

Public Awareness About the Advantages of Bariatric Surgery for Patients with Type 2 Diabetes in the Northern Border Region of Saudi Arabia: A Cross-Sectional Study

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Abstract Background: Obesity is a major risk factor for Type-2 Diabetes Mellitus (T2DM). Bariatric surgery effectively promotes weight loss and improves related comorbidities. **Objectives:** This study aims to assess public awareness of the advantages of bariatric surgery for patients with T2DM in the Northern border region of Saudi Arabia. **Methods:** This cross-sectional study was conducted between December 2023 and February 2024. Data were collected using a self-administered electronic questionnaire distributed via Google Forms, which assessed sociodemographic characteristics, obesity stage-related behaviors, awareness and perceived outcomes of bariatric surgery among patients with T2DM. The Mann-Whitney test, the Chi-squared test and the Fisher's exact test were used for data analysis, as appropriate. A p-value of <0.05 was considered statistically significant. **Results:** A total of 486 adults (>18 years) were included. Most participants (76.75%) had been exposed to obesity- and diabetes-related awareness messages. A higher proportion of participants with T2DM believed that obesity does not affect insulin sensitivity compared with non-diabetics (13.79% vs. 4.44%; $p = 0.02$). More than half were unaware of the eligibility criteria for bariatric surgery. Among participants with T2DM, mineral deficiency (60.34%) and gastric leakage (46.55%) were the most reported complications. Only 23 participants had undergone bariatric surgery, of whom three out of four diabetic subjects achieved normal blood glucose levels postoperatively. **Conclusion:** Despite widespread exposure to obesity and diabetes awareness messages, persistent misconceptions about obesity, insulin resistance and bariatric surgery highlight the need for targeted education to improve understanding and support better diabetes outcomes.

Key Words Obesity, Type-2 Diabetes Mellitus, Diabetic Patient, Arar, Awareness

INTRODUCTION

Obesity is an abnormal accumulation of fat that poses a high health risk. A well-known scale used to assess whether a person is obese or overweight is the body mass index or BMI scale. According to the World Health Organization (WHO), more than 1 billion people worldwide are obese including 33.7% of the population in Saudi Arabia [1]. Obesity is associated with a higher risk of comorbidities such as type 2 diabetes mellitus, hypertension, gallbladder disease, cardiovascular disease, dyslipidemia and obstructive sleep apnea [2].

Type 2 Diabetes Mellitus (T2DM) is a growing worldwide health concern, strongly associated with the

increasing rates of obesity. People with T2DM face a significant risk of developing microvascular complications, such as retinopathy, nephropathy and neuropathy, as well as macrovascular issues, including cardiovascular diseases. These risks are primarily due to elevated blood sugar levels and various elements of the insulin resistance (metabolic) syndrome [3].

Bariatric surgery results in significant and long-lasting weight loss. Approximately 30% of individuals who undergo this surgery have type 2 diabetes with a large percentage achieving remission following the procedure. For those undergoing bypass procedures, diabetes resolution occurs in 84% to 98% of cases, whereas for restrictive procedures, the

resolution rates range from 48-68% [4]. Recent studies have demonstrated that weight loss surgery can lead to a significant improvement in weight management, blood sugar control and the resolution of type 2 diabetes, as well as a reduction in cardiovascular complications and mortality rates [5].

Bariatric surgery is primarily indicated for patients with severe obesity, especially when it contributes to various health complications, including cardiovascular disease (CVD). It is considered when obesity significantly impacts health and when patients cannot achieve sustained weight loss through nonsurgical methods. This procedure aims to facilitate weight loss, which can help reverse or improve obesity-related health conditions [2].

Bariatric surgery is associated with immediate and long-term complications. Early complications include bleeding is the most common immediate, anastomotic leaks from surgical connection. Pulmonary embolism and deep venous thrombosis, respiratory complications, nausea and vomiting and dehydration. Late complications include nutritional deficiencies, anemia, dumping syndrome, gallstones, bowel obstruction, strictures or ulcers, weight regain, hypoglycemia and psychological disorders such as depression and eating disorders. The risk and type of complications vary depending on the surgical procedure (e.g., sleeve gastrectomy, gastric bypass, adjustable gastric banding) and patient factors such as comorbidities and adherence to follow-up care [6].

