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ORIGINAL CONTRIBUTIONS

Associations of COVID-19 Lockdowns on Eating Behaviors and Body Mass Index in Patients with a History of Bariatric Surgery: a Cross-Sectional Analysis

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Abstract

Introduction Few studies have explored the impact of the COVID-19 pandemic on the eating behaviors, dietary quality, and changes in weight of postoperative bariatric surgery patients.

Methods A cross-sectional survey on eating behaviors and attitudes toward food was emailed or given to patients who had bariatric surgery before March 2020. Patient charts were reviewed for weight measures.

Results Seventy-five (71.43%) patients experienced weight recurrence with an average increase in body mass index (BMI) of 2.83 kg/m^2 (SD: 2.19). The majority of patients reported no symptoms of binge eating ($n = 81$, 77.14%) with 16 (15.24%) qualifying for loss of control eating (LOCE). LOCE was significantly associated with grazing behavior ($p = 0.04$), emotional over-eating ($p = 0.001$), and food responsiveness ($p = 0.002$). LOCE was negatively associated with dietary quality ($p = 0.0009$) and satiety responsiveness ($p = 0.01$). Grazing behavior was significantly associated with emotional over-eating ($p < 0.0001$) and food responsiveness ($p < 0.0001$) as well as negatively associated with dietary quality ($p < 0.0001$). Slow eating was negatively associated with grazing ($p = 0.01$), emotional over-eating ($p = 0.003$), and food responsiveness ($p < 0.0001$). When included in a regression model controlling for age and sex, emotional over-eating was a significant predictor of weight recurrence ($\beta = 0.25$; $p = 0.04$).

Conclusion Our results suggest that maladaptive eating behaviors contributed to LOCE and poor dietary quality during the COVID-19 pandemic; however, slow eating may be protective against grazing, emotional over-eating, and food responsiveness.

Keywords Bariatric surgery · Surgical weight loss · Eating behaviors · Dietary quality · Loss of control eating · Weight recurrence · Adult eating behavior questionnaire · AEBQ

Key Points

- The majority of patients experienced weight recurrence.
- Loss of control eating was significantly associated with emotional over-eating.
- When included in a regression model controlling for age and sex, emotional over-eating was a significant predictor of weight recurrence.
- Slow eating may be protective against grazing, emotional over-eating and food responsiveness.

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Introduction

COVID-19 was declared a worldwide pandemic by the World Health Organization in March 2020, and almost every aspect of daily life was disrupted. Orders for social distancing and quarantine were critical to slow down disease spread, but came at the expense and limitation of other liberties such as physical activity, in-person socialization, and engagement in normal daily activities. An international survey examined the effect of stay-at-home orders during COVID-19 in 1074 adults and found that there was increased consumption of unhealthy food, impulsive eating, and snacking [1]. In patients with a current or past history of obesity, recent studies have examined the psychological impact of the COVID-19 pandemic and found increased psychological distress associated with changes in dietary compliance, including increased frequency of snacking and impulsive eating [2–4]. Patients have reported difficulty in achieving weight loss goals and increased frequency of stress eating [3, 5].

In the context of the bariatric patient population, emotional dysregulation resulting in maladaptive eating behaviors can lead to undesirable long-term postoperative outcomes, such as weight recurrence (WR) [6–8]. Poor dietary quality has been reported in postoperative bariatric patients, and patients reported some degree of return of maladaptive behaviors, such as smoking or drinking more alcohol than usual [5]. Maladaptive eating behaviors have been associated with less weight loss and/or more WR in the postoperative bariatric population, and up to 40% of postoperative bariatric patients have been reported to develop loss of control eating (LOCE) by 2 years after postoperatively [9, 10].

