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Emotional Regulation Underlies Gender Differences in Pathological Eating Behavior Styles of Bariatric Surgery Candidates

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Abstract: Almost a third of bariatric surgery patients present suboptimal weight loss or important weight regain in the first five postoperative years. While the reasons underlying this are not fully understood, it is known that pathological eating styles (such as emotional or binge eating) can thwart efforts to maintain weight loss. However, detailed characterization and understanding of these eating styles have yet to be achieved. In particular, research on gender differences in pathological eating styles and psychiatric symptoms before bariatric surgery is lacking. To characterize gender differences in eating styles and their association with clinical symptoms, we prospectively enrolled 110 bariatric surgery candidates, collecting eating styles and clinical scores. Women displayed a higher frequency of emotional eating as compared to men ($x^2 = 9.07$, $p = 0.003$), while men showed a higher frequency of quantitative eating behavioral style ($x^2 = 4.58$, $p = 0.044$). Binge eating style was associated with higher Difficulties in Emotion Regulation Scale (DERS), Hamilton Depression Scale (HAM-D), and Hamilton Anxiety Scale (HAM-A) scores ($p < 0.05$). Emotional eating style was associated with higher HAM-D and HAM-A scores ($p < 0.05$). The present findings highlight the importance of understanding the role of gender differences in emotion regulation processes involved in the development and maintenance of pathological eating styles in bariatric surgery candidates. This paves the way to gender- and symptoms-specific interventions on eating behaviors to improve surgery long-term outcomes.

Keywords: emotion regulation; emotion dysregulation; eating style; eating behavior; bariatric surgery; emotional eating; quantitative eating; gender

1. Introduction

Bariatric surgery is among the most effective methods to attain sustained and substantial weight loss for pathologically obese subjects (BMI ≥ 40) [1,2] Almost a third of patients present suboptimal weight loss or important weight regain in the first five postoperative years [3]. While the reasons underlying this are not fully understood [4], it is known that disordered eating styles (such as emotional eating) can thwart efforts to respect dietary recommendations in the long-term, which are of the utmost importance to maintain weight loss and adherence to a healthy post-surgical diet [2,5,6]. Thus, it is crucial to characterize patterns of disordered (or pathological) eating styles and psychiatric symptoms before bariatric surgery, identifying, for instance, gender differences in these patterns to plan

gender- and symptoms-appropriate interventions before and after surgery. The analysis of eating styles serves to identify pathological eating behaviors linked to emotion dysregulation that are, therefore, susceptible to little modification following surgery. Emotion regulation can be defined as the "attempt to influence which emotions we have, when we have them, and how these emotions are experienced or expressed" [7]. If emotion regulation fails, self-regulation in other areas, such as control overeating behavior, can fail as well [8]. Impulsiveness is a common feature in those who present dysregulation in emotion and a lack of impulse control may reduce the ability to inhibit an automatic behavior (e.g., overconsumption of highly palatable snack food), and may increase the preference for immediate over long-term rewards (e.g., choosing the highly palatable snack food over a healthier option). Emotion regulation becomes even more critical after bariatric surgery, when patients may be exposed to higher risk for developing addictions [9]. Thus, emotion dysregulation may contribute to the excessive weight gain seen in extreme obesity and may directly impact the results of bariatric surgery, through modulation of pathological eating behaviors [2].

