Journal of Population Therapeutics & Clinical Pharmacology

**RESEARCH ARTICLE**
**DOI: 10.53555/30c71a86**

# IMPACT OF BARIATRIC SURGERY ON INSULIN RESISTANCE IN PATIENTS ATTENDING SUEZ CANAL UNIVERSITY HOSPITALS

**Shorouk Gamal Salah Ibrahim[1*], Abd El-Raouf Mohamed El-Deib[2], Sameh Tolba Abu-Elela[3], Mohamed Osama Abdalla[4], Ahmed Mohammed Mossad[5]**

[1]Master Degree in internal medicine 2016 (Faculty of Medicine, Suez Canal University), Assistant lecturer of Internal Medicine, (Suez Canal University Hospitals).
[2]Professor of Internal Medicine, Faculty of Medicine, Suez Canal University.
[3]Assistant Professor of General Surgery, Faculty of Medicine, Suez Canal University.
[4]Assistant Professor of clinical pathology, Faculty of Medicine, Suez Canal University.
[5]Lecturer of Internal Medicine, Faculty of Medicine, Suez Canal University.

***Corresponding Author:** Shorouk Gamal Salah Ibrahim
*Master Degree in internal medicine 2016 (Faculty of Medicine, Suez Canal University), Assistant lecturer of Internal Medicine, (Suez Canal University Hospitals).

## ABSTRACT

**Background:** Obesity is considered a serious epidemic and one of the leading global causes of preventable deaths**.**

**Aim:** This prospective observational study aimed to assess the impact of bariatric surgery on insulin resistance in obese patients attending Suez Canal university hospitals so helping in promotion of management of insulin resistance and type 2 diabetes mellitus.

**Patients and Methods**: This prospective observational study included 40 patients with age over 18 years, BMI ≥35 (kg/m2) and HOMA-IR ≥2 who underwent bariatric surgery during the period from July 2021 to January 2023. Our data obtained by history taking, examination and investigations; including measurement of fasting insulin, fasting blood sugar, HbA1C, TNF- α and calculated HOMA-IR before and after 3 months of the surgery.

**Results:** The mean age of our patients was 39.95 ± 9.68 years, the majority of the patients (92.5%) were females, Most of the patients (80%) were married, (67.5%) received high level of education, 45% of the patients were diabetic, 17.5% were prediabetic and 37.5% were non-diabetic. There were 32.5% of our patients received oral treatment and only 2.5% (1 patient) was on insulin therapy for diabetes, 95% of our patients had laparoscopic sleeve gastrectomy and only 5 % patients had mini-gastric bypass. After 3 months of the surgery, the mean weight reduced from 135.27± 23.01 to 109.78±19.99 kg, the mean BMI was 50.93± 8.11 decreased to 41.35±7.10 kg/m$^2$. The mean HbA1C was 6.48 ± 1.10 % and improved to be 5.55 ± 0.75%. Mean fasting blood sugar decreased from 119.28± 38.93 mg/dl to 77.45±14.20 mg/dl. Mean fasting insulin level decreased from 25.81± 18.92 mcU/mL before operation to 10.27± 6.46 mcU/mL. Mean HOMA-IR decreased from 7.70 ± 7.06 to 1.98 ± 1.34 and mean TNF-α level was 145.32 ± 58.96 and reduces to 117.86 ± 27.43 postoperatively. Our study revealed that there was statistically significant decrease in weight and BMI (P < 0.0001), significant improvement in the metabolic parameters of the patients (P < 0.0001) including (HbA1C,

HOMA-IR, fasting insulin, fasting blood sugar), and a significant decrease ($P < 0.0001$) in the measured inflammatory marker (TNF- α) after 3 months of the surgery.
**Conclusion:** Bariatric surgery representing an effective option for obese patients for marked weight loss with significant improvement in insulin sensitivity either in diabetic, prediabetic and non-diabetic patients which helps in eliminating the predisposing factors of prediabetic and non-diabetic patients for developing diabetes and management of T2DM and prevention of its complications in the diabetic patients.