Around 27,000 bariatric surgeries are performed each year in Saudi Arabia [7]. Although bariatric surgery is becoming increasingly popular in Saudi Arabia, misconceptions and concerns about its eligibility criteria, safety, benefits, social stigma and financial barriers persist [8]. This study aims to evaluate the awareness and knowledge of the benefits of bariatric surgery for diabetes patients in the Northern Borders region of Saudi Arabia. It seeks to address the existing gap in understanding the advantages of this procedure. The primary goal is to assess how well the benefits and impacts of this surgery on diabetes management are understood in the region.

Aim of the Study

To evaluate the level of awareness regarding the benefits of bariatric surgery for patients with T2DM.

Study Objectives

The specific objectives are:

- To compare the level of awareness of the benefits of bariatric surgery for diabetic patients in the Northern Border region between diabetic and non-diabetic participants
- To assess awareness about potential indications for bariatric surgery
- To explore obesity-related complications experienced by patients

METHODS

Study Design, Setting and Participants

This cross-sectional study was conducted between December 2023 and February 2024 in the Northern Border Region of Saudi Arabia.

The study's inclusion criteria were adults aged 18-65 years residing in the Northern Border Region. The exclusion criteria involved people younger than 18 or older than 65 years and those who submitted incomplete questionnaires (>50% missing items).

Sample Size

The minimal sample size was calculated using the following equation:

$$\text{Sample size} = \frac{Z_{1-\alpha/2}^2 P(1-P)}{d^2}$$

where, $Z_{1-\alpha/2}$ is the standard normal variate at 5% type 1 error ($p < 0.05$); it is 1.96. P the expected proportion and d the absolute error (0.05).

Since no previous studies had been conducted in the Northern border region, the expected proportion of outcome will be considered 50% to maximize the sample size. Accounting for a 10% non-response rate, the calculated sample size was 422 ($384 + (384 \times 10\%)$).

Data Collection Tools

A self-administered questionnaire was adopted, with permission, from a recent study conducted in the Makkah region [9]. The questionnaire was distributed electronically via Google Forms and all collected data were kept secure and confidential. The survey included sections on sociodemographic characteristics, awareness of bariatric surgery and obesity in relation to diabetes mellitus, knowledge of potential complications of bariatric surgery and perceived outcomes of bariatric surgery in patients with T2DM.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. Approval of the study was obtained from the local bioethical committee of Northern Border University (No. 7/24/H).

Before accessing the electronic questionnaire, participants were provided with information about the study's purpose, procedures and potential benefits. They were informed participation was voluntary and they could discontinue the questionnaire at any time without penalty. No personally identifiable information was collected and all responses were kept confidential. Proceeding to complete and submit the electronic questionnaire was considered as providing informed consent.

Statistical Analysis

Collected data were summarized in terms of Mean \pm Standard Deviation (SD) and range for quantitative data and the

frequency and percentage for qualitative data. The Shapiro-Wilk W test was used to examine the distribution of numerical data. The Mann-Whitney test (Z), Chi-squared test (X²) and the Fisher Exact test (FET) were used for comparisons between the different study groups, as appropriate. Two-tailed p<0.05 was considered statistically significant. The collected data were entered, described and analyzed using the computerized statistical package STATA/SE version 11.2 for Windows (STATA Corporation, College Station, Texas) and MS Excel.

RESULTS

A total of 486 adults (>18 years old) participated in the study. Of these 58 (11.93%) had type-2 diabetes mellitus (T2DM) for an average duration of 8.12 (±7.32) years and 86.21% of them reported adherence to diabetes medications. Table 1 shows differences in sociodemographic characteristics between subjects with T2DM and those without. As expected, diabetic subjects were significantly older (p<0.001), more likely to have had a family history of diabetes in the first-degree relatives (p<0.001) and had a higher BMI than non-diabetics (p = 0.002).

