15) | Examine the psychometric properties of Turkish YFAS in post-bariatric patients | Cross-sectional | NI | Post-bariatric | NI | Internal consistency: .859. No significant differences between test and re-test ($p>.05$). Item-total correlation varied between .214 and .666. |

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| Prospective Studies | 17 | <p>Pepino 2014</p> <p>WT: NI Women: 72.6% Men: 27.4% Race: NI Marital: NI</p> <p>N=44 Age: NI BMI: 48 (SD=8) WT: NI Women: 88.63% Men: NI Race: NI (breakdown by groups, not overall) Marital: NI</p> | Examine whether FA remits after surgery and examine association of FA with eating behaviors and weight loss | Prospective | 56.81% RYGB 25% LAGB 18.18% SG | Both | 32% (pre-operative) 2% (post-operative) | <p>No differences in BMI, weight, %WL, pre- or post-surgery</p> <p>FA group > food cravings than non-FA group before surgery, no differences after surgery. FA group > starchy and fast food cravings than non-FA group before surgery. FA group > emotional and external eating before surgery. Decreases in emotional and external eating in FA and non-FA group after surgery, restrained eating increased in FA subjects after surgery.</p> <p>No differences in age, race, level of education, income between FA group and non-FA group.</p> |
| | 18 | <p>Servincoer 2016</p> <p>Final N=166 n=158 (6 month) n=94 (12 month) Age: 35.6 (SD=9.8) BMI: 47 (SD=7.1) WT: NI Women: 77.1% Men: 22.9% Race: NI Marital: NI</p> | Determine the rates of FA and examine whether FA is associated with weight loss after surgery | Prospective | 81.8% SG 18.1% OLG | Both | 57.8% (pre-operative) 7.2% (6-mon) 13.7% (12-mon) | <p>Rates of FA dx decreased at 6 and 12 months: 7.2% (p<.001) and 13.7% (p<.001) respectively.</p> <p>FA sx unrelated to 6- or 12-month EBL% No differences in BMI between FA group and non-FA group at all assessments.</p> |
| | 19 | <p>Koball et al., 2016</p> <p>N=923 (candidates) n=169 (post-bariatric) n=113 (12 month)</p> | Examine FA and weight loss outcomes before and after surgery in relation to eating and mood outcomes. | Prospective | RYGB | Both (YFAS only assessed at baseline) | 14% (pre-operative) 13% (who underwent surgery) | <p>Presurgical FA unrelated to %TWL at 6- and 12-month.</p> <p>FA group > binge eating episodes than non-FA group.</p> |

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| | | n=26 (6 month) n=82 (lost to f/u or had not reached 1 year postsurgery) Age: 49.9 (SD=12.4) BMI: 45.8 (SD=9) WT: 45.8 kg/m ² Women: 71% Men: NI Race: 91% Caucasian Marital: 60% married | | | | | | FA unrelated to current alcohol, tobacco, or drug use. FA unrelated to history of childhood trauma. FA associated with greater psychological distress before surgery. FA unrelated to rehospitalization after surgery. |

ABG = Adjustable Band Gastroplasty

AUDIT = Alcohol Use Disorders Identification Test

ASI = Addiction Severity Index

BA = Behavioral activation

BIS = Barratt Impulsiveness Scale

BE = Binge Eating

BED = Binge Eating Disorder

BES = Binge Eating Scale

BMI = Body Mass Index

DX = Diagnosis

EBL = Excess BMI loss

EDE-Q = Eating Disorder Examination Questionnaire

ED = Eating Disorder

EFA = Exploratory factor analysis

FA = Food Addiction

FA group = Participants diagnosed with FA based on the YFAS

FA sx = Symptom count on the YFAS

FCQ-T = Food Cravings Questionnaire - Trait

FCQ-S = Food Cravings Questionnaire - State

L/AGB = Laparoscopic adjustable gastric banding

NA = Not Applicable

NI = Not Included

OLGB omega loop gastric bypass

QoL = Quality of Life

RYGB = Roux-En-Y Gastric Bypass

SD = Standard Deviation

SEM = Structural equation modeling

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SG = Sleeve Gastrectomy
SUD = Substance Use Disorder
WEL-SF = Weight Efficacy Lifestyle Questionnaire-Short Form
WT = Weight
YFAS = Yale Food Addiction Scale.