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Health and economic outcomes of metabolic bariatric surgery: A patient perspective

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ABSTRACT

Objective: Türkiye has the highest obesity prevalence in Europe, contributing to significant health and economic burdens. Metabolic bariatric surgery (MBS) is the most effective intervention for achieving sustained weight loss and improving obesity-related conditions. This study aimed to assess short-term remission rates in six obesity-related conditions and quantify changes in direct medical costs from the patient's perspective at 3 and 6 months following MBS.

Material and Methods: This prospective multicentre cohort study included 179 patients aged 18-65 with Class II or higher obesity who underwent MBS between July 2017 and November 2018. Clinical parameters and self-reported direct medical expenditures were evaluated preoperatively and at 3 and 6 months post-operatively. Outcomes included remission or improvement in diabetes, hypercholesterolemia, hypertension, joint diseases, obstructive sleep apnea syndrome (OSAS), and depression, as well as cost reductions.

Results: Mean age was 38.8±11.7 years; 57.5% had been living with obesity for over 25 years. Preoperatively, 82.1% had obesity-related conditions. At 6 months, excess weight loss reached 68.3%. Remission rates were 89.5% for diabetes, 94.6% for hypertension, 85.7% for hypercholesterolemia, and 100% for joint diseases and OSAS. Depression remission was 95.7%. Medication/device use declined by 96%. Total direct medical costs decreased by 13.95%, and by 88.53% excluding surgery.

Conclusion: In a country with high obesity and diabetes rates, MBS offers rapid clinical improvements and substantial cost reductions. Notably, 57% of patients had used non-prescriptive supplements preoperatively, highlighting the need for better health literacy. These findings reinforce the need to prioritize early surgical intervention within national obesity care frameworks.

Keywords: Bariatric and metabolic surgery, economic evaluation, healthcare costs, obesity, treatment outcome

INTRODUCTION

The World Health Organization defines obesity as a chronic disease characterized by excessive fat accumulation that impairs health, typically classified by body mass index [(BMI) ≥30 kg/m^2]. According to this categorization, BMI 25-29.9 is overweight and BMI ≥30 is obesity for adults (1). The International Federation of Surgery of Obesity and Metabolic Disorders (IFSO) further categorizes BMI 30-35 as Class I, BMI 35-40 as Class II, BMI 40-50 as Class III (severe), BMI 50-60 as Class IV, and BMI 60-70 as Class V obesity (2). Globally, obesity is projected to rise from 14% in 2020 to 24% by 2035, affecting over 2 billion individuals, including children and adolescents (3). Contrary to conventional assumptions, the highest prevalence is seen in middle- and lower-middle-income countries (4). Türkiye had the highest obesity prevalence in Europe at 33% in 2019 (5), and is projected to reach 55% in adults by 2035 (3).

Obesity is linked to multiple serious complications and comorbidities such as diabetes, cardiovascular disease, stroke, cancer, and obstructive sleep apnea syndrome (OSAS), as well as non-lethal complications like joint disorders, infertility, depression, and reduced quality of life (1,2). The associated rise in healthcare utilization—including diagnostics, prescriptions, surgical procedures, and hospital stays—translates into a substantial economic burden. OECD countries are expected to allocate up to 8.4% of their health budgets to obesity-related diseases by 2050 (5). These economic burdens serve to highlight the pressing need for the implementation of effective interventions to address obesity-related complications and comorbidities. Such interventions are not only necessary to improve public health outcomes, but also to inform allocation decisions for healthcare managers.

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Treatment options for obesity include diet, exercise, behavioral therapy, pharmacotherapy, and metabolic bariatric surgery (MBS), with MBS shown to be most effective for Class II and above obesity. MBS provides sustainable weight loss, improved comorbidities, increased life expectancy, and better quality of life (6-8). Sleeve gastrectomy (SG), the most common MBS procedure worldwide, accounted for 53.6% of surgeries globally in 2016, rising to 55.4% in 2018 (9,10) and 60.2% in Türkiye.

According to the Turkish Social Security Institution (SGK), the number and cost of publicly reimbursed bariatric procedures in Türkiye have experienced notable changes over the five-year period between 2015 and 2019. The total number of procedures covered by SGK increased from 8.181 in 2015 to 11.594 in 2019, with a rise in expenditure from 28.69 million TL to over 52 million TL. A significant trend is the rapid expansion of SG, which accounted for 89.1% (n=10.327) of all reimbursed bariatric surgeries in 2019, compared to 7.331 procedures in 2015. By 2019, SG alone constituted 84.7% of all reimbursed bariatric operations and received the largest financial allocation 42.17 million TL out of the total 52.02 million TL in public reimbursement (11). The availability of such detailed national reimbursement data is rare in the literature, adding to the contextual and policy relevance of this study.

Existing studies on the economic impact of MBS primarily adopt a third-party payer or societal perspective in high-income countries, often overlooking direct costs to patients (12-18). Limited research from Türkiye has not comprehensively addressed these costs or from the patient's perspective (17-19). This study addresses that gap by evaluating six obesity-related conditions and five direct medical cost components from the patient's viewpoint in a low-middle-income country. This study aimed to assess short-term remission rates in six obesity-related conditions and quantify changes in direct medical costs from the patient's perspective at 3 and 6 months following MBS.

MATERIAL and METHODS

Study Design

This prospective, multicenter, cohort, and quantitative study included 190 patients aged 18-65 years who were referred to two bariatric surgery centers in Ankara between July 2017 and November 2018. Eligible participants had Class II obesity (BMI ≥35 kg/m^2) with at least one complication or comorbidity, or Class III and above obesity regardless of complications and comorbidities. All patients had previously failed to achieve optimal clinical outcomes with diet, exercise, and behavioral therapy administered for at least six months.

