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The effect of coronavirus pandemic on weight outcomes of patients after bariatric surgery

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Abstract

Introduction: Coronavirus 2019 (COVID-19) was first reported in December 2019 in Wuhan, China, and on January 30, 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 to be an international concern. Many governments around the world quarantined and forced millions to stay at home and remain isolated for long periods, an unprecedented impact on public life. Patients who have undergone bariatric surgery are no exception but are more vulnerable to the effects of isolation. This review study was conducted to help to better understand the consequences of the COVID-19 virus pandemic on the weight outcomes of patients after bariatric surgery.

Materials and Methods: This review study examined the data from several reliable databases such as Google Scholar, Scopus, and Science Direct from the beginning of the coronavirus pandemic (2019) until now (2023). According to the inclusion criteria, finally, 17 articles were reviewed.

Results: The findings of this study showed that increased psychological distress, anxiety, depression and loneliness, mood changes, decreased physical activity, decreased social support and loss of face-to-face meetings with a nutrition consultant, increased substance use Unhealthy diet, increased snacking and overeating, as well as loss of control over eating, are some of the adverse effects of coronavirus pandemic on patients who have undergone bariatric surgery, and these are risk factors for weight gain after bariatric surgery.

Conclusion: Patients who have undergone bariatric surgery are affected by the COVID-19 virus pandemic and subsequent quarantine and social isolation in many areas of their lives, which will ultimately have a negative impact on the weight outcomes of patients after surgery. Therefore, specialized care and interventions are needed to address behaviors that lead to weight regain during future pandemics or in the post-coronavirus era in vulnerable patients after bariatric surgery.

Keywords: Coronavirus, Weight outcomes, Bariatric surgery

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Introduction

Acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is the causative agent of the 2019 coronavirus disease (COVID-19) (1). The COVID-19 virus was first reported in December 2019 in Wuhan, China, and the World Health Organization (WHO) declared the outbreak of the COVID-19 virus an international concern on January 30, 2020, and on March 11, 2020, it was declared a global pandemic (2-4). According to the National Center for Immunization and Respiratory Diseases, high-risk groups for severe illness from COVID-19 include People aged 65 and over, immunocompromised people, and people with chronic diseases such as obesity (5). Obese people are at greater risk of severe COVID-19 (6). Studies have shown that even obesity is a risk factor for severe disease in young patients (7). As an urgent measure to limit the spread of the disease, many governments around the world imposed quarantines, forcing millions of people to stay at home and maintain isolation for extended periods (8), although these measures led to the control of the interruption of the transmission chain, these conditions had an unprecedented impact on the lives of the general public, including forced inactivity along with changes in people's eating habits, which are often associated with emotional problems and stress (9-11). During the quarantine period, the consumption of unhealthy food, the frequency of snacks, and the frequency of main meals have increased, and it has also caused people to lose control over eating (12). On the other hand, staying at home during quarantine causes psychological distress, mood disorders, and sleep disorders (13-16), which in turn may negatively affect eating behaviors (17-20). In addition, reducing leisure activities, boredom, increasing the time of watching TV and easy access to food can increase the number of snacks and overeating (21, 22). All the mentioned factors provide the hypothesis of body weight gain during the quarantine period, which may have metabolic consequences shortly and also increase the risk of cardiovascular disorders.

Obesity and related diseases are one of the most important public health problems in developed and developing countries due to their impact on quality of life, life expectancy, and financial healthcare issues, which can be caused by a large number of biological, psychological, and social factors (23-25). Over the past 30 years, the prevalence of obesity has been steadily increasing, and bariatric surgery is the most effective and durable option for this chronic medical disease and its related diseases (26, 27). Several studies confirm bariatric surgery due to a significant reduction in weight as well as a significant reduction or improvement of various obesity-related diseases (28, 29). However, there is considerable variability in long-term weight loss results (30), and weight gain after surgery is a common concern (31). Weight gain after bariatric surgery is more common in patients with depression, anxiety, low social support, and unhealthy eating habits, such as increased snacking and loss of control while eating (32-34). Evidence suggests that the COVID-19 virus pandemic has negatively impacted eating behaviors, psychological distress, and weight outcomes in bariatric surgery patients (35, 36). On the other hand, a lot of concern about weight, anxiety, less weight loss, and weight regain were shown in patients undergoing bariatric surgery during the COVID-19 virus pandemic (36). Weight regain, in turn, can increase the risk of severe COVID-19 infection, lead to the return of obesity-related diseases, and reduce the quality of life of patients (31,37).