**Key words:** Bariatric Surgery, BMI, DM, HOMAIR.

## 1. Introduction

Obesity is considered a serious epidemic and one of the leading global causes of preventable deaths**.** The rise in prevalence of obesity globally is the single largest contributor to the rising epidemic of type 2 diabetes mellitus (T2DM). As there is a direct relationship between T2DM and obesity, researches showed that, the risk of developing diabetes increases by 2% in patients with body mass index (BMI) ranges from 25 to 29.9 kg/m2 and reaches about 13% in those with BMI > 35 kg/m$^2$ **[1].**
About 96% of diabetes mellitus patients are T2DM. The global burden of diabetes study reported that, In 2021, there were 529 million people with diabetes worldwide and by 2050, more than 1·31 billion people are expected to have diabetes **[2].**
Patients with T2DM have a 15% increased risk of mortality rate more than people without diabetes and cardiovascular disease is the greatest cause of morbidity and mortality associated with T2DM **[3].**
It was showed that serum level of TNF-α was significantly higher in obese diabetic patients when compared with non-obese diabetic patients and obese non-diabetics patients. There is strong and consistent evidence that obesity management can delay the progression from prediabetes to T2DM. Also in patients with T2DM who have overweight or obesity, sustained weight loss has been shown to improve glycemic control and reduce the need for glucose-lowering medications **[4]** .
Bariatric surgery (BS) is a widely studied treatment for obesity. In obese patients with T2DM the benefit of bariatric surgery in improving glycemic control and other metabolic components gave it the term of "metabolic surgery" **[5]**. So American Diabetes Association (ADA) recommended metabolic surgery to be a treatment in T2DM patients with BMI ≥40 kg/m$^2$ and it may be considered in those with BMI (30.0–34.9) kg/m$^2$ (if not achieved effective weight loss and improvement in co-morbidities with nonsurgical methods) **[4]**.
Various types of bariatric surgical techniques have been studied and are used for weight reduction and treatment of co-morbidities. These include Gastric Banding (GB), Roux-en-Y Gastric Bypass (RYGB), Min-gastric Bypass (MGB), Biliopancreatic Diversion with duodenal switch (BPD-DS), and Sleeve Gastrectomy (SG) **[1].**
Although cost of metabolic surgery is higher than other strategies like life style modification and medical treatment, studies suggested that it is cost-effective for management of patients with T2DM with the long-term effectiveness and safety of the procedures **[4]** .
With or without diabetes relapse, the majority of patients who undergo surgery maintain substantial improvement of glycemic control from baseline for at least 5 years to 15 years **[4]**. There is also evidence that bariatric surgery decreases mortality rate in T2DM patients with up to 92% **[1]** .
So in this study we aimed to assess the impact of bariatric surgery on insulin resistance and by measuring HOMA-IR index and the pro-inflammatory marker (TNF-α) before and after 3 months of the surgery to in obese patients attending Suez Canal university hospitals.

## Aim of the study

In this study, we aimed to assess the impact of bariatric surgery on insulin resistance in obese patients attending Suez Canal university hospitals.

## 2. Patients and Methods

This prospective observational study was carried out in Suez Canal University hospitals, Ismailia, Egypt. This study included 40 obese patients scheduled to have bariatric surgery with age ≥18 years or older, both sex, patients with increased insulin resistance (HOMA IR ≥ 2), patients with impaired glucose tolerance or impaired fasting glycaemia or both, with type 2 DM treated with oral hypoglycaemic drugs and patients with type 2 DM treated insulin therapy and not controlled on high dose of insulin. While patients had Type1 Diabetes mellitus, patients had T2DM on insulin therapy and controlled on low dose of insulin, patients had BMI< 30 kg/m$^2$, patients had history of receiving immunosuppressant therapies and patients had medical history of chronic kidney, chronic liver disease or any malignancy were excluded from the study.

All patients were subjected to preoperative assessment and follow up was done after the surgery by 3 months through detailed history, physical and anthropometrical examination, laboratory investigations (Fasting blood sugar, Fasting insulin, HbA1c, TNF-α and HOMA-IR). Insulin resistance was considered if HOMA-IR ≥ 2.

### Data Management

Data collected from patients in the form of a written questionnaire. Data processed by SPSS v.23 computer package. Quantitative variables expressed as means and standard deviations or medians and percentiles, qualitative variables expressed as frequencies and percentages. Relative percentage change was calculated to get the actual change after surgery (Relative percentage change = [(post measure – pre measure)] x 100). Paired t -test used to compare pre- and post surgery data. The strength of the association between variables calculated using Pearson's method for parametric variables and the Spearman Rho correlation test for non-parametric variables. P values < 0.05 considered to be statistically significant.

## 3. Results

Table 1 showed basic demographic data of the study participants.

**Table 1: Socio-Demographic characteristics of the study patients.**

| Variable | Attribute | Frequency Percent (%) |
|---|---|---|
| **Gender** | Male | 3 (7.5 %) |
| | Female | 37 (92.5%) |
| | Total | 40 (100%) |
| **Age** | Range | 23- 59 |
| | Mean ± SD | 39.95 ± 9.68 |
| **Residence** | Rural | 18 (45%) |
| | Urban | 22 (55%) |
| **Marital Status** | Single | 6(15 %) |
| | Married | 32(80%) |
| | Widow | 1 (2.5%) |
| | Divorced | 1(2.5%) |
| **Level of Education** | Basic | 3(7.5%) |
| | Medium | 10(25%) |
| | High | 27 (67.5%) |

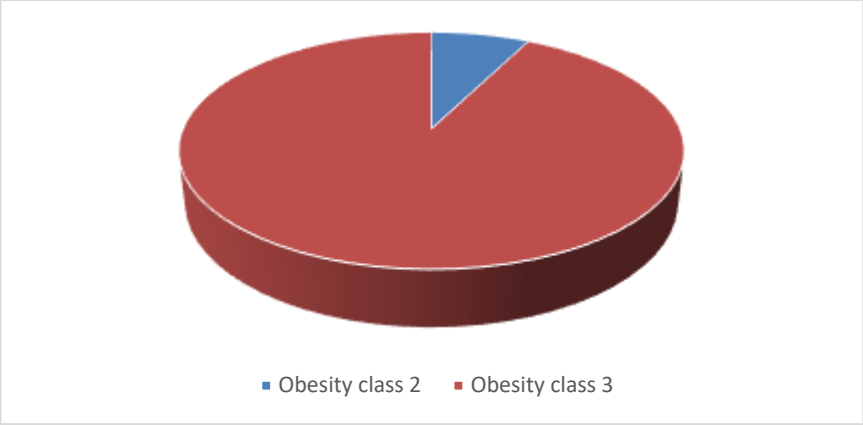


***Figure 1: Classes of obesity distribution.***

**Figure (1)** shows classes of obesity between the population, as the patients with obesity class 2 had BMI from 35 to 39.9(kg/m^2) and patients with obesity class3 had BMI ≥ 40(kg/m^2).

