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EFFECT OF BARIATRIC SURGERY ON GLYCEMIC AND BLOOD PRESSURE CONTROL IN PATIENTS WITH TYPE 2 DIABETES MELLITUS: A PROSPECTIVE COHORT STUDY

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Abstract
Objective: *This study examined how bariatric surgery affects type 2 diabetes and hypertension in patients with severe obesity over a six-month post-operative period.*
Methods: *A prospective cohort study was conducted at Jinnah Postgraduate Medical Centre, Karachi, Pakistan, from March 2025 to August 2025. Ninety patients with a body mass index (BMI) ≥ 35 kg/m² and coexisting type 2 diabetes mellitus and hypertension unresponsive to standard medical therapy were included. Patients underwent either sleeve gastrectomy or mini-gastric bypass. Pre- and postoperative measurements included body weight, BMI, fasting blood sugar (FBS), glycated hemoglobin (HbA1c), systolic and diastolic blood pressure, and medication use. Data were analyzed using paired t-tests with SPSS version 26.0.*
Results: *Bariatric surgery led to clear and meaningful improvements across all measured health parameters. On average, body weight dropped from 125.31 kg to 94.91 kg, and BMI decreased from 47.21 kg/m² to 35.71 kg/m². Mean HbA1c levels improved from 9.02% to 6.37%, and fasting blood sugar (FBS) fell from 198.54 mg/dL to 114.76 mg/dL. Blood pressure also improved significantly, with systolic pressure decreasing by 26.17 mmHg and diastolic pressure by 11.81 mmHg. In addition, patients required fewer medications after surgery, with the mean use of antidiabetic and antihypertensive drugs reduced by about 60% postoperatively.*
Conclusion: *Within six months, patients experienced substantial reductions in weight, blood sugar, blood pressure, and medication dependence. These findings demonstrate the significant efficacy of surgery in managing obesity-related conditions, though longer follow-up is needed to confirm lasting benefits.*

INTRODUCTION
Obesity is a multifactorial disease associated with reduced life expectancy and an increased risk of multiple comorbidities. It is linked to chronic inflammatory airway diseases, higher mortality, and significant healthcare utilization, as well as cardio-metabolic complications, including diabetes, hypertension, dyslipidemia, and cardiovascular disease.[1, 2] Non-surgical approaches to obesity management, including dietary modification, physical activity, behavioural therapy, and pharmacological

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treatment, are insufficient for achieving sustained weight loss in majority of patients.[3] Multiple high-quality studies have demonstrated that bariatric surgery is associated with substantial weight loss and significant improvement in obesity-related comorbidities.[4, 5]

Bariatric surgery, primarily indicated for the management of severe obesity, is an effective treatment for type 2 diabetes in patients with obesity. Evidence from longitudinal studies demonstrates that commonly performed bariatric procedures, including Roux-en-Y gastric bypass, sleeve gastrectomy, and one-anastomosis gastric bypass, are associated with significant improvements in glycemic control and high rates of diabetes remission following surgery.[6] Similarly, a strong body of evidence shows that bariatric surgery is associated with improved blood pressure control and reduced antihypertensive medication use.[7, 8, 9]

According to the 2022 ASMBS/IFSO joint guidelines, bariatric surgery is recommended for individuals with a BMI ≥ 35 kg/m² regardless of comorbidities, and should be considered for people with metabolic disease and a BMI of 30–34.9 kg/m².[10] Appropriate selection of procedure is one of the key steps to a successful bariatric surgery. Mini gastric bypass (MGB) and sleeve gastrectomy (SG) are among the most commonly performed weight loss surgeries around the globe.[11] Given the rising prevalence of obesity and its strong link to long-term cardiometabolic problems, it is clinically significant to evaluate the efficacy of bariatric procedures on glycemic and blood pressure regulation within a real-world clinical setting. While short-term benefits are documented, evaluating these outcomes over six months can provide helpful insights into early metabolic improvements and the potential for medication de-escalation.

MATERIAL AND METHODS

This is a prospective cohort study conducted at the Department of General Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan, over a period of six months from March 2025 to August 2025, to evaluate the effects of bariatric metabolic surgery on glycemic control and blood pressure at six months postoperatively.