Although many studies have been conducted regarding the prevalence of weight gain in the general population during the coronavirus pandemic, there are few studies on the effect of the coronavirus pandemic on the weight outcomes of patients after bariatric surgery. Since these patients are more vulnerable to stressful factors and their weight outcomes can have a significant impact on the incidence of obesity-related diseases and reduce the quality of life, this review study was conducted to help to know more and more precisely the consequences of the coronavirus pandemic on the weight outcomes of patients after bariatric surgery.

Materials and Methods

In this systematic review, a Prisma tool was used. The question considered in this study is: How has Coronavirus affected the weight outcomes of patients after bariatric surgery?

Search strategy

In the present study, researchers reviewed articles published in Google Scholar, Science Direct, and

Scopus databases since the beginning of the Coronavirus pandemic (2019) until now (June 21, 2023). It should be noted that the findings based on book chapters and conference abstracts were among the limitations. The authors also reviewed the reference list of eligible articles. Selected keywords in the search strategy included "Coronavirus" and "Weight outcomes" and "Bariatric surgery".

Data were collected in EndNote X20 software and duplicate studies were eliminated. All obtained articles' titles and abstract were screened and irrelevant articles were removed. The full text of the remaining articles was included in the study to find relevant studies that fit our inclusion criteria. It should be noted that data extraction was done by two researchers separately.

Inclusion and exclusion criteria

Criteria for inclusion of studies included publication of articles in reputable scientific databases, English language, access to the full text of articles, and relevance to the research topic. Editorials, notes, reviews, and letters to the editor were excluded.

Results

This review study yielded seventeen studies on patients with previous bariatric surgery (Table 1). The process of searching for articles and selecting them is shown in Figure 1. In the initial search, a total of 153 articles from three databases were found, and after removing 18 duplicates in EndNote X20 software, 135 articles remained and articles by title were reviewed and 27 articles remained in the end. By reviewing the titles and abstracts of the remaining articles, 17 articles were entered.

Table 1. Studies on patients with a previous bariatric surgery.

Row	Authors Name	Year Of Study	Country of Research	Type of Study	Title of the study	Findings
1	Haghighat et al. (50)	2023	Iran	Retrospective, single-center study	Impact of the COVID-19 Pandemic on the Success of Bariatric Surgeries in Patients with Severe Obesity	The effectiveness of bariatric surgery for weight loss decreased during the quarantine period caused by the coronavirus. In this study, to evaluate the weight outcomes of patients after bariatric surgery, the patients were divided into two groups. The first group was patients who had bariatric surgery during the coronavirus pandemic and were under quarantine due to the coronavirus pandemic. And the second group was patients who had undergone bariatric surgery before the coronavirus pandemic and were not affected by the quarantine. Weight loss and the decrease in body mass index 1 year after the surgery, as well as excess weight loss and total weight loss, were significantly higher in the second group than in the first group.
2	Salituro et al. (43)	2023	Italy	The observational retrospective cohort study	The impact of psychological distress on weight regain in post-bariatric patients during the COVID-19	43% and 34% of the post-bariatric patients reported clinically significant anxiety and depressive symptoms, respectively. 60% of patients reported clinically significant disturbed sleep. Post-bariatric patients in the high psychological distressed group

