

The Attitude of type 2 Diabetic Patients Toward Intensive Weight Management and Bariatric Surgery

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Abstract

Background: Currently, bariatric surgery is considered the most effective treatment to produce both sizable and durable weight losses and as another line of treatment for type 2 diabetes. These weight losses typically are associated with significant remission of type 2 diabetes

Objectives: To assess attitude of type 2 diabetes patients with a BMI of 30-40 kg/m² regarding bariatric surgery and address the knowledge gap in this regards among them.

Methods: A cross sectional study was conducted among a representative sample of adult type 2 diabetic patients whose body mass index ≥ 30 kg/m² recruited from chronic diseases clinics, primary healthcare centers in Prince Sultan Military Medical City, Riyadh, Kingdom of Saudi Arabia. Data were collected using an Arabic questionnaire consists of three main sections; patients demographic and clinical data, awareness of and attitude towards weight reduction programs and awareness of and attitude towards bariatric surgery.

Results: The study included 336 type 2 diabetic patients out of targeted 400 with a response rate of 84%. The age of almost one third of them (32.7%) ranged between 31 and 45 years whereas that of 22% was 60 years or more. Females represented 51.2% of them. More than one-third (39.3%) of the participants have heard about weight reduction programs; particularly keto diet (28.8%) and almost half of them (48.2%) were willing to follow a weight reduction program; particularly none-specific one (66.7%) and keto diet (18.5%). More than one-third of the patients (38.6%) were unaware whereas 18.5% were highly aware of bariatric surgery used for treatment of obesity and diabetes and history of undertaking bariatric surgery was reported by 28.6% of them. More than half of the participants agreed that bariatric surgery will change their nutritional habits (57.1%), affect their blood sugar level (55.4%) and change their life style (54.2%) whereas 44% of them believed that they will achieve their ideal weight one year after bariatric surgery.

Conclusion: Most of type 2 diabetic patients were unaware of intensive weight reduction programs and bariatric surgery. Their attitude towards these tools to control of both obesity and diabetes problem was inconsistent; positive in some aspects and negative in others.

Keywords: Bariatric Surgery; Ket Diet; Type 2 Diabetes; Attitude; Saudi Arabia

Introduction

Background

Currently, the world is facing an epidemic of obesity and type 2 diabetes mellitus, and Saudi Arabia is not an exception of that [1]. Worldwide, the prevalence of overweight and obesity has increased dramatically over the past 3 decades [2]. Saudi Arabia is currently among the nations with the highest obesity and overweight prevalence rates [3].

Alqarni in his study about review of prevalence of obesity in Saudi Arabia, published in 2016, revealed that the obesity rate is significantly high in Saudi Arabia among genders, different age groups, different regions and occupations, with an overall obesity prevalence of 52.9% in 2017, being higher among females compared to males at 67% and 38.2%; respectively [4].

Overweight and obesity are accompanied by increased rates of non-communicable diseases (NCDs) related to overweight, such as type 2 diabetes mellitus, hypertension, and cardiovascular diseases [5].

Diabetes being one of the most prevalent chronic diseases in the Gulf Cooperation Council (GCC) is the rapid economic development which has led to major lifestyle modifications manifested by the tendency to a westernized diet, less physical activity, and obesity. Data from a recent global review published in nature for selected countries, showed that the rapid economic development in GCC countries has led to soaring rate of diabetes, from around 6% in 1990 to over 20% in parts of middle eastern countries today [6]. Additionally, AlRubeaan, *et al.* found that the prevalence of diabetes among Saudis aged ≥ 30 years was 25.4% with 40.3% being unaware of their disease [7].

It is clear that the livelihood and health of many of the Saudi population are affected by obesity and type 2 diabetes. It is well known that diabetes is a chronic, progressive, and debilitating disease, which may unfortunately lead to end organ failure or dysfunction, despite its treatment with oral hypoglycaemic agents, insulin or even an intensified combination [8].

Diabetes control and its complication prevention is associated with maintaining normal level of plasma glucose. Normal glucose level is achieved by pharmacological approaches like anti-diabetic drugs as well as non pharmacological management such as diabetic diet and exercise. Despite the fact that diet and exercise play a vital role in maintaining normal blood glucose level and prevention of complications in diabetic patients, previous studies reported that diabetic patients have a negative attitude towards them [9-10]. On the other hand, Okonta HI, *et al.* reported in their study titled

Knowledge, attitude and practice regarding lifestyle modification in type 2 diabetic patient" that the majority of participants either had a strongly positive or a positive attitude toward lifestyle modifications [11]. This positive attitude was also reflected in other previous studies [12,13].

Currently, bariatric surgery is considered the most effective treatment to produce both sizable and durable weight losses (typically > 15% of initial body weight), and as another line of treatment for type 2 diabetes. These weight losses typically are associated with significant remission of type 2 diabetes [14].

The Roux-en-Y Gastric Bypass (RYGB) and Laparoscopic Adjustable Gastric Banding (LAGB) procedures induce type 2 diabetes remission rates of up to 80% and 57%, respectively [15,16]. Despite these highly impressive outcomes, previous studies reported that in any given year, as few as 0.6% of patients who meet current bariatric surgery criteria undergo a bariatric surgical procedure [17,18]. Such disparity between those who would benefit from bariatric surgery and those who actually undergo these surgeries could be explained by many reasons including lack of knowledge about the surgeries and varied insurance coverage [19-21].

The guidelines of the National Institute for Health and Care Excellence (NICE) for bariatric surgery in the United Kingdom for patients who have tried all appropriate non-surgical measures but are unable to achieve clinically beneficial weight loss. These patients include those with body mass index (BMI) > than 40 kg/m² (for Asians 37.5 kg/m²); or BMI of 35 - 40 kg/m² (32.5 to 37.5 kg/m² in Asians) together with significant disease that could be improved. There should also be expedited assessment for bariatric surgery to those with BMI > 35 kg/m² (32.5 kg/m² in Asians) with newly diagnosed type 2 diabetes. Those for consideration of surgery are patients with BMI of 30 - 34.9 kg/m² with newly diagnosed type 2 diabetes (27.5 to 32.5 kg/m² in Asians). Additionally, the National Institute of Health recommendations for bariatric surgery have not typically included those with a BMI of 30- 34.9 kg/m², however, recent research highlight the importance of studying the beliefs of patients with type 2 diabetes and a BMI of 30-40 kg/m² [22].

Rational

Currently, data is scarce and little is known about the attitude of type 2 diabetes patients with a BMI of 30-40 kg/m² regarding bariatric surgery.

General objective

To assess attitude of type 2 diabetes patients with a BMI of 30-40 kg/m² regarding bariatric surgery and address the knowledge gap in this regard among them.