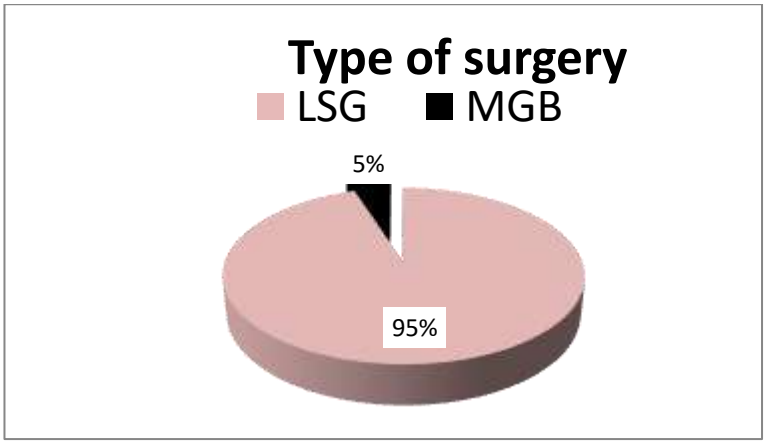


***Figure 2: Percentage distribution of surgery type {laparoscopic sleeve gastrectomy (LSG) and mini-gastric bypass (MGB)} among studied population.***

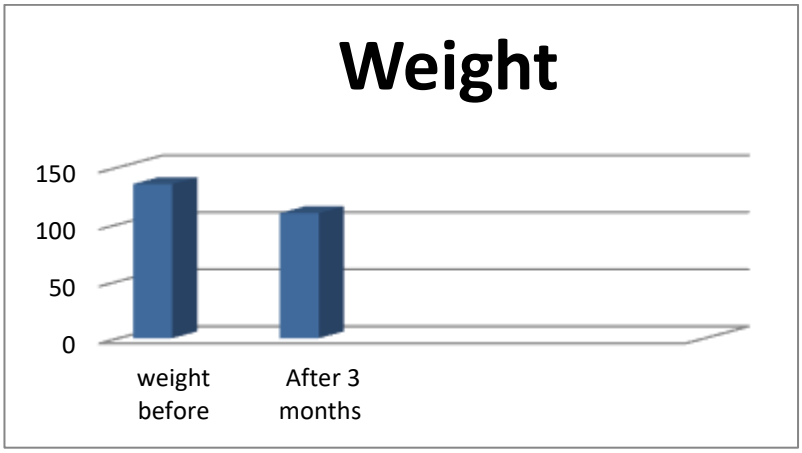


**Figure 3: Shows weight (kg) reduction from 135.27± 23.01 before to 109.78±19.99 kg after 3 months of the operation (p< 0.001).**

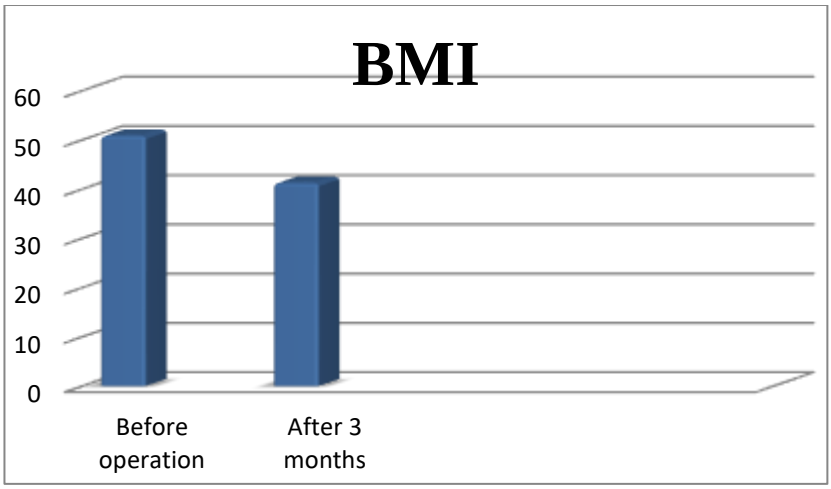


***Figure 4: Shows BMI (kg/m$^2$) decreased from 50.93± 8.11 preoperative to 41.35±7.10 kg/m2 after 3 months of the operation (p< 0.001).***

***Table 2: EBMIL% after 3 months of the surgery:***

| Variable | Minimum | Maximum | Mean | St.Deviation |
|---|---|---|---|---|
| **EBMIL %** | 20.05 | 71.34 | 38.86 | 11.70 |

**Table (2**) shows loss of excess body mass index percentage (EBMIL%) of the studied population after 3 months of the surgery.