					pandemic: A latent profile analysis	regained a mean of 1.4 kg, while patients in the low psychological distressed group lost a mean of 1.1 kg. This study showed a significant relationship between psychological distress and weight regain in patients after bariatric surgery during the COVID-19 quarantine.
3	Antoinette Hu et al. (47)	2021	USA	Cross-sectional study	Associations of COVID-19 Lockdowns on Eating Behaviors and Body Mass Index in Patients with a History of Bariatric Surgery: a Cross-Sectional Analysis	71.43% of patients experienced weight recurrence with an average increase in body mass index (BMI) of 2.83 kg/m2 during the quarantine due to COVID-19. Also, 15.24% of patients after bariatric surgery qualified for loss of control while eating, which was significantly related to emotional overeating. The results of this research showed that the significant social adversities experienced during the COVID-19 pandemic have a negative effect on the eating behaviors of patients after bariatric surgery.
4	Carolina Ferreira Nicoletti et al. (48)	2021	Brazil	Observational Study	Nutritional inadequacies among post-bariatric patients during COVID-19 quarantine in Sao Paulo, Brazil	Screening of dietary habits and food intake of patients with a history of bariatric surgery through three non-consecutive 24-h food recalls showed that many patients failed to receive the recommended daily protein and the recommendation for frequent animal protein intake during social isolation. Furthermore, about a quarter of these patients' diets consisted of ultra-processed foods.
5	Conceição et al. (36)	2021	Portugal	longitudinal study	Eating behaviors and weight outcomes in post-bariatric surgery patients during the COVID-19 pandemic: A three-year longitudinal study	COVID-19 lockdown resulted in higher weight concern, grazing behavior, and negative urgency that increase the risk of weight regain among post-bariatric patients.
6	Athanasiadis et al. (40)	2021	USA	case-control study	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	The patient's mental health condition was deteriorating during social isolation. Nearly half of the patients reported increases in their depression (44.2%), nervousness (54.7%), snacking (62.6%), loss of control when eating (48.2%), and decreases in healthy food eating (45.5%), and activity (55.2%), all of which led to weight regain. Weight regain was more prevalent among patients after 18 months of surgery and they regained more than 2 kg during an average of 47

						days of COVID-19 lockdown. 43.6% of patients gained weight after surgery.
7	Durão et al.(42)	2021	Portugal	cross-sectional study	Confinement During the COVID-19 Pandemic After Metabolic and Bariatric Surgery—Associations Between Emotional Distress, Energy-Dense Foods, and Body Mass Index	Among postoperative bariatric patients, higher reported levels of emotional distress during the COVID-19 lockdown are associated with increased EDF consumption. Sweets consumption was a subcategory of EDF significantly positively associated with the odds of a worse outcome in BMI change.
8	Messiah et al. (44)	2021	USA	Retrospective chart review	Substance Use, Mental Health, and Weight-Related Behaviors During the COVID-19 Pandemic Among Metabolic and Bariatric Surgery Patients	Post-bariatric patients who completed their postoperative period during quarantine experienced more sleep problems, anxiety, and substance use than other patients who followed up before social isolation. The depression rate was high in both groups.
9	El Moussaoui et al. (60)	2021	Belgium	case-control study	Impact of COVID-19 Lockdown on Short-Term Results After Laparoscopic Sleeve Gastrectomy	The purpose of this study was to compare the percentage of total weight loss (%TWL), and excess weight loss (%EWL) of patients in the first postoperative year between patients who underwent primary bariatric surgery between June 2019 and October 2019 (1-year postoperative period affected by COVID-19 lockdown; COV-group), and a control group operated between June 2018 and October 2018 (1-year postoperative period not affected by COVID-19 lockdown; CONTROL-group). The mean TWL and EWL were lower in first-group patients compared to second-group patients at one year from bariatric surgery.
10	Sisto et al. (35)	2020	Italy	case-control study	The psychological impact of COVID-19 pandemic on patients included in a bariatric surgery program	The coronavirus pandemic led to increased psychological distress in patients with a current or past history of obesity, reducing the quality of life and affecting dietary compliance. Analysis of post-bariatric patients showed a relationship between snacking, hunger, eating impulsivity, and anxiety, stress, and/or depression symptoms.
11	Andreu et al. (41)	2020	Spain	cross-sectional exploratory	Patients Undergoing Bariatric Surgery: a Special Risk Group for Lifestyle, Emotional and	Dietary habits were affected in 72% of the participants, with 83.5% reporting having more sedentary behaviors; 27% and 36% showing depression and

