Effectiveness of Combined Exercise and Nutritional-Behavioral Intervention on Health Outcomes among Patients with Bariatric Surgery

Amal S. Taha[1], Marwa M. Ali[2]

[1]Medical Surgical Nursing Department, Faculty of Nursing, Benha University, Benha, Egypt.
e-mail: Amal.said22@yahoo.com
[2]Medical Surgical Nursing Department, Faculty of Nursing, Benha University, Benha, Egypt.
e-mail: medicine_s2000@yahoo.com

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ABSTRACT

Context: Many bariatric surgery patients experience suboptimal long-term weight outcomes, including weight regain. Weight regaining threatens the benefits initially achieved from surgery, including improved health outcomes, and patients still require hard work and lifelong behavioral change to lose and maintain weight successfully.

Aim: This study aimed to evaluate the effectiveness of combined exercise and nutritional-behavioral intervention on health outcomes among patients with bariatric surgery.

Methods: A quasi-experimental (study/control group) design was utilized in the present study that was conducted at surgical departments and outpatient clinics in the Benha University Hospital, Qualubia Governorate, from January 2021 until April 2022. A convenience sample of 85 patients ended with 60 patients who completed the study (Intervention group 30 & control group 30). They were recruited according to to sample size equation based on the patient admitted to the study setting in 2020. Two tools were utilized for data collection; the patient structured interviewing questionnaire and the patient's health outcomes questionnaires that included anthropometric measures, eating behavior and food frequency questionnaire, international physical activity questionnaire, and the Moorehead-Ardelt quality of life questionnaire.

Results: The findings revealed a mean sample age of 35.53±4.06 for the intervention group and 34.47±4.11 for the control group. The intervention and control groups revealed a highly statistically significant difference regarding all knowledge elements and the total knowledge score. Besides, a statistically significant improvement in the intervention group's knowledge throughout the study phases. A highly statistically significant difference was revealed in the percentage of weight loss (%wt L) among the intervention group throughout the following study periods (first month, six months, and one year of intervention), with statistically significant differences between the intervention and control group after one and six months, and after one year of intervention regarding their weight, % wt L, BMI, and excess BMI loss percentage. Eating habit scores revealed statistically significant differences between the intervention and control group regarding eating behaviors and food frequency at one and six months and one year of intervention. Residence (p=0.01), total patient knowledge (p=0.002), food frequency (p=0.000), and physical activity (p=0.001) level predicted weight loss in the intervention group, while age was the only predictor in the control group (p=0.02).

***Conclusion*:** Implementing the combined exercise and nutritional-behavioral intervention post bariatric surgery significantly improved patients' health outcomes in terms of improved patient knowledge, weight loss percentage, eating habits, physical activity, and quality of life levels among the intervention group compared to the control group. There is a need to raise knowledge of bariatric surgery patients regarding the value of living a healthy lifestyle for improving surgical outcomes and maintaining weight loss.

Keywords: Bariatric surgery, behavioral intervention, exercise, nutrition, health outcomes

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1. Introduction

Obesity is now recognized as the most prevalent metabolic disease worldwide, reaching epidemic proportions in both developed and developing countries, and the prevalence of class II and III obesity (Body mass index (BMI) ≥35 kg/m²) has increased exponentially in recent decades. Annually, about 4.7 million premature deaths occur due to obesity. It was ranked fifth among the leading preventable causes of death, making up 8.4% of deaths worldwide *(Mehrzad, 2020).*

It is a complex health issue resulting from a combination of causes and individual factors such as behavior and genetics; behaviors include physical activity, inactivity, dietary patterns, medication use, and other exposures. Additional contributing factors include the food and physical activity environment, education, and skills *(Centers for Disease Control and Prevention CDC, 2022).* Severe obesity is associated with multiple comorbidities such as hypertension, insulin resistance, type 2 diabetes, dyslipidemia, cardiovascular disease, sleep apnea, and cancer and is often associated with musculoskeletal pain. All these comorbidities further lead to impaired health outcomes

[1]*Correspondance author: Amal Said Taha*

and reduced quality of life *(Baillot et al., 2015; Tabesh et al., 2019).*

Several strategies are recommended for treating obesity, including dietary therapy, regular physical activity (PA), behavioral therapy (BT), pharmacotherapy, and bariatric surgery, as well as combinations of these strategies. There are currently two major categories of bariatric surgery, grouped according to the predominant mechanism of action: Restrictive procedures, such as vertical banded gastroplasty (VBG) and adjustable gastric banding (AGB); and malabsorptive procedures with a restrictive component, such as Roux-en-Y gastric bypass (RYGB), vertical sleeve gastrectomy (VSG), and biliopancreatic diversion with duodenal switch (BPD-DS). Bariatric surgery produces marked and sustained weight loss; improves obesity comorbidities, physical function, and quality of life; and decreases mortality risk *(Courcoulas et al., 2018; Hamdy, 2021).*

Although bariatric surgery remains the most effective treatment to decrease and maintain weight loss and improve comorbidities and mortality, several behavioral interventions targeting standard lifestyle modification skills are recommended as the first step to achieving weight loss and treating obesity-related comorbidities in subjects with severe obesity. In addition, given the limited resources, lifestyle intervention remains an effective option to help more subjects with severe obesity *(Mingrone et al., 2018).* Physical activity (PA) is an important component of lifestyle intervention and should be systematically included in lifestyle management components. Moreover, nutritional adjustment, self-monitoring, and continued follow-up have been identified as key components of weight control. In addition, several studies showed that PA presents several benefits in individuals with class II and III obesity *(Stanish et al., 2017).*

Extensive teaching regarding diet, physical activity, and lifestyle are vital in helping patients to make the necessary changes, achieve and maintain weight loss, and adjust to life after surgery. Discharge teaching should include verbal and written instructions about the dietary progression; the medication regimen; incision care; signs and symptoms that must be reported to the physician; follow-up appointments (including those with the patient's surgeon, primary care provider, and nutrition counselor); contact information for postoperative support groups; and any restrictions on driving and other activities. The nurse should ensure that the patient understands the importance of periodic assessments for nutritional deficits. One study found that, during the first postoperative year, some patients demonstrated an inadequate intake of nutrients such as protein, calcium, and iron. The value of regular physical activity and participation in support groups should also be reiterated *(Deledda et al., 2021).*

2. Significance of the study

Obesity is now recognized as the most prevalent metabolic disease worldwide. It was ranked fifth among the leading preventable causes of death *(World Health Organization, 2021).* According to the World Health Organization (WHO), Egypt ranks 18th with the highest prevalence of obesity worldwide. The estimated annual deaths due to obesity was about 115 thousand (constituting 19.08% of the total estimated deaths in 2020) *(Aboulghateet al., 2021).*

Most bariatric surgery patients experience suboptimal long-term weight changes, including weight regain. Weight regaining threatens the benefits initially achieved from surgery, including improved health outcomes. Furthermore, patients still require hard work and lifelong behavioral change to lose and maintain weight successfully. Because their unhealthy habits have evolved over many years and, therefore, may not just disappear overnight *(Courcoulas et al., 2018).* It is, therefore, critical to develop effective interventions to stop and reverse weight regain in this subset of patients. So, the current study is an effort to investigate the effectiveness of combined exercise and cognitive behavioral intervention programs for weight control practice on bariatric surgery patient outcomes.

3. Aim of the study

The present study aimed to evaluate the effectiveness of combined exercise and nutritional-behavioral intervention on health outcomes among patients with bariatric surgery.

3.1. Operational definitions

Health outcomes

The impact of the behavioral intervention is detected in this study through; Anthropometrics, physical activity level (PAL), eating behavior, and quality of life (QoL).

Behavioral intervention

Behavioral intervention in this study will involve all interventions that can modify the patient's behaviors after bariatric surgery; it will include early postoperative behavioral intervention through exercise and nutrition education programs targeting improving the patient's lifestyle to enhance and maintain weight loss.

3.2. Research Hypothesis

The following research hypotheses have been developed to achieve the study's aim:

H1: The total knowledge scores will significantly improve among intervention group patients than the control group patients after program implementation.