Most of the current literature suggests that the pandemic has had detrimental effects on postoperative weight loss [11]. Conceição et al. (2021) conducted a cross-sectional study in Portugal of postoperative bariatric patients and found that the pandemic was associated with less total weight loss and larger WR at 3 years after surgery compared to patients whose postoperative course was completed before the pandemic [12]. Another cross-sectional study with 75 postoperative bariatric patients found that during the pandemic, higher reported levels of emotional distress during quarantine were associated with higher consumption of energy-dense micronutrient-poor foods, which was associated with higher odds of maintaining or increasing their body mass indices (BMI) [13].

There is a dearth of literature on the impact of maladaptive eating behaviors in the bariatric population in the context of the COVID-19 pandemic within a US population. The purpose of this study was to describe the pandemic's impact on eating behaviors such as binge eating, grazing, LOCE, its effects on dietary quality, and the resulting changes in post-surgical weight of bariatric surgery patients.

Methods

Participants and Procedures

This cross-sectional study was conducted at a single academic medical center from October to December 2021 using REDCap [14]. The survey was emailed and distributed in clinic to those who underwent weight loss surgery prior to March 2020. Topics included demographics, eating behaviors, and dietary quality with additional variables abstracted from the electronic health record (EHR). Inclusion criteria were as follows: patient of the institution, adult (age 18 or older), able to access the internet, and underwent surgery prior to March 2020. Exclusion criteria included patients under 18 as well as those who had surgery after March of 2020 or never had bariatric surgery. Respondents were instructed to reflect on their dietary quality and eating behaviors since the start of the COVID-19 lockdown orders in March of 2020. Those who offered completed responses were entered into a raffle for one of four $50.00 gift cards.

Data Collection Instruments and Measures

Dietary Quality Dietary quality was measured using the Rapid Eating Assessment for Participants (Short Version; REAP-S) [15], which has previously been used in samples including persons with obesity and those presenting for bariatric surgery [16, 17]. The REAP-S is a 16-item instrument that is designed to assess the quality of an individual's diet by accounting for the frequency with which individuals consume certain foods or engage in certain behaviors on a 3-point scale. The first 13 of these items are included in the total REAP-S score with higher numbers indicating better dietary quality and a total score range of 13 to 39.

Eating Behaviors Eating behaviors were evaluated using the Adult Eating Behaviors Questionnaire (AEBQ), which has been previously validated in a pre-bariatric patient sample [18, 19]. The AEBQ has 35 items and contains 8 subscales including hunger, food responsiveness, emotional overeating, enjoyment of food, satiety responsiveness, emotional undereating, food fussiness, and slowness in eating. Higher scores for the subscale indicated a stronger presence of the eating behavior. Pre-surgical AEBQ responses were also abstracted from the patient's intake evaluation at the beginning of the program. Additionally, two items from the Weight and Lifestyle Inventory (WALI) were used to assess for binge eating along with LOCE [20]. These items are consistent with the Diagnostic and Statistical Manual of Mental Disorders—5th edition for binge-eating disorder (BED) diagnostic criteria [21]. The sum of these two items resulted in a 3-point categorical scale of no binge eating, binge eating, and LOCE. Lastly, a single item was presented to each respondent with a definition of "grazing." Respondents were asked to identify how frequently they engaged in this style of eating using a 4-point ordinal scale of never to always.

Sociodemographic and Weight Data A number of items were included at the end of the questionnaire to capture sociodemographic information including age, sex, race, ethnicity, education, alcohol use, and tobacco use. Additionally, weight and height data for participants were abstracted from the EHR to avoid the potential for recall bias. Each