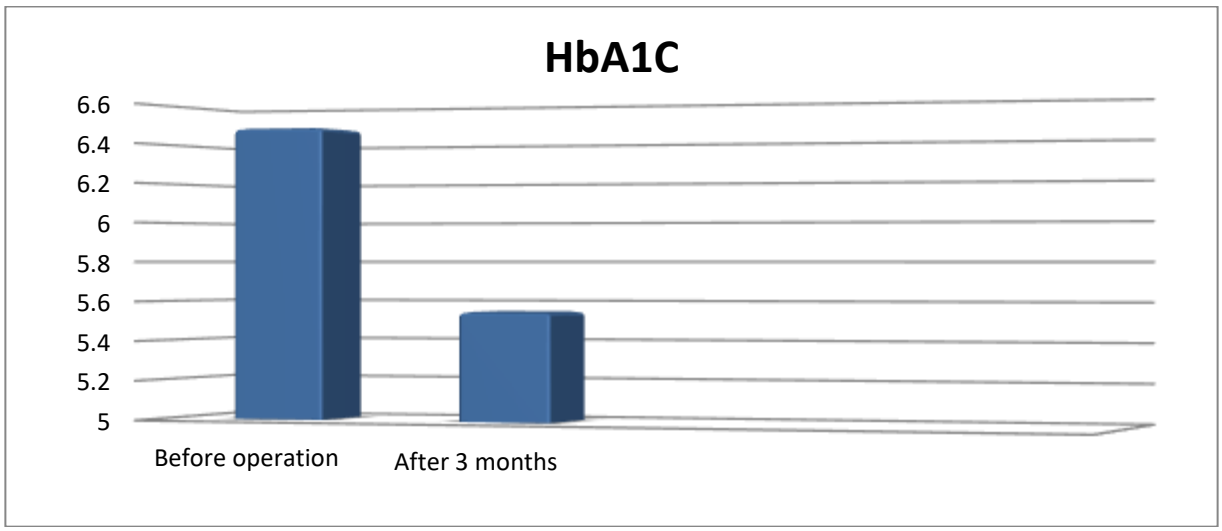


***Figure 5: HbA1C level percentage reduction from 6.48 ± 1.10 % before to be 5.55 ± 0.75% after 3 months of the operation (p< 0.001).***

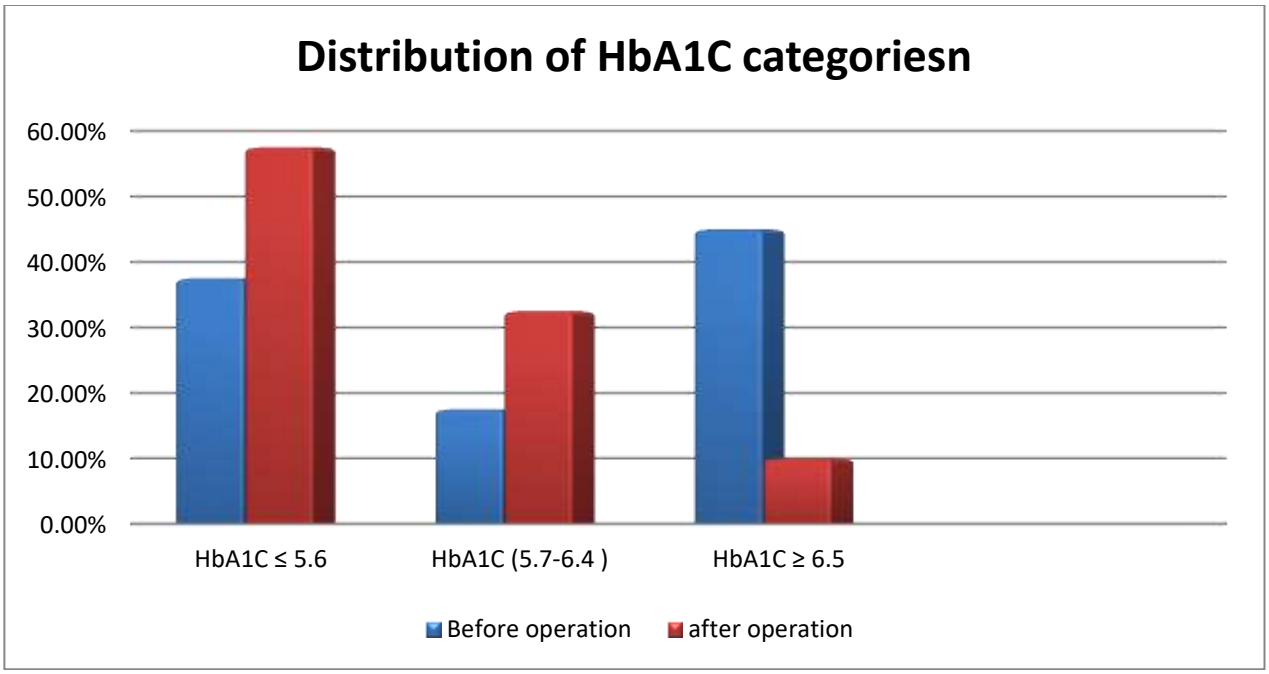


***Figure 6: shows Changes in distribution of HbA1C categories among the studied population before and after 3 months of the operation.***