H2: Anthropometric measurement scores will significantly increase the weight loss percentage among intervention group patients than the control group patients after program implementation.

H3: The total eating habits scores will significantly improve among intervention group patients than the control group patients after program implementation.

H4: The total physical activity scores will significantly increase among intervention group patients than the control group patients after program implementation.

H5: Quality of life scores will significantly improve among intervention group patients than the control group patients after program implementation.

4. Subjects & Methods

4.1. Research Design

Quasi-experimental design (study/control) was utilized to conduct the current study. A quasi-experimental design establishes a cause-and-effect relationship between an independent and dependent variable. The independent variables were combined exercise and nutritional-behavioral intervention, while the dependent variables were health outcomes among patients with bariatric surgery**.**

4.2. Study setting

This study was conducted in the general surgical departments at Benha University Hospital-Qualubia Governorate. The general surgical departments are divided into three departments. The female surgical department is on the third floor of the surgical building and contains five rooms. Each one contains four beds. The male surgical department is located on the fifth floor of the surgical building and contains four rooms, each with four beds. The outpatient surgical clinic department included two beds, one for examination and another for dressing surgical wounds.

4.3. Subjects

A sample of convenience of 85 patients undergoing bariatric surgery over three months was included in the study. Fulfilling inclusion criteria, ≥ 20 years of age, free from medical contraindications such as cardiovascular disease, uncontrolled hypertension, and functional limitation. At the end of the study, 25 patients were not contactable during the follow-up period. Sixty patients were randomly classified into two groups (Intervention and control group). The control group received routine care. The intervention group received the combined nutritional and behavioral intervention.

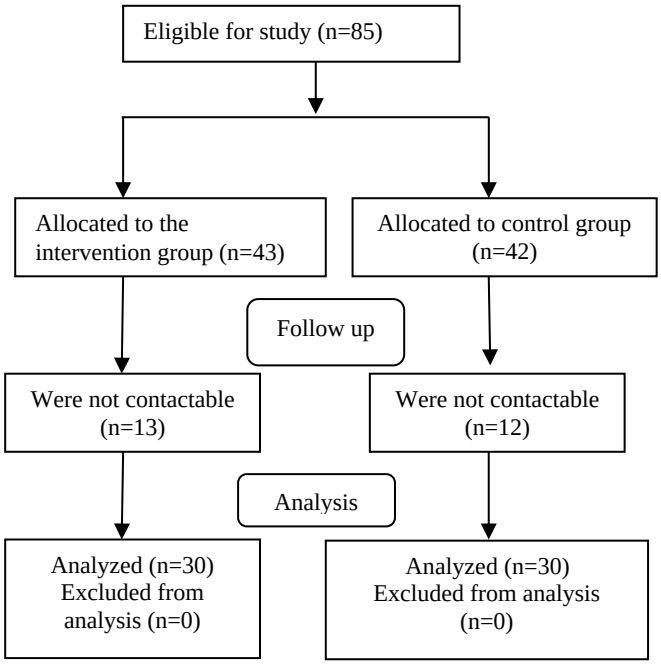

Figure (1): The process of sample recruitment.

4.4. Tools of data collection

Two tools were used to collect the data in this study.

4.4.1. Structured Interviewing Questionnaire

Researchers developed it to assess the demographic characteristics of the patients and illness-related data in addition to knowledge (pre/post-test). It involved three parts: Part 1 was concerned about the patient's demographic details, such as age, gender, residence, marital status, education level, and occupation.

Part 2 documented the illness-related data, such as the presence and types of comorbidities, types of surgical intervention, and following a previous program for weight loss and its outcomes.

Part 3 was a Structured Knowledge Questionnaire (Pre/Post Test) designed to assess patients' knowledge regarding behavioral changes post-bariatric surgery. Researchers developed it after analyzing relevant articles *World Health Organization (2019); Dendasck et al. (2021); El Ansari and Elhag (2021),* and with approval from an expert panel, have all used multiple-choice questions. It discusses the following in three sections:

Section 1 included basic knowledge of obesity: Morbid obesity definition, anthropometric measures, causes, complications, weight reduction methods, methods of diagnosis, and treatment. This section included 7 MCQ questions. Each had only one correct answer.

Section 2 explains the bariatric surgical intervention: Types, definition, benefits, preoperative preparation, and postoperative problems for each type, i.e., redundant skin, sense of hunger, return to work, and the possibility of pregnancy. This section included 12 MCQ questions. Each had only one correct answer.

Section 3 elucidated behavioral modification postoperatively:

- Nutritional adjustment of dietary principles (energy needed in Kcals, protein and fat contents, meal frequency, preoperative liquid diet, postoperative dietary phases, types of food after the surgery, and malnutrition symptoms such as dehydration, nausea, and vomiting, as well as supplementation of vitamins and minerals. It involved eight questions. Some contain more than one correct answer.
- Physical activity, resistance exercises, and continuous monitoring of weight. It involved two questions with more than one correct answer.
- Follow-up visits and their importance involved two questions with only one correct answer.

Scoring system

All knowledge items were included in multiple-choice questions. Questions that imply an answer (do not know or incorrect) get a score of (0), and other correct answers in the same question get a score of (1). The total score of all items of knowledge was 53 degrees. Adequacy of knowledge was classified as follows: The cut-off point is 60%, whereas ≥ 60% of the total score =≥32 scores was considered satisfactory knowledge, and <60% of the total score =<32 scores was considered unsatisfactory knowledge.

4.4.2. Patient's Health Outcomes Questionnaires

4.4.2.1. Anthropometric Measures Record

The researcher developed it. It involved the recording of the patient's weight, percentage of weight loss (%wt L), Body Mass Index (BMI), and percentage of excess Body Mass Index Loss (%EBMIL) (pre and post-intervention). These recorded values were used to assess the patient progress after combined and nutritional behavioral intervention among bariatric surgery patients.

Scoring system

- Body mass index (BMI) was calculated as weight in kilograms divided by height in squared meters (kg/m^2). Variations in BMI were investigated by measuring height and weight using a medical-certified scale and a stadiometer.
- Excess weight loss percentage (%wt L): 100% × (preoperative wt – current wt)/ (preoperative wt - ideal wt).
- Evaluating of patient's percentage of changes in BMI was calculated using the following formulas:
  Excess BMI loss percentage (%EBMIL): 100% × (preoperative BMI – current BMI)/ (preoperative BMI - ideal BMI).

4.4.2.2. Eating Behavior and Food Frequency Questionnaire

This questionnaire was adopted from *Zang et al. (2019)*, a Likert scale to assess eating behavior and food frequency among patients with bariatric surgery and to evaluate the progress of patients after combined and nutritional behavioral intervention. This questionnaire included two sections. The first section assessed eating behavior. It was focused on post-bariatric dietary practice, which is a list of behaviors associated with better weight loss outcomes, such as regular eating, staged meal progression, eating slowly, not drinking during a meal, self-monitoring, and goal setting. Items also asked about patients' self-awareness of eating habits and knowledge of balanced meals and appropriate portion sizes.

The second section asked about food frequency and was used to evaluate the intake of calorie-dense foods such as takeaway meals, fried foods, ready meals, and "soft calories" food such as fizzy drinks, fruit juices, liquid meals, crisp, cakes, biscuits, chocolate, and sweets.

Scoring system

Responses were scored by 0 = never, (1) less than once a week, (2) more than once a week, and (3) almost every day. For dietary fiber intake (fruits and vegetables), responses were scored by 0 = less than one portion daily, 1 = 1 to 2 portions daily, 2 = 3 to 4 portions daily, and 3 = 5 or more portions daily. Each section's subtotal score and the questionnaire's total score were presented as mean and SD.

4.4.2.3. International Physical Activity Questionnaire (IPAQ).

It is the long format of *Craig et al. (2003),* which assesses the total energy expenditure per week by considering minutes spent on vigorous/moderate-intensity activities and walking (pre/post-test). It is a self-reported questionnaire.