While pathological eating behaviors are not included in the DSM and are often not consistently defined, they have gained increasing empirical support and attention, being a frequent source of problems in managing bariatric surgery patients [10]. Eating styles can be classified as follows. Emotional eating commonly refers to abnormal eating in reaction to (pre-dominantly) negative emotions (e.g., stress, anger, fear, boredom, sadness, and loneliness) [11]. It is a maladaptive way of coping and is thought to represent more extensive problems with emotion regulation [12], which may be themselves features and risk factors for severe psychiatric disorders [13–15]. Emotional eating is one of the most frequent maladaptive eating behaviors in bariatric patients and is one of the major causes of weight regain after surgery, since emotion regulation problems usually remain unaltered over time [16] and associate with binge eating [17]. Binge eating is the excessive intake of unusually large amounts of food, resulting from a sudden unavoidable need, that feels out of control and unstoppable, often with contemporary ingestion of both sweet and savory foods up to a sensation of uncomfortable gastric fullness. It is characterized by the presence of high levels of impulsiveness, and feelings of depression, shame and guilt about one's eating. Qualitative (or external) eating refers to abnormal eating in response to qualitative aspects of the food, e.g., the smell, taste, or appearance of food [11]. Quantitative eating is an abnormal eating style aimed at pursuing a form of gratification mainly derived from the amount of food ingested. Gorging refers to the ingestion of a large amount of food, usually during main meals, while snacking defines the ingestion of palatable snacks or small quantities of food mainly between meals.

To better address, prevent, and treat pathological eating behaviors, it is important to note that gender differences in eating behaviors appear already in adolescence and susceptibility to pathological eating in general may differ between genders, for instance with women having higher rates of binge eating disorder, bulimia nervosa, and anorexia nervosa than men [18–20]. Indeed, eating disorders are the most pronounced sex-differentiated disorders among psychiatric disorders [21]. The male to female ratio of eating disorders is reported to range from 1:4 [22] up to 1:9 [19]. In particular, binge eating disorder is more common in women than men with the lifetime prevalence of 3.5% among women and 2% among men [22]. Moreover, there are several factors that may contribute to differential risks for pathological eating styles between sexes, such as gonadal hormones, environmental cues, social and cultural aspects, the effect of food on reward system (see the review of Anversa et al., 2021 [23]), or psychiatric comorbidities (such as depression, which is almost twice as frequent in females than in males) [24]. As mentioned, food intake may represent a coping mechanism to handle negative emotions, particularly in women [25,26]. Preclinical and clinical studies established that stress and negative emotions can heavily influence eating behavior and raise the risk of developing overeating or binge eating [27,28]. A meta-analysis of eight studies on gender differences in cerebral responses to food stimuli found that men show higher activation in the cingulate cortex compared to women [29]. On

the contrary, women show higher activation of the parahippocampal gyrus, precuneus, and thalamus when exposed to food stimuli [29]. All the aforementioned areas are involved in emotion regulation, cognitive integration of sensory information [30], and modulation of food intake [29]. Furthermore, when pooled, both women and men with binge eating behavior and obesity showed lower activity in response to a cognitive control task in brain areas involved in impulse control and self-regulation, including the inferior frontal gyrus, ventromedial prefrontal cortex, and insular cortex, compared to individuals with obesity but without binge eating [31]. These findings suggest that pathological eating behaviors underlying obesity may be tightly linked with emotion regulation networks, especially in women.

Further understanding of gender differences in eating behaviors is fundamental to the development of gender-specific treatments for pathological eating styles. Thus, the first aim of our study is to describe the prevalence of pathological eating behaviors and the characteristics of emotional dysregulation and anxious-depressive traits in a sample of patients who are candidates for bariatric surgery. The second aim is to investigate the association between these variables and gender, to bring more knowledge about gender differences in pathological eating behaviors.

2. Results

2.1. Population Demographic and Clinical Characteristics

We recruited a sample of 110 patients. No patient refused to participate nor was excluded. A total of 85 subjects (77.3%) identified themselves as female, and the median age was 47 years. There was no discordance between sex and gender in the sample. They all had a body mass index (BMI) $\geq$ 40 kg/m^2, or $\geq$35 kg/m^2 with one or more obesity-related co-morbidity.

Overall, subjects had mild depressive symptoms (median HAM-D = 9), mild anxiety (median HAM-A = 9), minor difficulties in emotion regulation.

2.2. Eating Behavioral Styles

Overall, the most prevalent eating behavioral style in our sample was quantitative (*n* = 78, 70.9%) and emotional eating (*n* = 74, 68.5%). Most patients (*n* = 102, 92.7%) showed two or more eating behavioral styles.