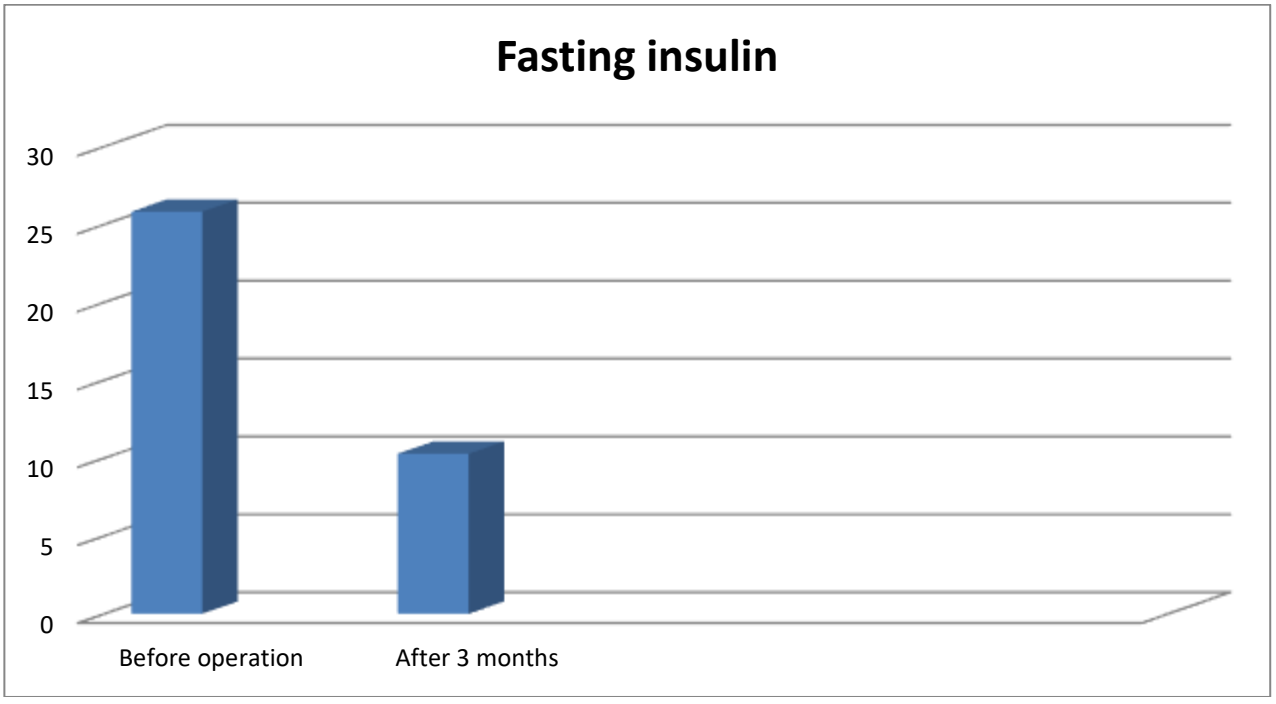


***Figure 7: fasting insulin level (mcu/ml) change from 25.81± 18.92 mcU/mL before to 10.27± 6.46 mcU/mL after 3 months of the operation (p< 0.001) .***

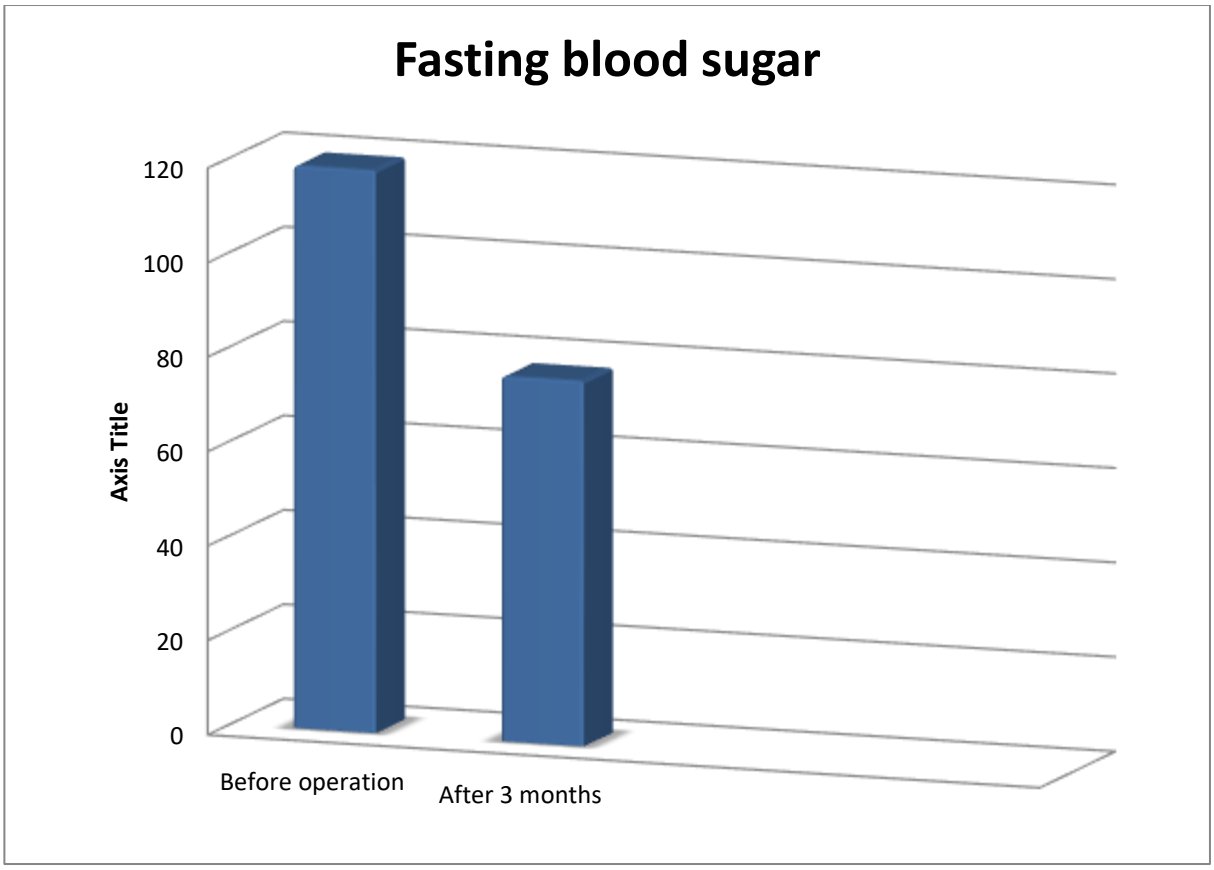


***Figure 8: fasting blood sugar level (mg/dl) changes from 119.28± 38.93 mg/dl before to 77.45±14.20 mg/dl after 3 months of the operation (p< 0.001).***