Scoring system

- Low-intensity activities such as walking at a comfortable pace.
- Moderate-intensity activities (above a comfortable pace).
- Vigorous-intensity activities (much above a comfortable pace). In addition, they recorded how much time participants were sedentary each day. A total weekly MET level was calculated according to guidelines by multiplying the reported minutes per week in each category by 3.3 for low-intensity activity, 4.0 for moderate-intensity activity, and 8.0 for vigorous-intensity activity *(International Physical Activity Questionnaire, 2016).* The scores from these three categories were consolidated into a total MET-minutes/week score.

4.4.2.4. The Moorehead-Ardelt Quality of Life Questionnaire II

It was developed by *Duval et al. (2006)*. It is a disease-specific instrument to assess QoL measurement in obese patients before and after bariatric surgery. The questionnaire is composed of six items to measure the patient's quality of life. It included six domains: General self-esteem, physical activity, social contact, work satisfaction, sexuality, and eating behavior. Points are added or deducted based on the patient's subjective perception.

Scoring system

Each item is answered on a Likert-type 10-point scale, ranging from −0.5 to +0.5. The total score is the sum of six dimensions with a range of −3.0 to +3.0. Higher scores mean a higher quality of life.

4.4.3. Combined Exercise and Nutritional Behavioral Intervention Program

It was written in Arabic with graphics and was developed by researchers using data from patient needs analyses, literature reviews, their own experience, and feedback from medical and nursing specialists. It included the following:

- Basic knowledge of obesity: Morbid obesity definition, anthropometric measures, causes, complications, weight reduction methods, methods of diagnosis, and treatment.
- Bariatric surgical intervention: Types, definition, benefits, preoperative preparation, and postoperative problems.
- Behavioral modification postoperatively:
  - Nutritional adjustment of dietary principles
  - Physical activity, resistance exercises, and continuous monitoring of weight.
  - Follow-up visits and their importance.

4.5. Procedures

Five medical and nursing professors who were asked to rate each item on a scoring scale as "essential," "useful but insufficient," or "unnecessary" was requested to perform content validity on the questionnaire. Changes were made

based on the panel's assessment of the sentence's clarity, appropriateness, and completeness.

A pilot study was undertaken on ten percent (6 participants) of all patient samples to estimate the time needed for comprehensive data collection and assess the study technique's viability. The Knowledge Questionnaire, Eating Behavior and Food Frequency Questionnaire, International Physical Activity Questionnaire (IPAQ), and The Moorehead-Ardelt Quality of Life Questionnaire II have Cronbach's alpha coefficient reliability scores of 0.95, 0.79, 0.81, and 0.84, respectively.

Ethics-related considerations: The Scientific Research and Ethics Committee of the Faculty of Nursing at Benha University gave its preliminary approval before this study was carried out. The Director of the Benha Hospital then gave the official approval. The study's goal was clarified to the participants. They stated that participants could leave the research at any moment. They were required to complete a written informed consent form before participating in the study. Participants were also informed that all information collected is confidential and used solely for research purposes.

Field of work: Conduct the research after expressing the purpose and receiving formal approval from the necessary authorities. Patients who met the inclusion and exclusion criteria for the study were interviewed individually to explain the study's goal and ensure confidentiality. Fifteen months of data collecting began in January 2021 and lasted until April 2022.

The combined exercise and nutritional, behavioral intervention program covered the following phases:

The preparatory phase included reviewing the available literature and studies related to the research problem and theoretical knowledge using textbooks, evidence-based articles, internet periodicals, and journals.

Assessment phase: Interviewing patients was conducted before the intervention to gather baseline patient data utilizing all research instruments. The conversation lasted between 30 and 35 minutes. The researchers interviewed the control group patients (pre- combined exercise and nutritional-behavioral intervention implementation) who received routine hospital care to complete the sociodemographic and medical history sheet and to record the anthropometric measurement. The eating behavior and food frequency were assessed, besides physical activity and quality of life. This phase took three months.

Planning Phase (Combined Exercise and Nutritional-Behavioral Intervention program development): Objectives were designed based on predetermined patients' needs, relevant recent literature, and opinions of nursing experts. This intervention was revised and modified based on the experts' comments, to be implemented using various methods, including a booklet containing major headlines of the combined exercise and nutritional-behavioral intervention program for patients with bariatric surgery, which researchers designed and written in very simple Arabic language, as well as supplemented by photos.

Implementation phase: The researcher approached the responsible nursing supervisors and the responsible surgeon of determined areas daily to identify the number of newly admitted patients suspected to have bariatric surgery. Then, patients were randomly assigned to either a control or intervention group (30 patients in the intervention group and 30 patients in the control group). The control group patients were subjected to the hospital routine, while the study group patients were subjected to the combined exercise and nutritional and behavioral intervention program.

Selected patients were met on daily bases for monitoring. After that, the sociodemographic and medical data sheet was completed for all intervention and control group patients. The tools were filled through interviewing. The purpose of the study was explained to the patients before answering the questions. The study was carried out during the morning and afternoon shifts. During intervention sessions, the researchers checked that patients followed their doctors' orders at home to ensure improved patient information.

The combined exercise and nutritional, behavioral intervention program has been implemented through four sessions (3 theoretical and one practical). The first session included basic knowledge about obesity, followed by session two on bariatric surgical intervention, and session three included the postoperative behavioral modification regarding nutritional adjustment, physical activity, exercise, weight monitoring, and follow-up. The practical session included a demonstration of recommended types of exercises and daily physical activity. Moreover, resistance exercises which recommended to be performed (three times/week). Considering that exercise prescription should be tailored to the patient's ability and health status and focus on a safe and gradual increase.

The schedule of sessions was based on how long the studied group of patients had been followed up. The duration of each session is approximately 30-35 minutes, including a 10-minute discussion. Then the adherence to exercise and nutrition were monitored through telephone calls and follow-ups at the hospital outpatients.

Evaluation phase: It aimed to reassess patients after the intervention phase to identify progress in terms of differences in their level of response from baseline to the following postoperative schedule; the first month, the sixth month, and one year after the combined exercise and nutritional-behavioral intervention program. The evaluation included patients' knowledge which was measured by the researcher using the same format of structured knowledge questionnaire, in addition to assessing the health outcomes by the same pretest format to assess the effectiveness of combined exercise and nutritional-behavioral intervention on health outcomes among patients with bariatric surgery

4. 6. *Data Analysis*

Data analysis was performed using the SPSS software (version 25). To determine the normal distribution of quantitative variables Kolmogorov-Smirnov test was used. Chi-square tests were used to compare nominal variables in

the two groups. Fisher's exact test was applied on smaller sample sizes, an alternative to the chi-square test, when the frequency count is <5 for more than 20% of cells. The mean scores in two groups were compared by the independent t-tests, ANOVA with repeated measures test to compare between more than two periods or stages. Linear regression was used for multivariate weight loss percentage analysis as a dependent factor. A p-value ≤0.05 was considered significant, and <0.001 was considered highly significant.

5. Results

Table 1 shows the demographic characteristics of patients undergoing bariatric surgery. The table shows a non-statistically significant difference between both (intervention & control groups) regarding their mean age of (35.53±4.06 & 34.47±4.11, respectively) and 83.3% & 70.0%, respectively of the study and control groups were females. As well, 73.3% & 63.3, respectively, were residing in an urban area. Moreover, 83.3% & 80.0%, respectively were married. Furthermore, more than half of them (46.7 % & 56.7%, respectively) had both groups' school qualifications and governmental work (46.7%).

Table 2 demonstrated a non-statistically significant difference between both (intervention & control groups) regarding their illness-related data, with more than half (56.7% & 46.7%, respectively) having comorbidities which were mainly hypertension (47.6% & 55%) and osteoarthritis (66.7% & 25%) among both groups respectively. Besides, 70.0% & 66.7%, respectively, had undergone gastric sleeve surgery and the highest percentage of them followed a weight loss program before surgery among 86.7% & 93.3 %, respectively, which focused on diet only, as reported by 66.7% of both groups that did not lead to weight loss among most of both groups (93.3% & 90.0%, respectively).

Table 3 reveals a non-statistically significant difference between both groups regarding their knowledge levels about basic knowledge for obesity, bariatric surgical intervention, and behavioral modification before intervention implementation, to be a highly statistically significantly different in terms of increased knowledge level among intervention group throughout the following study periods (immediate at first month, after six months and one year of combined exercise and nutritional, behavioral intervention). The table also shows a statistically significant difference in the knowledge level of the intervention group throughout the study phases.