					Behavioral Adaptations During the COVID-19 Lockdown. Lessons from the First Wave	anxiety, respectively; and 45% of participants reporting bad sleep quality. Regarding changes in the use of any substance, the use increased in the majority of patients who were previously users. Self-perception of one's health and fears related to COVID-19 were only moderate. Finally, emotional eating and time since bariatric surgery were statistically significant risk factors for predicting weight gain
12	de Luis et al. (38)	2020	Spain	Cross-sectional study	Factors Related to Weight Gain in Subjects with Sleeve Gastrectomy During Lockdown by the COVID-19 Pandemic	An increase in self-reported body weight among the patients during the interview was associated with a decrease in physical activity and the loss of face-to-face visits to the nutrition unit. 64% of patients became overweight after surgery. The increase in self-reported body weight was 3.8±2.1 kg during the 7 weeks of confinement.
13	Félix et al. (45)	2020	Portugal	Cross-sectional study	A preliminary study on the psychosocial impact of COVID-19 lockdown in post-bariatric surgery women: the importance of eating behavior, health care access, and social support	58.3% of post-bariatric patients reported perceived weight gain during the COVID-19 lockdown. Also, 54.1% of patients reported limited access to social support and 50% limited access to medical care.
14	Jimenez et al. (54)	2020	Spain	Cross-sectional study	Psychosocial, Lifestyle, and Body Weight Impact of COVID-19-Related Lockdown in a Sample of Participants with Current or Past History of Obesity in Spain	Changes in mood, negative changes in eating habits, consumption of unhealthy foods, and weight gain were among the adverse effects of the coronavirus pandemic on patients who underwent bariatric surgery.
15	Murtha et al. (39)	2020	USA	Cross-sectional study	Impact of COVID-19 on the Postoperative Bariatric Surgery Patient Experience	COVID-19 affected the postoperative bariatric surgery patient experience via 3 mechanisms: (1) it disrupted dietary and physical activity routines due to facility closures and fear of COVID-19 exposure; (2) it required patients to transition their follow-up care to telemedicine delivery; and (3) it increased stress due to financial and psychosocial challenges.
16	Vitiello et al. (49)	2019 - 2020	Italy	Retrospective study	Impact of COVID-19 Lockdown on Short-term Weight Loss in a	Two groups of patients were evaluated. The first group of patients underwent bariatric

					Single Italian Institution	surgery before the start of the coronavirus pandemic (year 2019) and the second group of patients underwent bariatric surgery during the virus pandemic (year 2020). Weight loss at 1, 3, and 6 postoperative months in the 2019 group was significantly higher at any point of follow-up when compared to 2020. Social restrictions and non-attendance at clinical appointments were among the factors affecting the weight outcomes of patients after surgery, because in 2019, no patient missed clinical appointments in the first 6 months, while in 2020, the rate of nonattendance at 1, 3, and 6 months was 15.6%, 18.7%, and 31.3%.
17	de Angulo et al. (65)	2019 – 2020	Spain	Case–control study	Influence of the lockdown due to COVID-19 on weight-loss results during the first year after sleeve gastrectomy	Population lockdown by COVID-19 did not get worse short-term results of bariatric surgery.

