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Original article

# How are bariatric patients coping during the coronavirus disease 2019 (COVID-19) pandemic? Analysis of factors known to cause weight regain among postoperative bariatric patients

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## Abstract

**Background:** The global coronavirus disease 2019 (COVID-19) pandemic is wreaking havoc on society. Bariatric patients are more prone to severe infection due to their high body mass index (BMI) and are more vulnerable to the effects of isolation, such as depression or disruption of their health habits.

**Objectives:** To quantify the impact of self-quarantine on bariatric patients and self-quarantine's relationship with weight gain.

**Setting:** Academic hospital, United States.

**Methods:** A 30-item survey examining several known contributors to weight regain was distributed among the postoperative bariatric patients of our clinic. Changes in eating habits, exercise, depression, social support, loneliness, and anxiety were studied, among others.

**Results:** A total of 208 patients completed the survey (29.3% response rate). A large percentage of patients reported increases in their depression (44.2%), loneliness (36.2%), nervousness (54.7%), snacking (62.6%), loss of control when eating (48.2%), and binge eating (19.5%) and decreases in their social support (23.2%), healthy food eating (45.5%), and activity (55.2%). Difficulty in accessing vitamins was reported by 13%. Patients more than 18 months out of surgery regained more than 2 kg during an average of 47 days. Risk factors for weight regain were found to be loss of control when eating, increases in snacking and binge eating, reduced consumption of healthy food, and reduced physical activity.

**Conclusion:** Bariatric patients are negatively affected by the COVID-19 pandemic and subsequent social isolation on many levels. This patient population is vulnerable to crisis situations; thus, additional intervention is needed to address behaviors that lead to weight regain. (Surg Obes Relat Dis 2021;17:756–764.) © 2020 American Society for Bariatric Surgery. Published by Elsevier Inc. All rights reserved.

## Key words:

Bariatric surgery; COVID-19 pandemic; Weight regain; Eating habits; Social support; Depression; Wellbeing; Worry; Loneliness; Nervousness

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent of coronavirus disease 2019 (COVID-19), was declared a worldwide pandemic by the World Health Organization (WHO) on March 11, 2020 [1]. The first U.S. COVID-19 case was reported in January 2020 and reached a peak incidence in early April [2]. The rapid spread of this highly contagious disease has mandated the adoption of social distancing and stay-at-home measures to reduce its transmission and “flatten the curve.” Preliminary data, however, have already shown that older age and obesity are major, negative prognostic factors for severe COVID-19 disease [3,4]. More specifically, obesity has been linked with higher requirements of invasive mechanical ventilation and mortality [5] and some studies have even suggested that obesity is a risk factor for severe disease in younger patients [6]. Given the fact that a vaccine will require time for development, clinical trials, Food and Drug Administration approval, and eventual manufacture and distribution, the main focus has been disease prevention. These include measures such as wearing a mask, social distancing, hand hygiene, and, additionally to prevent severe disease, control of co-morbidities and weight loss [5,7].

Obesity affects more than 42% of the U.S. population [8]. The most effective and durable option for weight loss is bariatric surgery [9]. Nevertheless, weight regain is a common concern after surgery [10,11] and has been shown to occur more frequently in patients with depression, anxiety, lower social support, and unhealthy eating habits, such as snacking and loss of control while eating [12–14].

The psychological impact of isolation/quarantine and the fear of transmission of a potentially life-threatening disease has been found to be both substantial and long lasting [15]. Even though studies have been undertaken regarding weight gain in the general population, little is known regarding the pandemic’s effects on patients following bariatric surgery [16,17], a population that is more vulnerable to stressors that can eventually lead to higher long-term weight regain and, thus, the return of co-morbidities. Regain of weight, in turn, can increase the risk of severe COVID-19 infection, lead to the return of obesity-associated co-morbidities, and decrease the quality of life of those patients [10,11]. Thus, the aim of this study was to assess the impact of the COVID-19 pandemic on several aspects of life that are likely to lead to weight regain in those patients.

## Methods

### *Survey design and distribution*

Following Institutional Review Board approval, a survey was distributed to patients who underwent weight loss surgery after December 31, 2013, at a single institution. A 30-item survey was sent to participants by email. Questions pertained to the patients’ employment status, eating habits, weight gain, vitamins and co-morbidities, exercise habits, lifestyle, and mental health since the disruption to their