Table 4 reveals a non-statistically significant difference between intervention and control groups regarding their weight and body mass index scores before intervention implementation, to be a highly statistically significantly different in terms of an increased percentage of weight loss among the intervention group throughout the following study periods (first month, six months, and one year of intervention implementation). The table shows a statistically significant difference in weight loss and excess body mass index percentage between the intervention and control groups at all study phases.

Table 5 shows a non-statistically significant difference between both groups regarding eating habits (behavior and food frequency) before combined exercise and nutritional-behavioral intervention to be statistically significantly different after the first, sixth months, and one year of its implementation in terms of improved eating behavior and reduced food frequency among the intervention group which was reflected by higher scores in eating behavior and lower scores in food frequency among the intervention group than in control group.

Table 6 reveals a non-statistically significant difference between both groups regarding self-reported physical activity and sedentary behavior score before behavioral intervention implementation, to be highly statistically significantly different after the first, six months, and one year of its implementation in terms of improvement in total weekly MET level among the intervention group which was reflected by its increased scores among the intervention group than in control group. The table also shows a significantly lower total mean score of the sedentary time between the intervention and control groups.

Table 7 clarifies a non-statistically significant difference between intervention and control groups regarding their quality-of-life levels before behavioral intervention implementation, to be a highly statistically significantly different after one, six months, and one year of its implementation in terms of improvement in the level of QOL among the intervention group compared to control group. The table also reveals a statistically significant overall difference among the intervention group.

Table 8 shows the multivariate linear regression model presents that weight loss percentage was best predicted by residence (p=0.010), total knowledge (p=0.002) acquired after the intervention, food frequency (p <0.000), and physical activity level (p=0.001) among intervention group accounting for 88.3 % of the variance in % of weight loss. In comparison, it was predicted in the control group by age (p=0.022), accounting for 58.9 % of the variance in % of weight loss.

Table (1): Comparison of intervention and control group patients' demographic characteristics.

Demographic characteristics	Intervention group No=30		Control group No=30		X^2	*p*-value (FEp)*
	No.	%	No.	%		
Age						
<35	13	43.3	16	53.3	0.60	0.606
≥35	17	56.7	14	46.7		
Mean±SD	35.53 ± 4.06		34.47 ± 4.11		t-test=1.012	0.316
Gender						
Male	5	16.7	9	30.0	1.49	0.360
Female	25	83.3	21	70.0		
Residence						
Rural	8	26.7	11	36.7	0.69	0.580
Urban	22	73.3	19	63.3		
Marital status						
Not married	5	16.7	6	20.0	0.11	1.000
Married	25	83.3	24	80.0		
Education level						
No qualification	12	40.0	9	30.0		
School qualification	14	46.7	17	56.7	0.71	0.698
University qualification	4	13.3	4	13.3		
Occupation						
Free work	11	36.7	9	30.0		
Governmental work	14	46.7	14	46.7	0.53	0.766
Housewife	5	16.7	7	23.2		

**FEp: p-value for Fisher exact for chi-square*

Table (2): Comparison of intervention and control group patients according to their illness-related data.

Illness related data	Intervention group No=30		Control group No=30		X^2	*p*-value (FEp)*
	No.	%	(No.)	%		
Presence of Comorbidities						
No	13	43.3	16	53.3	0.60	0.606
Yes	17	56.7	14	46.7		
Type of comorbidities #	(n=17)		(n=14)			
Hypertension	10	47.6	11	55.0	0.22	0.758
Diabetes Mellitus	7	41.2	5	25.0	1.09	0.482
Thyroid problems	2	11.8	2	10.0	0.03	1.000
Obstructive sleep apnea	4	23.5	4	20.0	0.06	1.000
Osteoarthritis	4	66.7	5	25.0	3.54	0.138
Type of surgical intervention						
Gastric sleeve	21	70.0	20	66.7	0.07	1.000
Gastric bypass	9	30.0	10	33.3		
Follow a weight loss program before losing weight						
Yes	26	86.7	28	93.3	0.74	0.671
No	4	13.3	2	6.7		
The program followed before consisted of						
Diet only	20	66.7	20	66.7		
Diet and physical exercise	3	10.0	2	6.7	0.26	0.875
Body slimming medicines and herbals	7	23.3	8	26.7		
Outcomes of the previous programs						
Weight loss	2	6.7	3	10.0	0.21	1.000
Weight gain	28	93.3	27	90.0		

*(#) Not mutually exclusive * FEp: p-value for Fisher exact for chi-square*

Table (3): Comparison of knowledge levels regarding behavioral changes between both studied groups throughout different study periods of intervention.

Patient's knowledge levels	No. %	Intervention group (n=30)				Control group(n=30)				X^2	p(1)	X^2	P(2)	X^2	P(3)	X^2	p(4)
		Pre-op	Postoperative 1 month	Postoperative 6 months	Postoperative 1 year	Pre-op	Postoperative 1 month	Postoperative 6 months	Postoperative 1 year								
Basic knowledge of obesity																	
Unsatisfactory	No	30	5	3	10	28	27	20	20	2.06	0.49	32.41	<0.001	20.37	0.001	6.66	0.01
	%	100.0	16.7	10.0	33.3	93.3	90.0	66.7	66.7								
Satisfactory	No	0	25	27	20	2	3	10	10								
	%	0.0	83.3	90.0	66.7	6.7	10.0	33.3	33.3								
Bariatric surgical intervention																	
Unsatisfactory	No	30	5	5	9	27	27	18	18	3.15	0.23	32.41	<0.001	11.91	0.001	5.45	0.037
	%	100.0	16.7	16.7	30.0	90.0	90.0	60.0	60.0								
Satisfactory	No	0	25	25	21	3	3	12	12								
	%	0.0	83.3	83.3	70.0	10.0	10.0	40.0	40.0								
Behavioral modification																	
Unsatisfactory	No	24	2	6	12	28	28	19	22	2.30	0.25	45.06	<0.001	11.58	0.001	6.78	0.018
	%	80.0	6.7	20.0	40.0	93.3	93.3	63.3	73.3								
Satisfactory	No	6	28	24	18	2	2	11	8								
	%	20.0	93.3	80.0	60.0	6.7	6.7	36.7	26.7								
Total knowledge																	
Unsatisfactory	No	30	2	8	11	30	28	20	21	a	a	45.06	<0.001	9.64	0.004	6.69	0.019
	%	100.0	6.7	26.7	36.7	100.0	93.3	66.7	70.0								
Satisfactory	No	0	28	22	19	0	2	10	9								
	%	0.0	93.3	73.3	63.3	0.0	6.7	33.3	30.0								
Overall difference		F= 0.069	p 5 value <0.001			F= 0.443	p 6 value <0.001										

(a) no statistics are computed

p1: The difference in knowledge level before program implementation between control and intervention groups.
p2: The difference in knowledge level one-month post-program implementation between control and intervention groups.
p3: The difference in knowledge level after six months of program implementation between control and intervention groups.
p4: The difference in knowledge level after one year of program implementation between control and intervention groups.
p5: Overall knowledge level differences throughout study periods among the intervention group.
p6: Overall knowledge level differences throughout study periods among a control group.

Table (4): Comparison of both studied groups' anthropometric measures pre and post-intervention.