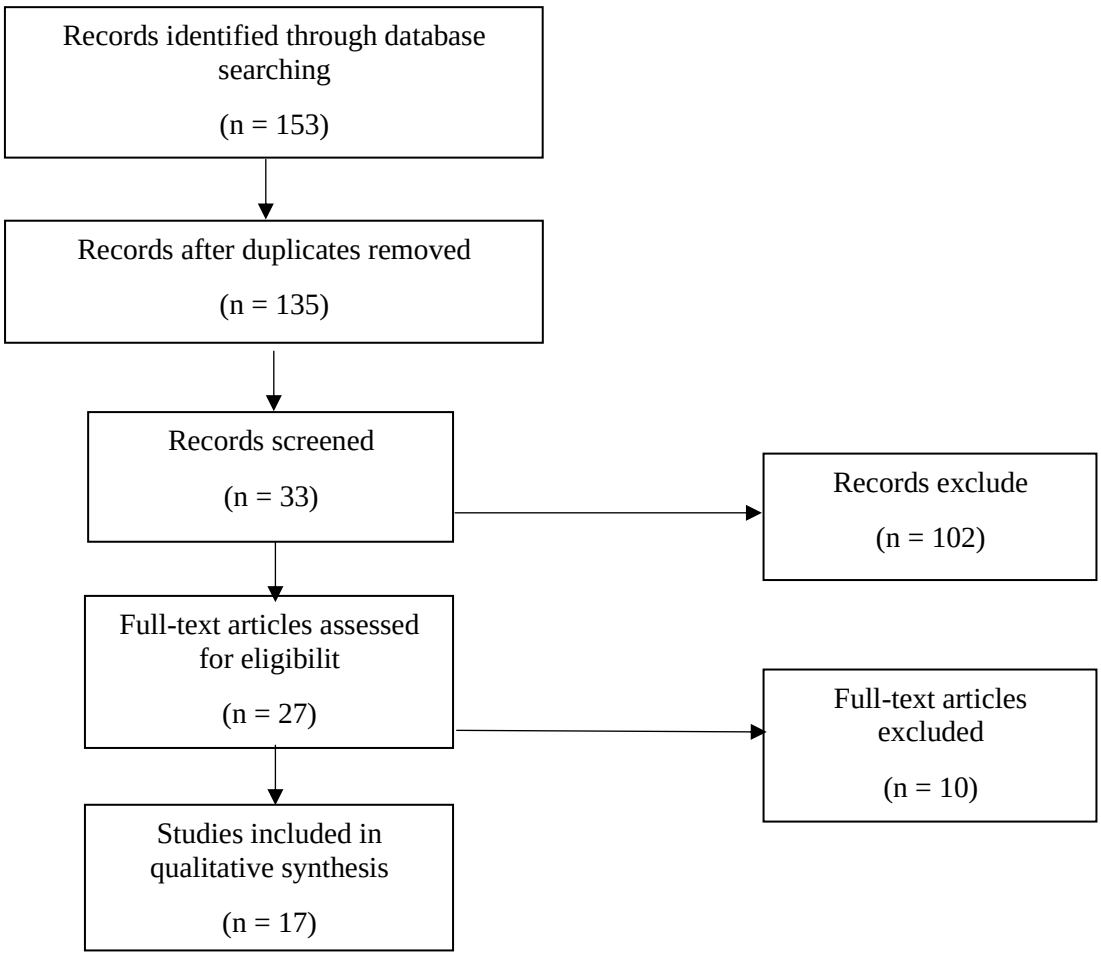

Figure 1. Flow diagram of the study selection for the review process.

The effects of the coronavirus pandemic and subsequent quarantine on post-bariatric surgery patients are shown in Figure 2.

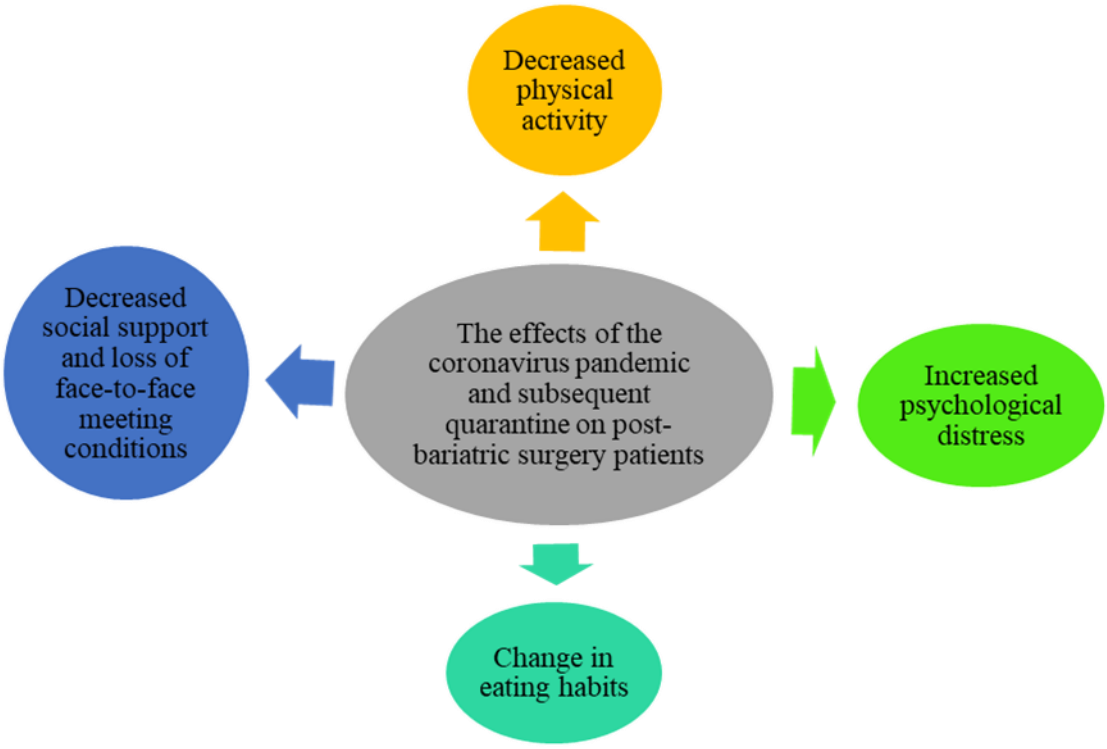

Figure 2. The effects of the coronavirus pandemic on post-bariatric surgery patients.