normal routine by the COVID-19 pandemic. All questions regarding mental health and eating habits were derived and/or modified from validated instruments (Table 1). The following modifications were made in accordance with our objectives: (1) the reporting time frame was changed to pre- and postpandemic disruption; (2) we chose a uniform response choice format (7-point Likert scale); (3) to keep the survey short and hence increase the response rate, we chose the most important, in our opinion, symptoms rather than including whole questionnaires to assess problem areas; and finally, (4) the wording sometimes needed to be changed slightly to fit our COVID-19 questionnaire format. The snacking, binge eating, and loss of control questions were based on the Eating Loss of Control Scale questionnaire [18]. The 2 depression items were based on the Patient Health Questionnaire 2-question version [19]. The 2 anxiety items were based on the Generalized Anxiety Disorder 2-question version [20]. A 2016 review of loneliness and social support classified 54 measures into 2 dimensions: functional/structural and subjective/emotional [21]. Valtorta et al. [21], in identifying the functional/structural dimension of social relationships, emphasized the size of the social network, source (e.g., family or friends), and availability. To capture this in 1 question, we asked: “I have \_\_\_\_ social support compared to before the disruption of my normal routine by the COVID-19 pandemic (social support can be family, friends, significant other, health-care professional support).” To assess the second dimension, we chose a direct question about loneliness [21], an approach recommended by the United Kingdom’s national program to assess loneliness if only 1 question is employed [22]. Finally, the rest of the questions were formulated by the authors (Table 1). Patients were also questioned on the duration of their social distancing at the time of the questionnaire completion. An additional manual review of each patient’s medical records was performed to obtain patient demographic characteristics, including age, sex, race, type of insurance, and number of months out from surgery. Those demographic characteristics were not captured through the questionnaire to reduce reporting bias. Importantly, the questionnaire was released during the state of Indiana’s peak day of COVID-19 cases, on April 26, 2020 [23].

### *Statistical analysis*

Survey results were imported into Microsoft Excel (Redmond, WA). Data were then imported into SPSS (Armonk, NY) for further statistical analysis. Means  $\pm$  standard deviations (SDs) were calculated for continuous data and total counts were tabulated for categorical data. Any missing data were addressed using the pairwise deletion method. Scores from the Likert scale responses (1–7) were treated as continuous data. The decision to treat the Likert scale as a continuous variable was made due to the large sample size of our study (i.e., more than 10 observations per group) and in order to gain the more robust and unbiased answers

Table 1  
Questions from validated questionnaires

Main questions, 7-point Likert-scale	Source from which derived
Related to binge eating and snacking	
Compared to before the disruption of my normal routine by the COVID-19 pandemic I am now snacking ____	Derived from ELOCS [18]
Compared to before the disruption of my normal routine by the COVID-19 pandemic I tend to consume large quantities of food in a short period of time ____	
Compared to before the disruption of your normal routine by the COVID-19 pandemic I eat despite not feeling hungry ____	
Related to depression	
Compared to before the disruption of your normal routine by the COVID-19 pandemic, I feel little interest or pleasure in doing things that I enjoyed doing before ____	Derived from PHQ-9 [19]
Compared to before the disruption of your normal routine by the COVID-19 pandemic, I am feeling down, depressed or hopeless ____	
Related to anxiety	
Compared to before the disruption of your normal routine by the COVID-19 pandemic, I feel nervous, anxious or on edge ____	Derived from GAD-2 [20]
Compared to before the disruption of my normal routine by the COVID-19 pandemic, I am unable to stop or control my worrying ____	
Compared to before the disruption of my normal routine by the COVID-19 pandemic, I feel lonely ____	Obtained from the recommended single direct-loneliness question by the England Office for National Statistics [22]
Related to exercise	
Compared to before the disruption of my normal routine by the COVID-19 pandemic I am now inactive __ (inactive = sitting, lying down, napping/or sleeping)	NV
My exercise routine includes ____ aerobic exercise (jogging, bike riding, brisk walking, swimming) now compared to before the disruption of my normal routine by COVID-19	NV
Related to food consumption	
Compared to before the disruption of my normal routine by the COVID-19 pandemic I now eat healthier food ____ (healthy food = vegetables, whole grains, lean meat, fewer sweets/ desserts)	NV
Related to social support	
I have ____ social support compared to before the disruption of my normal routine by the COVID-19 pandemic (social support can be family, friends, significant other, health-care professional support)	NV

COVID-19 = coronavirus disease 2019; ELOCS = Eating Loss of Control Scale; PHQ-9 = Patient Health Questionnaire 9-question version; GAD-2 = Generalized Anxiety Disorder 2-question version; NV = nonvalidated question.

offered by a parametric analysis [24,25]. Likert scale answers 1–7 were converted to a scale from –3 to +3, such that a positive value (+1, +2, and +3) represents a positive response (slightly more often, moderately more often, and much more often, respectively), while a negative value (–1, –2, and –3) represents a negative response (slightly less often, moderately less often, and much less often, respectively). A Likert response of 0 corresponded to the statement “about the same.”

To identify the various factors that affected our patients’ responses, we performed linear regression analyses for

each dependent variable (questions regarding emotions, eating habits, and exercise) while accounting for confounders, such as patient current age (continuous variable), patient sex (female/male), race (White, Black, and Latin/Hispanic), type of insurance (private and government), change of patient social support (Likert scale 1–7), change of weight (current weight minus the weight during the first day of social distancing), days in quarantine (continuous variable), and months out of surgery (continuous variable).

A binary logistic regression analysis was performed for binary variables, such as problems with access to essential

vitamins (yes/no) and any exacerbation of co-morbidities (yes/no), while accounting for the same confounders.

A subgroup analysis regarding weight change during the pandemic was conducted using an analysis of variance on patients with different postoperative follow-up times (0–6, 6–18, and >18 mo).

Responses to the free-text questions, such as asking respondents to elaborate on the problems faced with obtaining vitamins, were qualitatively analyzed for common themes.