	Preoperative assessment (pre-intervention)		Postoperative assessments (post-intervention)						F test	*P*5	F test	*P*6
			1st month		6th month		1st year					
	Intervention group	Control group	Intervention group	Control group	Intervention group	Control group	Intervention group	Control group				
	98.03±5.31	97.73±6.56	85.00±7.06	88.87±5.44	78.60±5.13	84.27±5.26	74.50±6.54	79.97±5.05	0.053	<0.001	0.020	<0.001
Wt	t= 0.195	p1= 0.846	t= -2.376	p2= 0.021	t= -4.225	p3= <0.001	t= -3.625	p4= 0.001				
%wt L	0	0	57.96±27.45	36.15±10.25	84.76±27.27	55.25±14.72	102.52±30.56	73.19±18.22	0.259	<0.001	0.092	<0.001
	-		t= -4.076	p= <0.001	t= -5.216	p= <0.001	t= -4.516	p= <0.001				
BMI (wt/ ht^2) †	38.82±0.56	38.65±0.87	33.17±0.83	33.80±0.81	28.97±0.81	30.27±1.01	26.47±0.78	28.57±2.96	0.002	<0.001	0.011	<0.001
	t= 0.878	p1= 0.383	t= -2.993	p2= 0.004	t= -5.378	p3= <0.001	t= -3.764	p4= <0.001				
%EBMIL	0	0	40.94±4.61	35.36±6.36	71.34±5.20	61.37±7.21	89.46±5.41	74.05± 20.88	0.030	<0.001	0.006	<0.001
	-		t= 3.890	p= <0.001	t= 6.140	p= <0.001	t= 3.913	p= <0.001				

Wt: Patient weight, †BMI: body mass index, %EBMI: Percentage of excess BMI loss.
p1: difference in wt & BMI between both groups before intervention.
p2: difference in wt & BMI between both groups at first-month post-intervention
p3 difference in wt & BMI between both groups at sixth-month post-intervention.
p4: difference in wt & BMI between both groups at 1st-year post-intervention
p5 difference in wt, %wt L, BMI & %EBMIL throughout measurement periods for the intervention group.
p6: difference in wt, %wt L, BMI & %EBMIL throughout measurement periods for the control group.

Table (5): Comparison of eating habits scores between both studied groups throughout different periods.

Study phases	Eating behavior		t-test	P value	Food frequency		t-test	*p*-value
	Intervention group (n=30)	Control group (n=30)			Intervention group (n=30)	Control group (n=30)		
	Mean±SD	Mean±SD			Mean±SD	Mean±SD		
Preoperative (preintervention)	11.03±6.69	11.97±5.82	-0.577	P1=0.566	21.13±2.87	21.57±3.00	-0.571	P1=0.570
One-month post-op (post-intervention)	38.13±6.21	14.10±4.13	17.655	P2=<0.001	15.40 ±3.18	20.10±2.39	-6.464	P2=<0.001
Six months post-op (post-intervention)	39.43±5.49	15.77±4.26	18.638	P3=<0.001	13.40±2.42	19.57±2.16	-10.388	P3=<0.001
One-year post-op (post-intervention)	40.57±4.47	16.43±3.49	23.308	P4=<0.001	12.23±2.31	19.07±2.07	-12.062	P4=<0.001
Overall difference	F= 0.506	F= 0.025			F= 0.077	F= 0.395		
	p5<0.001	P6<0.001			P7<0.001	P8 <0.001		

p1: The difference in eating behavior and food frequency scores before program implementation between control and intervention groups.
p2: The difference in eating behavior and food frequency scores immediately post-program implementation (one month) between both control and intervention groups.
p3: The difference in eating behavior and food frequency before scores after six months of program implementation between control and intervention groups.
p4: The difference in eating behavior and food frequency before scores after one year of program implementation between control and intervention groups.
p5: The overall difference in eating behavior among the intervention group.
p6: The overall difference in eating behavior among the control group.
p7: The overall difference in food frequency among the intervention group.
p8: The overall difference in food frequency among the control group.

Table (6): Comparison of self-reported physical activity level and sedentary behavior between studied groups throughout different study periods.

Study phases	Total weekly MET* LEVEL								t-test P value (1)	t-test P value (2)	t-test P value (3)	t-test P value (4)
	Intervention group (n=30)				Control group (n=30)							
	Low intensity of activity	Moderate intensity of activity	The vigorous intensity of activity	Total physical activity	Low intensity of activity	Moderate intensity of activity	The vigorous intensity of activity	Total physical activity				
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD				
Preoperative (Pre-intervention)	1140.55±623.75	3650.67±1038.88	2474.67±1123.18	7265.88±1799.55	1061.35±527.91	3482.00±1114.02	2450.67±1169.96	6994.02±1585.64	0.531 (0.598)	3.961 (<0.001)	7.318 (<0.001)	7.670 (<0.001)
One-month post-op (Post-intervention)	1977.22±1118.09	5350.67±945.97	3367.31±1185.92	10695.19±2091.32	1094.68±488.86	3748.67±1070.36	2611.33±1115.57	7454.68±1477.91	0.606 (0.547)	6.143 (<0.001)	10.360 (<0.001)	10.440 (<0.001)
Six months post-op (Post-intervention)	2772.88±1127.52	6510.67±991.69	4681.31±1761.07	13964.86±2268.88	1153.68±444.37	3803.00±1032.29	2684.67±1147.03	7641.35±1474.93	0.081 (0.936)	2.543 (0.014)	5.203 (<0.001)	5.990 (<0.001)
One-year post-op (Post-intervention)	2698.92±1135.52	6377.33±957.95	4601.31±1749.59	14056.73±2266.47	1026.68±69.69	3526.33±1148.81	2331.33±1116.65	7392.02±1592.61	0.621 (0.537)	6.931 (<0.001)	12.799 (<0.001)	13.178 (<0.001)
The overall difference in total activity level	F= 0.084 p 5 value <0.001				F= 0.345 p 6 value <0.001							
Sedentary time (min/ day)	520.00±71.05	435.33±68.27	393.50±63.04	379.17±64.22	548.00±85.92	528.33±89.06	515.00±88.97	507.67±89.89	-1.376 (0.174)	-4.539 (<0.001)	-6.103 (<0.001)	-6.371 (<0.001)

*(MET) metabolic equivalent task

p1: The difference in low activity intensity before program implementation between control and intervention groups.

p2: The difference in moderate intensity of activity during immediate post-program implementation (One month) between both control and intervention groups.

p3: The difference in vigorous-intensity activity after six months of program implementation between control and intervention groups.

p4: The difference in total intensity of activity after one year of program implementation between control and intervention groups.

p5: The overall difference in total physical activity level in the intervention group.

p6: The overall difference in total physical activity level in the control group.

Table (7): Comparison of quality-of-life levels between both studied groups throughout different study periods.

Patient's QoL* levels	Intervention group (n=30)								Control group(n=30)								X^2	p-value (1)	X^2	p-value (2)	X^2	p-value (3)	X^2	p-value (4)
	Pre-op		Postoperative (post-intervention)						Pre-op		Postoperative (post-intervention)													
			1 month		6 months		1 year				1 month		6 months		1 year									
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%								
Very poor (-3 to 2.1)	0	0.0	0	0.0	0	0.0		0.0	0	0.0	0	0.0	0	0.0	0	0.0								
Poor (-2 to -1.1)	21	70.0	4	13.3	0	0.0	0	0.0	18	60.0	18	60.0	15	50.0	15	50.0								
Fair (-1 to 1)	9	30.0	26	86.7	28	93.3	19	63.3	12	40.0	12	40.0	15	50.0	15	50.0	0.659	0.589	14.067	<0.001	20.930	<0.001	26.930	<0.001
Good (1.1 to 2)	0	0.0	0	0.0	2	6.7	10	33.3	0	0.0	0	0.0	0	0.0	0	0.0								
Very good (2.1 to 3)	0	0.0	0	0.0	0	0.0	1	3.3	0	0.0	0	0.0	0	0.0	0	0.0								
Overall difference	F= 0.139 p 5 value =<0.001								F= 0.555 p 6 value =0.001															

** (QoL) Quality of Life*

p1: The difference in QOL level before program implementation between control and intervention groups.

p2: The difference in QOL level during the first month of post-program implementation between both control and intervention groups.

p3: The difference in QOL level after six months of program implementation between control and intervention groups.

p4: The difference in QOL level after the first year of program implementation between control and intervention groups.

p5: The overall difference in QOL levels among the intervention group.

p6: The overall difference in QOL levels among the control group.