Specific objectives

- To explore the attitude of type 2 diabetic patients towards intensive weight management.
- To assess the attitude of type 2 diabetic patients towards bariatric surgery.
- To determine the difference between male and female type 2 diabetic patients regarding their attitudes towards extensive weight management and bariatric surgery.

Literature Review

There is one cross sectional study published recently from Saudi Arabia titled "Assessment of Knowledge and Attitude and Practice of Safety, Effectiveness and Consequences of Bariatric Surgery Among Community In Saudi Arabia", that aimed to evaluate the knowledge and beliefs about the safety and effectiveness of bariatric surgery among adult Saudi population. For data collection, the authors used a questionnaire that was distributed among 790 adult Saudi population during the period from January 2017- June 2017. The questionnaire was based on 4 aspects including subject's demographics, anthropometric measures, knowledge about obesity and its causes and beliefs about.

Bariatric surgery. The results showed that there was a good knowledge about obesity but low favorable beliefs about bariatric surgery since 55.7% of subjects have non-favorable beliefs about Bariatric surgery. Such favorable beliefs about bariatric surgery were significantly associated with female gender and those with high BMI. The authors of this study concluded that: knowledge about obesity and its preventive measures was high but the favorable perceptions about bariatric surgeries were low. These results indicated that efficient educational programs about obesity and bariatric surgeries are needed [23].

In a study that investigated the attitudes of subjects with type 2 diabetes and a BMI of 30-40 kg/m² concerning bariatric surgery for the treatment of type 2 diabetes, in which Patients were identified from the Pennsylvania Integrated Clinical and Administrative Research Database (PICARD) and were surveyed about perceptions of the safety and efficacy of bariatric surgery as a treatment for obesity and type 2 diabetes, and their willingness to be randomized to a surgical procedure. In the results, 130 of 513 (25.3%) individuals responded. Respondents had a median age of 58.0 years and self-reported BMI of 32.9 kg/m². Roughly half were female. Overall, only 20.3% of respondents had positive views of bariatric surgery, with few reporting that it is a safe (14.3%) and effective (28.5%) treatment for type 2 diabetes. < 20% of respondents were willing to be randomized to a surgical procedure for the treatment of diabetes (16.1%) or obesity (17.5%). The authors of this study concluded that few obese type 2 diabetes who responded to the survey had positive views about bariatric surgery. Patients' concerns about

safety and efficacy must be addressed to improve the acceptability of bariatric surgery as well as the feasibility of randomized controlled trials of bariatric surgery for these individuals [24].

Another study about the attitudes and concerns of diabetic patients towards bariatric surgery as treatment of diabetes was done. The aim of this study was to examine the perceptions and concerns of diabetic patients towards bariatric surgery as a treatment option for diabetes. A total of 150 patients were recruited from a specialized diabetic outpatient clinic and completed a questionnaire. Results: The 74 males and 76 females had mean age of 50 (range 20 to 78) and body mass index (BMI) of 29.6 kg/m² (range 18.1 to 51); 61% considered surgery favourably. Predictive factors for interest in surgery: higher educational levels (odds ratio "OR" = 2.3; 95% confidence interval "CI", 1.2 to 4.4), duration of diabetes (OR = 0.4; 95% CI, 0.2 to 1.0) and use of insulin (OR = 2.1; 95% CI, 1.1 to 4.1). Reasons for surgery were desire for remission (Likert scale 4.7 ± 0.7), to prevent complications (Likert scale 4.5 ± 0.9) and to reduce medications (Likert scale 4.3 ± 1.1). For those not keen on surgery, main reasons were fear of surgery (Likert scale 4 ± 1.5) and satisfaction with current therapy (Likert scale 3.7 ± 1.6). Conclusion: Many diabetic patients would consider surgery as an option to improve their metabolic disorder (greater interest in patients with higher educational levels, currently using insulin and with shorter duration of diabetes). Surgical complications, length of recovery and duration of benefits were the main concerns [25].

As regards to life style modification, attitude was assessed in an Ethiopian study on type 2 diabetic patients, and most of the participants showed positive attitude towards life style modification [26]. Similarly, another study from Pretoria showed that majority of patients have positive attitude regarding life style modification [11]. On the other hand, a study from Beshawar showed that type 2 diabetic patients lack the positive attitude towards diet and exercise for normal plasma glucose [10].

Methodology

Study design

Cross-sectional observational study was performed.

Study area

The study was conducted at chronic diseases clinics, primary healthcare centers in Prince Sultan Military Medical City, Riyadh, Kingdom of Saudi Arabia.

Target population

Type 2 diabetic patients recruited from chronic diseases clinics at the primary healthcare centers in Prince Sultan Military Medical City.

Inclusion/exclusion criteria

Inclusion criteria

- Adult patients aged 18-60 years old
- Type 2 diabetes
- BMI ≥ 30 kg/m²

Exclusion criteria

- Type 2 diabetes aged < 18 years old
- Type 1 diabetic patients
- BMI < 30 kg/m²

Sample size

The sample size was calculated by using the following formula

$$n = N / (1 + N * e^2)$$

Where

n = sample size

N = population size (type 2 diabetic patients with BMI ≥ 30 kg/m² and aged 18-60 years

e = margin of error (5%)

Sampling technique

Simple random technique was adopted

Data collection method

Data for the current study were collected from the chronic clinics at the primary healthcare centers in Prince Sultan Military Medical City. The questionnaire used for data collection in the current study was developed by the study investigators based on a previous study conducted in Singapore [24], with some changes and editions. After the questionnaire modification, it was translated into the Arabic form. The questionnaire consists of three main sections. The first section consists of questions that cover patients demographic data, diabetes duration, current diabetes treatment, participants impression for their diabetes control and latest glycated haemoglobin (HbA1C). The second section asked if the respondents had heard about weight reduction programs and if they would be interested in it, then a list of questions about certain factors that will affect the decision to proceed for such programs or not. The last section asked if the respondents had heard about bariatric surgery and if they would be interested in it, then a list of questions to be answered about certain factors that could affect their decision to proceed for bariatric surgery or not.

The questionnaire was filled independently by the participants in the presence of an interviewer.

The interviewers were the primary investigator and other two trained nurses.

Data entry and analysis

Data were analyzed by using Statistical Package for Social Studies (SPSS 28; IBM Corp., New York, NY, USA). Categorical variables were expressed as frequencies and percentages. Chi-square test was used to investigate for the association between two categorical variables and p-value < 0.05 was considered statistically significant.