All statistical analyses were performed using SPSS, and a *P* value of <.05 was considered statistically significant. We elected to present only the significant results of the multivariate analyses due to the high volume of data.

## Results

A total of 208 postoperative bariatric patients completed the survey out of the 710 emails that were sent (29.3% response rate). More specifically, 180 patients had undergone a primary bariatric procedure (86.5%), while 28 (13.5%) had undergone a revisional procedure. The primary procedures consisted of 114 laparoscopic Roux-en-Y gastric bypasses, 53 laparoscopic sleeve gastrectomies, and 13 others. All survey questions were answered by 87–100% of the participants. At the time of the questionnaire completion, the patients had been social distancing for an average of  $47.7 \pm 13.5$  days and were, on average,  $30.6 \pm 22.1$  months out of surgery. For those who were employed before the pandemic and were not retired (*n* = 158), 31% were still working at their office and 41.1% were working from home, while a smaller percentage were on a leave of absence (8.9%) or were terminated from their job (1.3%); the rest (17.7%) responded “other” for their work situation but did not specify further. Participants’ characteristics can be found in Table 2. During those days of quarantine, patients in the early postoperative period had  $6 \pm 3.5$  kg of weight loss. Patients who were 6–18 months out of surgery lost  $.7 \pm 3.9$  kg. Finally, those patients who were more than 18 months out from surgery reported an average weight gain of  $2 \pm 4.2$  kg (*P* < .001). Only 4 patients tested positive for COVID-19, and only 3 were hospitalized for another medical condition other than COVID-19.

The patients’ responses to the questionnaire can be found in Table 3. The majority of the respondents experienced some symptoms of mental health degradation. Many patients (36.2%) felt lonely either slightly, moderately, or much more often than before the COVID-19 pandemic. Similarly, 32.7% felt more worried and 54.7% felt more nervous. A depressed mood was seen in 44.2% of the respondents, while 37.4% of them felt a decrease in interest and/or pleasure. More specifically, following a multivariable analysis for confounders, higher levels of loneliness were observed among patients with government insurance (coefficient = .265; *P* = .009), younger age (coefficient = -.242; *P* = .021), and worsening social support

Table 2  
Patient characteristics

No. of patients	208
Age, mean $\pm$ SD, yr	48.9 $\pm$ 11.2
Female sex, %	86
Ethnicity, %	
White	86.1
Black	12.5
Latin/Hispanic	1.4
Private insurance, %	73.5
Months out of surgery, mean $\pm$ SD	30.6 $\pm$ 24.5
Prequarantine weight, mean $\pm$ SD, kg	92.1 $\pm$ 23.6
Current weight, mean $\pm$ SD, kg	92.8 $\pm$ 23.7
Weight change, mean $\pm$ SD, kg	
• 0–6 mo	-6 $\pm$ 3.5
• 6–18 mo	-.7 $\pm$ 3.9
• >18 mo	2 $\pm$ 4.2*

SD = standard deviation.

\* Weight gain of patients who were more than 18 months out of surgery was found to be significantly higher using an analysis of variance (*P* < .001).

following the COVID-19 pandemic (coefficient = -.447; *P* < .001). Similarly, younger patients were more worried (coefficient = -.292; *P* = .005) and had greater losses of social support (coefficient = -.248; *P* = .009). Nervousness was more frequently seen among younger patients (coefficient = -.371; *P* < .001), while depression was more common among patients with government insurance (coefficient = .265; *P* = .014).

Eating habits were severely affected as well, as 45.5% of respondents reported eating less healthy food than before the COVID-19 pandemic. Snacking was the most frequently reported bad eating behavior (62.6%), followed by loss of control when eating (48.2%) and binge eating (19.5%). Following a multivariable analysis, patients who were eating less healthy food were more likely to gain weight during the pandemic (coefficient = -.422; *P* < .001). Interestingly, patients who were social distancing for fewer days and were closer to their surgery date were eating unhealthier food (coefficient = .174 [*P* = .002] and coefficient = .233 [*P* = .002], respectively). Similarly, patients with exacerbated snacking habits regained more weight (coefficient = .409; *P* < .001) and were more likely to be White (coefficient = .210; *P* = .006) and younger (coefficient = .196; *P* = .014). Loss of control while eating was associated with more weight gain (coefficient = .457; *P* < .001) and was more common in patients further out from their date of surgery (coefficient = -.210; *P* = .01). Finally, binge-eating habits were more likely to lead to weight regain during the pandemic (coefficient = .394; *P* < .001).

Exercise during the pandemic was found to be negatively affected, with 51.8% of the respondents being less active and 55.2% reporting a reduction in their aerobic exercise. More specifically, before the pandemic, patients were exercising, on average, 2–3 hr/wk, while during the pandemic their exercise time was reduced to 1–2 hr/wk (*P* < .001).

