Original Article

Physical activity, eating habits and weight loss outcomes two years following sleeve gastrectomy in women

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Background and Objectives: Sleeve gastrectomy (SG) is a commonly utilized surgical procedure for managing weight and patients must adopt healthy lifestyle practices and dietary modifications to sustain weight loss and prevent relapse. This study aims to evaluate the dietary habits, levels of physical activity, and weight outcomes among Saudi women post-gastric sleeve surgery. **Methods and Study Design:** This study involved 352 female participants aged 20 to 50, who had undergone gastric sleeve surgery. The Bariatric Patients Association, Bariatric World and Patients Forum were also used and contacted via phone. Surveys were used to ascertain their physical activity levels and dietary behaviors; a food frequency questionnaire (FFQ) was also utilized and each participant's BMI was calculated. **Results:** The study involved 352 women, of whom the highest proportion was in the 40-50 age group. Prior to the surgery, nearly all of the participants (98.9%) were diagnosed as having obesity or morbid obesity, which significantly decreased following the surgery. According to the participants, the primary reason for undergoing the surgery was failed dietary regimens (26.4%). A considerable portion of participants continued consuming dietary supplements post-surgery (35.59%) and frequently consumed juices and sweets. Most of the participants did not meet the WHO recommendations for regular physical activity. Correlation analysis revealed a significant relationship between BMI and the consumption of healthy foods post-surgery. **Conclusions:** The study identified concerning lifestyle habits among the participants, underscoring the importance of maintaining a healthy diet and engaging in regular physical activity to optimize the long-term benefits of weight loss surgery and enhance overall well-being.

Key Words: sleeve gastrectomy, obesity, weight loss, dietary habits, Saudi Arabia

INTRODUCTION

Rapid transformations in dietary behaviors and lifestyle choices, as well as reduced physical activity and the extensive utilization of technology, have contributed to a notable surge in obesity prevalence within Saudi society. According to data disclosed by the Saudi Ministry of Health in 2020, obesity rates among Saudi adults had surged to 59.4%, with 28.7% being classified as obese and 30.7% categorized as overweight.[1] In terms of obesity prevalence, Saudi Arabia ranks third globally, with a pronounced impact on women.[2] This assertion is reinforced by comprehensive national surveys conducted from 1996 to 2011, which indicate a substantial escalation in obesity rates among women, from 23.6% to 44.0% within a decade.[3] Due to diminished metabolic activity and hormonal fluctuations post-menopause, the propensity for weight gain in women rises with age, engendering enduring health ramifications.[2]

The consequences of obesity encompass heightened susceptibility to metabolic syndrome (MS), type 2 diabetes (T2D), hypertension, cardiovascular ailments, stroke, arthritis, cancer, sleep disturbances, polycystic ovary syndrome, and diminished female fertility. Moreover, obesity exerts adverse effects on individuals' psychological well-being, manifesting in reduced self-esteem and confidence levels, increased social withdrawal, and predisposition to depression.[4]

Primary contributors to obesity include disparities in dietary intake and physical activity levels, recurrent setbacks in dieting endeavors, sedentary behaviors, inadequate engagement in physical exercise, excessive utilization of social media platforms, and prolonged television viewing. Data released by the General Authority for Statistics in 2021 revealed that 70.3% of Saudis exhibit a lack of physical activity and lead predominantly sedentary lifestyles.[5]

Certain individuals with insufficient willpower may struggle to embrace healthy dietary practices consistently over their lifespan, becoming quickly demoralized by setbacks in conventional weight loss approaches such as dieting and exercise. Consequently, they may turn to various forms of bariatric surgery in pursuit of sustained

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weight reduction after exhausting non-surgical alternatives. Recent data indicate that the number of gastric sleeve procedures performed in Saudi Arabia exceeds 40,000 annually, with women representing over 70% of the recipients of these surgeries.[6]

SG stands out as a frequently employed surgical intervention for weight management. Entailing the removal of a significant portion of the stomach, typically up to 80% of its volume, this procedure results in an early sensation of fullness and satiety following the consumption of a small quantity of food. Additionally, SG triggers hormonal alterations that facilitate additional weight reduction. However, it is crucial to emphasize that SG is a permanent surgical intervention, enduring throughout the individual's lifetime.[7] Bariatric surgeries have demonstrated efficacy in achieving sustained weight loss over the long term, thereby diminishing the incidence of chronic ailments and overall mortality rates. Research findings suggest that individuals undergoing obesity surgeries can shed between 14% and 25% of excess weight over a span of ten years, the extent of which varies depending on the specific type of surgery undertaken. Additionally, there is a notable 29% reduction in mortality causes associated with bariatric surgeries compared to conventional weight loss modalities.[8]

Obesity surgeries necessitate adherence to three key criteria: a body mass index (BMI) equal to or exceeding 40; the existence of chronic medical conditions; and the absence of gastroesophageal reflux disease. It should be noted that there is no single, universally applicable surgical approach. Rather, the selection of the appropriate procedure is contingent upon the individual patient's circumstances, notwithstanding the prevalence of SG as the most frequently performed surgery.[9]