2.3. Gender Differences in Eating Behavioral Styles

Women displayed a higher frequency of emotional eating as compared to men (75.9% vs. 44%, x^2 = 9.07, *p* = 0.003), while men showed a higher frequency of the quantitative eating behavioral style (88% vs. 65.9%, x^2 = 4.58, *p* = 0.044) (Table 1). There were no differences in the binge, qualitative, gorge, and snack eating styles.

Table 1. Gender differences in eating behavioral styles.

Eating Styles		Total	Male		Female		x^2 (df)	*p*-Value
			n	%	*n*	%		
Emotional	Yes		11	44.0	63	75.9	9.07 (1)	0.003
	No		14	56.0	20	24.1		
Binge	Yes		4	16.0	14	16.5	0.003 (1)	1.000 *
	No		21	84.0	71	83.5		
Qualitative	Yes		12	48.0	54	63.5	1.94 (1)	0.164
	No		13	52.0	31	36.5		
Quantitative	Yes		22	88.0	56	65.9	4.58 (1)	0.044 *
	No		3	12.0	29	34.1		
Gorge	Yes		13	52.0	33	38.8	1.38 (1)	0.240
	No		12	48.0	52	61.2		
Snack	Yes		11	44.0	48	56.5	1.21 (1)	0.272
	No		14	56.0	37	43.5		

* Fisher's Exact Test.

2.4. Gender Differences in Clinical Measures

HAM-D scores were significantly higher among women than men (median score = 9 vs. 7, mild depression, *p* = 0.048, Table 2). There were no gender differences in clinical measures of anxiety and emotion regulation (Table 2).

Table 2. Gender differences in clinical measures. Difficulties in Emotion Regulation Scale (DERS), Hamilton Depression Scale (HAM-D), and Hamilton Anxiety Scale (HAM-A).

	Total		Male		Female		Test Statistic	
	Median	25–75% Percentile	Median	25–75% Percentile	Median	25–75% Percentile	Mann–Whitney U	*p*-Value
DERS	76	60.75–95	73.5	57.25–98.25	77	61.5–94	683	0.457
HAM-D	9	5–16	7	2.25–12.75	9	5–17	1.082	0.048
HAM-A	9	4–14	6.50	2.25–13	9.5	5–15.5	1.029	0.161

2.5. Differences in Clinical Measures among Eating Styles

Binge eating style was associated with higher DERS, HAM-D, and HAM-A scores (*p* < 0.05 for all comparisons, Table 3, Supplementary Figures S1–S3). Emotional eating style was associated with higher HAM-D and HAM-A scores (*p* < 0.01 for all comparisons, Supplementary Figures S2 and S3). Quantitative eating style was associated with lower HAM-A scores (*p* = 0.01, Table 3, Supplementary Figure S3). In women, emotional eating style was similarly associated with higher depression and anxiety scores, while we observed no significant differences in clinical measures in the binge and quantitative eating styles, as detailed in Table 4. Qualitative, snacking, and gorging eating styles had no significant associations with any of the clinical measures (Tables 3 and 4).

Further details are given in the Supplementary Materials.

Table 3. Differences in clinical measures among eating styles. Difficulties in Emotion Regulation Scale (DERS), Hamilton Depression Scale (HAM-D), and Hamilton Anxiety Scale (HAM-A).