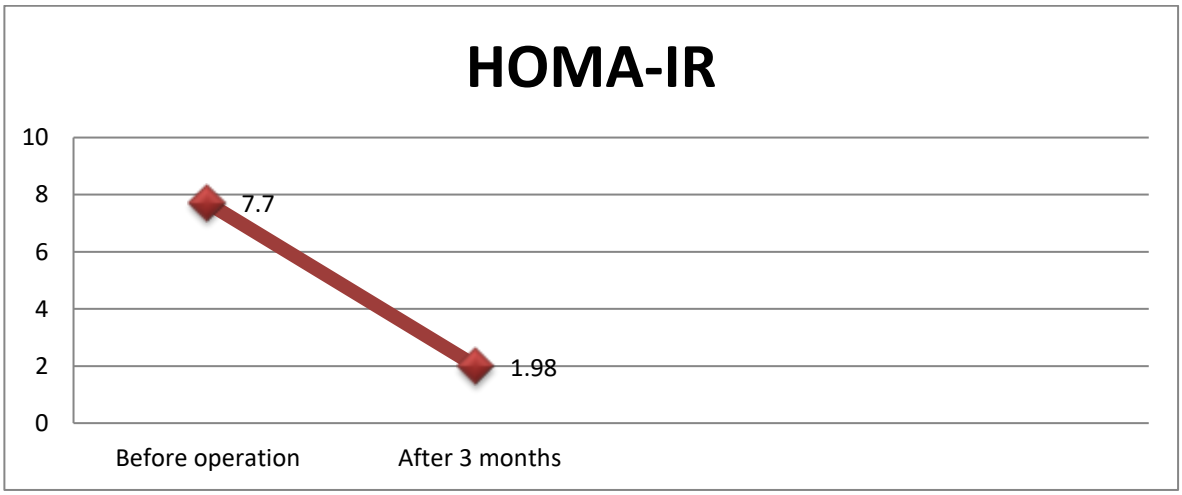


***Figure 9: shows improvement in HOMA-IR index after the 3 months of the operation (p< 0.001).***

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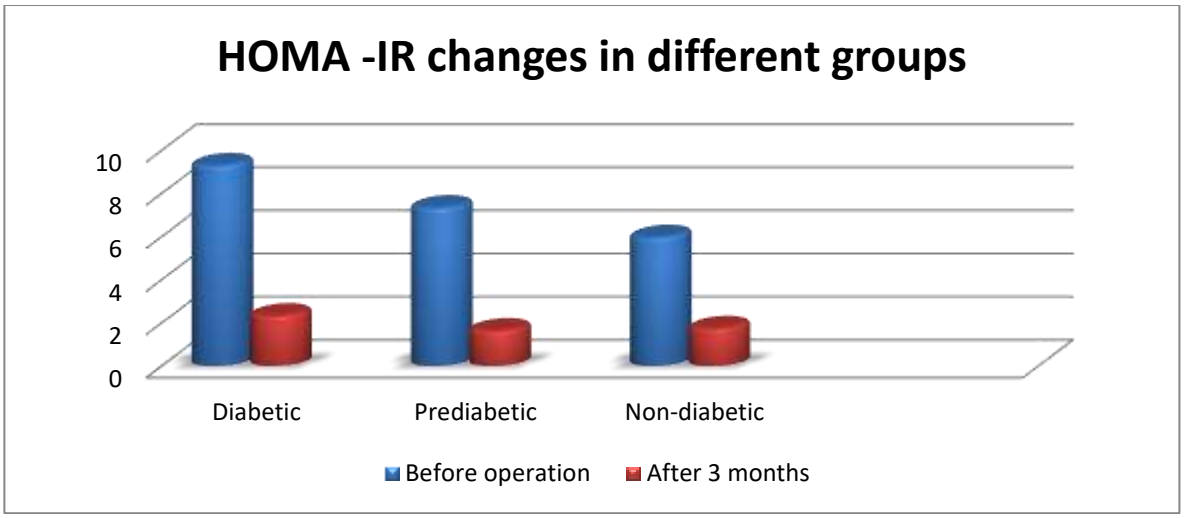


***Figure 10: shows changes in HOMA-IR index among; diabetic (p< 0.001), prediabetic (p = 0.008) and non-diabetic patients (p< 0.001) before and after 3 months of the operation.***