While obesity surgeries and their associated benefits are undeniable, in order to sustain weight loss and avoid relapse, patients must integrate healthy lifestyle practices and dietary adjustments into their daily lives after the surgery. Exercise assumes paramount importance in post-surgery management, as it facilitates continued weight reduction, preserves muscle mass, mitigates the occurrence of loose skin resultant from weight loss, and sustains bone density.[10]

In view of the dearth of existing research concerning post-gastric sleeve patients' lifestyles, dietary habits, physical activity levels, and their correlation with weight management and chronic ailments among Saudi women, investigating this area is imperative. Therefore, this study aims to assess the dietary behaviors, physical activity levels and weight outcomes among Saudi women who have undergone gastric sleeve surgery.

METHODS

Study population and sample

The Raosoft online calculator was used to determine the sample size for this study.[11] With an accepted margin error of 5%, confidence level of 95%, and response distribution of 50%, the sample size required was 377 (with a margin error of 5.18%). Prior to the start of data collection, a declaration and written consent were obtained from each of the participants. Ethical approval was granted by the University of King Faisal (KFU-REC-2024-MAR-ETHICS2108).

The study recruited 377 females aged between 20 and 50 years undergone gastric sleeve surgery two years ago. Qualifying individuals must be in stable condition without any acute post-surgical complications that could impact physical activity or diet. Moreover, they must have regularly attended follow-up appointments (A minimum of four times post-surgery) or have comprehensive records accessible for evaluation to provide an accurate assessment of their postoperative status. However, 25 respondents were excluded from the study due to missing data; thus, the final sample size was 352. The participants were purposively selected from hospitals in the Al-Ahsa governorate in Saudi Arabia from March to August 2024. Data collection was performed through questionnaire completion as well as personal interviews with sample individuals while visiting hospitals or private clinics in the governorate; others were contacted via telephone. Additionally, online platforms such as the Bariatric Patients Association, Bariatric World, and Bariatric Patients Forum were utilized to ensure an adequate sample size. The study criteria excluded respondents who were younger than 20 or older than 50 years of age, as well as smokers, pregnant women and anyone with contraindicated medications.

Materials and methods

The subjects completed two questionnaires: one pertained to physical activity levels and dietary behaviors; the second was a food frequency questionnaire (FFQ). The questionnaire on physical activity levels and dietary behaviors asked for information regarding height, pre-operative weight and post-operative weight at the second year. Demographic information (age, gender, monthly income, education level, employment status, and marital status) and health information following surgery, along with dietary behaviors and the frequency of consuming food items were also requested from study participants (reason for following dietary regimen, and dietary supplements consumed). In addition to questions related to health, pre- and post-operative comorbidities and types, duration and frequency of exercise were investigated.

The quantitative FFQ was used to measure the frequency of consumption of 139 foods and beverages, which were grouped into nine categories: dairy products, bread and cereal products, fruits, vegetables, meat and alternatives, fast food, sweets and desserts, beverages and fast food. The questionnaire used was a slightly modified version of a previously developed and validated questionnaire.[12] Subjects were asked about their eating behavior in the month prior to the first interview and were asked to indicate their usual intake of each of the foods per day, week or month, as well as determining their usual portion size in relation to a stated standard portion.

BMI was calculated for each participant using the formula Weight (kg)/Height (m^2) and classified according to WHO criteria[13] as one of the following: underweight (BMI less than 18.5); healthy weight (BMI 18.5 – 24.9); overweight (BMI 25 – 29.9); or obese (BMI $\geq$30.0).

Statistical methods

A pilot study was conducted among 20 participants and the data were analyzed. Cronbach's alpha was calculated for all items and was observed to be greater than 0.90, indicating high internal consistency.[14] Data analysis was performed using the Statistical Package for Social Sciences (SPSS 24). Frequency distributions, percentages, means, and standard deviations were calculated to describe the characteristics of the study population. Furthermore, the chi-square test was employed to measure significant relationships between dietary behavior variables, physical activity, and BMI.

RESULTS

This study included 352 women, among whom the largest age group having undergone SG procedures was the category of 40-50-year-olds (accounting for 57.1%), while the lowest percentage (6.53%) was the 20-29 age group, as illustrated in Table 1. The majority of the study participants held a university degree (69.03%), and (65.34%) were married. 73% of the women were employed, with the highest monthly income proportion (32.67%) falling within the range of 10,000-15,000 Saudi Riyals per family.

Prior to the surgery, 98.9% of the sample had an obese or morbidly obese BMI level. This percentage significantly decreased following the procedure, to 30.7% for obesity, 39.5% for overweight, and 28.4% for normal weight (Figure 1).