Binge Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	96.00	71.75–117.00	74.50	59.75–90.25	0.038
HAM-D	14.50	9.00–18.75	9.00	4.00–16.00	0.012
HAM-A	12.00	9.25–27.75	9.00	3.00–13.00	0.012
Emotional Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-value
DERS	77.50	64.25–100.50	67.50	56.00–87.75	0.056
HAM-D	12.00	6.00–17.25	5.00	3.00–9.75	0.001
HAM-A	11.00	5.00–17.00	5.00	3.00–11.00	0.001
Quantitative Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-value
DERS	74.00	59.00–93.75	80.50	66.75–107.25	0.222
HAM-D	9.00	5.00–14.00	14.00	4.00–18.00	0.138
HAM-A	9.00	3.00–12.00	12.00	7.25–19.00	0.014
Qualitative Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	77.00	63.00–98.25	70.50	59.00–93.75	0.317
HAM-D	9.00	4.25–17.00	9.00	5.00–14.00	0.591
HAM-A	11.00	5.00–15.00	8.00	3.00–13.00	0.195

Table 3. *Cont.*

Binge Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
Snacking Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	76.00	60.00–99.00	77.00	63.50–94.00	0.992
HAM-D	8.50	4.00–17.00	10.00	6.00–16.00	0.431
HAM-A	9.00	4.00–14.00	9.00	3.50–13.50	0.985
Gorging Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	74.50	63.25–95.75	76.50	60.25–97.00	0.793
HAM-D	9.00	5.00–16.00	9.50	4.00–16.25	0.682
HAM-A	9.00	3.00–13.50	10.00	5.00–14.00	0.356

Table 4. Differences in clinical measures among eating styles in women. Difficulties in Emotion Regulation Scale (DERS), Hamilton Depression Scale (HAM-D), and Hamilton Anxiety Scale (HAM-A).

Binge Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	85.50	71.00–108.50	77.00	60.25–92.25	0.326
HAM-D	14.50	9.00–17.75	9.00	5.00–16.00	0.132
HAM-A	11.00	7.50–17.00	9.00	4.25–15.00	0.240
Emotional Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	79.00	63.00–102.00	70.00	56.00–87.75	0.170
HAM-D	12.50	6.25–17.00	5.00	3.00–9.50	0.001
HAM-A	11.00	7.00–17.50	5.00	3.00–11.25	0.012
Quantitative Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	76.50	59.25–91.50	83.50	64.25–107.75	0.266
HAM-D	9.00	6.00–16.00	10.50	4.00–20.25	0.770
HAM-A	9.00	4.00–12.00	12.00	7.50–19.00	0.050
Qualitative Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	77.00	61.00–94.00	77.00	61.50–99.00	0.656
HAM-D	10.00	4.50–17.00	9.00	6.00–16.50	0.872
HAM-A	10.50	6.50–16.25	9.00	3.00–15.50	0.488
Snacking Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	74.00	60.00–90.00	82.00	69.50–97.50	0.276
HAM-D	9.00	4.00–16.75	12.00	7.00–18.00	0.103
HAM-A	9.00	5.00–15.00	10.00	4.00–19.00	0.527
Gorging Eating Style	Yes		No		
	Median	25–75% Percentile	Median	25–75% Percentile	*p*-Value
DERS	79.50	69.25–102.50	76.50	60.00–91.00	0.383
HAM-D	9.00	6.00–16.00	10.00	4.00–17.00	0.809
HAM-A	9.50	5.00–14.00	9.50	5.00–16.75	0.972

3. Discussion

This study provides novel evidence on gender differences in pathological eating styles, and on associations between eating styles and clinical measures in bariatric surgery candidates. Furthermore, the present study confirms existing evidence [5,32] on the high prevalence of dysfunctional eating styles in bariatric surgery candidates.

3.1. Gender Differences in Eating Styles

We report for the first time that, among candidates to bariatric surgery, women present more often with an emotional eating style than men, while men present more often with a quantitative eating behavior. This is in disagreement with a study on overweight subjects showing that emotional overeating is not related to gender [33]. This difference may be explained by the inclusion in that study of less overweight patients than in our study, which included only obese bariatric surgery candidates. On the contrary, our findings converge with and advance existing evidence showing that, both in adolescence [11] and in adult life [34], women are more often emotional eaters than males. We confirm this pattern in bariatric surgery candidates, linking pathological eating styles with clinical scores as detailed in the next section.