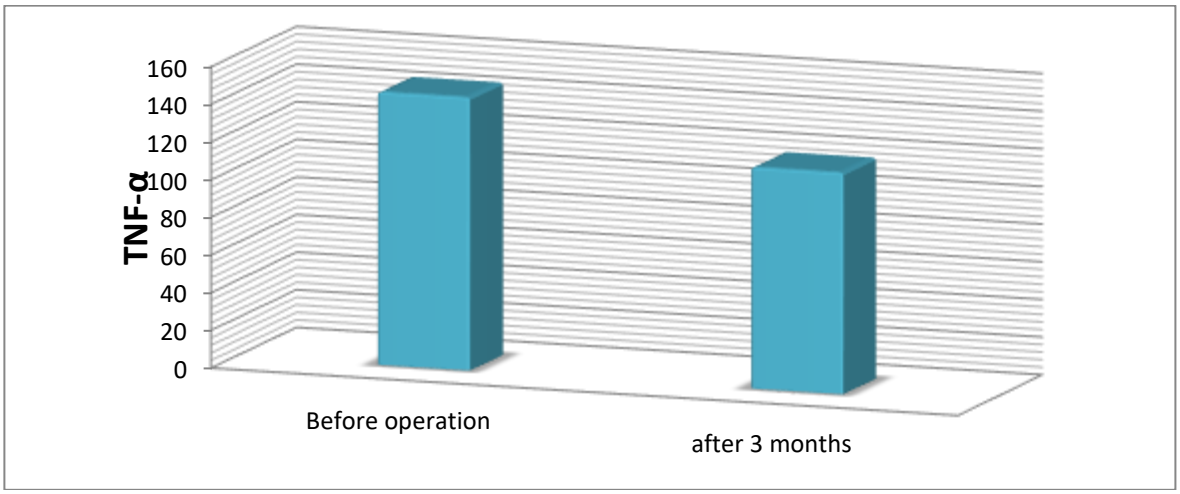


***Figure 11: shows improvement in TNF-α level (mcU/mL) from preoperative level of 145.32 ± 58.96 to 117.86 ± 27.43 postoperatively (p< 0.001).***

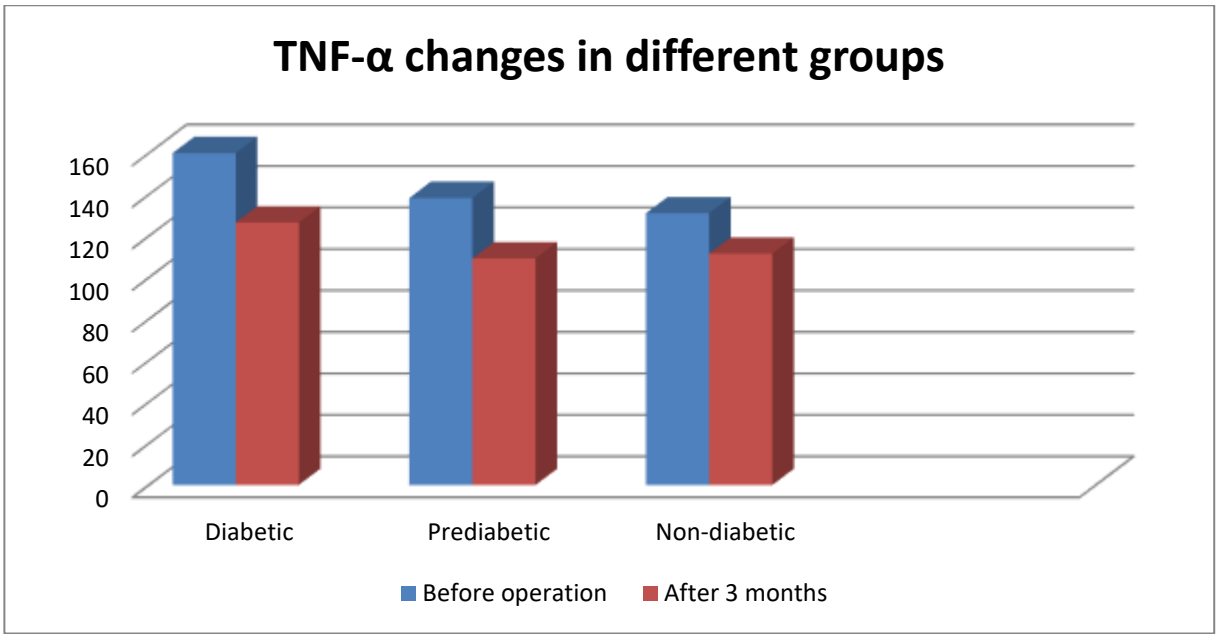


***Figure 12: shows changes in TNF-α level (mcU/mL) among ; diabetic (p=0.059) prediabetic (p=0.059) and non-diabetic patients (p< 0.001) before and after 3 months of the operation.***

## *4. Discussion*

Obesity and insulin resistance are two sides of the same coin, which are the main leading causes for T2DM. Bariatric surgery has shown to have a great effect in reducing these factors through maintaining weight loss, improving insulin sensitivity and more control or even remission of T2DM, which in turn results in less obesity and diabetic complications with better quality of life in these patients [6].

The aim of our study was to evaluate the impact of bariatric surgery on insulin resistance in obese patients attending Suez Canal university hospitals so helping in promotion of management of insulin resistance and type 2 diabetes mellitus.

Our study included 40 patients with age over 18 years, BMI ≥35 (kg/m2) who underwent bariatric surgery (38 patients had sleeve gastrectomy and only 2 patients had mini-gastric bypass) during the period from July 2021 to January 2023.