In regard to the main reasons that led participants to undergo SG (Figure 2), it was evident that the majority of the sample (26.4%) attribute it to the failure of dietary regimens. Other reasons included an actual diagnosis of diseases related to obesity, such as diabetes and heart diseases (23.9%), followed by fear of future obesity-related diseases (19.3%). Additionally, some respondents

Table 1. Distribution of sample individuals according to demographic variables (n=352)

Variable	Frequency	Percentage
Age		
20-29	23	6.53
30-39	128	36.4
40-50	201	57.1
Educational level		
Middle school or less	8	2.3
High school	73	20.7
University degree	243	69.0
Postgraduate (master's or Ph.D.	28	7.1
Marital status		
Single	105	29.8
Married	230	65.3
Divorced	15	4.3
Widowed	2	0.6
Employment status		
Student	25	7.1
Employee (government/ private sector)	257	73.0
Self-employed	9	2.6
Unemployed	61	17.3
Monthly family income		
Less than 5000 SAR	85	24.**2**
5000-10000 SAR	97	27.6
10000-15000 SAR	115	32.**7**
More than 15000 SAR	55	15.6

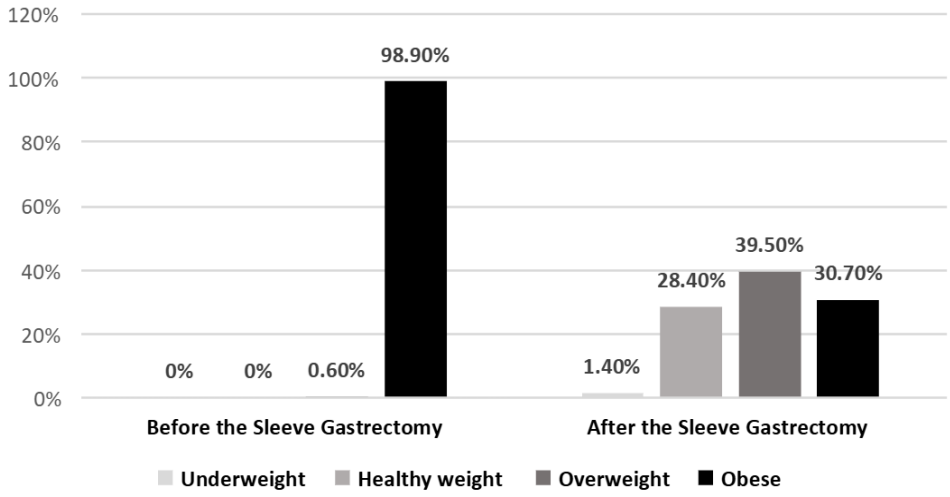

Figure 1. Comparison of body mass index levels, before and after sleeve gastrectomy procedure.

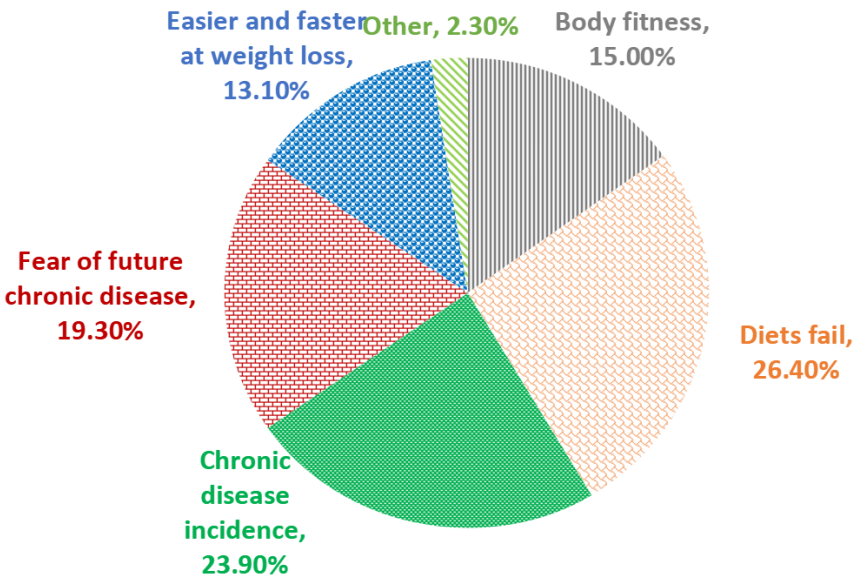

Figure 2. Distribution of study participants according to the main factors motivating them to undergo the gastrectomy procedure.

perceived the surgery as being an easier and quicker way to lose weight and achieve fitness (13.1%). Other responses, accounting for (12.5%), were more varied and included issues such as back disc herniation, fear of developing chronic diseases related to obesity in the future, accumulation of fat around the heart, accidents, as well as the desire for pregnancy and the treatment of ovarian cysts. Doctors' recommendations also prompted some participants to undergo the procedure.