Ethical consideration

- The proposal of this study was approved by the research ethical committee of Medical Services Department for Armed Forces, Scientific Research Center, Riyadh.
- Consent was obtained from every participant and data were treated confidentially.
- Confidentiality of Study Data:

Study data were coded without the use of names, medical record numbers, National ID numbers, initials, or other identifiable personal information. A unique code number was generated for each study subject and data were stored at a secure location available only to the study investigators.

Results

Response rate

The study included 336 type 2 diabetic patients out of targeted 400, giving a response rate of 84%.

Sociodemographic characteristics

Table 1 summarizes the sociodemographic characteristics of the respondents. The age of almost one third of them (32.7%) ranged between 31 and 45 years whereas that of 22% was 60 years or more. Females represented 51.2% of them. About two-thirds (66.4%) were married and 49.4% were employed. More than half of them (52.4%) were university graduated. The income of more than one-third of them (37.5%) was 3000 Saudi Riyals "SR"/month or less whereas that of 19.6% exceeded 10000 SR/month.

Clinical characteristics

The duration of diabetes ranged between one and 7 years among most of patients (62.2%). Majority of patients (98.2%) were under treatment; particularly metformin (47.3%) and oral hypoglycemic (32.4%) whereas insulin was mentioned by almost a fifth of them (20.3%). Most of them (75.6%) were aware of their HbA1c levels. Of them, 31.9% had HbA1c less than 7%. Heart and vision problems were mentioned by 18.5% and 55.4% of the patients, respectively. Peripheral neuropathy and renal disturbance were reported by 47.6% and 17.9% of patients, respectively. Overall, 36.2% of the

	Frequency	Percentage
Age in years		
18-30	56	16.7
31-45	110	32.7
46-59	96	28.6
≥60	74	22.0
Gender		
Male	164	48.8
Female	172	51.2
Marital status		
Single	64	19.0
Married	223	66.4
Divorced	49	14.6
Educational level		
Primary	28	8.3
Intermediate	30	8.9
Secondary	50	14.9
University	176	52.4
Postgraduate	52	15.5
Job status		
Unemployed	88	26.2
Employed	166	49.4
Student	36	10.7
Retired	46	13.7
Income (SR/month)		
≤3000	126	37.5
3001-6000	83	24.7
6001-10000	61	18.2
>10000	66	19.6

Table 1: Socio-demographic characteristics of the participants (n = 336).

participants perceived their health as “good” whereas 5.4% perceived it as “very bad”.

Awareness about and practice of weight reduction programs

More than one-third (39.3%) of the participants have heard about weight reduction programs; particularly keto diet (28.8%) whereas 54.5% of them have mentioned none-specific weight reduction program. However, almost half of them (48.2%) were willing to follow a weight reduction program; particularly none-specific one (66.7%) and keto diet (18.5%) table 3.

	Frequency	Percentage
Duration of diabetes (years)		
1-7	209	62.2
8-15	87	25.9
>15	40	11.9
Using treatment for diabetes		
No	6	10.6
Yes	330	98.2
Type of therapy (n=330)		
Metformin	156	47.3
Oral hypoglycemic	107	32.4
Insulin	67	20.3
Do you know your HbA1c level?		
No	82	24.4
Yes	254	75.6
HbA1c value (n=254)		
<7%	81	31.9
≥7%	173	68.1
Having heart problems		
No	274	81.5
Yes	62	18.5
Having vision problems		
No	150	44.6
Yes	186	55.4
Having peripheral neuropathy		
No	176	52.4
Yes	160	47.6
Having defects in renal functions		
No	276	82.1
Yes	60	17.9
Overall health perception		
Very bad	18	5.4
Bad	50	14.9
Good	122	36.2
Very good	98	29.2
Excellent	48	14.3

Table 2: Clinical characteristics of the participants (n = 336).

	Frequency	Percentage
Hearing about weight reduction programs		
No	204	60.7
Yes	132	39.3
Specify known weight reduction program (s)*		
Keto diet	38	28.8
Dash diet	10	7.6
Dukan diet	8	6.1
Interrupted fasting	4	3.0
Atkins diet	8	6.1
None-specific	72	54.5
Wellness to follow a weight reduction program		
No	174	51.8
Yes	162	48.2
If yes, which program		
Keto diet	30	18.5
Dash diet	8	4.9
Dukan diet	6	3.7
Interrupted fasting	6	3.7
Atkins diet	4	2.5
None-specific	108	66.7

Table 3: Awareness and practice of weight reduction programs among the participants.

*Not mutually exclusive (sum exceeded 100%).

Attitude towards weight reduction programs

From table 4, it is shown that 29.2% of the participants agreed that weight reduction programs are enough to control their blood sugar. Majority of them agreed that addition of anti-diabetic medications to weight reduction programs is necessary (75.6%) and chronic use of anti-diabetic medications might cause complications in vital organs (91.7%) whereas only 16.7% agreed that traditional therapy methods are better than medications.

Statements	Response	
	No N (%)	Yes N (%)
Weight reduction programs are enough to control my blood sugar	98	29.2
Addition of anti-diabetic medications to weight reduction programs is necessary	254	75.6
Chronic use of anti-diabetic medications might cause complications in vital organs	308	91.7
Traditional therapy methods are better than medications	56	16.7

Table 4: Response of the participants to statements concerning their attitude towards weight reduction programs.

Factors associated with attitude towards weight reduction programs

- Sociodemographic factors:** Older participants (≥60 years) were more likely than others to agree that traditional therapy methods are better than medications, $p < 0.001$. Males were more likely compared to females to agree that addition of anti-diabetic medications to weight reduction programs is necessary ($p = 0.041$) and chronic use of anti-diabetic medications might cause complications in vital organs ($p = 0.002$). Singles were more likely to agree that chronic use of anti-diabetic medications might cause complications in vital organs than married/divorced participants ($p = 0.007$). Higher educated participants were less likely to agree that traditional therapy methods are better than medications, compared to lower educated participants, $p < 0.001$. Employed participants were more likely to agree that weight reduction programs are enough to control my blood sugar ($p < 0.001$), whereas retired persons were more likely to agree that addition of anti-diabetic medications to weight reduction programs is necessary ($p = 0.004$) whereas unemployed participants were more likely to agree that traditional therapy methods are better than medications ($p < 0.001$). Also, participants with lowest income were more likely to agree that traditional therapy methods are better than medications ($p = 0.028$). Table 5
- Clinical factors:** Patients with lower duration of diabetes (1-7 years) were more likely to agree that weight reduction programs are enough to control their blood sugar ($p = 0.001$) whereas those with higher duration (> 15 years) were more likely to agree that traditional therapy methods are better than medications ($p < 0.001$). Patients treated with metformin were more likely to agree that weight reduction programs