Table 2 shows that the majority of participants (76.75%) have seen some messages raising awareness about obesity and diabetes. About 13.79% of subjects with T2DM thought that obesity did not affect the level of insulin sensitivity compared

to 4.44% of non-diabetics (p = 0.02). More than half of the participants did not know what was necessary for a person to undergo bariatric surgery and had heard about the complications of bariatric surgery. The majority of participants believed that obesity was an incurable disease. Even more diabetics did not agree that losing excess weight helps control diabetes and reduce its complications (p = 0.01).

Figure 1 shows that the most frequently reported reasons for bariatric surgery among subjects with T2DM were a BMI>35 with the presence of a chronic disease (25.86%), a BMI>40 (22.41%) and beauty purposes (20.69%). As for non-diabetic subjects, the most common reasons were a BMI>40 and a BMI>35 with the presence of a chronic disease (28.27% and 27.1%, respectively). There were no significant differences in the reasons for bariatric surgery between diabetic and non-diabetic individuals (p = 0.38).

Figure 2 shows complications of bariatric surgery reported by subjects with T2DM and those without. Among those with T2DM, the most frequently reported complications were a lack of minerals and stomach leakage (60.34% and 46.55%, respectively). In non-diabetics, anemia and lack of minerals were the most commonly reported complications (47.43% and 45.79%, respectively). The proportion of subjects with T2DM who reported a lack of body minerals was significantly higher than the non-diabetics (χ² = 4.34; p = 0.04).

Table 1: Sociodemographic Characteristics of the Studied Subjects with Diabetes Type 2 and Those Without in Arar, Saudi Arabia

Variable		No T2DM type 2 (n. = 428; 88.07%)		T2DM (n. = 58; 11.93%)		Total (n. = 486)		Test	p-value
		n.	%	n.	%	n.	%		
Gender	Female	338	78.97	40	68.97	378	77.78	χ ² = 2.96	0.08
	Male	90	21.03	18	31.03	108	22.22		
Age (year)	Mean±SD	31.05±10.99		45.95±11.46		32.83±12.05		Z = 7.87	<0.001
	Range	18-62		22-65		18-65			
	<20	48	11.21	0	0.00	48	9.88	χ ² = 79.47.47	<0.001
	20 to <30	191	44.63	6	10.34	197	40.53		
	30 to <40	59	13.79	8	13.79	67	13.79		
	40 to <50	103	24.07	21	36.21	124	25.51		
50-65	27	6.31	23	39.66	50	10.29			
Nationality	Saudi	424	99.07	57	98.28	481	98.97	FET	0.47
	Non-Saudi	4	0.93	1	1.72	5	1.03		
Educational level	A university degree	298	69.63	38	65.52	336	69.14	FET	0.12
	High school/ diploma	121	28.27	16	27.59	137	28.19		
	No educational certificate	9	2.10	4	6.90	13	2.67		
Family history of diabetes	First degree relatives	185	43.22	40	68.97	225	46.30	χ ² = 17.16	<0.001
	Second degree relatives	92	21.50	12	20.69	104	21.40		
	Nothing	151	35.28	6	10.34	157	32.30		
Family history of or a family member who is overweight/obese	Yes	228	53.27	36	62.07	264	54.32	χ ² = 1.59	0.21
	No	200	46.73	22	37.93	222	45.68		
Family history or family member who had a bariatric surgery	Yes	162	37.85	25	43.10	187	38.48	χ ² = 0.59	0.44
	No	266	62.15	33	56.90	299	61.52		
BMI (kg/m ²)	Mean±SD	26.34±6.14		28.46±5.06		26.59±6.06		Z = 3.02	0.002
	Range	12.89-69.53		18.36-42.97		12.89-69.53			
	<18.5	29	6.78	1	1.72	30	6.17	FET	0.06
	18.5-24.99	163	38.08	14	24.14	177	36.42		
	25-29.99	132	30.84	22	37.93	154	31.69		
	30-34.99	74	17.29	14	24.14	88	18.11		
≥35	30	7.01	7	12.07	37	7.61			
Ever had a bariatric surgery	Yes	19	4.44	4	6.90	23	4.73	FET	0.34
	No	409	95.56	54	93.10	463	95.27		