Among the study population, there was a noticeable improvement (29.6%) in the prevalence of various obesity-related diseases after the participants had undergone SG. Moreover, the results showed that SG led to a significant decrease ($p \geq 0.05$) in the incidence of sleep apnea (50%), elevated liver fat (42.1%), T2D (36.8%), total cholesterol and blood fat elevation (34.0%). However, there was an insignificant improvement in high blood pressure (HBP) and the incidence of ovarian cysts. On the other hand, SG had a negative effect on women in terms of menstrual disorders, hair loss, anxiety, and depression (Table 2).

Regarding dietary supplements, the highest proportion of individuals in the sample continued to consume dietary supplements after undergoing SG (35.6%), compared to 26.1% who did not consume supplements and 14.20% who consumed them occasionally. Approximately half of the sample did not undergo tests to detect mineral deficiencies (50.6%), compared to a lower percentage of those who underwent the tests and did not suffer from deficiencies (15.3%). Some individuals in the sample reported suffering from deficiencies in certain vitamins and minerals. It was found that vitamin D deficiency was the most prevalent (25.6%), followed by iron (17.3%), then vitamin B-12 (16.2%), and calcium (3.13%), with the vitamin B group totaling 2.65% (Table 3).

A high percentage of participants reported drinking juices more than three times a week (84.7%) and consuming sweets, cakes, or chocolates more than twice a day (35.5%) . 55.1% of the participants felt hungry shortly after eating and ate food late at night (28.1%). Addi-

Table 2. Health problems and diseases among female participants, before and after gastrectomy

Diseases	Before gastrectomy		After gastrectomy	
	Frequency	Percentage	Frequency	Percentage
I have no disease	71	20.1‡	92	26.1†
Heart disease	3	0.9†	3	0.9†
High total cholesterol and blood lipids	94	26.7†	62	17.6‡
Type 1 diabetes mellitus	18	5.1†	18	5.1†
Type 2 diabetes mellitus	68	19.3†	43	12.2‡
Hypertension	20	5.7†	16	4.5†
Fatty liver	38	10.8†	22	6.3‡
Backache, joint and knee pain	44	12.5†	40	11.4†
Polycystic ovary disease or infertility	10	2.8†	8	1.7†
Menstrual disturbances (late and irregular cycles)	27	7.7†	39	11.1†
Hair loss	13	3.7†	268	76.1‡
Anxiety and depression	12	3.4†	29	8.2‡
Paroxysmal nocturnal dyspnea	4	1.1†	2	0.6‡
Other diseases (hypothyroidism, gall stones, asthma, irritable bowel syndrome, etc.)	8	2.3†	7	1.1†

The values represent the standard deviation. Values with superscript symbols (†, ‡) in the same row differ significantly at $p \geq 0.05$.

Table 3. Prevalence of dietary supplement use and vitamin deficiencies, following gastrectomy

Variable	Frequency	Percentage
Using dietary supplements		
Yes	210	35.6
No	92	26.1
Sometimes	50	14.2
Vitamin deficiency		
I don't have vitamin deficiencies	54	15.3
Iron	61	17.3
Vitamin D	90	25.6
Calcium	11	3.1
Vitamin B complex	9	2.6
Vitamin B 12	57	16.1
I don't know/ haven't been tested	178	50.6

tionally, 38.07% of the participants reported drinking fewer than eight cups of water daily and experienced vomiting when consuming large amounts of food (57.1%), as indicated in Table 4.

On average, women reported consuming 1.46 servings of fruits per day and 1.46 servings per day of cooked and raw vegetables. Furthermore, the participants consumed 5.2 servings of grains per day, especially white rice and white bread. The average consumption of meat and alternatives was 2.48 servings per day, with poultry being consumed more than fish or red meat. Additionally, participants consumed 2.16 servings of dairy products per day, especially milk and yogurt. In terms of juice consumption, women consumed an average of 2.98 servings per day, preferring canned juice. The average consumption of high-calorie foods such as crackers and sweets was 2.72 servings per day (such as potato chips, chocolate, and ice cream), while the average intake of fast food was 0.61 servings/day (such as shawarma, burgers, pizza, and fried chicken) (Figure 3).

The majority of the sample (67.6%) did not engage in regular physical activity, whereas almost one-third (32.4%) engaged in physical activity regularly, with most of these (54.4%) engaging in a moderate level of exercise. Of those who reported being physically active, 62.28% reported engaging in physical activity at least three times per week, with the average duration of each physical activity being 45.4 ± 28.3 minutes (Table 5).

Correlation testing revealed a significant relationship between body mass index and the regular consumption of healthy food after undergoing weight loss surgery. Approximately half of the sample reported occasionally consuming healthy food, indicating that the respondents had not changed their behavior for the better. In addition, a significant relationship was found between body mass index and exercise after weight loss surgery (Table 6 and 7).

DISCUSSION

Rapid transformations in eating routines, lifestyle choices, reduced levels of physical exercise, and excessive dependence on technology have contributed to a troubling rise in obesity rates within Saudi communities in recent years.