Table (8): Multiple Linear Regression Analyses for Predictor Variables of weight loss percentage among both intervention and control groups

Predictor Variable of wtl%	Intervention group					Control group				
	Unstandardized Coefficients		Standardized Coefficients	t	p-value	Unstandardized Coefficients		Standardized Coefficients	t	p-value
	B	Std. Error	Beta			B	Std. Error	Beta		
(Constant)	33.635	57.824		0.582	0.567	89.218	57.948		1.540	0.139
Age	-1.509	.917	-.200	-1.645	0.115	3.567	1.435	.683	2.485	0.022
Residence	22.864	8.053	.337	2.839	0.010	-2.039	1.792	-.231	-1.137	0.269
Marital status	11.213	10.080	.139	1.112	0.279	.182	.133	.385	1.367	0.187
Occupation	-8.588	4.711	-.201	-1.823	0.083	-1.277	.860	-.288	-1.484	0.153
Total knowledge	1.292	.363	.410	3.561	0.002	8.943	8.513	.241	1.050	0.306
Eating behavior	.814	.758	.119	1.073	0.296	5.894	9.141	.132	0.645	0.526
Food frequency	7.252	1.709	.549	4.245	0.000	-1.334	4.996	-.054	-0.267	0.792
Physical activity level	-.007	.002	-.493	-4.008	0.001	-.388	.566	-.183	-0.685	0.501
Quality of life	.055	.049	.138	1.109	0.281	.002	.003	.155	0.698	0.493
	Adjusted R^2= 0.883			p<0.001		Adjusted R^2= 0.589			p<0.001	

(wtl%) weight loss percentage *(**B**) Beta Co-Efficient* *(SEB) Standard Error*

6. Discussion

Several behavioral interventions targeting standard lifestyle modification skills have been developed to prevent or reverse postoperative weight regain in patients after bariatric surgery. Patients who received the cognitive behavioral intervention had improved clinical outcomes, were more satisfied and were more likely to meet the targeted discharge dates. The present study aimed to evaluate the effectiveness of combined exercise and nutritional-behavioral intervention on health outcomes among patients with bariatric surgery.

Regarding the demographic characteristics of patients undergoing bariatric surgery, the present study shows non-statistically significant differences between intervention and control groups concerning all demographic characteristics, revealing the homogeneity among study subjects regarding their characteristics before study conduction. The highest percentage of both groups were in the age group 35 to more, with a mean age of 35.53±4.06 and 34.47±4.11 for the intervention and control groups, respectively. This result could be related to the fact that many adults undergo significant lifestyle changes such as leaving home, starting work, marrying, potentially experiencing pregnancy, and child-rearing. Adults who feel a sense of 'loss' are vulnerable to energy imbalance, often leading to weight gain. At the same time, they seek jobs and attend work interviews, so they become to care about their body shapes and physical health.

This result is in line with *Villarroel, Blackwell, and Jen's (2019)* study about the " National Health Interview Survey " and found that the prevalence of obesity was higher among adults aged 35–44 years than among those aged 20–24 years. In the same line, *Barich et al. (2018),* whose study about "Association of obesity and socioeconomic status among women of childbearing age living in the urban area of Morocco," found that most of the study group sample mean age was 30.0±9.9 years.

This result disagrees with *Altman et al. (2022),* whose study "Participating in bariatric support groups: The effects on self-management changes," reported that the participants' mean age was 49. In the same line as this study finds, *Barbuti et al. (2022),* whose study was about "Prevalence of mood, panic, and eating disorders in obese patients with bariatric surgery: Patterns of comorbidity and relationship with body mass index," and reported that the mean age of the participants was 45 years.

Concerning gender and marital status, the current study's results reveal that most of the studied sample were females and married. This finding might be because married women are more susceptible to being overweight or obese. Marriage is a strong predictor that can contribute to women's obesity. Obesity negatively affects both contraception and fertility as well. Maternal obesity is linked with higher rates of cesarean section and higher rates of high-risk obstetrical conditions such as diabetes and hypertension. The study of *Altman et al. (2022)* supports this finding, who documented that most of the study group were women and married.

Concerning educational level, the current study's finding reveals that about half of them had school qualifications with governmental work among both groups. This finding might be due to time off school qualifications being the main cause of skipping breakfast and consuming a few large meals daily. Moreover, the government works a good environment for low intake of fruits and vegetables, high intake of fast foods and sweets, and high intake of sugar-sweetened beverages such as soft drinks. In agreement with this finding, *Altman et al. (2022)* displayed that more than half of the participants had at least school education and worked full-time. This finding is in the same line with *Barich et al. (2018),* who showed that the prevalence of obesity among adults with school levels of education is twice as high as that among adults with higher levels of education. *Barbuti et al. (2022)* reported that overall, the sample showed a school level of education.

Regarding illness-related data among the control and intervention groups, the result of the current study demonstrates that hypertension was the main comorbid disease that affected both groups. This finding might be that obesity can result in serious and potentially life-threatening health issues, including hypertension and type II diabetes mellitus.

The current study findings illustrated that more than two-thirds of both groups had undergone gastric sleeve surgery. Moreover, most studied patients in both groups tried a weight loss program before surgery. These programs were mainly concerned with diet only (equally for both groups), which did not lead to weight loss. This finding might be due to around half of the studied patients suffering from comorbidity diseases such as hypertension and diabetes. Also, it might be due to most patients in both groups lacking basic knowledge regarding obesity and behavioral modification, so they might focus only on a diet, neglecting exercise benefits. In agreement with this study finding, *Altman et al. (2022)* illustrated that more than two-thirds of the participants reported having undergone sleeve gastrectomy surgery. In contradiction with this study finding, *Courcoulas et al. (2020),* whose study about "Bariatric surgery vs. lifestyle intervention for diabetes treatment: 5-Year outcomes from a randomized trial," reported that more than two-thirds of participants performed Roux-en-Y gastric bypass surgery.

Concerning knowledge levels regarding behavioral changes between both studied groups throughout different study periods, results of the current study indicated a non-statistically significant difference between both groups regarding their knowledge levels about basic knowledge for obesity, bariatric surgical intervention, and behavioral modification before the intervention, to be a highly statistically significantly different in term of increased knowledge level among intervention group throughout the following study periods (One month, six months, and one year) of combined exercise and nutritional, behavioral intervention), supporting the first research hypothesis. This finding might be due to the implementation of the intervention program for the intervention group having a positive effect on enhancing their improvement. This finding may also be attributed to the inclusion of exercise as an essential element in weight loss and following up for one year to support the patient planned outcomes. Also, good communication with the health care team may cause the patients to grasp knowledge correctly.

Agreeing with the study finding, *Pereira et al. (2022),* in the study about "Effect of a nutritional, behavioral intervention on intuitive eating in overweight women with chronic kidney disease," reported that a statistically significantly different in terms of increased knowledge level among studied patient post-intervention as compared to pre-intervention.

Regarding the comparison of both studied and control groups' anthropometric measures, the results of the current study indicate a non-statistically significant difference between both groups regarding their weight and body mass index scores before the intervention, to be a highly statistically significantly different in terms of increased percentage loss among intervention group throughout the following study periods (one month, sixth months, and one year of intervention) and percentage of excess body mass index. This finding supports the second research hypothesis.

This finding is similar to that of *Bellicha et al. (2018).* They conducted a systematic review and meta-analysis of controlled trials assessing exercise training programs in patients with obesity undergoing bariatric surgery. They concluded that intervention programs after bariatric surgery optimized their weight loss and fat mass loss and improved their physical fitness. While this finding was incompatible with *Gade et al. (2015)* in his study entitled "The impact of a preoperative cognitive behavioral therapy (CBT) on dysfunctional eating behaviors, affective symptoms, and body weight one year after bariatric surgery: A randomized controlled trial" and reported a non-statistically significant body weight differences between both groups were found one year postoperatively, indicating that the reduction of mood and anxiety symptoms did not affect weight loss results at 1-year follow-up.

The comparison of eating habits scores (Eating behavior and food frequency) between both study and control groups throughout different study periods (one month, six months, and one year) of intervention stated a non-statistical significant difference between both groups regarding eating behavior and food frequency before behavioral intervention implementation, to be statistically significantly different after the first, sixth months, and one year of intervention in terms of improved eating behavior and reduced food frequency among the intervention group compared to the controls. This improvement is also reflected by higher eating behavior scores and lower food frequency scores among the intervention group than in the control group. This finding supports the third research hypothesis. This improvement in eating behavior and food frequency may be due to the positive effect of behavior combined with exercise and nutritional-behavioral intervention that were scientifically prepared according to the nature of patients and continuous monitoring and communication of the researchers to the studied patients.