χ²: The Chi-square test, FET: Fisher Exact test, Z: The Mann-Whitney test, Statistical significance was considered at p<0.05

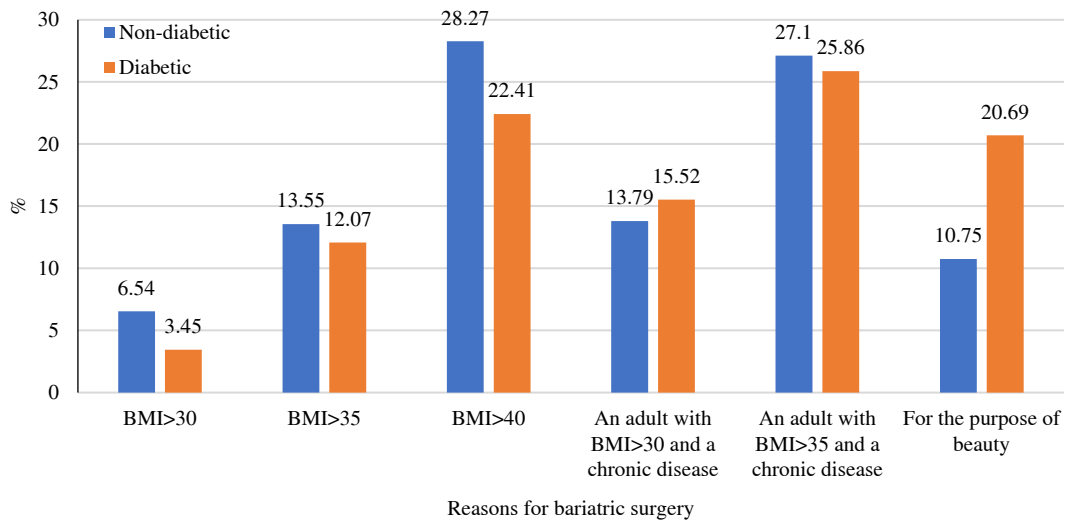


Figure 1: Comparisons of Reported Reasons for Bariatric Surgery Among the Studied Diabetic and Non-Diabetic Adults in Arar, Saudi Arabia

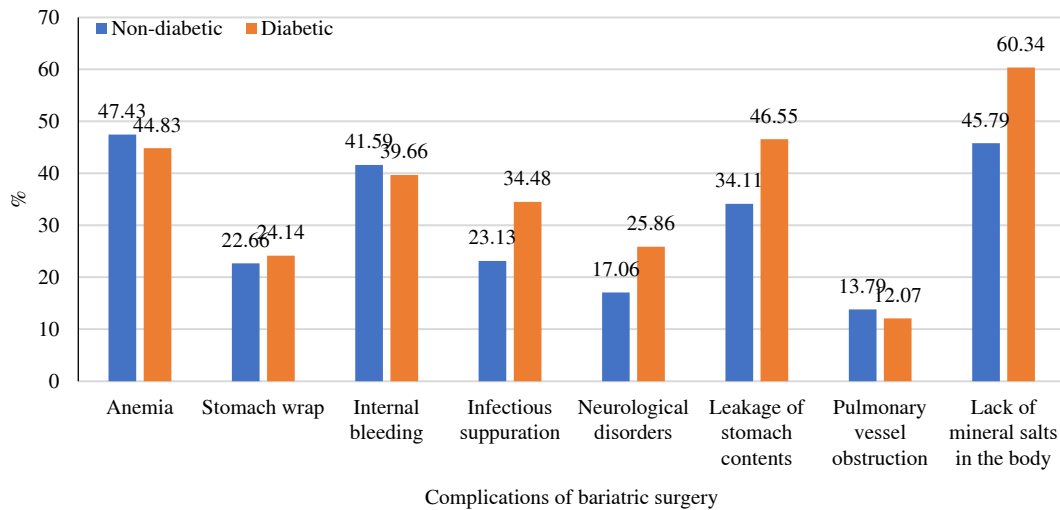


Figure 2: Comparisons of Bariatric Surgery Complications Reported by the Studied Diabetic and Non-Diabetic Adults in Arar, Saudi Arabia