This study's main objective was to examine the dietary habits, physical activity levels, and weight reduction outcomes among Saudi women who have undergone gastric sleeve surgery. Of the 253 women who were enrolled in this study, the highest percentage of people who underwent SG procedures was in the range of 40-50 years, accounting for 57.1%, while the lowest percentage was in the 20-29 age group (6.53%). Various factors might explain why this age group had the highest representation. For example, women of this age might be more likely to experience weight-related health concerns or may already have struggled with weight management over an extended period. Similarly, the lower percentage in the younger age group (20-29) could be due to several factors. Bariatric surgery is typically recommended only after trying other weight loss methods and for individuals with a body mass

Table 4. Dietary habits of participants, following gastrectomy

Variable	Frequency	Percentage
1. I consume large quantities of food.	8	2.3
2. I eat food very quickly.	20	5.7
3. I consume sweets, cakes, or chocolates more than twice a day.	125	35.5
4. I suffer from vomiting when consuming large quantities of food.	204	57.1
5. I feel hungry shortly after eating.	194	55.1
6. I skip meals or leave a gap of more than five hours between meals.	17	4.8
7. I eat out more than three times a week.	29	8.2
8. I drink fewer than eight cups of water daily.	143	38.1
9. I consume fried foods and fast food more than three times a week.	56	15.1
10. I drink carbonated beverages and energy drinks more than three times a week.	9	2.6
11. I drink juices more than three times a week.	298	84.7
12. I eat 5-6 meals spread throughout the day.	100	28.4
13. I eat food late at night.	102	28.1
14. I eat when feeling stressed.	14	3.1

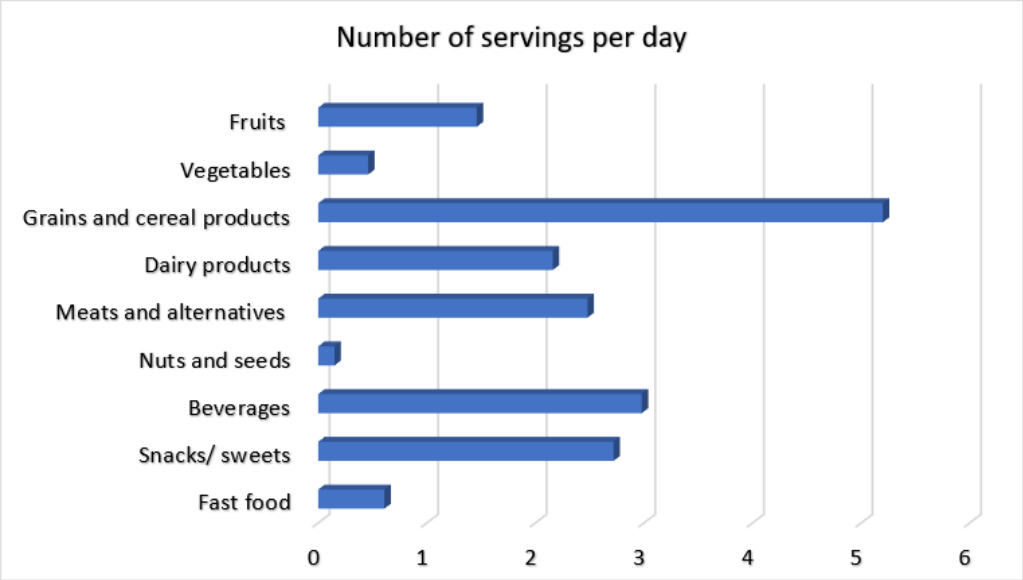

Figure 3. Mean average of daily consumption of dietary groups

Table 5. Physical activity behaviors of participants, following gastrectomy

Answer	Frequency	Percentage
Engagement in physical activity		
Yes	238	67.6
No	114	32.4
Type of physical activity		
Light exercise	44	38.6
Moderate exercise	62	54.4
Heavy exercise	8	7.0
Frequency of physical activity		
2 times per months or fewer	5	4.4
1-2 times per week	38	33.4
3-7 times per week	71	62.3
Duration of each physical activity (min)	45.4 ± 28.3	

Table 6. Association between the regular consumption of healthy food and BMI

Regular consumption of healthy food	BMI				Total
	Underweight	Normal	Overweight	Obese	
Yes	1 (20%)	40 (40%)	52 (37.4%)	45 (41.7%)	138 (39.2%)
No	0 (0%)	7 (7%)	13 (9.4%)	9 (8.3%)	29 (8.2%)
Sometimes	4 (80%)	53 (53%)	74 (53.2%)	54 (50%)	185 (52.6%)

Chi square= 12.234, degree of freedom= 6, *p* value: 0.002

Table 7. Association between regular exercise and BMI

Regular consumption of healthy food	BMI				Total
	Underweight	Normal	Overweight	Obese	
Yes	3 (60%)	34 (34%)	52 (37.4%)	34 (31.5%)	123 (34.9%)
No	2 (40%)	66 (66%)	87 (62.6%)	83 (68.5%)	229 (65.1%)

Chi square=14.436, degree of freedom= 3, *p* value: 0.001

index (BMI) exceeding specific thresholds. Additionally, younger individuals might be less likely to have developed the severe health complications that often prompt consideration of surgery.