This study uses the term "obesity-related conditions" as an umbrella term to refer to both complications and comorbidities. In line with the 2024 IFSO Consensus (5), diabetes, hypertension, and OSAS are considered complications due to their established causal relationship with obesity, while conditions such as hypercholesterolemia, joint disorders, and depression are treated as comorbidities.

Prior to surgery, all patients were evaluated by a multidisciplinary team comprising a general surgeon specializing in MBS, an endocrinologist, an anesthesiologist, and a psychiatrist. The study aimed to enroll all eligible patients consecutively during the study period, based on voluntary participation, without applying any sampling methods. Patients were excluded if they were re-hospitalized within 30 days post-operatively or failed to attend follow-up appointments.

The study protocol was approved by the Ankara University Ethics Committee (date: May 29, 2017, number: 10/174), and conducted in accordance with the Declaration of Helsinki. All participants received a cover letter outlining the study purpose, the voluntary nature of participation, confidentiality, withdrawal rights, and signed an informed consent form.

All surgical procedures were performed by one of two experienced general surgeons specialized in MBS. The surgical technique was determined based on a comprehensive pre-op assessment and surgeon's preference. Of the 190 patients enrolled, 11 were excluded from final analysis: Three due to early rehospitalization and 8 due to loss to follow-up. The final analysis included 179 patients. No life-threatening complications or deaths occurred during the study period.

A post-hoc power analysis was conducted using G*Power, based on a medium effect size (d=0.5), α=0.05, and n=179, yielding a statistical power of 0.81. The effect size assumption was guided by the estimated prevalence of obesity in the Turkish population.

Data Collection

Upon referral to either of the two centers, patients were registered in the electronic health records system. Data were collected from these records and through a structured questionnaire administered preoperatively and at 3 and 6 months post-operatively, using a data record form developed by the researchers.

Pre-op data included sociodemographic characteristics, duration of obesity, height, weight, and BMI. Additional information was collected on blood values, blood pressure, general health status, and the duration of obesity-related conditions as well as prior obesity treatments, medication use, and work absences due to obesity. However, the question on work absences was excluded from analysis due to inadequate responses.

Post-op data at 3 and 6 months included blood values, blood pressure, BMI, and medication use, gathered through follow-up questionnaires. Height and weight were directly measured during outpatient visits.

Excess weight loss (EWL%)—a key indicator of MBS success—was calculated using the following formula (20):

EWL%= [pre-op weight-post-op weight (kg)]/[pre-op weight-ideal weight* (kg)]x100

(*) ideal weight was accepted as BMI =25 kg/m^2 for each patient.

Remission of obesity-related conditions was defined as the complete cessation of all medications and/or medical devices. Improvement was defined as a reduction in dosage or number of medications/devices (21-23). Changes in metabolic markers and blood pressure were assessed according to the diagnostic, treatment, and follow-up guidelines of the Turkish Society of Endocrinology and Metabolism (TEMD), as summarized in Table 1 (24-26). Remission of joint disorders was defined as absence of symptoms as reported by the patient and discontinuation of pain medication. For OSAS, remission was defined as absence of self-reported symptoms and discontinuation of continuous positive airway pressure (CPAP) use without clinical reassessment.

Due to the heterogeneity in the onset and duration of obesity-related conditions, preoperative cost data were treated as cumulative rather than time-bound. This reflects real-world financial trajectories experienced by patients before undergoing MBS. All direct medical expenditures were assumed to be out-of-pocket, irrespective of patients' insurance status. It was presumed that patients regularly attended medical appointments and adhered to treatments. The frequency of outpatient visits was determined using national guidelines, with expert opinion applied and where guideline data were lacking: Every 6 months for diabetes, annually for hyperlipidemia, hypertension, and joint diseases, and every 3 months for depression.

Medication costs were calculated using retail prices from the Turkish Medicines and Medical Devices Agency's Detailed Drug Price List as of 29.11.2019, based on usage period and dosage (27). Non-prescriptive supplements were excluded. Costs for treatments, visits, and medical procedures were based on 2019 HAC Annex-2 PHPL tariffs (28). The cost of medical devices (e.g., glucose meters, test strips, CPAP masks, canes, walkers, and wheelchairs) was calculated using the average prices of the three best-selling products listed by certified online retailers in November 2019. Due to missing data on CPAP device specifications, the average price of the three top-selling global models, as recommended by specialists, was used.

Statistical Analysis

Data were coded and entered a database for analysis aligned with the study's aim and hypotheses. Descriptive statistics included frequencies and percentages for categorical variables, mean ± standard deviation for normally distributed continuous variables, and median (min-max) for non-normal data. Statistical analyses were performed using SPSS v.15.0. Paired samples t-test, Wilcoxon signed-rank test, and chi-square test were applied where appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS

Descriptive Findings

The study included 179 patients, of whom 66.5% were female and 33.5% male, with a mean age of 38.8011.74± years. More than half (54.2%) were under the age of 40. The average height was 1.670.09± meters, mean body weight was 126.4524.12± kg,

Table 1. Classification of metabolic parameters and blood pressure

Diabetes classification			
	Pre-diabetes	**Diabetes**	**High risk**
Fasting blood glucose (mg/dL)	100-125	≥126	-
HbA1c (%)	-	≥6.5	5.7-6.4
HbA1c: Glycated hemoglobin A1c			
Serum lipid classification			
	Optimal	**Borderline**	**High risk**
Total cholesterol (mg/dL)	<200	200-239	>240
LDL cholesterol (mg/dL)	<100	100-159	>160
HDL cholesterol (mg/dL)	≥60	40-59	<40
Triglycerides (mg/dL)	<150	150-499	>500
Blood pressure classification			
	Normal	**Pre-hypertension**	**Hypertension**
Systolic (mmHg)	<120	120-139	≥140
	and	and/or	and/or
Diastolic (mmHg)	<80	80-89	≥90

LDL: Low-density lipoprotein, HDL: High-density lipoprotein.

and the mean pre-op BMI was 45.176.90± kg/m^2. The duration of obesity exceeded 25 years in 57.5% of participants.