Table 1 Sample characteristics

Variable	($N=105$)
Age$^{\mu}$	47.95 (12.48) [25, 78]
Highest BMI$^{\mu}$	48.48 (8.11) [35.22, 70.83]
Lowest BMI$^{\mu}$	34.37 (7.62) [19.85, 61.38]
March BMI$^{\mu}$ ($n=39$)	34.96 (8.11) [22.85, 61.38]
Current BMI$^{\mu}$	36.61 (8.29) [25.40, 69.53]
Change in BMI from highest$^{\mu}$	− 11.87 (6.29) [− 33.08, 0.82]
Change in BMI from March$^{\mu}$	0.30 (3.08) [− 5.61, 8.15]
%EWL from highest (in kg)	66.94 (25.79) [− 3.34, 98.13]
%TWL from highest (in kg)	24.25 (11.53) [− 1.65, 49.21]
Average amount of BMI recurrence ($n=75$)$^{\mu}$	2.83 (2.19) [0.07, 11.70]
Average amount of BMI recurrence since March 2020 ($N=22$)$^{\mu}$	2.43 (1.77) [0.14, 8.15]
Average time since surgery (months)	40.33 (20.90) [16, 200]
Sex	
Male	22 (21.36)
Female	81 (78.64)
Race	
Black/African American	2 (1.90)
White/Caucasian	101 (96.19)
Other/decline to answer	2 (1.90)
Ethnicity	
Hispanic/Latino	1 (0.98)
Non-Hispanic/Latino	98 (96.08)
Decline to answer	3 (2.94)
Education	
High school diploma/ GED	30 (28.57)
Associate's, some college, or trade	38 (36.19)
Bachelor's degree	22 (20.95)
Graduate	14 (13.33)
Decline to answer	1 (0.94)
Alcohol use	
No Alcohol	38 (36.54)
1 drink or less per month	32 (30.77)
2–3 drinks per month	15 (14.42)
1–2 drinks per week	9 (8.65)
3–6 drinks per week	5 (4.81)
1 drink per day	-
More than 1 drink per day	5 (4.81)
Smoking	
Current	8 (7.62)
Former	29 (27.62)
Never	68 (64.76)

BMI, body mass index (kg/m2); *%EWL*, percent excess weight loss; *%TWL*, percent total weight loss; *GED*, graduate educational development

Data are presented as frequencies (*N*) and percents (%) unless indicated with ($^{\mu}$), which are presented as means and standard deviations. %EWL was calculated taking the difference between the patient's highest weight and current weight over the calculated excess body weight using a reference of BMI equal to 25. %BWL was calculated taking the difference between the patient's highest weight and current weight over their highest weight

patient's highest recorded weight, lowest recorded weight since surgery, pre-pandemic weight (measured at or within 2 months of March 2020), and their current weight at the time of survey completion were recorded along with their height to calculate BMI. All weights were measured in kilograms (kg) and BMI in kg/m^2.

Statistical Analyses

Statistical analyses were conducted using SAS Version 9.4 (SAS Institute Inc., Cary, NC). Missing data was minimal with ranges of 0.00 to 8.57%. Variables with missing data were excluded from analyses. Summary statistics were used to characterize the sample along with the instrument scores. Pre-surgical AEBQ scores were compared to current scores using paired means Student's *T*-test to compare scores for those respondents who completed both time points. A linear multivariable stepwise regression model was built predicting the amount of WR from the patient's lowest recorded weight. All continuous predictor variables were standardized using the sample standard deviation (SD). The significance levels for stay and entry were set to 0.15. Due to limits for the sample size, only the AEBQ subscales were included in the stepwise model and controlled for age and sex. A correlation matrix was also built using Spearman's correlation coefficients with rho values from 0 to 0.29 considered poor, values from 0.30 to 0.60 considered fair, and values from 0.61 to 0.80 considered strong [22].

Results

Across all recruitment methods, 124 participants completed part or all of the survey. A total response rate could not be calculated as the total number of participants who were recruited in clinic and saw the institutional recruitment boards could not be ascertained. Of those 124 individuals, 6 (4.84%) declined to participate after reading the study summary, 12 (9.68%) responses were incomplete and deemed to be a withdrawal of consent, and 1 (0.81%) was a duplicate response. The total number of complete responses included in these analyses is 105 (84.68%) with sample characteristics presented in Table 1. Informed consent was obtained from all individual participants included in the study.