Table 3  
Implications of COVID-19 pandemic on patients' mental health, eating habits, and exercise

Change during pandemic	Mean $\pm$ SD*	n/N (% of affected patients)	n/N (% of neutral patients)	n/N (% of unaffected patients)
Increased loneliness	1 $\pm$ 1.5	72/190 (37.9)	107/190 (56.3)	11/190 (5.8)
Increased nervousness	1 $\pm$ 1.3	104/190 (54.7)	76/190 (40.0)	10/190 (5.3)
Increase in snacking	.8 $\pm$ 1.4	119/190 (62.6)	49/190 (25.8)	22/190 (11.6)
Increase in depressed mood	.8 $\pm$ 1.3	84/190 (44.2)	95/190 (50.0)	11/190 (5.8)
Increased worry	.7 $\pm$ 1.3	64/190 (33.7)	116/190 (61.0)	10/190 (5.3)
Increased loss of interest/pleasure	.5 $\pm$ 1.4	71/190 (37.4)	98/190 (51.6)	21/190 (11.0)
Increased loss of control when eating	.5 $\pm$ 1.4	92/191 (48.2)	76/191 (39.8)	23/191 (12)
Increase in binge eating	.4 $\pm$ 1.3	37/190 (19.5)	131/190 (68.9)	22/190 (11.6)
Decrease in social support	.4 $\pm$ 1.1	44/189 (23.3)	125/189 (66.1)	21/189 (11.1)
Decrease in healthy food eating	.6 $\pm$ 1.4	87/191 (45.6)	77/191 (40.3)	27/191 (14.1)
Decreased aerobic exercise	1.1 $\pm$ 1.7	106/192 (55.2)	56/192 (29.1)	32/192 (16.7)

COVID-19 = coronavirus disease 2019; SD = standard deviation.

\* The values range from +3 to -3, with the positive and negative values indicating the amount each parameter increased or decreased, respectively, during the COVID-19 pandemic. Affected patients responded with +1 to +3, neutral patients responded with 0, and unaffected patients responded with -1 to -3.

The multivariable analysis revealed that White patients were exercising more than Black patients (coefficient = .167;  $P$  = .039) and were involved in more aerobic activities (coefficient = .170;  $P$  = .042). Additionally, socioeconomic factors were observed to affect our patients' activity, as patients with private insurance were exercising more than those with government insurance (coefficient = .172;  $P$  = .038). Also, more exercise was found to be associated with less weight gain (coefficient = -.180;  $P$  = .026), while inactivity was more common among patients who were in quarantine for fewer days (coefficient = -.178;  $P$  = .031).

Social support was reported to be decreased due to the pandemic by 23.2% of our patients. To improve their social support, 71% of our patients were using our clinic's Facebook social support group. In this group, they have the ability to communicate, motivate, and be motivated by their peers through chat in a protected environment where only patients of the clinic are allowed. Additionally, patients can seek advice from our group's supervising healthcare professionals, such as physician assistants, nurse practitioners, dietitians, and nurses.

The pandemic created obstacles for access to essential vitamins, as reported by 13% patients. Interestingly, nearly 26% of the patients reported some worsening in their co-morbidities. Nearly 26.3% were smoking more than usual, and 40.1% of those who were drinking alcohol had an increase in consumption. Patients who reported a worsening of their co-morbidities were also given a follow-up question allowing for them to free type which co-morbidities were worsening and how. Many of the participants who responded described multiple co-morbidities, ranging from worsening blood pressure (BP), higher blood glucose levels, worsening of anxiety and depression, worsening arthritis pain due to inactivity, and worsening of their inflammatory bowel syndrome. The most frequent answer provided was disruption to their sleep (either worsening sleep apnea or increased insomnia). Additionally, there were 4 participants that reported improvement in their co-morbidities, 2 of

whom stated that they felt less tired because of better sleep, 1 who reported better-controlled BP, and another who stated they had lower blood glucose. A small proportion of the participants (9%) acknowledged smoking. Of those, only 5 had increased the amount that they smoked since the start of the pandemic.

Following the multivariable analysis, White people had fewer issues with obtaining their vitamins compared to Black people (odds ratio = .279;  $P$  = .025), older patients had slightly less of an issue with vitamin accessibility (odds ratio = .926;  $P$  = .004), and patients with private insurance were less likely to have any hardship obtaining vitamins (odds ratio = .260;  $P$  = .017).

Of note, half of the patients who attended an online meeting with the bariatric clinic during the pandemic preferred it over the in-person meetings (50.5%).

## Discussion

The COVID-19 pandemic, as with most other pandemics, is relatively unique among disasters, in that initially there was not much information known about the disease. The virus causing COVID-19 is an invisible enemy, and the complete list of symptoms, degree of contagiousness, incubation period, lethality, timeframe for a return to "normal," and long-term sequela are not immediately known. In this study, we investigated the implications of the COVID-19 pandemic on patients after bariatric surgery, a population which is significantly more vulnerable to social isolation, depression, anxiety, and eating disorders. More specifically, we were interested in identifying how social isolation affected their mental health, social support, eating habits, exercise, and weight regain (if any), among other factors. Our results revealed that the pandemic has significantly affected our post-bariatric surgery population in most of our studied aspects, which sadly confirms the hypothesis.

Since the onset of measures to manage the pandemic, bariatric surgery patients have experienced increases in

depressed moods, anxiety/worry, and loneliness. Not surprisingly, pandemics can trigger or exacerbate these and other mental health symptoms, including insomnia, anger, numbness, and bereavement [15], and can even raise rates of suicide [26,27]. Mental health problems can last longer than the infection itself and spread more widely than the epidemic [28]. For these reasons, it has been recommended that mental health professionals should be on the “front line” [29].