The causes of this gender difference in pathological eating styles may be psychological, socio-cultural, and biological-organic. While investigating these mechanisms is out of the scope of the present work, we briefly discuss below these hypothetical causes of the gender difference in pathological eating styles.

From a psychological perspective, Kheirollahpour et al. [35] highlight how emotion dysregulation and excessive attention to weight and body shape are associated with dysfunctional eating behaviors.

From a socio-cultural perspective, women seem to be more exposed to social pressure concerning their body image [36,37], which may thus lead to higher rates of pathological eating styles related to emotion dysregulation and impulsiveness, such as emotional eating in our study.

From a biological-organic perspective, ovarian hormones (i.e., estradiol and progesterone) might expose to higher overeating risk, and hormonal fluctuations may therefore favor disordered eating in women. Indeed, the mid-luteal menstrual phase is associated with increased risk for emotional and binge eating [23].

The present study partially converges with existing findings showing that men present lower emotional response in association with pathological eating styles [38]. This is in agreement with our finding that men candidate to bariatric surgery show more often a quantitative eating style, and less often an emotional one, than women. Additionally, women seem to express emotions more prominently and globally to have more strategies to regulate emotions compared to men [39,40]. This may partly explain why women show more emotional eating than men in our sample and in general.

3.2. Associations between Eating Styles and Clinical Measures

We report that eating styles are associated with different levels of emotion dysregulation, anxiety, and depressive symptoms. In detail, subjects presenting emotional or binge eating styles had higher levels of depression and anxiety, and those presenting a binge eating style had also more difficulties in regulating emotions. On the other hand, subjects presenting quantitative eating styles had lower anxiety levels than those without quantitative eating style. This is in agreement with previous evidence [41–44], and suggests that emotional dysregulation may underlie binge and emotional eating styles, through difficulties in impulse control and engagement in goal-directed behavior, and ineffective emotion regulation strategies.

The association between psychiatric symptoms, i.e.,anxiety, depression, and emotional dysregulation and emotional or binge eating styles has been described in previous studies showing that emotional eating is associated with higher depressive symptoms compared to other eating styles in 592 subjects without specific psychiatric diagnoses [45], and in

361 subjects with obesity [46]. This also partly explains why emotional eating is more frequent in women, who presented higher depressive symptoms in our study. Of note, emotional eating style predicted higher BMI increases independently of depressive symptoms [45]. Additionally, results from a large sample of 1388 pre-bariatric surgery adults support the hypothesis that emotional dysregulation is implicated in the psychological mechanisms underlying binge eating style [2].

Overall, these findings suggest that anxiety, depression, and emotional dysregulation may play a more important role in the development of emotional or binge eating styles than in the development of other eating styles. Longitudinal studies are needed to test the potential causality of this association.

3.3. Significance, Future Research Directions, Strengths, and Limitations

Future research is warranted to further characterize the longitudinal trajectories of eating styles to pinpoint clinical markers of risk of excessive weight gain or dysfunctional eating, for instance, post-bariatric surgery. Given that emotion regulation difficulties are likely to persist after bariatric surgery, future prospective longitudinal studies should focus on assessing whether these associations between gender, clinical scores, and eating styles persist or re-emerges after surgery. This would also allow understanding how emotion regulation difficulties impact pathological eating styles in the long term. Research on predictors of post-surgery pathological eating styles is much needed because it would better delineate the temporal pattern and potential causality between these variables, but such research is currently limited.

The identification of gender-specific patterns of pathological eating styles paves the way to gender- and symptoms-appropriate interventions for pathological eating behaviors targeted at differentially expressed psychiatric symptoms, such as emotion dysregulation, anxiety, and depression. Finally, there is evidence that bariatric surgery may affect emotion regulation [47]. Thus, longitudinal randomized control trials are needed to evaluate whether gender-specific treatments of emotion regulation difficulties and/or dysfunctional eating styles may improve the outcomes of bariatric surgery through an effect on patients' psychiatric symptoms.