The majority of the study participants held a university degree (69%). Individuals with higher education may have greater access to health information and may therefore be more aware of the potential benefits and risks of weight loss surgery, leading them to consider it as an option.[15] In addition, university degrees can be associated with higher income and better access to healthcare, possibly making bariatric surgery more accessible to these individuals. It was found that 73% of the women were employed, with the highest monthly income proportion (32.7%) falling within the range of 10,000-15,000 Saudi Riyals per family. Certain professions associated with

university degrees might demand more time commitment or might involve specific physical limitations that could contribute to weight-related challenges.

In terms of marital status, the vast majority of the women were married (65.3%). Marriage can provide social support and encouragement, which might be beneficial for individuals considering weight loss surgery, which is a significant undertaking with both physical and emotional ramifications. Also, as spouses often share lifestyles and dietary habits, a supportive partner might be more willing to participate in the lifestyle changes necessary for the success of weight loss surgery.

With regards to BMI, analysis revealed that 98.9% of the sample had an obese or morbidly obese BMI level prior to the surgery. Following the procedure, this percentage significantly decreased to 30.7% obesity, 39.5% overweight, and 28.4% normal weight. These results align with those of a study conducted in Kuwait, which reported that mean (SD) BMI decreased from 47.1 (8.3) kg/m^2 before surgery to 34.3 (7) kg/m^2 5-8 years after surgery. Mean (SD) body weight decreased from 126.3 (25.3) kg to 91.6 (19.9) kg 5-8 years following laparoscopic SG.16 Other studies report similar improvements in post-operative BMI.[17,18] Thus, the results suggest that the SG was effective in helping a substantial portion of the participants to achieve significant weight loss and improve their BMI classification. However, it is important to note that this study involved a limited sample, and the long-term effectiveness of surgery for weight loss management may vary, depending on individual factors.

When investigating the main factors that led participants to undergo SG, the majority of the sample attributed it to the failure of dietary regimens. This highlights the limitations of diet alone for some individuals who struggle with severe obesity and the potential frustration they might experience. Additional reasons included the fear of future obesity-related diseases, as well as the perception of the surgery being an easier and quicker way to lose weight and achieve fitness. A multi-center European study resulted in similar findings, noting that weight loss and improved co-morbidities had been identified as the main reasons for undergoing bariatric surgery.[17] This suggests that participants were concerned about the potential health consequences of their weight, such as diabetes, heart disease, or joint issues. This, in turn, demonstrates their awareness of the risks associated with obesity and their desire to take proactive steps towards a healthier future. However, SG is a significant medical intervention and requires ongoing lifestyle changes to maintain weight loss and improve health.

Data on the prevalence of several obesity-related diseases among the study population, prior to undergoing SG, revealed post-operative improvements in 29.58% of the women. It was observed that SG led to a significant decrease ($p \geq 0.05$) in the incidence of sleep apnea (50%), elevated liver fat (42.13%), T2D (36.8%), total cholesterol and blood fat elevation (34.0%). These findings are compatible with a previous systematic review, which aimed to examine the long-term outcomes following SG. Five years post-SG, a significant resolution or improvement in T2D was noted in 77.8% of patients, while improvements or resolution in arterial hypertension, dyslipidemia, obstructive sleep apnea, gastroesophageal reflux disease, and degenerative joint diseases were noted among 68.0%, 65.9%, 75.8%, 30.6%, and 55.7% of patients, respectively. Therefore, this systematic review indicates that SG can result in substantial and enduring loss of excess weight and notable enhancement in obesity-related comorbidities.16 However, there was an insignificant improvement in HBP and the incidence of ovarian cysts. The lack of significant improvement in HBP might be due to various factors, such as the participants needing additional medication alongside the surgery's effects or the specific characteristics of the participants with HBP before surgery. On the other hand, the insignificant change in ovarian cyst prevalence does not necessarily indicate that there was no improvement. Possibly, the results could be due to the condition's natural course, the limited sample size, or other factors. Moreover, it is important to note that SG is not specifically indicated for treating ovarian cysts.

In contrast, SG had a negative effect on women in terms of menstrual disorders, hair loss, anxiety, and depression. Again, this finding is supported by a previous study, which identified that among 307 subjects, pre-operative depression had affected 30.2% while 37.7% suffered from post-operative depression ($p = 0.025$).[18] This result suggests that undergoing bariatric surgery might be associated with increased anxiety and depression in some women. The reasons for this could be complex and may involve various factors such as stress about the surgery and its aftermath, body image changes, or the emotional challenges associated with weight loss.