We found that there was statistically significant decrease in weight and BMI ($P < 0.0001$), significant improvement in the metabolic parameters of the patients ($P < 0.0001$) including (HbA1C, HOMA-IR, fasting insulin, fasting blood sugar), and a significant decrease ($P < 0.0001$) in the measured inflammatory marker (TNF- α) after 3 months of the surgery. That indicated reduction of insulin resistance, better control of T2DM and improvement in the inflammatory status of these patients.

In agreement with our results, the systematic review of **Ilyas et al.** [1] which included 42 articles with 5,411 patients, showed that bariatric surgery has a major effect on decreasing insulin resistance and remission of T2DM and this effect is even superior to that of lifestyle and medical intervention .

Our study revealed that after 3 months of the surgery, there was a mean weight loss of 25.5 kg which represent 18.85 % of the preoperative level , mean BMI also reduced by 9.59 kg/m2 (18,82%) and mean loss of excess BMI (EBMIL%) was 38.86 %, indicating a significant weight and BMI reduction postoperatively.

In agreement with our finding, the study done in Benha, Egypt revealed a significant decrease in BMI after LSG at 3 and 6 months postoperatively [7].

Another study in Egypt from Assuit, which assessed the effectiveness of LSG and MGB on weight reduction, reported that there was a significant reduction in weight and BMI after 3, 6 and 12 months of LSG and MGB with insignificant differences between both of them [8].

In addition, the study done by **AsHabi et al.** [9] reported a significant decrease in weight (15%) and BMI loss (6.2%) after 2 months of LSG. Another interesting study from Australia assessed the early changes of LSG, observed a significant reduction of weight and BMI after only 3 weeks of the surgery [10].

We founded that Mean HbA1C dropped from 6.48% before surgery to 5.55% after ($p<0.001$). Moreover, before surgery, there were 45% of the patients with HbA1C ≥ 6.5% but this percentage reduced to only 10% after surgery. These results confirmed the great role of bariatric surgery in overcoming T2DM in a period as short as 3 months.

This was consistent with the study from Qatar**, which** reported a reduction of HbA1c from 6.54 mg/dl to 5.79 mg/dl ($P < 0.05$) during the first 3 months after LSG in both diabetic and non-diabetic patients that was similar to our result [11].

In agreement with our study, in Saudi Arabia there was a retrospective study on patients underwent LSG revealed significant improvement of HbA1c level after 12 months of the surgery [12]. Another study from turkey was also consistent with our study; it reported that after MGB surgery HbA1c significantly decreased after 12 months of the surgery [13].

Our study resulted in, highly significant improvement (p-value <0.001) of our patients in both; mean fasting blood sugar which decreased from 119.28 mg/dl to 77.45 mg/dl and mean fasting insulin reduced from 25.81mcU/mL to 10.27mcU/mL after the surgery which indicated normalization of mean FBS and lower fasting insulin that concludes less insulin resistance after only 3 months of the surgery.

This was confirmed by the drop of the mean HOMA-IR index from 7.70 to 1.98 after surgery and this reduction was significant in all patients including diabetic ($P < 0.0001$), prediabetic ($P = 0.0008$) and non-diabetic ($P < 0.0001$) patients. This infers improvement of insulin sensitivity in prediabetic

and non-diabetic patients besides the diabetics, which supports the bariatric surgery as a prophylactic and therapeutic method for T2DM.

In consistent with our results, the study conducted by **Van Vilet et al. [14]** they revealed statistically significant reduction in fasting insulin level and HOMA-IR after 3 months of the surgery, Also the study of **Ozmena et al. [13]** reported that after MGB surgery HOMA-IR was significantly decreased after 12 months of the surgery ($p < 0.05$).

Also the study of **Haran et. al. [10]** observed significant early changes in insulin resistance in 32 patients who underwent LSG and revealed that mean HOMA-IR had significant decrease on day 1 postoperatively and had more decrease after 3 weeks of the surgery, while significant weight changes only observed after 3 weeks.

In the present study, we found that TNF-α level decreased significantly after 3 months of the surgery as its mean level was 117.86 postoperatively compared to the preoperative mean level 145.32 which was statistically highly significant ( $P < .0001$), but when we compared its level change among diabetic, prediabetic and non-diabetic patients, it was only significant in the non-diabetic group.

The study of **Van Vilet et al. [14]** agreed with our results regarding reduction of TNF-α after bariatric surgery, but disagreed with our study regarding the duration needed for reaching a significant reduction. their study included 32 patients who underwent bariatric surgery (LSG or RYGB) TNF-α level was measured before and after 3 and 6 months of the surgery, they reported that the reduction detected in TNF-α level after 3 months wasn't statistically significant but it was significant when reassessed after 6 months of the surgery.

## 5. Conclusion

Bariatric surgery representing an effective option for obese patients for marked weight loss with significant improvement in insulin sensitivity either in diabetic, prediabetic and non-diabetic patients which helps in eliminating the predisposing factors of prediabetic and non-diabetic patients for developing diabetes and management of T2DM and prevention of its complications in the diabetic patients.

## 6. Recommendations

- We recommend improvement of patient's awareness and their relatives regarding benefits of bariatric surgery through organization of health education programs explaining the surgical procedure, benefits, expected complications and follow up period after surgery.
- Further studies needed to support the role of bariatric surgery on reducing the chronic inflammatory status in obese patients and so preventing the cardiovascular complications of obesity and T2DM.
- Raising the awareness of health care providers regarding, consideration of bariatric surgery as a management option for obesity, insulin resistance and T2DM in patients meeting the guidelines criteria.

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