Physical activity conditions among post-bariatric surgery patients during the quarantine :

Social quarantine has reduced physical activity in patients with a history of bariatric surgery (38, 39). In the study of Athanasiadis et al., 55.2% of patients with bariatric surgery, reported decreased physical activity, which plays an important role in weight regain in the postoperative period (40). Andreu et al. showed that 83.5% of patients with bariatric surgery during the coronavirus pandemic, reported more sedentary behaviors than before (41).

Mental health conditions among post-bariatric surgery patients during the quarantine:

Among post-bariatric surgery patients, higher reported levels of emotional distress during the COVID-19 quarantine (42). In the study by Athanasiadis et al., out of 208 patients with bariatric surgery, 54.7% reported nervousness, 44.2% depression, and 36.2% loneliness (40). Salituro et al. showed that 43% and 34% of the post-bariatric patients reported clinically significant anxiety and depressive symptoms, respectively. In this study, 60% of patients reported clinically significant disturbed sleep (43). According to Andreu et al., out of 156 patients with bariatric surgery, 27% reported depression, 36% anxiety, and 45% bad sleep quality (41). Messiah et al.'s study showed that post-bariatric patients who completed their postoperative period during quarantine experienced more sleep problems, anxiety, and substance use than other patients who followed up before social isolation (44).

Finally, Mandatory quarantine caused by the coronavirus has created many psychological challenges for patients with bariatric surgery, which increases the risk of weight regain and this issue highlights the importance of regular follow-up (36, 39, 43, 45, 46).

Food habits among post-bariatric surgery patients during the quarantine:

Andreu et al. showed that dietary habits were affected in 72% of patients with bariatric surgery during social quarantine (41). Patients with previous bariatric surgery, experienced an increase in snacking (35, 40), loss of control while eating (40, 45, 47), consumption

of unhealthy foods (38, 40), and grazing behavior (36) during social quarantine. On the other hand, emotional eating and time since bariatric surgery were statistically significant risk factors for predicting weight gain (41). Moreover, Nicoletti et al. stated that many patients failed to receive the recommended daily protein and the recommendation for frequent animal protein intake during social isolation, and the intake of highly processed foods had increased (48).

Social support conditions among post-bariatric surgery patients during the quarantine:

Social restrictions and non-attendance at clinical appointments were among the factors affecting the weight outcomes of patients after bariatric surgery during the COVID-19 quarantine (39, 49). In the study of de Luis et al., an increase in self-reported body weight among the post-bariatric surgery patients during the interview was associated with a decrease in loss of face-to-face visits during the COVID-19 quarantine (38). According to Félix et al., 54.1% of patients reported limited access to social support and 50% limited access to medical care (45).

Weight gain among post-bariatric surgery patients during the quarantine:

COVID-19 quarantine increases the risk of weight regain among post-bariatric patients (36, 43, 50). According to Athanasiadis et al., 43.6% of patients gained weight after bariatric surgery. In this study, weight regain was more prevalent among patients after 18 months of surgery and they regained more than 2 kg during an average of 47 days of COVID-19 quarantine (40). In the study of de Luis et al., 64% of patients became overweight after surgery. The increase in self-reported body weight was 3.8±2.1 kg during the 7 weeks of quarantine (38). Félix et al. showed that 58.3% of post-bariatric patients reported perceived weight gain during the COVID-19 quarantine (45). Also, in Antoinette Hu et al.'s study, 71.43% of patients experienced weight recurrence with an average increase in body mass index (BMI) of 2.83 kg/m2 during the COVID-19 quarantine (47).

Discussion

One of the high-risk groups for severe illness caused by the coronavirus is people with chronic diseases, including obesity (5). Bariatric surgery and subsequent weight loss significantly reduce the risk of serious consequences caused by the coronavirus (51). Weight loss is more evident in the first year after surgery because it increases the individual's motivation and creates healthy life habits in many patients (52). Among the measures that were taken to control the chain of transmission of the coronavirus pandemic in many governments, was to establish quarantine and force people to stay at home and maintain isolation for a long time (8), these conditions had an unprecedented negative impact on the lives of the general public (9-11). Patients who have undergone bariatric surgery are no exception to this rule. Both pre and post-operative management of post-bariatric patients requires a multidisciplinary approach, including nutrition and dietary interventions, physical activity as well as psychological support focused on promoting adherence to treatment and the adoption of healthy lifestyles over the short and longer term (58). During post-operative follow-ups, bariatric patients often feel a sense of isolation, abandonment, and ambivalence toward surgery outcomes (59) which could negatively affect the quality of life, psychological distress, and eating habits (10). Social distancing and the great stress burden generated by the COVID-19 pandemic might enhance those feelings, increasing psychological distress, undermining healthy lifestyle compliance, and fostering weight regain and comorbidities recurrence in at-risk post-bariatric patients (60). As we observed in the review of studies, several psychosocial and physical factors can cause weight gain for patients with a history of bariatric surgery during the coronavirus pandemic. In this study, we categorized factors affected by the pandemic era into four categories: physical activity, mental health, food habits, and social support.