are enough to control their blood sugar ($p = 0.001$) whereas those treated oral hypoglycemic were more likely to agree that addition of anti-diabetic medications to weight reduction programs is necessary ($p = 0.018$). Patients treated with insulin were more likely to agree that traditional therapy methods are better than medications ($p < 0.001$). Patients who knew their HbA1c level were more likely to agree that chronic use of anti-diabetic medications might cause complications in vital organs ($p < 0.001$) and less likely to agree that traditional therapy methods are better than medications ($p = 0.005$). Patients with heart problems were more likely to agree that traditional therapy methods are better than medications ($p = 0.032$). Patients with vision problems were less likely to agree that weight reduction programs are enough to control their blood sugar ($p < 0.001$) whereas they were more likely to agree that addition of anti-diabetic medications to weight reduction programs is necessary ($p < 0.001$) and traditional therapy methods are

better than medications ($p = 0.039$). Similarly, patients with peripheral neuropathy were less likely to agree that weight reduction programs are enough to control their blood sugar ($p = 0.002$) whereas they were more likely to agree that addition of anti-diabetic medications to weight reduction programs is necessary ($p = 0.021$) and traditional therapy methods are better than medications ($p = 0.032$). Patients with an overall excellent health perception were more likely to agree that weight reduction programs are enough to control their blood sugar ($p < 0.001$), less likely to agree that addition of anti-diabetic medications to weight reduction programs is necessary ($p < 0.001$). Patients with very bad health perception were more likely to agree that chronic use of anti-diabetic medications might cause complications in vital organs ($p = 0.020$). Patients with an overall bad health perception were more likely to agree that traditional therapy methods are better than medications ($p = 0.001$).

	Weight reduction programs are enough to control my blood sugar		Addition of anti-diabetic medications to weight reduction programs is necessary		Chronic use of anti-diabetic medications might cause complications in vital organs		Traditional therapy methods are better than medications	
	No	Yes	No	Yes	No	Yes	No	Yes
	N = 238 N (%)	N = 98 N (%)	N = 82 N (%)	N = 254 N (%)	N = 28 N (%)	N = 308 N (%)	N = 280 N (%)	N = 56 N (%)
Age in years								
18-30 (n = 56)	38 (67.9)	18 (32.1)	10 (17.9)	46 (82.1)	8 (14.3)	48 (85.7)	50 (89.3)	6 (10.7)
31-45 (n = 110)	74 (67.3)	36 (32.7)	36 (32.7)	74 (67.3)	10 (9.1)	100 (90.9)	98 (89.1)	12 (10.9)
46-59 (n = 96)	66 (68.8)	30 (31.3)	22 (22.9)	74 (77.1)	6 (6.3)	90 (93.7)	86 (89.6)	10 (10.4)
≥60 (n = 74)	60 (81.1)	14 (18.9)	14 (18.9)	60 (81.1)	4 (5.4)	70 (94.6)	46 (62.2)	28 (37.8)
p-value	0.181		0.080		0.255		<0.001	
Gender								
Male (n = 164)	124 (75.6)	40 (24.4)	32 (19.5)	132 (80.5)	6 (3.7)	158 (96.3)	140 (85.4)	24 (14.6)
Female (n = 172)	114 (66.3)	58 (33.7)	50 (29.1)	122 (70.9)	22 (12.8)	150 (87.2)	140 (81.4)	32 (18.6)
p-value	0.060		0.041		0.002		0.329	
Marital status								
Single (n = 64)	48 (75.0)	16 (25.0)	14 (21.9)	50 (78.1)	0 (0.0)	64 (100)	58 (90.6)	6 (9.4)
Married (n = 223)	158 (70.9)	65 (29.1)	61 (27.4)	162 (72.6)	20 (9.0)	203 (91.0)	180 (80.7)	43 (19.3)
Divorced (n = 49)	32 (65.3)	17 (35.7)	7 (14.3)	42 (85.7)	8 (16.3)	41 (83.7)	42 (85.7)	7 (14.3)
p-value	0.532		0.136		0.007		0.153	
Educational level								
Primary (n = 28)	22 (78.6)	6 (21.4)	8 (28.6)	20 (71.4)	2 (7.1)	26 (92.9)	10 (35.7)	18 (64.3)
Intermediate (n = 30)	26 (86.7)	4 (13.3)	2 (6.7)	28 (93.3)	4 (13.3)	26 (86.7)	20 (66.7)	10 (33.3)
Secondary (n = 50)	36 (72.0)	14 (28.0)	10 (20.0)	40 (80.0)	6 (12.0)	44 (88.0)	40 (80.0)	10 (20.0)
University (n = 176)	118 (67.0)	58 (33.0)	44 (25.0)	132 (75.0)	16 (9.1)	160 (90.9)	162 (92.0)	14 (8.0)
Postgraduate (n = 52)	36 (69.2)	16 (30.8)	18 (34.6)	34 (65.4)	0 (0.0)	52 (100)	48 (92.3)	4 (7.7)
p-value	0.217		0.064		0.148		<0.001	

Job status									
Unemployed (n = 88)	66 (75.0)	22 (25.0)	28 (31.8)	60 (68.2)	12 (13.6)	76 (86.4)	54 (61.4)	34 (38.6)	
Employed (n = 166)	102 (61.4)	64 (38.6)	46 (27.7)	120 (72.3)	14 (8.4)	152 (91.6)	150 (90.4)	16 (9.6)	
Student (n = 36)	28 (77.8)	8 (22.2)	4 (11.1)	32 (88.9)	0 (0.0)	36 (100)	36 (100)	0 (0.0)	
Retired (n = 46)	42 (91.3)	4 (8.7)	4 (8.7)	42 (91.3)	2 (4.3)	44 (95.7)	40 (87.0)	6 (13.0)	
p-value	<0.001		0.004		0.058		<0.001		
Income (SR/month)									
≤3000 (n = 126)	94 (74.6)	32 (25.4)	30 (23.8)	96 (76.2)	14 (11.1)	112 (88.9)	98 (77.8)	28 (22.2)	
3001-6000 (n = 83)	60 (72.3)	23 (27.7)	21 (25.3)	62 (74.7)	6 (7.2)	77 (92.8)	67 (80.7)	16 (19.3)	
6001-10000 (n = 61)	44 (72.1)	17 (27.9)	11 (18.0)	50 (82.0)	4 (6.6)	57 (93.4)	53 (86.9)	8 (13.1)	
>10000 (n = 66)	40 (60.6)	26 (39.4)	20 (30.3)	46 (69.7)	4 (6.1)	62 (93.9)	62 (93.9)	4 (6.1)	
p-value	0.227		0.449		0.551		0.028		

Table 5: Participants` sociodemographic factors associated with attitude towards weight reduction programs. Chi-square test.