Regarding obesity-related conditions, 17.9% of patients had no obesity-related complications or comorbidities before surgery, while 33.0% had one, 23.5% had two, 15.6% had three, 6.1% had four, and 3.9% had five.

Before undergoing MBS, 63.7% of patients had consulted a dietitian, 70.9% had attempted a popular diet, 37.4% had tried acupuncture, and 57.0% reported using non-prescription weight-loss supplements.

Findings Related to Health Status

The mean EWL% was calculated to be 45.85±15.78% at 3 months and 68.2721.33%± at 6 months post-operatively (Figure 1).

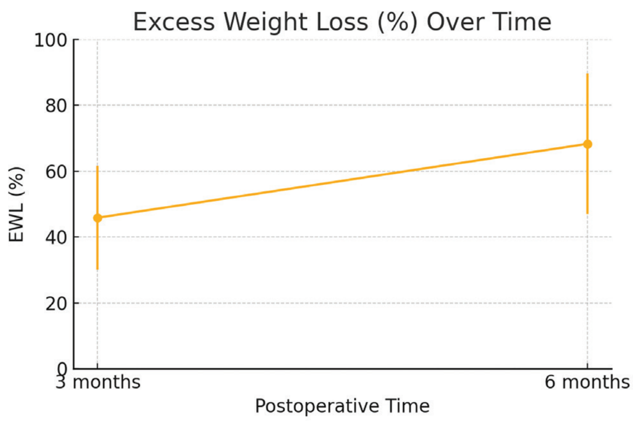

Figure 1. Excess weight loss (%) over time.
EWL: Excess weight loss

Remission rates for all six obesity-related conditions improved markedly between the third and sixth post-operative months, as illustrated in Figure 2. At the 6-month follow-up, remission and improvement rates for obesity-related conditions were as follows: For diabetes, 89.5% remission and 7.9% improvement; for hypercholesterolemia, 87.5% and 2.9%, respectively; and for hypertension, 94.6% and 3.6%. Among patients with joint disease (n=103), all reported symptom resolution at 6 months and had discontinued the use of pain medication. Similarly, among patients diagnosed with OSAS (n=27), no ongoing symptoms were reported, and all had ceased the use of CPAP devices. These figures reflect self-reported improvements supplemented by behavioral indicators and are not based on objective clinical re-evaluation. Additionally, depression showed a remission rate of 95.7% at the sixth month (Table 2).

Post-op laboratory assessments at the 3rd and 6th months demonstrated significant improvements in fasting blood glucose, lipid profile, and blood pressure compared to pre-op values ($p<0.05$), except for diastolic blood pressure between months 3 and 6, which showed no significant change ($p=0.479$) (Table 3). Fasting glucose decreased from 98 mg/dL to 88 mg/dL, HbA1c from 5.6% to 4.9%, and total cholesterol from 189 mg/dL to 162 mg/dL.

Based on TEMD guidelines, the proportion of patients with diabetes declined from 20.7% to 0.6% at six months. High-risk HbA1c profiles reduced from 25.0% to 11.5%, and high total cholesterol was reduced from 16.2% to 2.5%. The percentage of patients classified as hypertensive decreased from 45.3% preoperatively to 0%—all statistically significant—($p<0.05$) (Table 4).

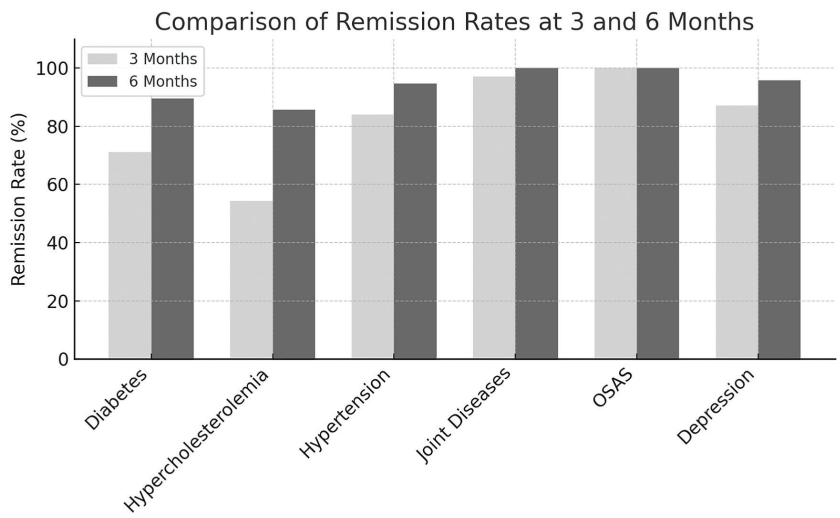

Figure 2. Remission rates at 3 and 6 months.
OSAS: Obstructive sleep apnea syndrome