Of these, the majority of the sample were female ($n=81$, 78.64%), White/Caucasian ($n=101$, 96.19%), and non-Hispanic/Latino ($n=98$; 96.08%). There was an average reduction of total BMI of – 11.87 kg/m^2 (SD: 6.29) from the highest recorded weight. Of those who responded, 75 (71.43%) experienced WR with an average increase in BMI of 2.83 kg/m^2 (SD: 2.19) and a total range from 0.07 to 11.70 kg/m^2. In total, 39 (37.14%) had a recorded weight at or around March 2020. Of these individuals, 22 (56.41%) experienced WR with an average increase in BMI of 2.43 kg/m^2 (SD: 1.77) and a range of 0.14 to 8.15 kg/m^2. The average time since surgery was 40.33 (SD: 20.90) months with a range of 16 to 200 months.

In terms of instrument scores (Table 2), the majority of patients reported no symptoms of binge eating ($n=81$; 77.14%) with 16 (15.24%) qualifying for LOCE. An equal number of respondents (n = 43; 40.95%) indicated that they engage in grazing eating behaviors "sometimes" or "often." Mean (SD) dietary quality scores were fair at 28.65 (4.32). Some of the highest mean subscales scores for the AEBQ were emotional overeating (15.69 [5.38]), satiety responsiveness (14.48 [2.98]), and hunger (13.82 [3.63]). Figure 1 shows the average change in AEBQ subscale scores from the patients' presurgical assessments. Paired mean analyses indicated that satiety responsiveness had the highest mean increase of 3.75 with a 95% confidence limits (95% CL) of [2.95, 4.55]; $p<0.0001$. Emotional overeating and slowness in eating scores also significantly increased by 2.33 [1.03, 3.63] points ($p<0.0001$) and 1.54 [0.74,2.35] ($p=0.0003$), respectively.