	Weight reduction programs are enough to control my blood sugar		Addition of anti-diabetic medications to weight reduction programs is necessary		Chronic use of anti-diabetic medications might cause complications in vital organs		Traditional therapy methods are better than medications	
	No N = 238 N (%)	Yes N = 98 N (%)	No N = 82 N (%)	Yes N = 254 N (%)	No N = 28 N (%)	Yes N = 308 N (%)	No N = 280 N (%)	Yes N = 56 N (%)
Duration of DM								
1-7 (n = 209)	133 (63.6)	76 (36.4)	53 (25.4)	156 (74.6)	19 (9.1)	190 (90.9)	187 (89.5)	22 (10.5)
8-15 (n = 87)	71 (81.6)	16 (18.4)	21 (24.1)	66 (75.9)	7 (8.0)	80 (92.0)	69 (79.3)	18 (20.7)
>15 (n = 40)	34 (85.0)	6 (15.0)	8 (20.0)	32 (80.0)	2 (5.0)	38 (95.0)	24 (60.0)	16 (40.0)
p-value	0.001		0.768		0.688		<0.001	
Using treatment for DM								
No (n = 6)	5 (83.3)	1 (16.7)	3 (50.0)	3 (50.0)	0 (0.0)	6 (100)	4 (66.7)	2 (33.3)
Yes (n = 330)	233 (70.6)	97 (29.4)	79 (23.9)	251 (76.1)	28 (8.5)	302 (91.5)	276 (83.6)	54 (16.4)
p-value	0.437		0.158		0.591		0.263	
Type of therapy								
Metformin (n = 156)	233	97	79	251	28	302	276	54
Oral hypoglycemic (n = 107)	95 (60.9)	61 (39.1)	47 (30.1)	109 (69.9)	16 (10.3)	140 (89.7)	141 (90.4)	15 (9.6)
Insulin (n = 67)	83 (77.6)	24 (22.4)	16 (15.0)	91 (85.0)	4 (3.7)	103 (96.3)	95 (88.8)	12 (11.2)
	55 (82.1)	12 (17.9)	16 (23.9)	51 (76.1)	8 (11.9)	59 (88.1)	40 (59.7)	27 (40.3)
p-value	0.001		0.018		0.092		<0.001	
Do you know your HbA1c level?								
No (n = 82)	64 (78.0)	18 (22.0)	24 (29.3)	58 (70.7)	16 (19.5)	66 (80.5)	60 (73.2)	22 (26.8)
Yes (n = 254)	174 (68.5)	80 (31.5)	58 (22.8)	196 (77.2)	12 (4.7)	242 (95.3)	220 (86.6)	34 (13.4)
p-value	0.098		0.238		<0.001		0.005	
HbA1c value								
<7% (n = 81)	176	78	58	196	12	242	220	34
≥7% (n = 173)	50 (61.7)	31 (38.3)	19 (23.5)	62 (76.5)	2 (2.5)	79 (97.5)	75 (92.6)	6 (7.4)
	126 (72.8)	47 (27.2)	39 (22.5)	134 (77.5)	10 (5.8)	163 (94.2)	145 (83.8)	28 (16.2)
p-value	0.074		0.872		0.204		0.056	

Having heart problems									
No (n = 274)	188 (68.6)	86 (31.4)	72 (26.3)	202 (73.7)	22 (8.0)	252 (92.0)	234 (85.4)	40 (14.6)	
Yes (n = 62)	50 (80.6)	12 (19.4)	10 (16.1)	52 (83.9)	6 (9.7)	56 (90.3)	46 (74.2)	16 (25.8)	
p-value	0.060		0.093		0.672		0.032		
Having vision problems									
No (n = 150)	90 (60.0)	60 (40.0)	52 (34.7)	98 (65.3)	12 (8.0)	138 (92.0)	132 (88.0)	18 (12.0)	
Yes (n = 186)	148 (79.6)	38 (20.4)	30 (16.1)	156 (83.9)	16 (8.6)	170 (91.4)	148 (79.6)	38 (20.4)	
p-value	<0.001		<0.001		0.843		0.039		
Having peripheral neuropathy									
No (n = 176)	112 (63.6)	64 (36.4)	52 (29.5)	124 (70.5)	16 (9.1)	160 (90.9)	154 (87.5)	22 (12.5)	
Yes (n = 160)	126 (78.8)	34 (21.3)	30 (18.8)	130 (81.3)	12 (7.5)	148 (92.5)	126 (78.8)	34 (21.3)	
p-value	0.002		0.021		0.598		0.032		
Having defects in renal functions									
No (n = 276)	190 (68.8)	86 (31.2)	72 (26.1)	24 (73.9)	24 (8.7)	252 (91.3)	232 (84.1)	44 (15.9)	
Yes (n = 60)	48 (80.0)	12 (20.0)	10 (16.7)	50 (83.3)	4 (6.7)	56 (93.3)	48 (80.0)	12 (20.0)	
p-value	0.085		0.124		0.606		0.445		
Overall health perception									
Very bad (n = 18)	18 (100)	0 (0.0)	2 (11.1)	16 (88.9)	0 (0.0)	18 (100)	14 (77.8)	4 (22.2)	
Bad (n = 50)	42 (84.0)	8 (16.0)	8 (16.0)	42 (84.0)	10 (20.0)	40 (80.0)	32 (64.0)	18 (36.0)	
Good (n = 122)	92 (75.4)	30 (24.6)	8 (6.6)	114 (93.4)	8 (6.6)	114 (93.4)	108 (88.5)	14 (11.5)	
Very good (n = 98)	66 (67.3)	32 (32.7)	36 (36.7)	62 (63.3)	6 (6.1)	92 (93.9)	86 (87.8)	12 (12.2)	
Excellent (n = 48)	20 (41.7)	28 (58.3)	28 (58.3)	20 (41.7)	4 (8.3)	44 (91.7)	40 (83.3)	8 (16.7)	
p-value	<0.001		<0.001		0.020		0.001		

Table 6: Participants` clinical factors associated with attitude towards weight reduction programs.

Chi-square test.

Awareness about and practice of bariatric surgery

On a scale ranged between 1 and 5, the mean ± SD of awareness of the participants about bariatric surgery was 2.59 ± 1.56. More than one-third of them (38.6%) were unaware whereas 18.5% were highly aware of bariatric surgery used for treatment of obesity and diabetes.

History of undertaking bariatric surgery was reported by 28.6% of the participants as shown in Figure 2.

Attitude towards bariatric surgery

From table 7, it is shown that more than half of the participants agreed that bariatric surgery will change their nutritional habits (57.1%), affect their blood sugar level (55.4%) and change their life style (54.2%) whereas 44% of them believed that they will achieve their ideal weight one year after bariatric surgery.