Additionally, the quarantine order that is necessary to limit contagion further complicates the emotional distress involved. In their rapid review of the psychological impact of quarantines, Brooks et al. [15] found several contributors which determine the level of distress, including fear of infection, boredom, inadequate basic supplies, economic strain, stigma, and insufficient information. Unlike other disasters, such as earthquakes, floods, and tornados, pandemics do not easily promote social support. Loneliness was thought to contribute to the rise in older adults' suicides during the 2002–2004 severe acute respiratory syndrome (SARS) outbreak [27]. Relatedly, the resulting quarantine of a dysfunctional family unit can cut off healthy outside connections, such as schools and employers, and lead to increased violence against those most vulnerable [30,31]. Our study demonstrated an overall reduction in perceived social support and an increase in loneliness. The exacerbation of loneliness was especially reported by patients with noncommercial insurance. This makes sense, as the type of insurance can be a proxy for the degree to which an individual has the financial means to circumvent the isolating effects of a pandemic (e.g., technology). Support group attendance has been associated with greater weight loss after bariatric surgery [32,33]. With clinics reducing availability and even closing during a pandemic, alternative means of providing support to patients are needed. Social media platforms can at least partially fill this gap, but the feasibility and effectiveness of this form of support are only recently being researched [34]. Telehealth visits have been well received by patients. For example, physical training via telehealth has been shown to be helpful in patients preparing for bariatric surgery [35]. There is strong evidence for the acceptability, effectiveness, and cost savings of telebehavioral health interventions in general [36] and in the bariatric population more specifically [37]. As mentioned above, not all patients have the financial means to afford up-to-date hardware and Wi-Fi, so telephone-only contact will need to suffice. Fortunately, even telephone-only contact can be experienced as helpful by patients who have had bariatric surgery [38] and can be effective in the treatment of anxiety and depression [39].

Based on the results of this study, unhealthy eating habits worsened during a pandemic. We identified increases in snacking, binge eating, and loss of control while eating, which were all associated with higher weight regain. It is

known in the literature that unhealthy eating habits are associated with weight regain following bariatric surgery. Specifically, studies using validated questionnaires have shown that loss of control when eating was associated with weight regain [40–42]. Moreover, snacking is associated with weight increases even when the consumed calories between patients remain stable [43]. A similar association was found between binge eating and weight regain in postoperative bariatric patients [41,44]. During the quarantine, patients further out of their surgery date were eating relatively healthier food, which may be explained by greater experience with dietary adherence [45]. In addition, patients in the first days of quarantine were eating unhealthier food, which might be due to the initial high stress that social distancing inflicted on patients.

Weight regain was more prevalent among patients more than 18 months out of surgery. The amount of weight regain was nonnegligible, especially when taking into consideration the limited time most patients had been social distancing at the time of the survey. That finding is even more significant in bariatric patients, as it is known that once weight regain starts, it gets cumulative over time, as it is hard to lose weight afterwards [46].

Moreover, since the start of the pandemic, the amount of exercise performed per week by the participants was overall decreased and there was an increase in inactivity, resulting in increased weight gain. Aerobic exercise, which has been shown to have a greater impact on weight loss, was much affected [47]. Mandated closures of gymnasiums also likely contributed to decreases in exercise in some patients who depended on the equipment and the community for motivation. As previously mentioned, being of Black race and lower socioeconomic status were shown to be associated with decreased aerobic exercise and increased weight gain during this time. A possible explanation for this is higher population density in residential areas with lower socioeconomic levels. There are also lower numbers of local parks in those areas [48,49]. Both factors might explain the difference we are observing in the amount of aerobic exercise. Another possible explanation is that people of lower socioeconomic status might be living in food deserts or be prone to food insecurity, promoting the consumption of cheaper, unhealthy foods [50]. It is well established that Blacks and Hispanics have disproportionately larger incidences of poverty than Whites [51]. In a time when the whole population is under stress due to rising unemployment and fear of infection caused by a global pandemic, it is logical that people who were already suffering with financial hardship would pay less attention to their physical well-being. Participants that reported difficulty obtaining vitamins (13% of participants) were given a follow-up question to determine the cause. Although there were a few responses pertaining to lack of funds to pay for the medication, the vast majority did not want to go to a pharmacy or hospital to pick up the medication and were having difficulty obtaining the

vitamins online due to shipment delays or the vitamins being out of stock. A multivariable analysis showed that elderly patients and patients with private insurance had less hardship in obtaining their vitamins. It is counterintuitive that the elderly, who are at higher risk of serious complication due to SARS-CoV-2 infection, would have less difficulty obtaining vitamins. Some studies have showed that as age increases, so does medication compliance [52,53]; although our question was focused on difficulty obtaining vitamins, it is possible that older patients, who put a greater importance on medication compliance, were more willing to risk leaving their homes to obtain their vitamins. Another possibility is that elderly patients could have had help obtaining their medications from family and friends, whereas younger patients had to obtain the vitamins themselves. What is more, many patients reported increased insomnia or worsening sleep apnea during the COVID-19 pandemic. A possible explanation for the effect on the participants' insomnia, in addition to the increased stress from the pandemic, is the decrease in exercise and increase in inactivity, which have previously been shown to affect sleep [54]. Only 5 of the 208 patients had either started smoking or increased the amount of smoking since the start of the pandemic. This number could possibly be biased if participants feared answering truthfully about their smoking due to the importance of smoking cessation as stressed by surgeons, because of the increased risk of marginal ulcers [55,56]. Of the 208 patients, 27 had either started drinking or had an increase in alcohol consumption since the start of the pandemic. This comes as no surprise, as new stressors, such as those caused by a public health crisis, have been shown to cause an increase in alcohol consumption [57].