A total of 90 patients were enrolled using a non-probability consecutive sampling technique. The sample size was calculated using data from previous studies, which reported a mean preoperative HbA1c level of about 7.4%. The study was planned to have enough statistical power to detect a 20% relative reduction in HbA1c levels after surgery. A minimum of 80 patients was needed to achieve 90% power at $\alpha = 0.05$. To account for potential loss to follow-up, an additional 10 patients (12.5%) were recruited.

Eligible participants were male and female patients aged 20–60 years with a body mass index (BMI) ≥ 35 kg/m² and a diagnosis of poorly controlled type 2 diabetes mellitus and hypertension despite optimal medical therapy. All participants had previously failed dietary and lifestyle modifications. All procedures were performed as either sleeve gastrectomy (SG) or mini-gastric bypass (MGB), using standard, previously published surgical techniques, without major procedural modifications. Of the 90 patients, 66 (73.3%) underwent SG, and 24 (26.7%) underwent MGB. Patients who refused consent, were unable to complete follow-up, or were deemed unfit for general anesthesia were excluded from the study.

The primary outcomes of this study were changes in glycemic control and blood pressure six months after surgery. Fasting blood glucose and glycated hemoglobin (HbA1c) levels were measured to assess glycemic control. Blood pressure was tracked by recording changes in both systolic and diastolic blood pressure. Changes in body weight, BMI, and medication use were considered secondary outcomes.

The Institutional Review Board of Jinnah Postgraduate Medical Centre granted ethical approval for this study (NO.F.2-81/2025-GENL/211/JPMC). All participants provided written informed consent. Also, to ensure confidentiality, each participant was given a unique identification code, and all data were securely stored and permanently deleted after the study concluded.

Statistical analysis was conducted using SPSS version 26.0. Continuous variables and categorical variables were expressed as mean ± standard deviation, and frequencies and percentages, respectively. Paired *t*-tests were used to compare pre- and postoperative values. A *p*-

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value < 0.05 was considered statistically significant, and results were reported with 95% confidence intervals.