This prospective, monocentric, observational study recruited a large sample of bariatric surgery candidates. The intentionally broad inclusion criteria and the clinical expertise of the Fatebenefratelli Sacco Hospital allow fair representativeness of the sample. The findings overall converge with existing literature, despite the fact that the topic of gender differences in pathological eating styles and emotion regulation in bariatric surgery candidates is understudied. The study provides novel and original findings validated by existing evidence [2,45,46]. However, the cross-sectional design and correlational analyses do not allow to infer causality or temporal dynamics. Furthermore, this study's reliance on self-report questionnaires inevitably involves a potential risk of response bias, and we cannot exclude a certain extent of observer bias as well, although the clinical characterization of the participants was thoroughly performed by specialists in the field. Finally, the monocentric nature of the study and the inclusion of Italian-speaking subjects partially limits the generalizability of the present findings. However, our sample's demographic corresponds to common demographics of bariatric surgery patients. Consistently with previous literature [48,49], and a recent global systematic review and metanalysis [50], our participants are all Caucasian and predominantly women. Non-Caucasian women, despite their higher prevalence of obesity according to the National Center for Health Statistics [50], are under-represented in the literature on bariatric surgery. Future studies are needed to investigate whether our results are replicable in other ethnic groups, and to unveil if non-Caucasian women have limited access to bariatric surgery to overcome potential sources of inequalities.

4. Materials and Methods

4.1. Population

Subjects were recruited from the multidisciplinary obesity surgery center of the Fatebenefratelli Sacco Hospital in Milan in a period between 2019 and 2021. Details on sample size estimation are given in the Supplementary Materials. All subjects scheduled for bariatric surgery and satisfying SICOB (the Italian Society of Surgery for Obesity and Metabolic Diseases) criteria for bariatric surgery (detailed in the Supplementary Materials) were consecutively recruited. They were excluded if they were younger than 18 years old, if they did not speak Italian, or if they did not consent to take part in research. They underwent a clinical interview to exclude any mental disorders comorbidity and to assess eating behavioral styles. Thus, for instance, patients were included if they presented binge eating style, but not if they presented the full-blown binge eating disorder. Patients signed an informed consent, and their identity was protected.

4.2. Eating Behavioral Styles and Clinical Scores

In the context of the evaluation of the surgery eligibility, patients were thoroughly monitored through a multi-disciplinary medical consultation (with dietologists, gastroen-terologists, psychiatrists, and psychologists). In particular, a psychiatrist (PL) and psy-chotherapist (MS) clinically assessed and classified the eating behavior styles for each subject based on their symptoms and clinical history, through detailed clinical interviews involving specific questions to assess the presence of each eating style. Details about such clinical interviews are provided in the Supplementary Materials (Supplementary Table S1).

Additionally, clinical scores were collected, i.e., Difficulties in Emotion Regulation Scale (DERS), Hamilton Depression Scale (HAM-D), and Hamilton Anxiety Scale (HAM-A). Details about these clinical scores are provided in the Supplementary Materials.

4.3. Statistical Analyses

We analyzed gender differences in eating behavioral styles and their relationships with clinical scores. In detail, we tested gender differences in clinical measures (DERS, HAM-D/A) and eating styles (emotional, binge, qualitative, quantitative, gorge, and snack eating) using independent-samples Mann–Whitney U test and Fisher's Exact Test in SPSS©.

5. Conclusions

The present findings highlight the importance of understanding the role of gender differences in emotion regulation processes involved in the development and maintenance of pathological eating behaviors in bariatric surgery candidates. The evidence discussed above indicates that gender-specific interventions targeting underlying emotion dysregula-tion may be pivotal in reducing dysfunctional eating styles that commonly undermine the long-term outcomes of bariatric surgery, especially binge and emotional eating in women. Our findings give momentum to recent efforts towards a more personalized and gender-conscious medicine, which is essential to develop more gender-appropriate treatments and preventive interventions [45].

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