Decreased physical activity

The studies extracted in the current research showed that one of the negative factors affecting the coronavirus pandemic and the subsequent quarantine and social isolation of patients who have undergone bariatric surgery is the reduction of physical activity. In the research of Athanasiadis et al., 55.2% of people who had bariatric surgery reported a decrease in physical activity during the coronavirus pandemic and the resulting quarantine, and the results of this study showed that reducing physical activity is one of the risk

factors for gaining weight after bariatric surgery during the coronavirus pandemic (40). Also, in the study of De Luis et al., it was shown that during the coronavirus pandemic, more than half of the patients became overweight after bariatric surgery, and this weight gain is associated with a decrease in physical activity (38). The amount of exercise performed per week by the patients overall decreased (53). Mandated closures of gymnasiums likely contributed to decreases in exercise in some patients. Planning and counseling by specialists to increase physical activity after bariatric surgery is an important factor in creating favorable outcomes of surgery.

Increased psychological distress

Another negative factor affecting the coronavirus pandemic and the subsequent quarantine and social isolation of the mentioned patients is an increase in psychological distress in patients who have undergone bariatric surgery. The results of Conceição et al.'s study showed that the increase in anxiety in patients undergoing bariatric surgery was one of the negative effects of the coronavirus pandemic on patients (36). Jimenez et al also stated in their study that one of the adverse effects of the coronavirus pandemic on patients who underwent bariatric surgery was mood changes (54). Also reported an increase in depression, loneliness, and anger as the adverse effects of the coronavirus pandemic on patients who underwent bariatric surgery (40). The mentioned factors, in turn, can negatively affect the eating behaviors of patients (17-20), and provide the hypothesis of body weight gain after surgery. Sisto et al.'s study showed that there was a significant relationship between symptoms of anxiety, depression, and stress and increased snack consumption, desire to eat, and hunger in patients after bariatric surgery during the coronavirus pandemic (35). According to Salituro et al., there is a significant relationship between psychological distress and weight regain in patients after bariatric surgery during the COVID-19 quarantine (43). Mental health problems can last longer than the infection itself and spread more widely than the pandemic (55). Targeted psychological support during times of increased stress, anxiety, depression, and mood changes is essential for fragile people such as patients after bariatric surgery. For these reasons, it has been recommended that mental health professionals should be on the “front line” (56). Even telephone-only contact can be experienced as helpful by patients who have had bariatric surgery (57) and can be effective in the treatment of anxiety and depression (58).In only one study, the rate of depression was not affected by the quarantine and was high in both groups of patients before and after social isolation, and this may be due to different perceptions of patients (44).

Change in eating habits

The coronavirus pandemic and the quarantine of people caused an increase in the consumption of unhealthy food, the frequency of snacking and overeating, as well as the loss of control over eating (12). Nicoletti et al.'s study showed that almost 90% of patients after bariatric surgery did not receive the necessary protein during the coronavirus pandemic, and 25% of them consumed too much processed foods (59). Jimenez et al also considered the consumption of unhealthy foods as one of the adverse effects of the coronavirus pandemic on patients after bariatric surgery (54). The results of Athanasiadis et al.'s study showed that the risk factors for weight gain among post-bariatric surgery patients during the coronavirus quarantine include decreased consumption of healthy food, increased consumption of snacks, overeating, and loss of control while eating (40). During the quarantine, patients further out of their surgery date were eating relatively healthier food (40), which may be explained by greater experience with dietary adherence (53). 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 (40). To solve the mentioned problems, specialists can provide online guidance to their patients through mobile phone programs and encourage patients to have healthy eating habits, consume healthy foods, and do appropriate sports activities. For patients with limited access to the Internet, direct phone calls can still be a valuable source of encouragement (40). In this regard, a recent study showed that about half of post-bariatric surgery patients did not attend face-to-face nutrition counseling sessions during the quarantine, and this was a risk factor for their weight regain (38).