Our work has several implications for clinical practice. Bariatric programs should have initiatives in place that can address similar issues and minimize the negative effects on this vulnerable population. The development of support systems, such as online group meetings, can be a way to increase patients' social support and morale. For patients with limited access to the Internet, direct phone calls can still be a valuable source of encouragement. Additionally, more regular follow-up meetings with this patient population during difficult times can assist in addressing any issues, such as worsening of their co-morbidities, by offering counseling and adjusting some of their medications. Additionally, developing services for delivering vitamins would be beneficial, as many patients seemed to face difficulties in acquiring them.

Our study, however, does not come without limitations. This study entails results from patients of only 1 institution. Moreover, the response rate achieved increases the probability for a response bias. However, it is well known that email surveys have small response rates, and a 29.3% rate is on the high end of the expected rates. For reasons listed in the Methods section, we chose not to include entire validated

questionnaires in our survey, to keep it short enough to encourage completion and to provide response options that were uniform in our questionnaire. An additional limitation of this study is that the weight loss or regain was based on the patient's reported weight, which is known to be underreported by obese individuals [58]. Additionally, even though there is literature supporting the use of the 7-point Likert scale as a continuous variable, there might be an inherent bias according to other studies. Furthermore, another limitation is that the participants' time since weight loss surgery varied. Some weight regain is expected a few years after surgery [59,60]; thus, the weight regains seen in the patients who were more than 18 months out of surgery might not be entirely explained by the implications of the COVID-19 pandemic. Additionally, there is also a subgroup of patients who are between 6 and 18 months out of their surgery who are expected to lose more weight during the same period but might have lost less than expected due to the COVID-19 pandemic. However, this did not affect the associations between weight regain and the studied parameters, as the time after surgery was accounted as 1 of the confounders. Future studies looking at these patients' actual versus expected weight loss through historical cohorts could help set expectations for patients if a situation like this arises again.

## Conclusions

Our study's results confirm that postoperative bariatric patients experienced difficulties during the COVID-19 pandemic at many levels; our patients' mental health is deteriorating, their social support is declining, their eating habits are worsening, and their exercise is decreasing, all leading to weight regain. The bariatric population is vulnerable to crisis situations; thus, extra efforts should be taken to intervene, as the weight regained in these patients is difficult to lose afterwards.

## Disclosures

*The authors have no commercial associations that might be a conflict of interest in relation to this article.*

## References

- [1] World Health Organization [homepage on the Internet]. WHO timeline—COVID-19. 2020 April 27 [cited 2020 May 13]. Available from: <https://www.who.int/news-room/detail/27-04-2020-who-timeline—covid-19>.
- [2] Previous U.S. 2020. COVID-19 Case Data. 2020 April [cited 2020 May 17]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/previouscases.html>.
- [3] Stefan N, Birkenfeld AL, Schulze MB, Ludwig DS. Obesity and impaired metabolic health in patients with COVID-19. *Nat Rev Endocrinol* 2020;16(7):341–2.
- [4] Rebelos E, Moriconi D, Virdis A, Taddei S, Foschi D, Nannipieri M. Letter to the editor: importance of metabolic health in the era of COVID-19. *Metabolism* 2020;108:154247.