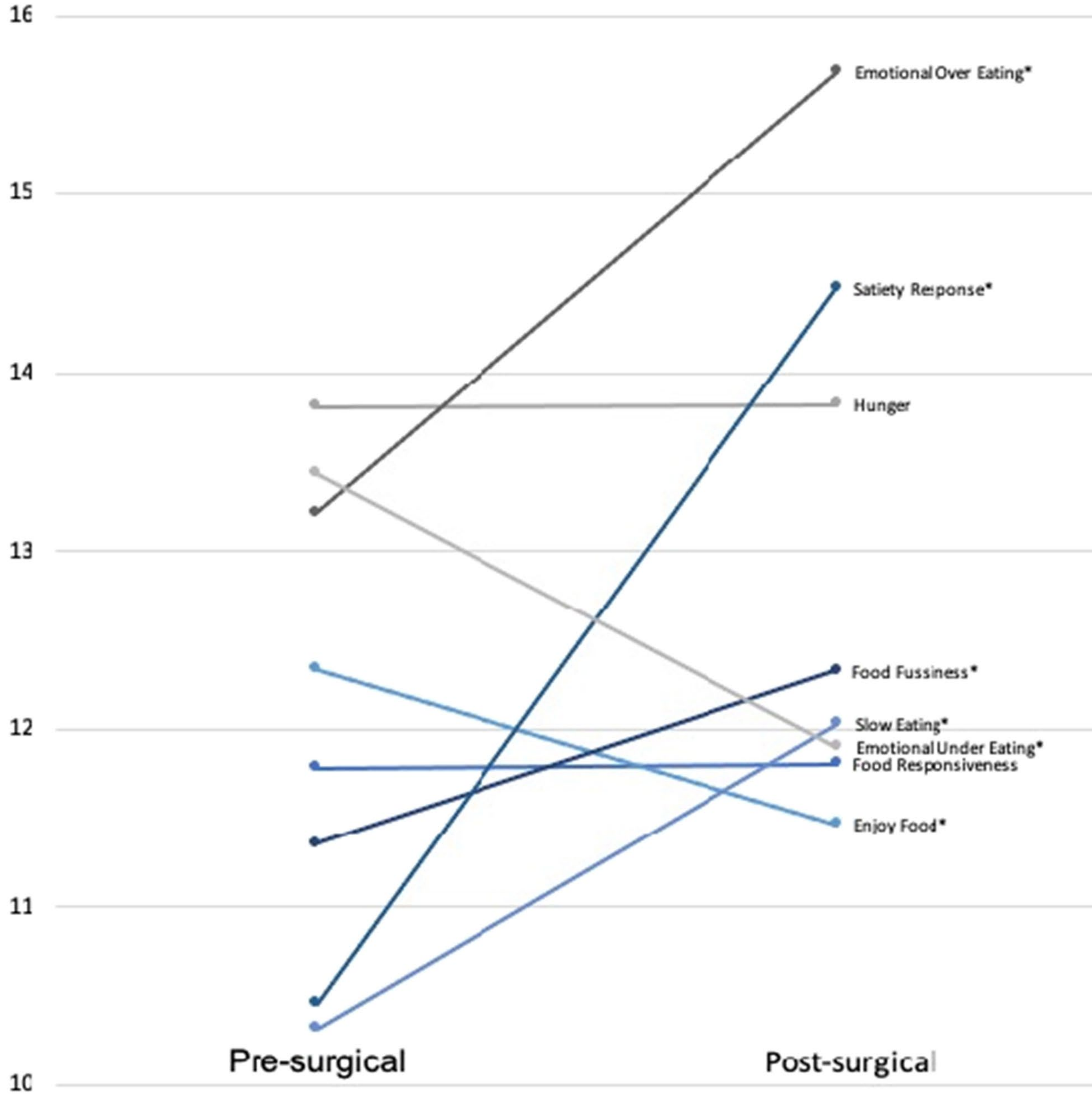
Table 3 shows the results of the stepwise linear regression model including the eight AEBQ subscales and WR predictions. After controlling for age and sex, only the emotional overeating subscale remained in the model with a parameter estimate of 1.69 and a *p*-value of 0.01 with a significant model *p*-value of 0.02. Thus, emotional overeating was significantly associated with WR after controlling for age and sex with an increase of 1.69 kg for every increase in SD of the emotional overeating score.

Univariable analyses are presented in Table 4 and demonstrated that without controlling for other variables, WR was

Table 2 Eating behavior instrument scores

	N(%)
Binge eating ($n=105$)	
None	81 (77.14)
Binge Eating	8 (7.62)
LOCE	16 (15.24)
Grazing ($n=105$)	
Never	8 (7.62)
Sometimes	43 (40.95)
Often	43 (40.95)
Always	11 (10.48)
	Mean (SD); Total possible score range
REAPS ($n=96$)	28.65 (4.32); [13–39]
AEBQ	
Enjoyment of food ($n=103$)	11.47 (2.33); [3–15]
Food fussiness ($n=103$)	12.33 (4.53); [5–25]
Emotional overeating ($n=104$)	15.69 (5.38); [5–25]
Hunger ($n=100$)	13.82 (3.63); [5–25]
Satiety response ($n=104$)	14.48 (2.98); [4–20]
Food responsiveness ($n=104$)	11.81 (3.76); [4–20]
Slow eating ($n=104$)	12.03 (3.71); [4–20]
Emotional undereating ($n=102$)	11.90 (4.56); [5–25]

LOCE, loss of control eating; *SD*, standard deviation; *REAP-S*, rapid eating assessment for participants—short version; *AEBQ*, adult eating behavior questionnaire



Subscale	N	Change in Score (95% Confidence Limits)	P-value
Enjoyment of Food*	74	-0.74 (-1.20, -0.29)	P=0.001
Food Fussiness*	74	0.77 (0.04, 1.51)	p=0.04
Emotional Overeating*	73	2.33 (1.03, 3.63)	p=0.0006
Hunger	71	-0.30 (-1.35, 0.76)	p–0.58
Satiety Response*	72	3.75 (2.95, 4.55)	p<0.0001
Food Responsiveness	75	0.11 (-0.60, 0.82)	p=0.77
Slowness in Eating*	74	1.54 (0.74, 2.35)	p=0.0003
Emotional Undereating*	72	-1.53 (-2.85, -0.21)	p=0.02