Decreased social support and loss of face-to-face meeting conditions

One of the risk factors for gaining weight after bariatric surgery during the coronavirus pandemic and the subsequent quarantine and social isolation reducing the presence of patients in clinical appointments for post-surgery consultation and replacing face-to-face consultations with telephone consultations (49, 60). De Luis et al.'s study showed that the loss of face-to-face meetings with a nutrition consultant is one of the factors influencing the weight gain of patients after bariatric surgery (38). Also, Vitiello et al. stated in their study that the rate of weight loss after bariatric surgery in patients who underwent surgery during the coronavirus pandemic was significantly lower than in patients who underwent surgery before the start of the pandemic, which is the reason was social restrictions and not attending clinical appointments. In this study, the rate of nonattendance of post-bariatric surgery patients during the coronavirus pandemic in clinical appointments at the first 1, 3, and 6 months after surgery was 15.6%, 18.7%, and 31.3%. (49). These findings warn doctors about the need to closely monitor these patients and the importance of facilitating access to consultations and promoting social support. 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 been researched (61). Telehealth visits have been well received by patients. For example, physical training via telehealth is helpful for patients preparing for bariatric surgery (62). There is strong evidence for the acceptability, effectiveness, and cost savings of tele behavioral health interventions in general (63) and in the bariatric population more specifically (64).

Weight gain after bariatric surgery

The results obtained from the review of studies show the negative impact of the coronavirus pandemic and the subsequent quarantine and social isolation on the weight outcomes of patients after bariatric surgery. The rate of weight loss after surgery is significantly lower in patients who underwent bariatric surgery during the coronavirus pandemic and were quarantined compared to patients who underwent surgery before the virus pandemic (36, 49, 60). On the other hand, some studies showed that patients who underwent bariatric surgery during the coronavirus pandemic gained weight after the surgery. In Andreu et al.'s study, 72% of participants believed their weight had changed during quarantine. Weight gain was the most frequent change reported (86%), with a mean of 2.1 ± 2.8 kg (41). De Luis et al stated in their study that the coronavirus pandemic causes weight gain in patients who have undergone bariatric surgery, and during the coronavirus pandemic, 64.4% of patients became overweight after bariatric surgery (38). Athanasiadis et al.'s study also showed that 43.6% of patients who underwent bariatric surgery gained weight during the coronavirus pandemic (40). The results of Félix et al.'s study showed that 58.3% of people who underwent bariatric surgery gained weight within 36 months after the surgery during the quarantine caused by the coronavirus pandemic (45). The results of Jimenez et al.'s study also indicate that one of the adverse effects of the coronavirus pandemic on patients who underwent bariatric surgery is weight gain after surgery (54). While most studies have shown the negative impact of the coronavirus pandemic on the weight outcomes of the aforementioned patients, the results of the research by De Angulo et al showed that the coronavirus pandemic did not worsen the weight outcomes of patients after bariatric surgery (65). Regular follow-up of post-bariatric surgery patients with a team of psychologists in addition to physicians and nutritionists can help them to achieve self-management and reduce the burden on the health system in the long term.

Conclusions

The coronavirus pandemic and the subsequent quarantine and social isolation have affected many areas of the lives of people who have undergone bariatric surgery, which has ultimately caused a negative impact on the results of weight outcomes of patients after surgery. Post-bariatric surgery patients during the coronavirus pandemic were mentally and physically prone to quarantine complications, and many of these patients reported weight gain during this period. These findings will contribute to developing effective therapeutic strategies to address difficulties faced by post-bariatric surgery patients, which can be further exacerbated under circumstances such as this challenging pandemic. Therefore, specialized care and interventions are needed to address behaviors that lead

to weight regain during future pandemics or in the post-coronavirus era in vulnerable patients after bariatric surgery, as the weight regained in these patients is difficult to lose afterward.

Author contribution

SHM and **SH** wrote and completed the manuscript. **SHM** designed wrote and edited the manuscript comprehensively. **SHM** and **SH** confirmed the final version of the paper.

Conflict of interest

The authors declare that they have no conflicts of interest.

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This article is a systematic review study that does not have a code of ethics. This article is a study without human or animal samples. There were no ethical considerations in this study.

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