Table 2: Awareness About Bariatric Surgery and Obesity Among Diabetic and Non-Diabetic Adults in Arar, Saudi Arabia

Variable		No T2DM (n. = 428; 88.07%)		T2DM (n. = 58; 11.93%)		Total (n. = 486)		Test	p-value
		n.	%	n.	%	n.	%		
Have you ever seen awareness messages about obesity and diabetes via email, SMS or social media?	Yes	328	76.64	45	77.59	373	76.75	$\chi^2 = 0.02$	0.87
	No	100	23.36	13	22.41	113	23.25		
Does obesity affect the level of insulin sensitivity?	Yes	279	65.19	35	60.34	314	64.61	FET	0.02
	No	19	4.44	8	13.79	27	5.56		
	I do not know	130	30.37	15	25.86	145	29.84		
Do you know what is necessary for a person to perform bariatric surgery?	Yes	204	47.66	24	41.38	228	46.91	$\chi^2 = 0.81$	0.37
	No	224	52.34	34	58.62	258	53.09		
Have you heard about the complications of bariatric surgery?	Yes	295	68.93	34	58.62	329	67.70	$\chi^2 = 2.48$	0.11
	No	133	31.07	24	41.38	157	32.30		
Obesity is an incurable disease	Yes	376	87.85	46	79.31	422	86.83	FET	0.08
	No	14	3.27	5	8.62	19	3.91		
	I do not know	38	8.88	7	12.07	45	9.26		
Reducing excess weight helps control diabetes and limits its complications	Yes	359	83.88	48	82.76	407	83.74	FET	0.01
	No	11	2.57	6	10.34	17	3.50		
	I do not know	58	13.55	4	6.90	62	12.76		

χ^2 : The Chi-square test, FET: Fisher Exact test, Statistical significance was considered at $p < 0.05$

Only 23 participants reported undergoing bariatric surgery, with four of them having T2DM and 19 being non-diabetic. Among the diabetic subjects, three had achieved normal blood glucose levels after the surgery, while two reported a reflux and one reported joint roughness. Among non-diabetics, eight reported reflux, four reported high blood pressure, two reported joint roughness, one reported high blood glucose and one reported sleep apnea after the bariatric surgery.

DISCUSSION

Obesity is a chronic disorder; a person is said to be obese when their BMI is equal to or greater than 30 kg/m². There are several treatment options available, one of the most effective treatments is Bariatric surgery. Bariatric surgery is a successful therapeutic option for long-term weight loss and the resolution of medical comorbidities associated with obesity, particularly type 2 diabetes [10].

This study aimed to assess the awareness and knowledge of the advantages of bariatric surgery and its effects on diabetic patients in the Northern border region of Saudi Arabia. A total of 486 adults were included in the study, with 77.78% being female and 22.22% male. The findings showed that 11.93% of the participants had type-2 diabetes and the majority of 86.21% reported adherence to diabetes medications. The prevalence of T2DM in our study is comparable to a recent national study in Saudi Arabia of 12% [11]. However, it is lower than the estimate from a systematic review, which reported a pooled prevalence of T2DM in Saudi Arabia of 16.4% (95% CI: 11.6-17.5). The high prevalence of T2DM in the Saudi population underscores a significant public health burden [12].

The overall prevalence of obesity (BMI \geq 30 kg/m²) in the present study was 25.72%. Althumiri *et al.* [13] reported obesity levels across the 13 administrative regions of Saudi Arabia ranging from 14.3-29.4%. In agreement with these findings, a study conducted among Saudi individuals covered by private health insurance reported an obesity prevalence of 19.8% [11]. However, a higher prevalence of obesity (58.3%) in the Northern Border region was recorded by Alanazi *et al.* [14]. The prevalence observed in the current study falls within the nationally reported range and remains higher than many global estimates. This elevated burden of obesity in Saudi Arabia has been attributed to rapid lifestyle transitions, including reduced physical activity and a shift toward Westernized dietary patterns rich in fats and refined sugars. These findings highlight the urgent need for targeted public health interventions aimed at promoting healthy dietary habits and effective weight management strategies [15].