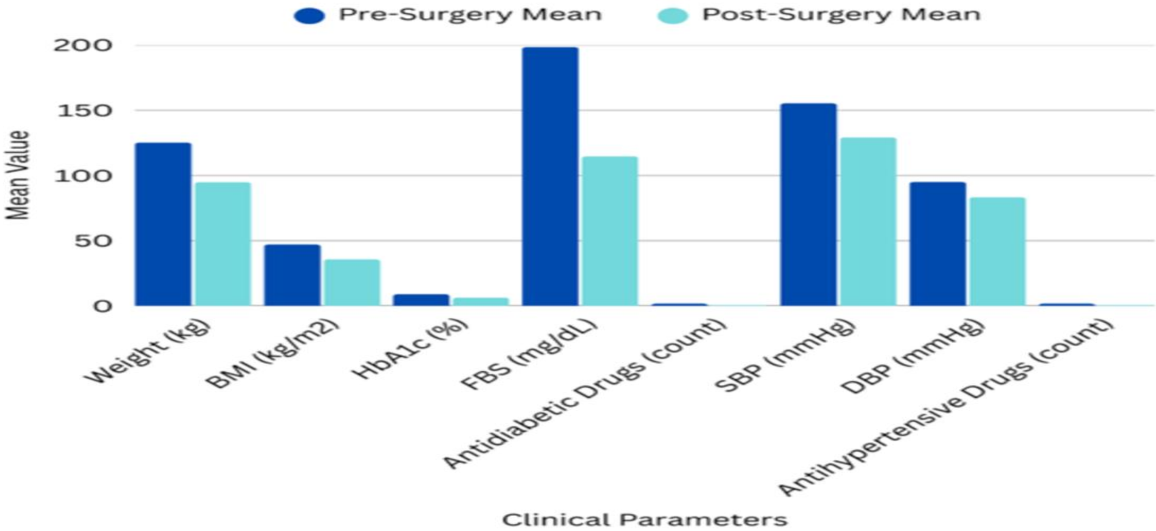
RESULTS

Bariatric surgery led to marked improvements across all measured parameters. Patients lost a substantial amount of weight, with mean body weight decreasing from 125.3 ± 21.3 kg before surgery to 94.9 ± 18.2 kg after surgery (mean reduction 30.4 kg, 95% CI: 27.7–33.1). In line with this, BMI decreased from 47.2 ± 8.0 kg/m² to 35.7 ± 6.6 kg/m² (mean reduction of 11.5 kg/m²; 95% CI: 10.5–12.6). Weight variability decreased from 21.3 kg to 18.2 kg, and BMI variability declined from 8.0 to 6.6 kg/m², indicating more consistent postoperative outcomes in both weight and BMI. Glycemic control improved markedly, mean HbA1c fell from 9.0 ± 1.9% to 6.4 ± 0.8%, a 2.66 % drop (95% CI: 2.4–2.9), while fasting glucose declined by 83.8 mg/dL (from 198.5 ± 41.4 mg/dL to 114.8 ± 15.1mg/dL; 95% CI: 77.6–90.0). The SD for HbA1c halved, and for fasting glucose fell by two-thirds. The use of glucose-lowering and antihypertensive medications was substantially reduced. The mean number of antidiabetic agents decreased from 1.83 ± 1.03 to 0.73 ± 0.75, and the mean number of antihypertensive agents decreased from 1.82 ± 1.16 to 0.70 ± 0.64, representing an approximate 60% reduction in each class.

Table 1: Distribution of Variables Pre- and Post-surgery

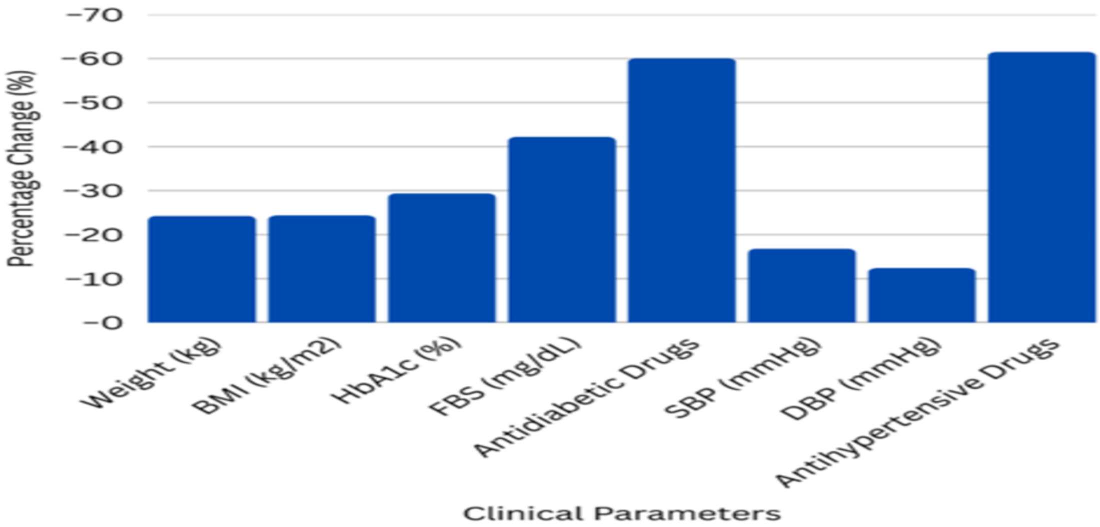
Variables	Pre-Surgery	Post-Surgery
Weight (kg)	125.31±21.26	94.91±18.19
BMI	47.21±8.02	35.71±6.63
HbA1C	9.02±1.86	6.36±0.84
Fasting Blood Sugar (FBS)	198.54±41.43	114.76±15.12
Antidiabetic drugs	1.83±1.03	0.733±0.746
Systolic blood pressure	155.42±15.83	129.26±15.39
Diastolic blood pressure	95.2±8.87	83.38±9.15
Antihypertensive drugs	1.82±1.16	0.7±0.64

Note. BMI, body mass index; HbA1C, glycated hemoglobin.
These pre- and postoperative distributions are illustrated in Figure 1.