Table 2. Comparison of pre-op and post-op obesity-related conditions

Obesity-related conditions (complications and comorbidities)*	T_0	ΔT_0-T_1			ΔT_0-T_2		
	n (%)	Remain n (%)	Remission n (%)	Improvement n (%)	Remain n (%)	Remission n (%)	Improvement n (%)
Diabetes	38 (21.2)	6 (15.8)	27 (71.0)	5 (13.2)	1 (2.6)	34 (89.5)	3 (7.9)
Hypercholesterol	35 (19.5)	12 (34.3)	19 (54.3)	4 (11.4)	4 (11.4)	30 (85.7)	1 (2.9)
Hypertension	56 (31.3)	2 (3.6)	47 (83.9)	7 (12.5)	1 (1.8)	53 (94.6)	2 (3.6)
Joint diseases	103 (57.5)	0 (0.0)	100 (97.1)	3 (2.9)	0(0.0)	103 (100.0)	0 (0.0)
OSAS	27 (15.1)	0 (0.0)	27 (100.0)	0 (0.0)	0 (0.0)	27 (100.0)	0 (0.0)
Depression	47 (26.2)	6 (12.8)	41 (87.2)	0 (0.0)	2 (4.3)	45 (95.7)	0 (0.0)
Total	179 (100.0)						

T_0: Pre-op, T_1: Post-op 3rd month, T_2: Post-op 6th month
ΔT_0-T_1: Change between pre-op and post-op 3rd month
ΔT_0-T_2: Change between pre-op and post-op 6th month
Remission: Discontinuation of all medications and/or medical devices.
Improvement: A reduction in the dose or number of medications and/or medical devices
*: There are patients with more than one complication or comorbidity, all comparisons yielded statistically significant results ($p<0.05$), OSAS: Obstructive sleep apnea syndrome

Table 3. Comparison of pre-op and post-op clinical parameters

	Time	Median (min-max)	Mean ± SD	Effect size (Cohen's d, 95% CI)
Fasting blood glucose (mg/dL)	T_0 T_1 T_2	98.0 (73.0-288.0) 89.0 (66.0-149.0) 88.0 (65.0-133.0)	110.7±37.7 92.0±15.0 89.0±9.8	0.8 (0.5-1.1)
	$P_1<0.001$; $P_2<0.001$; $P_3=0.001$			
HbA1c (%)	T_0 T_1 T_2	5.6 (4.4-11.4) 5.2 (4.2-9.5) 4.9 (4.1-6.6)	6.1±1.5 5.5±1.0 5.0±0.6	1.4 (1.07-1.73)
	$P_1<0.001$; $P_2<0.001$; $P_3<0.001$			
Total cholesterol (mg/dL)	T_0 T_1 T_2	189.0 (49.0-339.0) 167.0 (97.0-290.0) 162.0 (104.0-290.0)	194.5±41.4 170.4±31.5 164.6±30.3	0.71 (0.41-1.01)
	$P_1<0.001$; $P_2<0.001$; $P_3<0.001$			
LDL cholesterol (mg/dL)	T_0 T_1 T_2	121.0 (43.0-241.0) 110.0 (40.0-212.0) 101.0 (54.0-211.0)	126.4±35.2 110.8±27.4 106.7±28.1	0.62 (0.32-0.92)
	$P_1<0.001$; $P_2<0.001$; $P_3=0.001$			
HDL cholesterol (mg/dL)	T_0 T_1 T_2	35.0 (23.0-77.0) 40.3 (22.0-78.0) 47.0 (22.0-91.0)	37.5±9.5 42.3±9.5 49.9±11.5	-1.1 [(-1.41) - (-0.79)]
	$P_1<0.001$; $P_2<0.001$; $P_3<0.001$			
Trigliycerides (mg/dL)	T_0 T_1 T_2	139.0 (52.0-681.0) 109.0 (49.0-275.0) 98.0 (41.0-271.0)	152.5±71.5 118.5±41.1 104.0±35.2	0.88 (0.57-1.19)
	$P_1<0.001$; $P_2<0.001$; $P_3<0.001$			
Systolic blood pressure (mmHg)	T_0 T_1 T_2	130.0 (100.0-200.0) 110.0 (100.0-140.0) 110.0 (100.0-130.0)	132.8±21.1 115.0±7.9 112.7±6.8	2.56 (2.16-2.96)
	$P_1<0.001$; $P_2<0.001$; $P_3<0.001$			

Table 3. Continued

	Time	Median (min-max)	Mean ± SD	Effect size (Cohen's d, 95% CI)
Diastolic blood pressure (mmHg)	T_0 T_1 T_2	80.0 (60.0-120.0) 70.0 (60.0-90.0) 60.0 (60.0-80.0)	78.3±12.7 65.5±5.9 65.1±5.4	0.94 (0.63-1.25)
	P_1<0.001; P_2<0.001; P_3=0.479			

T_0: Pre-op, T_1: Post-op 3rd month, T_2: Post-op 6th month
P_1: T_0 vs. T_1
P_2: T_0 vs. T_2
P_3: T_1 vs. T_2
Wilcoxon Signed-Rank test used for comparisons
Effect sizes calculated using pooled standard deviation; CI based on normal approximation. CI: Confidence interval, SD: Standard deviation, LDL: Low-density lipoprotein, HDL: High-density lipoprotein

Table 4. Comparison of pre-op and post-op diabetes, serum lipid and blood pressure classification