Factors associated with attitude towards bariatric surgery

- **Sociodemographic factors:** Older participants (≥60 years) were less likely than others to agree that bariatric surgery will affect their blood sugar level, change their nutritional habits, change their life style and they will achieve their ideal weight one year after bariatric surgery (p < 0.001).

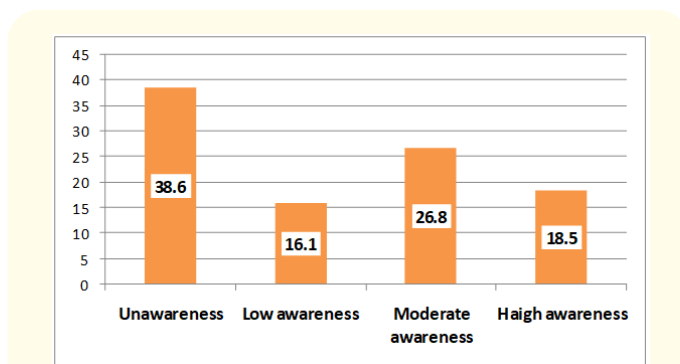


Figure 1: Awareness of the participants about bariatric surgery.

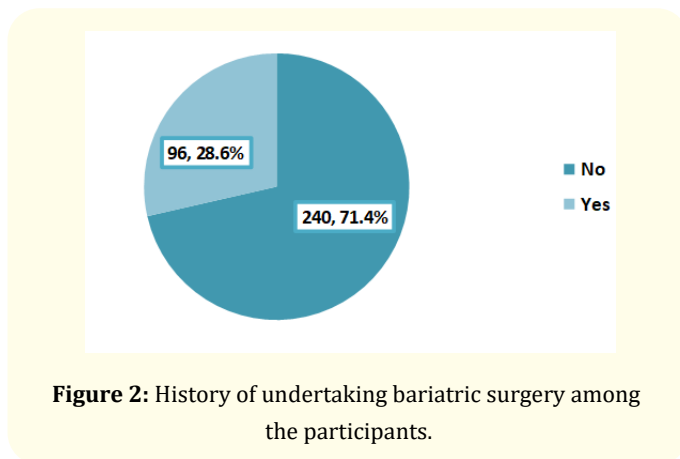


Figure 2: History of undertaking bariatric surgery among the participants.

Married patients were more likely than others to agree that bariatric surgery will affect their blood sugar level ($p = 0.001$) whereas single patients were more likely than others to agree that bariatric surgery will affect nutritional habits ($p = 0.038$). Higher educated participants (university/postgraduate) were more likely than others to agree that bariatric surgery will affect their blood sugar level, change their nutritional habits, change their life style and they will achieve their ideal weight one year after bariatric surgery ($p < 0.001$). Retired participants were less likely than others to agree that bariatric surgery will affect their blood sugar level ($p = 0.008$), change their nutritional habits ($p < 0.001$), change their life style ($p = 0.039$) and they will achieve their ideal weight one year after bariatric surgery ($p = 0.022$). Patients with higher income (> 10000 SR/month) were more likely to agree that bariatric surgery will affect their life style ($p = 0.003$) and nutritional habits ($p = 0.018$).

- Clinical factors:** Patients with lower duration of diabetes (1-7 years) were more likely than others to agree that bariatric surgery will change their nutritional habits ($p < 0.001$), change their life style ($p < 0.001$) and they will achieve their ideal weight one year after bariatric surgery ($p = 0.007$). Patients treated with metformin were more likely than others to agree that bariatric surgery will change their nutritional habits ($p < 0.001$), change their life style ($p < 0.001$) and they will achieve their ideal weight one year after bariatric surgery ($p = 0.015$). Patients who knew their HbA1c levels were more likely to agree that bariatric surgery will change their life style ($p = 0.008$). Patients with HbA1c levels $< 7\%$ were more likely to agree that bariatric surgery will change their nutritional habits ($p = 0.019$). Patients with heart problems were less likely to agree that bariatric surgery will change their nutritional habits ($p = 0.035$) and life style ($p = 0.001$). Patients with vision problems were less likely than others to agree that bariatric surgery will change their blood glucose level, nutritional habits and life style ($p < 0.001$), and they will achieve their ideal weight one year after bariatric surgery ($p = 0.008$). Patients with peripheral neuropathy were less likely than others to agree that bariatric surgery will change their blood glucose level, ($p = 0.006$), nutritional habits and life style ($p < 0.001$), and they will achieve their ideal weight one year after bariatric surgery ($p = 0.021$). Patients with defects in renal functions were less likely to agree that bariatric surgery will change their nutritional habits ($p = 0.017$) and life style ($p = 0.003$). Patients who perceived their overall health as very good or excellent were more likely than others to agree that bariatric surgery will affect their blood sugar level ($p < 0.001$), change their nutritional habits ($p = 0.002$), change their life style ($p < 0.001$) and they will achieve their ideal weight one year after bariatric surgery ($p < 0.001$). table 9.

Statements	Response	
	No N (%)	Yes N (%)
Bariatric surgery will affect my blood sugar level	186	55.4
It will achieve my ideal weight one year after bariatric surgery	148	44.0
Bariatric surgery will change my nutritional habits	192	57.1
Bariatric surgery will change my life style	182	54.2

Table 7: Response of the participants to statements concerning their attitude towards bariatric surgery.

Discussion

Obesity has been proved as a strong risk factor for many chronic diseases, among them the type 2 diabetes mellitus (T2DM) [27]. Therefore, early action regarding obesity management among T2DM patients should be regarded as an urgent global priority due to limited patients adhere to lifestyle modifications and achieve long-term weight management and glycemic control [28]. Thus the present study aimed to explore the attitude of obese type 2 diabetes patients (BMI 30-40 kg/m²) regarding intensive weight reduction programs as well as bariatric surgery as method to manage both of obesity and type 2 diabetes at the same time.

In the current study, 39.3% of obese T2DM patients have heard about weight reduction programs particularly Keto diet and almost half of them were willing to follow a weight reduction program. A recent published meta-analysis concluded that the ketogenic diet is beneficial in glycemic control and lipid profile improvements in lipid profile [29]. In addition, Gershuni, *et al.* observed that the ketogenic diet has positive impact on reducing bodyweight, improving fasting glucose level, decreasing cholesterol level, and reducing diabetic medications in diabetic patients as a result shifting the basic metabolism of energy from glucose to ketone bodies due to decrease intake of carbohydrates [30].