This finding agrees with *Vanderkruik Gist and Dimidjian's (2020)* findings. Their study titled "Preventing eating disorders in young women: A randomized control trial and mixed-methods evaluation of the peer-delivered body project" reported a statistically significant increase in desire to control weight and shape, desire to engage in healthy weight control behaviors, and a decrease in weight satisfaction following exposure to program intervention. The finding of the current study was in the same line as the result of *Cassin et al. (2013)* in their study entitled "Cognitive behavioral therapy for bariatric surgery patients: Preliminary evidence for feasibility, acceptability, and effectiveness" and demonstrated statistically significant improvements with large effect sizes in eating behaviors and psychological well-being. This finding was consistent with *Sockalingam et al. (2017),* who showed significant reductions in binge eating, emotional eating, and mood and anxiety symptoms post-intervention.

It also contradicted the study finding of *Paul et al. (2021).* Their study titled "Cognitive behavioral therapy versus usual care before bariatric surgery: One-year follow-up results of a randomized controlled trial" reported that at

one-year post-surgery, there were no statistically significant differences between both intervention and control group regarding weight change, eating behavior, and food frequency.

Concerning the comparison of self-reported physical activity and sedentary behavior levels between the studied and control groups throughout different study periods, the findings of the current study reported a non-statistically significant difference between both groups regarding self-reported physical activity and sedentary behavior scores before combined exercise and nutritional-behavioral intervention, to be highly statistically significantly different after one, sixth months, and one year of its implementation in term of improvement in total weekly MET level among the intervention group which was reflected by its increased scores among the intervention group than in control group. This finding supports the fourth research hypothesis. This finding might be due to the increased patients' awareness about exercises and the long-term follow-up of the study researchers.

The findings of the present study were compatible with the result of *Himes (2015)*, who conducted a study entitled "Stop regain: A pilot psychological intervention for bariatric patients experiencing weight regain" and demonstrated statistically significant improvements in depressive symptoms, subjective binge eating, grazing, and weight loss. Treatment intervention included physical activity, self-monitoring, sedentary behavior, stress management, diet skills, and interventions for preventing emotion dysregulation and changing disordered eating.

As regards the comparison of quality of life levels between both studied groups throughout different study periods, there was no statistically significant difference between both groups regarding their quality of life levels before combined exercise and nutritional-behavioral intervention, to be a highly statistically significantly different after one, sixth months, and one year of its implementation in term of improvement in the level of QoL among the intervention group compared to control group. This finding supports the fifth research hypothesis. These findings might be referred to as the improvement in health knowledge regarding obesity, bariatric surgery, and the increased awareness with behavioral modifications, self-monitoring, researchers' follow-up, and reinforcement done throughout the study periods.

This finding is consistent with that of *Bellicha et al. (2018)*, in a study entitled "Effectiveness of exercise training after bariatric surgery: A systematic literature review," which reported a statistically significant improvement observed between the intervention and control group regarding their quality of life. As well, *Ambak et al. (2018)*, in the study entitled "The effect of weight loss intervention program on health-related quality of life among low-income overweight and obese housewives," reported that weight loss intervention program utilizing behavioral modification has led to a significant improvement in quality of life among overweight and obese housewives. Besides, the significant statistical difference between both groups regarding their quality-of-life levels before and after the behavioral intervention.

Multiple linear regression analyses for predictor variables of weight loss percentage among intervention and control groups illustrate that weight loss was best predicted by residence, total knowledge, food frequency, and physical activity among the intervention group. This finding might be because weight loss can reduce the health risks associated with being overweight or obese. The combined exercise and nutritional-behavioral intervention program emphasize physical activity, diet, and enhanced patient knowledge potentiating weight loss.

In the same line with this study, findings of *Gradaschi et al. (2020)*, who clarified in their study entitled "Effects of the postoperative dietetic/behavioral counseling on the weight loss after bariatric surgery," those postoperative behaviors intervention related to eating behavior, eating problems, weight control practices had shown positive effect when multiple behavior changes were obtained. Also, *El-Maghawry et al. (2021)*, who conducted their study on "Effect of an educational program on lifestyle modification for patients undergoing laparoscopic sleeve gastrectomy surgery," showed significant differences within the study groups regarding weight loss after LSG (weight, BMI, % EWL, % EBMIL).

7. Conclusion

Implementing the combined exercise and nutritional-behavioral intervention post bariatric surgery significantly improved patients' health outcomes in terms of increased patient knowledge, anthropometrics, eating habits, physical activity, and quality of life among the intervention group compared to the control group. It also shows that the intervention group best predicted weight loss by residence, total knowledge, food frequency, and physical activity.

8. Recommendations

The following recommendations are suggested in light of the research's findings:

- Health education programs for patients before bariatric surgery should be developed to increase awareness of healthy behaviors leading to better health outcomes.
- Provision of needed equipment for assessing nutritional statuses, such as skin fold calipers, non-stretchable tape measurements, and body weight scales.
- Future research should specifically examine the influence of patient variables, such as weight status and comorbidities, and the type of surgery on the effectiveness of interventions.
- It is critical to return for follow-up appointments to monitor the patient's condition and ensure he/she maintains a healthy lifestyle to prevent complications.
- Both health care professionals and patients should be aware of the type of benefits they should expect from an exercise program.
- More studies are needed to identify the most effective and feasible strategies and to better understand the role of

exercise and nutritional-behavioral intervention in the follow-up of bariatric surgery.
- Replicating the current study with a larger probability sample is advised to ensure generalizability and wider use of the designed method.

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10. References

Aboulghate, M., Elaghoury, A., Elebrashy, I., Elkafrawy, N., Elshishiney, G., Abul-Magd, E., Bassiouny, E., Toaima, D., Elezbawy, B., Fasseeh, A., Abaza, S., & Voko, Z. (2021). The burden of obesity in Egypt. *Front. Public Health*, Sec. Health Economics

https://doi.org/10.3389/fpubh.2021.718978.

Altman, S. S., Sandbank, G. K., Katzav, H. N., & Soskolne, V. (2022). Participating in bariatric support groups: The effects on self-management changes. *International Journal of Behavioral Medicine, 9*(1), 1-5. https://doi.org/10.1007/s12529-022-10066-w.

Ambak, A., Nor, N. S. M., Puteh, N., Tamil, A., Omar, M., Shahar, S., Ahmed, N., & Aris, T. (2018). The effect of weight loss intervention program on health-related quality of life among low-income overweight and obese housewives in the MyBFF@home study. *BMC Women's Health, 18*(1), 111. https://doi.org/10.1186/s12905-018-0591-3.

Baillot, A., Romain, A., Boisvert-Vigneault, K., Audet, M., Baillargeon, J., Dionne, I., Valiquette, L., Abou Chakra, C., Avignon, A., & Langlois, M. (2015). Effects of lifestyle interventions that include a physical activity component in class II and III obese individuals: A Systematic Review and Meta-Analysis. *PLoS ONE, 10*(4), e0119017. https://doi.org/10.1371/journal.pone.0119017.

Barbuti, B., Brancati, G., Calderone, A., Fierabracci, P., Salvetti, G., Weiss, F., Carignani, G., Santini, F., & Perugi, G. (2022). Prevalence of mood, panic and eating disorders in obese patients referred to bariatric surgery: Patterns of comorbidity and relationship with body mass index, *Eating, and Weight Disorders - Studies on Anorexia, Bulimia, and obesity, 27*(3), 1021–1027. https://doi.org/10.1007/s40519-021-01236-y.

Barich, F., Zahrou, F. E., Laamiri, F. Z., El Mir, N., Rjimati, M., Barkat, A., Rjimati, E., & Aguenaou, H. (2018). Association of obesity and socioeconomic status among women of childbearing age living in urban area of Morocco. *Journal of Nutrition and Metabolism, 29*(1), 2018:6043042. https://doi.org/10.1155/2018/6043042.