Diabetes classification				
	Time	**Optimal** **n (%)**	**Pre-diabetes** **n (%)**	**Diabetes** **n (%)**
Fasting blood glucose	T_0 T_1 T_2	100 (55.8) 140 (78.2) 161 (89.9)	42 (23.5) 32 (17.9) 17 (9.5)	37 (20.7) 7 (3.9) 1 (0.6)
HbA1c	Time	Low diabetes risk n (%)	Diabetes n (%)	High diabetes risk n (%)
	T_0 T_1 T_2	61 (50.8) 70 (69.3) 81 (85.3)	29 (24.2) 14 (13.9) 3 (3.2)	30 (25.0) 17 (16.8) 11 (11.5)
Serum lipid classification				
	Time	Optimal n (%)	Risky n (%)	High risk n (%)
Total cholesterol	T_0 T_1 T_2	113 (63.1) 153 (85.5) 162 (90.5)	37 (20.7) 20 (11.2) 12 (6.7)	29 (16.2) 6 (3.3) 5 (2.8)
LDL cholesterol	T_0 T_1 T_2	26 (18.1) 47 (32.6) 65 (46.1)	91 (63.2) 92 (63.9) 69 (48.9)	27 (18.8) 5 (3.5) 7 (5.0)
HDL cholesterol	T_0 T_1 T_2	7 (4.9) 6 (4.2) 24 (16.9)	37 (25.7) 73 (50.7) 98 (69.0)	100 (69.4) 65 (45.1) 20 (14.1)
Blood pressure classification				
	Time	Optimal n (%)	Pre-hypertension n (%)	Hypertension n (%)
Systolic+ diastolic	T_0 T_1 T_2	37 (20.6) 97 (54.2) 110 (61.5)	61 (34.1) 79 (44.1) 69 (38.5)	81 (45.3) 3 (1.7) 0 (0.0)

T_0: Pre-op, T_1: Post-op 3rd month, T_2: Post-op 6th month
P_1: T_0 vs. T_1
P_2: T_0 vs. T_2
P_3: T_1 vs. T_2
All comparisons yielded statistically significant results ($p<0.05$),
chi-square test used for comparisons, LDL: Low-density lipoprotein, HDL: High-density lipoprotein.

Preoperatively, patients used an average of 2.09 medications or medical devices related to obesity management. This number decreased markedly to 0.24 per patient at three months (an 88.5% reduction) and to 0.08 at six months (a 96% reduction). In contrast, the use of proton pump inhibitors and multivitamin supplements—routinely prescribed following SG—increased significantly, rising by 200% at three months and 100% at six months. These trends reflect standard post-op supplementation protocols rather than continued pharmacologic management of comorbid conditions.

Findings Related to Costs

As presented in Table 5, diabetes accounted for the highest share of pre-op costs, representing 40.06% of the total expenses. This was followed by hypertension (14.19%), joint diseases (13.27%), obesity (10.30%), OSAS (10.09%), depression (9.86%), and hypercholesterolemia (2.24%). Notably, 94% of pre-op diabetes-related expenses were attributed to medication and medical devices.

As shown in Table 6, medications and medical devices collectively accounted for 75.4% of the total pre-op costs. Following surgery, the cost distribution shifted markedly, with surgical procedures accounnting for 86.7% of total post-op expenses. Meanwhile, expenditures for diet therapy and traditional or complementary treatments, which together accounted for over 5% of pre-op costs, were completely eliminated in the post-op period (Figure 3).

At the third post-op month, the average cost per patient was 6,307.76 TL (approx. $1.098), increasing slightly to 6,706.96 TL (approx. $1.167) by the sixth month. Of this amount, 86.7% was attributed to the surgical procedure. When the operation cost was included, a 13.95% reduction in total expenses was observed at six months compared to the pre-op period. However, when surgical costs were excluded, the average cost per patient decreased from 7,794.07 TL (approx. $1.357) to 893.96 TL (approx. $156), corresponding to an 88.53% reduction (Table 7).

Table 5. Distribution of pre- and postoperative costs by diagnosis

	Pre-op		Post-op month six		
Diagnosis	**Share in total cost (%)**	**Cost TL($)[1,2]**	**Share in total cost (%)**	**Cost TL($)[2,3]**	
Diabetes		40.06	558,951.33 (97,281.68)	0.54	6,539.55 (1,138.16)
Hypertension	14.19	197,906.72 (34,444.32)	0.01	141.32 (24.59)	
Joint diseases	13.27	185,123.36 (32,219.46)	0.00	0.00 (0.00)	
Obesity	10.30	143,656.70 (25,002.47)	99.28	1,191,871.50 (207,437.13)	
OSAS	10.09	140,784.64 (24,502.61)	0.00	0.00 (0.00)	
Depression	9.86	137,518.50 (23,934.16)	0.17	1,992.73 (346.82)	
Hypercholesterol		2.24	31,197.12 (5,429.65)	0.00	0.00 (0.00)
Total cost		1,395,138.37 (242,814.34)		1,200,545.10 (208,946.71)	
Average cost per patient		7,794.07 (1,356.50)		6,706.96 (1,167.30)	