Furthermore, the present study showed that only 29.2% of the obese T2DM patients believed that weight reduction programs are enough to control their blood sugar and majority of them thought that addition of anti-diabetic medications to weight reduction programs is necessary. Majority of them believed that chronic use of anti-diabetic medications might cause complications in vital organs whereas only 16.7% agreed that traditional therapy methods are better than medications. Thus attitude of patients in the present study towards intensive weight reduction programs was

	Bariatric surgery will affect my blood sugar level		It will achieve my ideal weight one year after bariatric surgery		Bariatric surgery will change my nutritional habits		Bariatric surgery will change my life style	
	No N = 150 N (%)	Yes N = 186 N (%)	No N = 188 N (%)	Yes N = 148 N (%)	No N = 144 N (%)	Yes N = 192 N (%)	No N = 154 N (%)	Yes N = 182 N (%)
Age in years								
18-30 (n = 56)	30 (53.6)	26 (46.4)	26 (46.4)	30 (53.6)	20 (35.7)	36 (64.3)	20 (35.7)	36 (64.3)
31-45 (n = 110)	36 (32.7)	74 (67.3)	46 (41.8)	64 (58.2)	28 (25.5)	82 (74.5)	32 (29.1)	78 (70.9)
46-59 (n = 96)	38 (39.6)	58 (60.4)	54 (56.3)	42 (43.8)	46 (47.9)	50 (52.1)	52 (54.2)	44 (45.8)
≥60 (n = 74)	46 (62.2)	28 (37.8)	62 (83.8)	12 (16.2)	50 (67.6)	24 (32.4)	50 (67.6)	24 (32.4)
p-value	< 0.001		< 0.001		< 0.001		< 0.001	
Gender								
Male (n = 164)	74 (45.1)	90 (54.9)	92 (56.1)	72 (43.9)	72 (43.9)	92 (56.1)	76 (46.3)	88 (53.7)
Female (n = 172)	76 (44.2)	96 (55.8)	96 (55.8)	76 (44.2)	72 (41.9)	100(58.1)	78 (45.3)	94 (54.7)
p-value	0.863		0.958		0.705		0.855	
Marital status								
Single (n = 64)	30 (46.9)	34 (53.1)	28 (43.8)	36 (56.3)	22 (34.4)	42 (65.6)	24 (37.5)	40 (62.5)
Married (n = 223)	87 (39.0)	136(61.0)	127(57.0)	96 (43.0)	99 (44.4)	124(55.6)	105(47.1)	118(52.9)
Divorced (n = 49)	33 (67.3)	16 (32.7)	33 (67.3)	16 (32.7)	23 (46.9)	26 (53.1)	25 (51.0)	24 (49.0)
p-value	0.001		0.038		0.297		0.292	
Educational level								
Primary (n = 28)	20 (71.4)	8 (28.6)	24 (85.7)	4 (14.3)	22 (78.6)	6 (21.4)	20 (71.4)	8 (28.6)
Intermediate (n = 30)	20 (66.7)	10 (33.3)	24 (80.0)	6 (20.0)	20 (66.7)	10 (33.3)	24 (80.0)	6 (20.0)
Secondary (n = 50)	34 (68.0)	16 (32.0)	38 (76.0)	12 (24.0)	30 (60.0)	20 (40.0)	30 (60.0)	20 (40.0)
University (n = 176)	68 (38.6)	108(61.4)	84 (47.7)	92 (52.3)	52 (29.5)	124(70.5)	56 (31.8)	120(68.2)
Postgraduate (n = 52)	8 (15.4)	44 (84.6)	18 (34.6)	34 (65.4)	20 (38.5)	32 (61.5)	24 (46.2)	28 (53.8)
p-value	< 0.001		< 0.001		< 0.001		< 0.001	
Job status								
Unemployed (n = 88)	42 (47.7)	46 (52.3)	50 (56.8)	38 (43.2)	44 (50.0)	44 (50.0)	48 (54.5)	40 (45.5)
Employed (n = 166)	60 (36.1)	106(63.9)	78 (47.0)	88 (53.0)	58 (34.9)	108(65.1)	64 (38.6)	102 (61.4)
Student (n = 36)	20 (55.6)	16 (44.4)	20 (55.6)	16 (44.4)	16 (44.4)	20 (55.6)	16 (44.4)	20 (55.6)
Retired (n = 46)	28 (60.9)	18 (39.1)	40 (87.0)	6 (13.0)	26 (56.5)	20 (43.5)	26 (56.5)	20 (43.5)
p-value	0.008		< 0.001		0.022		0.039	
Income (SR/month)								
≤3000 (n = 126)	54 (42.9)	72 (57.1)	66 (52.4)	60 (47.6)	60 (47.6)	66 (52.4)	64 (50.8)	62 (49.2)
3001-6000 (n = 83)	40 (48.2)	43 (51.8)	50 (60.2)	33 (39.8)	42 (50.6)	41 (49.4)	46 (55.4)	37 (44.6)
6001-10000 (n = 61)	30 (49.2)	31 (50.8)	40 (65.6)	21 (34.4)	24 (39.3)	37 (60.7)	26 (42.6)	35 (57.4)
> 10000 (n = 66)	26 (39.4)	40 (60.6)	32 (48.5)	34 (51.5)	18 (27.3)	48 (72.7)	18 (27.3)	48 (72.7)
p-value	0.608		0.168		0.018		0.003	

Table 8: Participants` sociodemographic factors associated with attitude towards bariatric surgery.

Chi-square test.