As expected, the diabetic patients were notably older, more likely to have a family history of diabetes in first-degree relatives and had a higher BMI than non-diabetics, these findings are similar to a study conducted in India in 2017 [16]. Also, Socioeconomic and biodemographic characteristics, including obesity, a positive family history of diabetes, marital status, higher socioeconomic status and

a lower level of education, were found to be substantially linked to an increased risk of diabetes in the older adult population in West Bengal. Because excess body fat, particularly around the abdomen, induces insulin resistance, hinders glucose metabolism and upsets the hormone balance that controls blood sugar, obesity raises the risk of developing diabetes [17].

Results from a community-based survey that investigated the prevalence and risk factors for type 2 diabetes and pre-diabetes in adult Egyptians who had not yet received a diagnosis, revealed that, Age, physical inactivity and an increased waist circumference were all found to be significant predictors for type 2 diabetes [18].

Although 76.75% of the study participants had seen messages raising awareness about obesity and diabetes, a significant number of participants held the belief that obesity was an incurable disease. Additionally, a higher proportion of the diabetic participants disagreed that losing excess weight could help control diabetes and reduce its complications. Furthermore, 13.79% of patients with T2DM thought that obesity did not affect insulin sensitivity compared to 4.44% of non-diabetics. Meanwhile, a study conducted in Malaysia reported that adopting physical activity and making dietary modifications were essential in managing BMI, waist circumference and body lipids, ultimately leading to an enhanced glycemic control [19].

This study shows that the most compelling reasons for patients with T2DM to consider bariatric surgery were a BMI>35 with the presence of a chronic disease (25.86%), a BMI>40 (22.41%) and beauty purposes (20.69%). As for non-diabetic subjects, the most common reasons were a BMI>40 and a BMI>35 with the presence of a chronic disease (28.27% and 27.1%, respectively). A similar study reported that some of the most common reasons for undergoing bariatric surgery included a desire to improve medical conditions and to make daily life easier [20].

More than half of the participants were aware of the potential complications of bariatric surgery. Similarly, a study conducted in Saudi Arabia in 2024 reported that 81% of individuals were aware of the complications associated with sleeve gastrectomy [21]. This relatively high level of awareness regarding surgical risks may partly explain the low uptake of bariatric surgery among the study participants and their family members.

The cross-sectional design of this study provided a comprehensive snapshot of the current level of awareness and perceptions regarding obesity, diabetes and bariatric surgery. However, several limitations should be considered when interpreting the findings. The cross-sectional nature precludes the establishment of causal relationships and may be subject to inherent biases. Data collection through online Google Forms may have introduced selection bias, as individuals with limited access to or familiarity with digital technology could have been underrepresented. Moreover, diabetes status was self-reported rather than clinically verified, which may have led to misclassification due to recall bias or social desirability bias. The relatively small

number of participants with T2DM, along with the low prevalence of bariatric surgery among respondents, further limits the statistical power and generalizability of subgroup comparisons. Future large-scale studies with clinically confirmed diagnoses are recommended to validate and expand upon these findings.

CONCLUSIONS

In conclusion, a large proportion of participants reported exposure to awareness messages about obesity and diabetes. However, important gaps in knowledge and misconceptions persist both among diabetic and non-diabetic individuals. More than one-third of participants did not recognize the impact of obesity on insulin sensitivity. Fewer than half were aware of the proper indications for bariatric surgery and a considerable proportion incorrectly believed that it is performed for cosmetic purposes. Although approximately two-thirds of participants were aware of potential complications of bariatric surgery, misconceptions regarding obesity itself were evident, as most participants perceived it as an incurable disease. Nevertheless, the majority acknowledged that weight reduction plays a significant role in controlling diabetes and limiting its complications. These findings highlight the need for targeted educational interventions to address misconceptions and improve understanding of obesity and bariatric surgery as a treatment option that could contribute to better obesity management and improved health outcomes for those with type 2 diabetes.

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