- [5] Simonnet A, Chetboun M, Poissy J, et al. High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) requiring invasive mechanical ventilation. *Obesity (Silver Spring)* 2020;28(7):1195–9.
- [6] Kass DA, Duggal P, Cingolani O. Obesity could shift severe COVID-19 disease to younger ages. *Lancet* 2020;395:1544–5.
- [7] Caussy C, Wallet F, Laville M, Disse E. Obesity is associated with severe forms of COVID-19. *Obesity (Silver Spring)* 2020;28(7):1175.
- [8] Hales CMM, Fryar CD, Ogden CL. *Prevalence of obesity and severe obesity among adults: United States, 2017–2018*. NCHS data brief, no 360, Hyattsville (MD): National Center for Health Statistics; 2020.
- [9] O'Brien PE, Hindle A, Brennan L, et al. Long-term outcomes after bariatric surgery: a systematic review and meta-analysis of weight loss at 10 or more years for all bariatric procedures and a single-centre review of 20-year outcomes after adjustable gastric banding. *Obes Surg* 2019;29:3–14.
- [10] Karmali S, Brar B, Shi X, Sharma AM, de Gara C, Birch DW. Weight recidivism post-bariatric surgery: a systematic review. *Obes Surg* 2013;23:1922–33.
- [11] Sarwer DB, Steffen KJ. Quality of life, body image and sexual functioning in bariatric surgery patients. *Eur Eat Disord Rev* 2015;23:504–8.
- [12] Devlin MJ, King WC, Kalarchian MA, et al. Eating pathology and associations with long-term changes in weight and quality of life in the longitudinal assessment of bariatric surgery study. *Int J Eat Disord* 2018;51:1322–30.
- [13] Conceicao EM, Fernandes M, de Lourdes M, Pinto-Bastos A, Vaz AR, Ramalho S. Perceived social support before and after bariatric surgery: association with depression, problematic eating behaviors, and weight outcomes. *Eat Weight Disord* 2020;25(3):379–92.
- [14] Conceicao E, Mitchell JE, Vaz AR, et al. The presence of maladaptive eating behaviors after bariatric surgery in a cross sectional study: importance of picking or nibbling on weight regain. *Eat Behav* 2014;15:558–62.
- [15] Brooks SK, Webster RK, Smith LE, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 2020;395(10227):912–20.
- [16] Yeo C, Ahmed S, Oo AM, Koura A, Sanghvi K, Yeo D. COVID-19 and obesity—the management of pre- and post-bariatric patients amidst the COVID-19 pandemic. *Obes Surg* 2020;30(9):3607–9.
- [17] Di Renzo L, Gualtieri P, Pivari F, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *J Transl Med* 2020;18:229.
- [18] Blomquist KK, Roberto CA, Barnes RD, White MA, Masheb RM, Grilo CM. Development and validation of the eating loss of control scale. *Psychol Assess* 2014;26:77–89.
- [19] Arroll B, Goodyear-Smith F, Crengle S, et al. Validation of PHQ-2 and PHQ-9 to screen for major depression in the primary care population. *Ann Fam Med* 2010;8:348–53.
- [20] Plummer F, Manea L, Trepel D, McMillan D. Screening for anxiety disorders with the GAD-7 and GAD-2: a systematic review and diagnostic metaanalysis. *Gen Hosp Psychiatry* 2016;39:24–31.
- [21] Valtorta NK, Kanaan M, Gilbody S, Hanratty B. Loneliness, social isolation and social relationships: what are we measuring? A novel framework for classifying and comparing tools. *BMJ Open* 2016;6:e010799.
- [22] Office for National Statistics [homepage on the Internet]. Recommended national indicators of loneliness: overview of our recommendations for national measures of loneliness, London (UK): Office for National Statistics; 2018 Dec 5. [cited 17 May 2020] Available from: <https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/compendium/nationalmeasurementofloneliness/2018/recommendednationalindicatorsof Loneliness>.
- [23] State of Indiana [homepage on the Internet]. Indiana's novel coronavirus response [Internet]. 2020 April 26 [cited 17 May 2020]. Available from: <https://www.coronavirus.in.gov/>.
- [24] Jamieson S. Likert scales: how to (ab)use them. *Med Educ* 2004;38:1217–8.
- [25] Norman G. Likert scales, levels of measurement and the “laws” of statistics. *Adv Health Sci Educ Theory Pract* 2010;15:625–32.
- [26] Shigemura J, Ursano RJ, Morganstein JC, Kurosawa M, Benedek DM. Public responses to the novel 2019 coronavirus (2019-nCoV) in Japan: mental health consequences and target populations. *Psych Clin Neurosci* 2020;74:277–83.
- [27] Cheung YT, Chau PH, Yip PSF. A revisit on older adults suicides and severe acute respiratory syndrome (SARS) epidemic in Hong Kong. *Int J Geriatr Psychiatry* 2008;23:1231–8.
- [28] Reardon S. Ebola's mental-health wounds linger in Africa: health-care workers struggle to help people who have been traumatized by the epidemic. *Nature* 2015;519:13–4.
- [29] Ornell F, Schuch JB, Sordi AO, Kessler FHP. “Pandemic fear” and COVID-19: mental health burden and strategies. *Braz J Psychiatry* 2020;42(3):232–5.
- [30] Boserup B, McKenney M, Elkbuli A. Alarming trends in US domestic violence during the COVID-19 pandemic. *Am J Emerg Med* 2020;38(12):2753–5.
- [31] Campbell AM. An increasing risk of family violence during the COVID-19 pandemic: strengthening community collaborations to save lives. *Forensic Sci Int* 2020;2:100089.
- [32] Andreu A, Jimenez A, Vidal J, et al. Bariatric support groups predicts long-term weight loss. *Obes Surg* 2020;30(6):2118–23.
- [33] Livhits M, Mercado C, Yermilov I, et al. Is social support associated with greater weight loss after bariatric surgery? A systematic review. *Obes Rev* 2011;12:142–8.
- [34] Koball A, Jester D, Domoff S, Kallies K, Grothe K, Kothari S. Examination of bariatric surgery Facebook support groups: a content analysis. *Surg Obes Relat Dis* 2017;13:1369–75.
- [35] Baillet A, Boissy P, Tousignant M, Langlois MF. Feasibility and effect of in-home physical exercise training delivered via telehealth before bariatric surgery. *J Telemed Telecare* 2017;23:529–35.
- [36] Bashshur RL, Shannon GW, Bashshur N, Yellowless PM. The empirical evidence for telemedicine interventions in mental disorders. *Telemed J E Health* 2016;22:87–113.
- [37] Bradley LE, Thomas G, Hood MM, Corsica JA, Kelly MC, Sarwer DB. Remote assessments and behavioral interventions in post-bariatric surgery patients. *Surg Obes Relat Dis* 2018;14:1632–44.
- [38] Voils CI, Adler R, Strawbridge E, et al. Early-phase study of a telephone-based intervention to reduce weight regain among bariatric surgery patients. *Health Psychology* 2020;39(5):391–402.
- [39] Lamb T, Pachana NA, Dissanayaka N. Update of recent literature on remotely delivered psychotherapy interventions anxiety and depression. *Telemed J E Health* 2019;25:671–7.
- [40] Bakr AA, Fahmy MH, Elward AS, Balamoun HA, Ibrahim MY, Eldahdoh RM. Analysis of medium-term weight regain 5 years after laparoscopic sleeve gastrectomy. *Obes Surg* 2019;29:3508–13.
- [41] Kofman MD, Lent MR, Swencionis C. Maladaptive eating patterns, quality of life, and weight outcomes following gastric bypass: results of an Internet survey. *Obesity (Silver Spring)* 2010;18:1938–43.
- [42] Odom J, Zalesin KC, Washington TL, et al. Behavioral predictors of weight regain after bariatric surgery. *Obes Surg* 2010;20:349–56.
- [43] Jakubowicz D, Barnea M, Wainstein J, Froy O. High caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. *Obesity (Silver Spring)* 2013;21:2504–12.
- [44] Nicoletti CF, de Oliveira BA, de Pinhel MA, et al. Influence of excess weight loss and weight regain on biochemical indicators during a 4-year follow-up after Roux-en-Y gastric bypass. *Obes Surg* 2015;25:279–84.