Significant parallel benefits were observed in blood pressure parameters, systolic readings fell from 155.4 ± 15.8mmHg to 129.3 ± 15.4 mmHg, a 26.2 mmHg reduction (95% CI: 25.6–26.7), and diastolic values declined by 11.8 mmHg (from 95.2 ± 8.9 mmHg to 83.4 ± 9.2 mmHg; 95 % CI: 10.8–12.8). Postoperative variability decreased for both measures.
Collectively, these data demonstrate a robust and statistically significant improvement across all measured metabolic and anthropometric indices within the six-month study period.

The corresponding percentage changes from baseline to 6 months are shown in Figure 2.



DISCUSSION

We found that bariatric surgery has shown marked improvements in weight and body composition. On average, patients shed 30.4 kg (95 % CI 27.7–33.1 kg), their BMI fall by 11.5 kg/m² (95 % CI 10.5–12.6 kg/m²), with postoperative variability narrowing from SD 21.3 to 18.2 kg for weight and from 8.0 to 6.6 kg/m² for BMI. Large registry analyses support these findings which show durable weight loss after Roux-en-Y and biliopancreatic diversion procedures. [12, 13, 14]We also measured and found improved glycaemic control. Mean HbA_1c decreased by 2.7 % (95 % CI 2.4–2.9 %), and fasting glucose dropped by 83.8 mg/dL (95 % CI 77.6–90.0 mg/dL). Additionally, the SD of both HbA_1c and fasting glucose was approximately halved. There was a reduction in anti-diabetic medications, taken by patients, by nearly 60% from 1.8 to 0.7. Our findings are supported by systematic reviews and longitudinal studies which show early and continued improvements in glycaemic outcomes and a reduction in the intake of antidiabetic medications after bariatric surgery. [15, 16, 17]

Our data also showed an improvement in blood pressure control. We recorded average systolic and diastolic drops of 26.2 mmHg (95 % CI 25.6–26.7 mmHg) and 11.8 mmHg (95 % CI 10.8–12.8 mmHg), respectively. Anti-hypertensive drug also decreased by 60% accompanied by narrower postoperative distributions. These outcomes align with previous reports of hypertension remission and reduced medication intake following bariatric procedures. [18, 19]

Our findings are consistent with meta-regression evidence indicating that each 5-unit reduction in BMI is associated with a 30–35% reduction in diabetes risk and a 25–30% reduction in hypertension. Blood-pressure improvements appear to plateau at approximately 18–24 months postoperatively, whereas metabolic benefits persist beyond one year. [20]

However, despite these positive results, many patients stayed within the obese BMI range (30–35 kg/m²). This determines the importance for continued lifestyle support and for more nuanced eligibility criteria as relying on BMI alone may fail to identify individuals at high cardiometabolic risk whose metabolic profiles are not adequately reflected by body-mass index. The inclusion of measures of visceral adiposity or emerging indices, such as the body adiposity index, may allow more accurate patient selection and improved clinical and economic outcomes. [21]

A substantial body of epidemiological evidence links increasing adiposity with a growing burden of cardiometabolic disease. Longitudinal studies indicate that for every 5-unit rise in BMI, the risk of type 2 diabetes increases almost two-fold, independent of age and lifestyle-related factors.[22] Evidence from the Framingham Heart Study similarly demonstrated that overweight and obesity are associated with approximately double the long-term incidence of coronary heart disease, a finding consistently replicated in more recent cohort studies and reflected in current clinical guidelines.[23] Data from large international cohorts and meta-analyses further identify elevated BMI as a key driver of hypertension, with each 5-unit increment associated with a 25–30% increase in risk. From a mechanistic perspective, excess adiposity contributes to systemic inflammation and endothelial dysfunction through adipokine imbalance and activation of the renin–angiotensin–aldosterone system, thereby accelerating the development of hypertension and broader cardiometabolic disease.[24, 25] Together, these interrelated pathways help explain why interventions that induce substantial weight loss, such as metabolic surgery, may alter the trajectory from obesity to established cardiometabolic disease.[26]

Future studies should aim to identify preoperative predictors of optimal response, including fat distribution and duration of diabetes, and assess the durability of these benefits in routine clinical practice.