[1]: Costs include medication, medical devices (blood glucose meter, test strips), outpatient visits for diabetes; medication, outpatient visits, surgical procedures (knee prosthesis, breast reduction due to back and joint pain), medical devices (cane, walker, wheelchair) for joint diseases; traditional and complementary medicine (acupuncture, lipolysis with mesotherapy), surgical procedures (liposuction, adjustable gastric band, gastric balloon, medication, diet therapy, outpatient visits for obesity; medical devices (CPAP) and outpatient visits for OSAS; medication and outpatient visits for hypertension, depression and hypercholesterol before MBS.
[2]: According to the average exchange rate of the Central Bank of the Republic of Türkiye in November 2019 1 $=5,7457 TL
[3]: Costs include medication, medical devices (blood glucose meter, test strips), outpatient visits for diabetes; medication, outpatient visits, surgical procedures (knee prosthesis, breast reduction due to back and joint pain), medical devices (cane, walker, wheelchair) for joint diseases; traditional and complementary medicine (acupuncture, lipolysis with mesotherapy), surgical procedures (liposuction, adjustable gastric band, gastric balloon, medication, diet therapy, outpatient visits for obesity; medical devices (CPAP) and outpatient visits for OSAS; medication and outpatient visits for hypertension, depression and hypercholesterol after MBS.
CPAP: Continuous positive airway pressure, OSAS: Obstructive sleep apnea syndrome, MBS: Metabolic bariatric surgery.

Table 6. Distribution of pre- and postoperative costs by type of cost

	Pre-op		**Post-op month six**	
Type of cost	**Share in total cost (%)**	**Cost TL($)[1]**	**Share in total cost (%)**	**Cost TL($)[1]**
Medication[2]	53.72	749,525.24 (130,449.77)	11.61	139,478.74 (24,275.32)
Medical devices	21.75	303,476.77 (52,818,07)	0.12	1,539.36 (267.91)
Outpatient visit	13.82	192,850.00 (33,564.23)	1.58	19,000.00 (3,306.82)
Surgical procedures[3]	5.64	78,726.36 (13,701.79)	86.67	1,040,527.00 (181,096.65)
Traditional and complementary medicine therapy[4]	3.70	51,600.00 (8,980.63)	0.00	0.00 (0.00)
Diet therapy	1.36	18,960.00 (3,299.86)	0.00	0.00 (0.00)
Total cost	100.00	1,395,138.37 (242,814.34)	100.00	1,200,545.10 (208,946.71)

[1]: According to the average exchange rate of the Central Bank of the Republic of Türkiye in November 2019 1 $=5,7457 TL
[2]: Costs include prescribed oral forms and subcutan injection flacons
[3]: Costs include liposuction, adjustable gastric band, gastric balloon for pre-op; laparoscopic sleeve gastrectomy for post-op
[4]: Costs include acupuncture and lipolysis with mesotherapy.

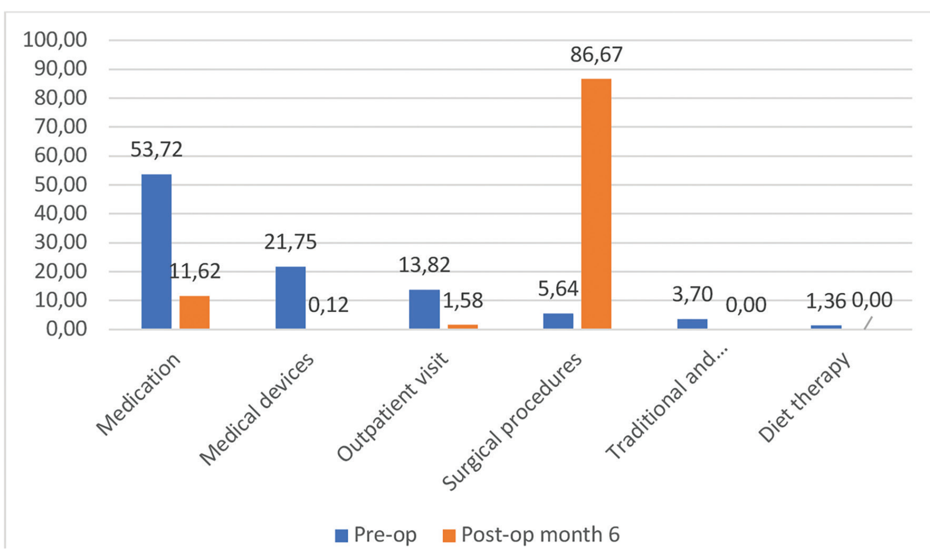

Figure 3. Comparison of pre- and post-operative cost shares by category.

Table 7. Change in average cost per patient pre- and post-operatively

	T_0 cost TL($)[1]	**T_1 cost TL($)[1]**	**T_2 cost TL ($)[1]**	**ΔT_0-T_1 (%)**	**ΔT_0-T_2 (%)**	**p**
Operation cost included	7,794.07 (1,356.50)	6.307,76 (1,097.82)	6.706,96 (1,167.30)	-19.07	-13.95	<0.05
Operation cost excluded	7,794.07 (1,356.50)	494.76 (86.11)	893.96 (155.59)	-93.65	-88.53	<0.05

[1]: According to the average exchange rate of the Central Bank of the Republic of Türkiye in November 2019 1 $=5,7457 TL
T_0: Pre-op, T_1: Post-op 3rd month, T_2: Post-op 6th month
ΔT_0-T_1: Change between pre-op and post-op 3rd month
ΔT_0-T_2: Change between pre-op and post-op 6th month.

DISCUSSION

The high rate of patients who had previously attempted popular diets, alternative therapies, and non-prescription supplements underscores the widespread reliance on unproven or unsupervised weight-loss methods. These findings highlight the need to improve health literacy and guide patients toward evidence-based obesity treatments. The findings presented here represent early post-operative outcomes observed within a six-month follow-up period and should be interpreted in the context of short-term recovery and adjustment.