- [45] Bergh I, Lundin Kvalem I, Rissstad H, Sniehotta FF. Preoperative predictors of adherence to dietary and physical activity recommendations and weight loss one year after surgery. *Surg Obes Relat Dis* 2016;12:910–8.
- [46] King WC, Hinerman AS, Belle SH, Wahed AS, Courcoulas AP. Comparison of the performance of common measures of weight regain after bariatric surgery for association with clinical outcomes. *JAMA* 2018;320:1560–9.
- [47] Al Saif A, Alsenany S. Aerobic and anaerobic exercise training in obese adults. *J Phys Ther Sci* 2015;27:1697–700.
- [48] Moore LV, Diez Roux AV, Evenson KR, McGinn AP, Brines SJ. Availability of recreational resources in minority and low socioeconomic status areas. *Am J Prev Med* 2008;34:16–22.
- [49] Cohen DA, Han B, Derose KP, et al. The paradox of parks in low-income areas: park use and perceived threats. *Environ Behav* 2016;48:230–45.
- [50] Hilmers A, Hilmers DC, Dave J. Neighborhood disparities in access to healthy foods and their effects on environmental justice. *Am J Public Health* 2012;102:1644–54.
- [51] Williams DR, Priest N, Anderson NB. Understanding associations among race, socioeconomic status, and health: patterns and prospects. *Health Psychol* 2016;35:407–11.
- [52] Cohen MJ, Shaykevich S, Cawthon C, Kripalani S, Paasche-Orlow MK, Schnipper JL. Predictors of medication adherence postdischarge: the impact of patient age, insurance status, and prior adherence. *J Hosp Med* 2012;7:470–5.
- [53] Rolnick SJ, Pawloski PA, Hedblom BD, Asche SE, Bruzek RJ. Patient characteristics associated with medication adherence. *Clin Med Res* 2013;11:54–65.
- [54] Kline CE. The bidirectional relationship between exercise and sleep: implications for exercise adherence and sleep improvement. *Am J Lifestyle Med* 2014;8:375–9.
- [55] Azagury DE, Abu Dayyeh BK, Greenwalt IT, Thompson CC. Marginal ulceration after Roux-en-Y gastric bypass surgery: characteristics, risk factors, treatment, and outcomes. *Endoscopy* 2011;43:950–4.
- [56] Dittrich L, Schwenninger MV, Dittrich K, Pratschke J, Aigner F, Raakow J. Marginal ulcers after laparoscopic Roux-en-Y gastric bypass: analysis of the amount of daily and lifetime smoking on postoperative risk. *Surg Obes Relat Dis* 2020;16:389–96.
- [57] Keyes KM, Hatzenbuehler ML, Grant BF, Hasin DS. Stress and alcohol: epidemiologic evidence. *Alcohol Res* 2012;34:391–400.
- [58] Lin CJ, DeRoo LA, Jacobs SR, Sandler DP. Accuracy and reliability of self-reported weight and height in the Sister Study. *Public Health Nutr* 2012;15:989–99.
- [59] Bastos EC, Barbosa EM, Soriano GM, dos Santos EA, Vasconcelos SM. Determinants of weight regain after bariatric surgery. *Arq Bras Cir Dig* 2013;26(Suppl 1):26–32.
- [60] Magro DO, Geloneze B, Delfini R, Pareja BC, Callejas F, Pareja JC. Long-term weight regain after gastric bypass: a 5-year prospective study. *Obes Surg* 2008;18:648–51.