Fig. 1 Plotted mean scores represent all pre- and post-questionnaire responses. Paired *T*-test was conducted for those who completed both assessments. *Indicates statistically significant change in scores from pre-surgical assessments $p < 0.05$

Table 3 Stepwise multivariable linear regression model predicting weight recurrence ($n=91$)

Variable	Parameter estimate (SE)	p-value
Age	−0.73 (0.66)	0.28
Sex	−3.13 (1.65)	0.06
Emotional overeating	1.69 (0.65)	0.01*

Full model included all subscales of the Adult Eating Behavior Questionnaire and controlled for age and sex. Continuous independent variables were standardized using the sample standard deviation for that specific variable. Model was significant at $p=0.02$

SE, standard error

*$p<0.05$

most strongly correlated with emotional overeating, though this association was non-significant. In addition, emotional overeating was positively correlated with hunger ($r=0.27$), binge eating ($r=0.34$), grazing ($r=0.41$), enjoyment of food ($r=0.44$), and food responsiveness ($r=0.51$) as well as negatively correlated with slow eating ($r=-0.28$), dietary quality ($r=-0.35$), satiety responsiveness ($r=-0.37$), and emotional undereating ($r=-0.37$). Satiety responsiveness was also negatively correlated with food responsiveness ($r=-0.50$) and positively associated with slow eating ($r=0.42$). Food responsiveness was also positively associated with hunger ($r=0.38$), grazing ($r=0.52$), and enjoyment of food ($r=0.67$).

Discussion

Our study found that approximately 15% of postoperative patients reported clinical symptoms of LOCE—a central component of BED. Previous studies have estimated the prevalence of eating disorders to be about 7.83% among post-surgical bariatric patients [23]. The relationship between maladaptive eating disorders and postoperative WR has been established in the pre-pandemic context, and LOCE is a negative prognostic indicator for long-term weight outcomes [5–10]. However, the literature is rather heterogenous in regards to the type of bariatric surgery performed, various types of assessment, differing definitions of weight outcomes (BMI, % excess weight loss, WR), and variable definitions of LOCE particularly in self-reported assessment measures [10, 24]. Our study sought to examine these relationships in the context of the COVID-19 pandemic.

In line with the available literature, our results suggest that maladaptive eating behaviors may have contributed to LOCE and poor dietary quality in a subset of the bariatric patient population during the COVID-19 pandemic [25]. In our study, LOCE was significantly associated with grazing behavior, emotional over-eating, and food responsiveness. Both LOCE and grazing behavior were negatively associated with dietary quality, and LOCE was also negatively associated with satiety responsiveness. It has been established that consuming foods with higher micronutrient density is associated with long-term weight loss maintenance [26]. These factors may have contributed to the WR experienced by more than half of the postoperative bariatric patients in our study, as 75 (71.43%) patients experienced WR and 81 (77.14%) experienced binge eating with 16 (15.24%) of those experiencing LOCE. These issues present opportunities for clinicians and bariatric programs to counsel patients regarding triggers for LOCE in both pre-operative and post-operative settings as a form of preventative medicine, particularly during the COVID-19 pandemic in which LOCE may be exacerbated.

Furthermore, our cohort displayed more "eating off-set" traits according to the AEBQ than "eating onset" traits [19]. "Eating off-set traits" include satiety response, emotional under-eating, food fussiness, and slowness in eating, while "eating onset" traits include hunger, food responsiveness, emotional over-eating, and enjoyment of food [27]. Patients reported increased satiety response, food fussiness, and slow eating in the peri-COVID time frame compared to the pre-surgical time frame, which may be due to the ramifications of bariatric surgery, such as the restrictive component likely leading to earlier satiety. However, despite increases in these "eating off-set" traits, emotional over-eating was still significantly associated with WR after controlling for age and sex. Hunger and food responsiveness remained the same over time while food enjoyment experienced by our patients in this study decreased with time. Clinicians may find it beneficial to counsel patients on triggers for emotional overeating and its relationship with WR.