EWL%, a key metric for evaluating surgical success, was 45.85% at 3 months and 68.27% at 6 months. These findings are consistent with systematic reviews reporting 3-month EWL% between 36.3-47.2% and 6-month values ranging from 51.7-72% (29-31). Variation in outcomes across studies may stem from differences in baseline BMI, patient age, and surgical techniques (32).

Early remission of obesity-related conditions supports the metabolic effectiveness of MBS. This study observed remission or improvement in several conditions before significant weight loss occurred, highlighting the metabolic efficacy of MBS. In particular, the 89.5% remission rate for diabetes at 6 months exceeds reported rates of 64.7-81.9% in prior LSG studies (23,33-36). This supports not only the clinical efficacy but also the economic value of early MBS, especially given diabetes' substantial burden on healthcare systems globally and in Türkiye (37). Since patients with early-stage diabetes show better outcomes, surgery should not be delayed in those diagnosed with obesity and diabetes (38).

Remission rates for hypercholesterolemia and hypertension reflect the known benefits of MBS. Hypercholesterolemia remission was 85.7%, aligning with systematic review data (64-84%) (23,39). Our findings support previous conclusions on SG's favorable impact on lipid profiles and its role in reducing long-term costs associated with cardiovascular risk (39,40).

The observed remission in joint disorders is likely driven by post-operative weight loss and reduced mechanical stress on joints. Additionally, the reduction in analgesic use, including NSAIDs, may reflect improved symptom control and decreased dependency on pharmacological pain management. As this study is based on patient-reported outcomes, these findings capture subjective improvements in joint symptoms, which are important indicators of functional recovery and patient satisfaction following MBS. Systematic reviews indicate a wide range of improvement rates (50-100%) due to varying definitions and assessment tools (23,40-44). Our high remission rate may also be influenced by behavioral changes post-operatively, such as patients' reluctance to use NSAIDs due to concerns over gastrointestinal side effects (45).

Remission of OSAS was consistent with the literature but highlights diagnostic variability. OSAS remission and improvement rates in the literature vary (78-100% and 75.8-90.77%, respectively) due to differences in BMI, disease severity, and assessment tools (23,33,40,46). Our results align with these ranges, though the absence of standardized measurement tools remains a limitation. Long-term CPAP use is associated with weight regain, reinforcing the importance of sustained post-op management.

The mental health benefits of MBS are well-documented, with significant improvements in depressive symptoms typically observed within the first two years post-operatively (47,48). However, some studies have reported a recurrence or worsening of symptoms beyond this period (48,49). In our study, a 95.7% remission rate for depression was recorded at six months, supporting the short-term psychological efficacy of MBS. Variability in outcomes may stem from differences in diagnostic criteria and definitions of remission across studies. Prior research from Türkiye has shown that psychological constructs such as self-esteem, body image dissatisfaction, and emotional eating are strongly associated with depression and anxiety in bariatric surgery candidates (50). Our findings suggest that MBS not only addresses physical comorbidities but also helps mitigate psychological burdens, particularly when supported by structured multidisciplinary care.

Significant reductions in medication and device use following MBS indicate both economic and clinical benefits. In our study, the average number of obesity-related prescriptions declined from 2.09 preoperatively to 0.24 at three months and to 0.08 at six months—a 96% reduction. This aligns with international findings; Lopes et al. (12) reported a decrease from 3.9 to 1.75 medications per patient after surgery. Beyond financial savings, this reduction also carries gastroenterological relevance and may reflect overall improvements in patient health, contributing to better adherence, fewer side effects, and enhanced quality of life (12,45,51,52).

To accurately contextualize this study's cost findings within the broader international literature, several structural factors must be considered. Reported costs of MBS and obesity-related healthcare are consistently higher in studies from other countries. This discrepancy is due primarily to Türkiye's low exchange rate and its position as the OECD country with the lowest healthcare service prices—approximately 20% of the OECD average (53). In this study, costs were calculated from the patient's perspective, considering each individual's obesity and related conditions profile. In contrast, most international studies adopt a health system or third-party payer perspective, using reimbursement data obtained from national health databases or institutional records. These structural differences significantly limit direct monetary comparisons. Therefore, rather than comparing absolute cost values, it is more appropriate to examine the distribution and proportion of cost components (e.g., medication, outpatient visits, medical devices) to derive meaningful international insights. To enable more comprehensive and comparable analyses in future research, large-scale cost and outcomes data should be made accessible to researchers through structured health information systems and national databases.

Detailed cost distribution comparisons reinforce the long-term economic value of MBS. In our study, 53.7% of pre-op costs were attributable to medications, highlighting the dominant share of pharmaceutical expenses in patient-borne obesity-related healthcare. This distribution differs significantly from international findings. For instance, Weiner et al. (54) reported cost allocations as follows: 34% for outpatient visits, 25% for inpatient treatments, 21% for private examinations, and 20% for medications. Similarly, Cremieux et al. (55) found that 73% of total costs were due to outpatient and inpatient care, with medications accounting for 27%. Karim et al. (56) reported 58% for inpatient treatment, 33% for medications, and 9% for outpatient care. These differences emphasize not only variations in healthcare delivery systems but also in the pricing and coverage models across countries.

Despite these discrepancies, a consistent finding across the literature is that the initial cost of MBS is largely offset within 2 to 5 years (55,57,58). The Turkish Ministry of Health has also confirmed that the economic burden of MBS is typically neutralized by the end of the second year, with financial gains emerging in years three and four post-operatively (17). Keating et al. (51) further emphasized that the primary driver of cost savings post-surgery is the significant reduction in diabetes-related medication use. A systematic review concluded that MBS is cost-effective in diabetic patients, although it also noted a lack of data from broader societal perspectives, long-term cost evaluations, and methodological consistency across studies (15).