Regarding dietary supplements, the results showed that the highest proportion of individuals in the sample continued to consume dietary supplements after undergoing SG (35.6%). While promoting weight loss, SG can also limit nutrient absorption due to the reduced stomach size and altered digestive process. Supplements can help to address potential deficiencies in vitamins and minerals such as iron, vitamin B-12, and calcium, which are crucial for maintaining overall health. Some individuals in the sample reported suffering from deficiencies in certain vitamins and minerals. It was found that vitamin D deficiency was the most prevalent (25.6%), followed by iron (17.3%), then vitamin B-12 (16.2%), and calcium (3.13%), with the vitamin B deficient group totaling 2.65%. In a one-year follow-up study, it was found that micronutrient deficiencies persisted or were found de novo in a considerable number of patients, despite significant weight loss and supplementation. Significant reductions were seen for folate and vitamin D.[19] Following SG, maintaining a healthy diet, rich in various nutrients, and considering additional supplementation under medical guidance can help to ensure an adequate intake of essential vitamins and minerals, reducing the risk of deficiencies. Very low calorie diets (VLCD) and very low calorie ketogenic diets (VLCKD) are the most frequently used methods for the induction of a pre-operative weight loss today. Additionally, specific nutritional problems – such as dumping syndrome and reactive hypoglycemia – can occur and should be managed largely through nutritional manipulation.[20]

According to the results, most of the subjects consumed an adequate amount of dairy products (2.16 servings/day), meat (2.48 servings/day) and grains (5.2 servings/day). However, the majority of the sample had a high intake of juice, sweets and snacks, indicating that they had not changed their eating behaviors following the operation. Correspondingly, other studies have noted a significantly higher intake of non-liquid sweets by Roux-en-Y gastric bypass (RYGB) subjects and a higher consumption of soft-calorie and high-sugar and fatty foods among SG subjects after one year of post-operative follow-up. [21]

Regularly consuming sugary drinks and sweets in excess can contribute to various health problems, including weight regain and obesity, T2D, dental problems, and other health issues.[22,23] In contrast, some studies have reported decreased sweet food consumption following Roux-en-Y gastric bypass compared to pre-surgery procedures. Behary et al.'s two-year study observed a 14–21% reduction in sweet and dairy intake post- Roux-en-Y gastric bypass, contrasting with gastrectomy patients.[24] It is possible that the difference in dietary intake is related to the type of gastric sleeve surgery.

On average, women reported consuming 1.46 servings per day of fruits and 1.46 servings per day of cooked and raw vegetables, indicating a decrease in the intake of fruits and vegetables. This may result from a deliberate attempt to avoid dumping syndrome (bloating), which is one of the problems suffered by some people who have undergone gastric sleeve surgery.[25]

In fact, post-surgery fruit and vegetable consumption data vary; some research has reported increased vegetable intake and decreased fruit intake post-Roux-en-Y gastric bypass,[26] while others have observed a greater consumption of fruits and vegetables in Roux-en-Y gastric bypass diets compared to vertical banded gastroplasty.27 Nevertheless, some studies have reported a consumption of fruit and vegetables that is lower than advised,[28] while others have found no significant change in vegetable consumption post-surgery.[29]

In terms of physical activity behaviors, this study found that 39% of post-operative bariatric patients engaged in light exercise, while 54% engaged in moderate exercise and 7% engaged in heavy exercise. These results agree with a longitudinal study that found that 47% of post-operative bariatric patients were sedentary or somewhat active, while 47% were active and 6% were highly active.[30]

Interestingly, some studies have found a significant decrease in physical activity after gastrectomy. For example, a prospective cohort study[31] found that patients who had undergone gastrectomy engaged in a significantly lower level of physical activity than prior to the surgery. Various physiological and psychological factors may contribute to the decline in physical activity observed after gastrectomy. For example, surgical trauma, alteration of the gastrointestinal anatomy, and changes in dietary habits can directly affect energy levels and physical functioning.[32] Aside from immune disorders, psychological factors can also prove to be another barrier to patients' wellness, such as anxiety, depression, and fear of exertion.[33] In contrast, one study found that patients who had undergone gastrectomy reported significant improvements in their quality of life, including increased physical activity levels, attributed to symptom relief and improved well-being.[34] However, an intervention study targeting women undergoing RYGB surgery reported that after two-years' follow-up, no differences in physical activity levels between the intervention group and the control group were observed.[35]

Correlation testing revealed a significant relationship between body mass index and the regular consumption of healthy food after undergoing weight loss surgery. This finding aligns with general health recommendations and suggests that individuals who consume healthy foods regularly tend to have lower BMIs after undergoing weight loss surgery. This could be due to several factors such as reduced calorie intake, improved nutrient intake, and increased satiety.