Our analysis was restricted to observational data, which introduces the potential for residual confounding by unmeasured factors. For example, socioeconomic status and health-related behaviours may influence both surgical selection and postoperative outcomes. In addition, BMI was used as the sole measure of adiposity, limiting our ability to account for fat distribution or changes in muscle mass. Detailed postoperative data on diet, physical activity and medication adjustments were not available, precluding the separation of surgical effects from those attributable to lifestyle modification.

Regional Implications for Metabolic Health in South Asia

Rapid urbanization, dietary changes, and genetic predisposition to insulin resistance are driving South Asia's emerging obesity problem, with prevalence rates even higher than 20% in urban parts such as Pakistan. The immense scale of type 2 diabetes and hypertension in this region more than 25% of the global burden emphasizes the urgency need for scalable means of intervention beyond pharmacotherapy, which is often not affordable in this population.

Based on our results, bariatric surgery offers a cost-effective option in resource-limited settings since it allows for early improvement of metabolic status (i.e., 2.66% reduction in HbA1c, 26.17 mmHg decrease in systolic blood pressure) and ~60% medication de-escalation within six months. Following ASMBS/IFSO recommendations, these surgery procedures are expected to reduce long-term complications such as CVD and thus healthcare costs by 30-50%, due to lower reliance on medications and hospitalizations.

In terms of clinical application, the findings suggest that implementing bariatric surgery into public health systems in South Asia may be a means to bridging the gap, focusing on high-risk patients with BMI ≥35 kg/m2 with refractory comorbidities. But barriers of surgical infrastructure and cultural stigma require policy reforms, training initiatives and multicenter trials to verify long-term outcomes and beautification of procedures in multiple ethnicities. Ultimately, this could provide means to stem the skyrocketing cardiometabolic disease crisis and improve lifetime and health span for all in the region.

LIMITATIONS

There are a few limitations of the study. It is an observational cohort study and is therefore vulnerable to residual confounding by unmeasured factors such as socioeconomic status and health behaviors, which may also be associated with selection for surgery and surgical outcomes. Use of BMI as the sole measure of adiposity fails to take into account fat distribution and changes in muscle mass. Comprehensive postoperative information on diet, exercise and medication use were not available, so surgical effects could not be separated out from lifestyle changes. The six-month follow-up only provides early data and does not allow for assessment of long-term durability, weight regain, or rates of adverse events. Consecutive sampling at a single center in Pakistan may introduce selection bias and limit the applicability of findings to other populations or settings.

CONCLUSION

In this prospective cohort study performed in sleeve gastrectomy (SG) and mini-gastric bypass (MGB) groups, we observed rapid and significant bariatric surgery-induced improvements in patients living with severe obesity, type 2 diabetes, and hypertension: mean

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body weight reduction (30.40 kg; 6 months following the surgery), BMI (11.51 kg/m²), HbA1c (2.66%), fasting blood sugar (83.79 mg/dL), systolic blood pressure (26.17 mmHg), diastolic blood pressure (11.81 mmHg), and antidiabetic/antihypertensive medications (~60%; all $p < 0.0001$). These results, in line with international data, confirm the metabolic efficiency of surgery in a real world setting in Pakistan.

From a clinical perspective, bariatric surgery is a powerful tool for refractory co-morbid disease, which can be rendered into early remission and purified from complications of these diseases (e.g., cardiovascular events), and in a cost-effective manner in terms of medication de-escalation as endorsed by ASMBS/IFSO guidelines, especially critical in resource-challenged environments given burgeoning prevalence of obesity. Longer-term randomized trials are warranted to evaluate sustainability, predictors of response, and head-to-head comparisons with GLP-1 agonists thereby positioning surgery as a transformative approach to curing cardiometabolic disease.

Declarations

Ethics Approval and Consent to Participate

The study was approved by the Institutional Review Board of Jinnah Postgraduate Medical Centre, Karachi, Pakistan, and written informed consent was obtained from all participants.

Availability of Data and Materials Statement

All data supporting the conclusions of this article are held by the authors and are available on reasonable request.

Declaration of Conflicts of Interest

The authors declare that they have no financial or personal conflicts of interest that could have affected the work reported in this manuscript.

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