MBS provides long-term economic advantages, particularly for patients with high-cost complications such as diabetes. Several studies have highlighted that although MBS may lead to modest increases in short-term costs due to procedural expenses and reimbursement dynamics, the long-term financial benefits are substantial. Palli et al. (16) reported that while there was a slight increase in short-term costs due to MBS reimbursements, long-term savings were significant, particularly for diabetic patients. Terranova et al. (59) demonstrated that MBS not only offers clinical improvements but can also extend life expectancy at a reasonable cost, resulting in significant savings for healthcare systems—especially for individuals burdened by high-cost obesity-related complications such as diabetes. Another study further emphasized considerable impact of diabetes medication on public expenditure. Gallagher et al. (60) found that the average healthcare cost per patient decreased from 10.800 USD in the year before surgery to 2.840 USD in the first post-op year, reflecting a nearly fourfold decrease. Moreover, delaying surgical treatment for patients with severe obesity is considerably more costly for healthcare systems (61). Collectively, these findings support the position that timely MBS not only improves health outcomes but also serves as a cost-saving strategy in national healthcare planning, particularly in countries with a high prevalence of obesity and related conditions.

Study Limitations

This study has several limitations. As the primary focus of the study was on clinical and economic outcomes, biochemical parameters such as micronutrient levels were not assessed. Although some patients received care in public hospitals, the majority were treated in private hospitals where out-of-pocket payments were common. To ensure consistency in cost analysis, all expenditures were calculated using the SGK public pricing tariff and categorized as out-of-pocket, regardless of insurance status. This assumption, based on the patient-reported perspective, may limit the generalizability of cost findings to other healthcare financing models. The lack of a prospectively defined sample size calculation is acknowledged as a minor methodological limitation, however, a post-hoc power analysis confirmed sufficient statistical power. As this was a patient-centered study from a health management and health economics perspective, depression, joint disease, and OSAS status were assessed via self-report without clinical retesting or the use of standardized instruments. Additionally, the follow-up period was limited to six months, which may not capture long-term trends. Cost calculations were based on patient-reported expenditures, rather than system-level reimbursement data. Nevertheless, this approach offers valuable insight into the financial burden experienced directly by patients and provides a relevant perspective for healthcare managers and policymakers.

It should be noted that pre-op costs may accumulate over an extended period due to the chronic progression of obesity and its related conditions, while post-op costs in this study reflect only the first six months after surgery. Therefore, these figures do not represent a direct time-adjusted cost comparison, but rather demonstrate the short-term economic impact of MBS from the patient perspective. Nevertheless, the strength of this study lies in its comprehensive approach, which includes six obesity-related conditions and a detailed account of all medications, medical devices, and treatment categories used both pre- and post-operatively, offering nuanced insight into individual-level cost dynamics. Furthermore, all cost estimates were self-reported, which may introduce recall bias. The analysis also assumed adherence to national treatment guidelines, though individual compliance could not be verified. Surgical costs were standardized using a national public pricing tariff, but granular breakdowns of cost components (e.g., hospital stay, consumables) were not available.

CONCLUSION

This study demonstrates that MBS provides substantial health and economic benefits for patients with obesity-related complications and comorbidities. In Türkiye—where obesity affects over one-third of the adult population and diabetes prevalence continues to rise—these findings are especially relevant. High remission rates for conditions such as diabetes, hypertension, hypercholesterolemia, joint disorders, sleep apnea, and depression within just six months after surgery confirm the broad therapeutic efficacy of MBS.

From an economic perspective, the procedure resulted in a dramatic reduction in the use of medications and medical devices—averaging over 95%—leading to significant cost savings. These reductions are particularly important in low- and middle-income countries, where out-of-pocket payments often create barriers to long-term disease management. The widespread pre-op use of non-prescriptive supplements (reported by 57% of participants) further highlights the need to enhance public health literacy around evidence-based treatments for obesity.

To our knowledge, this is the first study in Türkiye to integrate patient-reported economic data with detailed remission outcomes across six obesity-related conditions following MBS. These results provide compelling support for the early adoption of MBS within national obesity treatment strategies as both a clinically effective and economically advantageous intervention. In addition to short-term savings through reduced medication use, the long-term economic impact of improved disease remission may translate into fewer hospitalizations, lower disability rates, and reduced productivity losses—critical considerations for healthcare managers and policy-makers. Sustained, structured post-operative follow-up remains essential to maintain these gains and detect potential nutritional or metabolic complications.

Ethics

Ethics Committee Approval: The study protocol was approved by the Ankara University Ethics Committee (date: May 29, 2017, number: 10/174), and conducted in accordance with the Declaration of Helsinki.

Informed Consent: All participants received a cover letter outlining the study purpose, the voluntary nature of participation, confidentiality, withdrawal rights, and signed an informed consent form.

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Footnotes

The research is based on the first author's (Y.Ö.) doctoral thesis, which was conducted at Ankara University Graduate School of Health Sciences under the supervision of the second author.

Author Contributions

Concept - Y.Ö., İ.A.; Design - Y.Ö., İ.A.; Data Collection or Processing - Y.Ö., İ.A.; Analysis or Interpretation - Y.Ö., İ.A.; Literature Search - Y.Ö.; Writing - Y.Ö.

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