Most notably, our study found that slow eating was negatively associated with grazing, emotional overeating, and food responsiveness. Consequently, eating meals slowly may be protective against these maladaptive eating behaviors that may encourage WR. Slow eating strategies have been described in literature as a way to maximize satiation, reduce energy intake within meals, and aid with body weight regulation [28, 29]. However, there is limited literature on slow eating strategies in postoperative bariatric patients. These results highlight the clinical and practical importance to encourage slow eating for postoperative bariatric patients in efforts to reduce maladaptive eating behaviors even outside of the context of the COVID-19 pandemic. Additionally, our patients experienced increased satiety response over time, which is also beneficial in conjunction with eating meals slowly.

Limitations

Limitations of this study include a small sample size. The limited sample size, single center, and demographics of the respondents may limit the generalizability of these

Table 4 Spearman Correlation Matrix

	Binge eating	Grazing	REAP-S	Enjoyment of food	Food fussiness	Emotional over-eating	Hunger	Satiety response	Food responsive-ness	Slowness in eating	Emotional undereat-ing
Weight recur-rence^	0.07	0.08	−0.04	0.09	−0.04	0.17	−0.12	−0.06	0.08	0.02	−0.13
Binge eating		0.21*	−0.36**	0.27**	−0.03	0.34**	0.16	−0.22*	0.29**	−0.15	−0.08
Grazing			−0.49***	0.34**	0.05	0.41***	0.15	−0.33**	0.52***	−0.23*	−0.12
REAP-S				−0.23*	−0.25*	−0.35**	−0.16	0.15	−0.33**	0.11	0.08
Enjoyment of food					0.01	0.44***	0.30**	−0.41***	0.67***	−0.26**	−0.17
Food fussiness						0.19	0.23*	0.02	−0.02	−0.09	−0.01
Emotional over-eating							0.27**	−0.37***	0.51***	−0.28**	−0.37**
Hunger								−0.11	0.38***	−0.16	0.19
Satiety response									−0.50***	0.42***	0.31**
Food responsive-ness										−0.38***	−0.15
Slow eating											0.32**

REAP-S, rapid eating assessment for participants—short form

^Measured in kg from the lowest recorded weight

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.0001$

findings. Furthermore, the directionality of these associations is not definitive given the cross-sectional design of the study. Additionally, as this study was issued by the surgical weight loss program where these participants sought care and was self-reported, respondents may engage in impression management, resulting in response bias. Lastly, interpretations of definitions and the assessment of grazing and binge-eating behaviors may not be consistent as the "objectively large" criterion may not be uniform across all bariatric patients [30]. One factor that was not accounted for was type of bariatric surgery, which may or may not impact eating behaviors in the context of the pandemic.

Conclusions

These findings highlight that significant social adversity (such as that experienced during the COVID-19 pandemic) can have a negative impact on eating behaviors of post-operative bariatric patients. Clinicians should be aware of these stressors and counsel patients to utilize adaptive eating behaviors to maintain weight loss from bariatric surgery. In order to assess better the relationship between LOCE and WR in bariatric surgery patients, future studies should be designed to include pre-operative data on the presence of existing or a prior history of eating behavior disorders.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11695-023-06460-2.

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Data Availability Data are not available due to regulatory restrictions.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest AHu has no conflict of interest. AHarvey has no conflict of interest. AMR has received honoraria from Intuitive Surgical, Medtronic, Ethicon Endosurgery, and WL Gore. All other authors have no financial disclosures. AR has no conflict of interest. MB has no conflict of interest.

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