Bellicha, A., Ciangura, C., Poitou, P., Portero, P., & Oppert, J. (2018). Effectiveness of exercise training after bariatric surgery: A systematic literature review and meta-analysis, exercise training and bariatric surgery. *Obesity Reviews, 19*(11), 1544–1556. https://doi.org/10.1111/obr.12740.

Cassin, S. E., Sockalingam, S., Wnuk, S., Strimas, R., Royal, S., Hawa., R., & Parikh, S. (2013). Cognitive behavioral therapy for bariatric surgery patients: preliminary evidence for feasibility, acceptability, and effectiveness. *Cogn Behav Pract., 20*(1), 529–543. https://www.academia.edu/13698952/Cognitive_Behavioral_Therapy_for_Bariatric_Surgery_Patients_Preliminary_Evidence_for_Feasibility_Acceptability_and_Effectiveness.

Centers for Disease Control and Prevention (CDC). (2022). Overweight and Obesity. https://www.cdc.gov/obesity/index.html.

Courcoulas, A. P., Gallagher, J. W., Neiberg, R. H., Eagleton, E. B., Delany, J. P., Lang, W., Punchai, S., Gourash, W., & Jakicic, J. M. (2020). Bariatric surgery vs. lifestyle intervention for diabetes treatment: 5-year outcomes from a randomized trial, *J Clin Endocrinol Metab., 105*(3), 866–876. https://doi.org/10.1210/clinem/dgaa006.

Courcoulas, A., King, W., Belle, S., Berk, P., Flum, D., Garcia, L., Gourash, W., Horlick, M., Mitchell, J., Pomp, A., Pories, W., Purnell, J., Singh, A., Spaniolas, K., Thirlby, R., Wolfe, B., & Yanovski, S . (2018). Seven-year weight trajectories and health outcomes in the Longitudinal Assessment of Bariatric Surgery (LABS) study. *JAMA Surg, 153*(5), 427–434. https://doi.org/10.1001/jamasurg.2017.5025.

Craig, C. L., Marshall, A. J., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Pekka, O. J. A. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise, 35*(8), 1381-1395. 10.1249/01.MSS.0000078924.61453.FB.

Deledda, A., Pintus, S., Loviselli, A., Fosci, M., Fantola, G., & Velluzzi, F. (2021). Nutritional management in bariatric surgery patients. *Int. J. Environ. Res. Public Health, 18*(22), 12049. https://doi.org/10.3390/ ijerph 182212049.

Dendasck, C. V., Dos Santos, R. B., Santos V. M., De Andrade, T. U., & Pflug, A. R.M. (2021). The importance of psychological and nutritional follow-up after bariatric surgery: Literature review. *Revista Científica Multidisciplinar Núcleo do Conhecimento, 01*, 20-44. https://doi.org/10.32749/nucleodoconhecimento.com.br/psychology/after-bariatric.

El Ansari, W., & Elhag, W. (2021). Weight regain and insufficient weight loss after bariatric surgery: Definitions, prevalence, mechanisms, predictors, prevention and management strategies, and knowledge gaps—a scoping review. *Obesity Surgery, 31*(4), 1755–1766. https://doi.org/10.1007/s11695-020-05160-5.

El-Maghawry, H., Said, H., Amin, M., Yehia, A., & Nofal, H. (2021). Effect of an educational program on lifestyle modification for patients undergoing laparoscopic sleeve gastrectomy surgery. *The Egyptian Journal of Community Medicine, 39* (1), 1-11. https://ejcm.journals.ekb.eg/article_144067_634776eec325d68defe65199b4398d99.pdf.

Gade, H., Friborg, O., Rosenvinge, J., Småstuen M., & Hjelmesæth J. (2015). The impact of a preoperative

cognitive behavioral therapy (CBT) on dysfunctional eating behaviors, affective symptoms, and body weight one year after bariatric surgery: a randomized controlled trial. *Obes Surg., 25*(11), 2112–2119. https://doi.org/10.1007/s11695-015-1673-z.

Gradaschi, R., Molinari, V., Sukkar, S., De Negri, P., Adami, G., & Camerini, G. (2020): Effects of the postoperative dietetic/behavioral counseling on the weight loss after bariatric surgery. *Obes Surg., 30*(1), 244–248. https://doi.org/10.1007/s11695-019-04146-2.

Hamdy, O. (2021). Obesity treatment & management. Medscape. https://emedicine.medscape.com/article/123702-treatment.

Himes, S. M., Grothe, K.B., Clark, M. M., Swain, J., Collazo-Clavell, M., & Sarr, M. (2015). Stop regain: A pilot psychological intervention for bariatric patients experiencing weight regain. *Obes Surg., 25*(5), 922–927. https://doi.org/10.1007/s11695-015-1611-0.

International Physical Activity Questionnaire. (2016). Home. Retrieved from https://sites.google.com/site/ theipaq/

Mehrzad, R. (2020). *Obesity. The global impact of obesity*. Amsterdam: Elsevier p. 55–72. https://www.elsevier .com/books/obesity/mehrzad/978-0-12-818839-2.

Mingrone, G., Bornstein, S., Le & Roux, C. (2018). Optimization of follow-up after metabolic surgery. *Lancet Diabetes Endocrinol., 6*(6), 487-499. https://doi.org/10.1016/S2213-8587(17)30434-55.

Paul, L., Van der Heiden, C., Van Hoeken, D., Deen, M., Vlijm, A., Klaassen, R., Biter, L., & Hoek, H. W. (2021). Cognitive behavioral therapy versus usual care before bariatric surgery: One-year follow-up results of a randomized controlled trial. *Obesity Surgery, 31*(3), 970–979. https://doi.org/10.1007/s11695-020-05081-3.

Pereira, R. A., Alvarenga, M.D., De Andrade, L. S., Teixeira, R. R., Teixeira, P. C., Da Silva, W. R., & Cuppari, L. (2022). Effect of a nutritional, behavioral intervention on intuitive eating in overweight women with chronic kidney disease. *Journal of Renal Nutrition, 2*;S1051-2276(22)00012-7. https://doi.org/10.1053/j.jrn.2022.01.012.

Sockalingam, S., Cassin, S., Wnuk, S., Du, C., Jackson, T., Hawa, R., & Parikh, S. (2017). A pilot study on telephone cognitive behavioral therapy for patients six months post-bariatric surgery. *Obes Surg., 27*(3), 670-675. https://doi.org/10.1007/s11695-016-2322-x.

Stanish, H. I., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. G. (2017). Physical activity levels, frequency, and type among adolescents with and without autism spectrum disorder. *Journal of autism and developmental disorders, 47*(3), 785–794. https://doi.org/10.1007/s10803-016-3001-4.

Tabesh, M., Maleklou, F., Ejtehadi, F., & Alizadeh, Z. (2019). Nutrition, physical activity, and prescription of supplements in pre-and post-bariatric surgery patients: A practical guideline. *Obesity Surgery, 29*(10), 3385–3400. https://doi.org/10.1007/s11695-019-04112-y.

Vanderkruik, R., Gist, D., & Dimidjian, S. (2020). Preventing eating disorders in young women: An RCT and mixed-methods evaluation of the peer-delivered Body Project. *Journal of Consulting and Clinical Psychology, 88*(12), 1105-1118. https://doi.org/10.1037/ccp0000609.

Villarroel, M. A., Blackwell, D. L., & Jen, A. (2019). 2018 National Health Interview Survey. Tables of summary health statistics for US adults. Atlanta, GA: US Department of Health and Human Services, CDC; 2019. https://www.cdc.gov/nchs/nhis/SHS/tables.htm

World Health Organization (WHO). (2019). Global strategy on diet, physical activity, and health https://apps.who.int/iris/handle/10665/43035.

World Health Organization. (2021). WHO's Non-communicable diseases. Response. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.

Zang, J., Luo, B., Chang, S., Jin, S., Shan, C., Ma, L., Zhu, Z., Guo, C., Zou, S., Jia, X., & Wu, F. (2019). Validity and reliability of a food frequency questionnaire for assessing dietary intake among Shanghai residents. *Nutrition Journal, 18*(1), 30. https://doi.org/10.1186/s12937-019-0454-2.