In addition, a significant relationship between body mass index and exercise after weight loss surgery was noticed. Exercise burns calories, creating an additional calorie deficit and contributing to weight loss. Furthermore, building muscle mass can help to boost metabolism and increase the body's ability to burn calories, even at rest.[10,36] Studies indicate that, after two years post-surgery, lifestyle interventions can facilitate weight loss that equates to ~5%. Even though lifestyle interventions are plagued by weight regain, they can have substantial beneficial effects on T2D and cardiovascular disease risk.[37,38] Although 10-year percentage excess weight loss can surpass 50% after bariatric surgery, weight regain is likely. To mitigate weight regain, instituting a multifactorial maintenance program is imperative. Such a program can integrate diet, exercise, and pharmacotherapy. Moreover, behavioral therapy can substantially complement a maintenance program.[39] However, it is important to note that correlation does not necessarily indicate causation. While this study has demonstrated a relationship between healthy food consumption, exercise, and BMI after weight loss surgery, it does not definitively prove that these factors directly cause lower BMI. Nevertheless, the findings of this study support the widely recognized connections between these factors and their positive impact on weight management and overall health.

The focus of this study on women who have undergone SG allows for a more targeted and relevant analysis of their experiences and outcomes. Another strength is that it collected data on various aspects, including demographics, pre-operative health status, post-operative outcomes, dietary habits, and physical activity levels. Such a comprehensive approach provides a more holistic understanding of the participants' experiences.

On the other hand, the data presented here focuses solely on women who have undergone surgery. Including a control group of participants who have not undergone surgery but who are aiming for weight loss through other methods could provide a clearer picture of the specific effects of the surgery compared to alternative approaches. Furthermore, this study relied on self-reported data for such factors as dietary habits and physical activity levels. Therefore, the data can be prone to bias as individuals might underreport unhealthy behaviors or overestimate their adherence to healthy habits.

Research advocates for the utilization of clinical markers to enhance the correlation between clinical indicators and outcomes in post-surgical weight control, thereby monitoring metabolic health and behavioral effects. The authors in a study discovered that post-bariatric surgery patients who consistently participated in physical activity and adhered to healthy dietary practices exhibited sustained enhancements in clinical indicators, including BMI, lipid profiles, and insulin sensitivity, thereby establishing a direct correlation between these behaviors and improved long-term outcomes.[40] Similarly, another study examined the metabolic consequences of bariatric surgery and emphasized the importance of monitoring clinical indicators such as blood glucose and lipid levels to evaluate the comprehensive impacts of lifestyle modifications on health outcomes.[41] Future research should investigate the correlation between clinical test indicators (such as BMI, lipid profiles, and insulin sensitivity) and long-term outcomes in women post-gastric sleeve surgery, while considering the impact of age-related hormonal fluctuations (e.g., estrogen and insulin levels). This method would yield more thorough insights into the effects of hormonal changes on post-surgical weight management and metabolic health, thereby facilitating more customized therapies that enhance both exercise and nutrition guidelines for women following bariatric surgery.

Limitations

The study faced constraints by the fact that the study may not fully address psychological aspects that could influence eating behaviors and weight loss maintenance. Moreover, there could be inaccuracies in dietary information and the level of exercise as they were self-reported, which may have been influenced by memory or social expectations. Furthermore, the study's exclusive focus on women may hinder its applicability to men in generalizing findings. Additionally, the period of monitoring for two years might not encompass the enduring effects or possible weight reacquisition that might happen subsequently. Therefore, it is recommended to extend the follow up duration (e.g., 5 Or 10 years) to evaluate lasting effects and weight management. A further limitation of this research is the lack of subgroup analysis of age-related hormonal variations linked to obesity in women. Fluctuations in hormone release especially estrogen and insulin may affect weight regulation and metabolic reactions post-gastric sleeve surgery. Including subgroup analysis by age may yield more refined insights into the effects of hormonal variations on exercise and dietary behaviors in women following surgery. The data collection for this study utilized questionnaires and personal interviews, which are inherently limited by potential subjectivity and recall bias. Consequently, future research should consider incorporating objective measurement methods, such as the use of physical activity monitoring devices and the examination of medical records, to augment data precision and bolster the general dependability of the results.

Conclusion

Valuable insights into the experiences of women who had undergone SG surgery for weight loss were provided in this data analysis. Indeed, the study revealed high success rates in terms of weight reduction and improvement in several obesity-related health conditions. However, it also highlighted the potential disadvantages, such as the increased prevalence of certain vitamin and mineral deficiencies and the need for continued monitoring and management. Additionally, the study identified concerning lifestyle habits among some participants, emphasizing the importance of maintaining a healthy diet and engaging in regular physical activity to maximize the long-term benefits of weight loss surgery and promote overall well-being. While this study had certain limitations, it nevertheless provides valuable information to consider and discuss with a healthcare professional before informed decisions are made regarding weight management strategies, including whether SG is the right option in any set of individual circumstances.

CONFLICT OF INTEREST AND FUNDING DISCLOSURES

The author declares that there are no conflicts of interest regarding the publication of this paper.

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