	Bariatric surgery will affect my blood sugar level		It will achieve my ideal weight one year after bariatric surgery		Bariatric surgery will change my nutritional habits		Bariatric surgery will change my life style	
	No	Yes	No	Yes	No	Yes	No	Yes
	N = 150 N (%)	N = 186 N (%)	N = 188 N (%)	N = 148 N (%)	N = 144 N (%)	N = 192 N (%)	N = 154 N (%)	N = 182 N (%)
Duration of DM								
1-7 (n = 209)	87 (41.6)	122(58.4)	103(49.3)	106(50.7)	68 (32.5)	141(67.5)	72 (34.4)	137 (65.6)
8-15 (n = 87)	42 (48.3)	45 (51.7)	58 (66.7)	29 (33.3)	49 (56.3)	38 (43.7)	53 (60.9)	34 (39.1)
> 15 (n = 40)	21 (52.5)	19 (47.5)	27 (67.5)	13 (32.5)	27 (67.5)	13 (32.5)	29 (72.5)	11 (27.5)
p-value	0.327		0.007		< 0.001		< 0.001	
Using treatment for DM								
No (n = 6)	3 (50.0)	3 (50.0)	2 (33.3)	4 (66.7)	2 (33.3)	4 (66.7)	2 (33.3)	4 (66.7)
Yes (n = 330)	147(44.5)	183(55.5)	186(56.4)	144(43.6)	142(43.0)	188(57.0)	152(46.1)	178(53.9)
p-value	0.552		0.238		0.485		0.424	
Type of therapy								
Metformin (n = 156)	60 (38.5)	96 (61.5)	76 (48.7)	80 (51.3)	48 (30.8)	108(69.2)	52 (33.3)	104(66.7)
Oral hypoglycemic (n = 107)	51 (47.7)	56 (52.3)	64 (59.8)	43 (40.2)	54 (50.5)	53(49.5)	54 (50.5)	53 (49.5)
Insulin (n = 67)	36 (53.7)	31 (46.3)	46 (68.7)	21 (31.3)	40 (59.7)	27 (40.3)	46 (68.7)	21 (31.3)
p-value	0.080		0.015		< 0.001		< 0.001	
Do you know your HbA1c level?								
No (n = 82)	38 (46.3)	44 (53.7)	48 (58.5)	34 (41.5)	42 (51.2)	40 (48.8)	48 (58.5)	34 (41.5)
Yes (n = 254)	112(44.1)	142(55.9)	140(55.1)	114(44.9)	102(40.2)	152(59.8)	106(41.7)	148(58.3)
p-value	0.722		0.588		0.078		0.008	
HbA1c value								
< 7% (n = 81)	30 (37.0)	51 (63.0)	40 (49.4)	41 (50.6)	24 (29.6)	57 (70.4)	28 (34.6)	53 (65.4)
≥7% (n = 173)	82 (47.4)	91 (52.6)	100(57.8)	73 (42.2)	78 (45.1)	95 (54.9)	78 (45.1)	95 (54.9)
p-value	0.121		0.209		0.019		0.113	
Having heart problems								
No (n = 274)								
Yes (n = 62)	120(43.8)	154(56.2)	148(54.0)	126(46.0)	110(40.1)	164(59.9)	114(41.6)	160(58.4)
	30 (48.4)	32 (51.6)	40 (64.5)	22 (35.5)	34 (54.8)	28 (45.2)	40 (64.5)	22 (35.5)
p-value	0.511		0.133		0.035		0.001	
Having vision problems								
No (n = 150)	48 (32.0)	102(68.0)	72 (48.0)	78 (52.0)	46 (30.7)	104(69.3)	52 (34.7)	98 (65.3)
Yes (n = 186)	102(54.8)	84 (45.2)	116(62.4)	70 (37.6)	98 (52.7)	88 (47.3)	102(54.8)	84 (45.2)
p-value	< 0.001		0.008		< 0.001		< 0.001	
Having peripheral neuropathy								
No (n = 176)	66 (37.5)	110(62.5)	88 (50.0)	88 (50.0)	58 (33.0)	118(67.0)	62 (35.2)	114(64.8)
Yes (n = 160)	84 (52.4)	76 (47.5)	100(62.5)	60 (37.5)	86 (53.8)	74 (46.3)	92 (57.5)	68 (42.5)
p-value	0.006		0.021		< 0.001		< 0.001	
Having defects in renal functions								
No (n = 276)	120(43.5)	156(56.5)	150(54.3)	126(45.7)	110(39.9)	166(60.1)	116(42.0)	160 (58.0)
Yes (n = 60)	30 (50.0)	30 (50.0)	38 (63.3)	22 (36.7)	34 (56.7)	26 (43.3)	38 (63.3)	22 (36.7)
p-value	0.357		0.204		0.017		0.003	

Overall health perception									
Very bad (n = 18)	16 (88.9)	2 (11.1)	16 (88.9)	2 (11.1)	14 (77.8)	4 (22.2)	16 (88.9)	2 (11.1)	
Bad (n = 50)	24 (48.0)	26 (52.0)	34 (68.0)	16 (32.0)	24 (48.0)	26 (52.0)	26 (52.0)	24 (48.0)	
Good (n = 122)	66 (54.1)	56 (45.9)	74 (60.7)	48 (39.3)	58 (47.5)	64 (52.5)	60 (49.2)	62 (50.8)	
Very good (n = 98)	28 (28.6)	70 (71.4)	42 (42.9)	56 (57.1)	34 (34.7)	64 (65.3)	36 (36.7)	62 (63.3)	
Excellent (n = 48)	16 (33.3)	32 (66.7)	22 (45.8)	26 (54.2)	14 (29.2)	34 (70.8)	16 (33.3)	32 (66.7)	
p-value	< 0.001		< 0.001		0.002		< 0.001		

Table 9: Participants` clinical factors associated with attitude towards bariatric surgery. Chi-square test.

positive in some issues such as complications in vital organs with chronic use of anti-diabetic medications while it was negative in some others, particularly regarding the role of intensive weight reduction programs in control of blood glucose and the necessity of adding ant-diabetic medications in combination of these programs.

Bariatric surgery is a surgical procedure aimed to modify the upper gastrointestinal tract to manage obesity and its related diseases, including T2DM among patients with moderate to severe obesity [31-33]. Additionally, Mingrone G., *et al.* concluded from their 5-years of follow-up randomized controlled trial that bariatric surgery group showed significantly lower plasma lipids, drug use, and cardiovascular complications of diabetes compared to those with conventional treatment for obesity in T2DM patients [34]. In Sweden, microvascular and macrovascular complications of diabetes were much decreased in patients managed by bariatric surgery [35]. Also, other meta-analysis studies concluded that bariatric surgery was more effective than other lines of treatment in reducing patients` blood glucose, weight and cardiovascular risks [36-38]. Its mechanism depended on alteration of the physiological role played by the GIT in metabolic regulation [39-41].

In the present study conducted among obese type 2 diabetic patients, more than one-third of them (38.6%) were unaware whereas 18.5% were highly aware of bariatric surgery used for treatment of obesity and diabetes. Furthermore, history of undertaking bariatric surgery was reported by 28.6% of the patients. Similarly in Singapore [25], minority of diabetic patients had heard about bariatric surgery in the management of diabetes. However, more than 60% of them were willing to undertake bariatric surgery after a short description of the benefits of it; particularly those with higher education, shorter duration of the disease and those treated with insulin.

Concerning attitude of the patients towards bariatric surgery, the present study revealed that more than half of the obese T2DM patients believed that bariatric surgery will change their nutritional habits, affect their blood sugar level and change their life style whereas 44% of them believed that they will achieve their ideal

weight one year after bariatric surgery. In another Saudi study targeted adult population done by Alqurashi., *et al.* (2017), the authors observed low favorable beliefs about bariatric surgery as 55.7% of subjects have non-favorable beliefs about bariatric surgery; particularly among females and those with high BMI [23]. In a similar study carried out in USA among T2DM patients whose BMI ranged between 30 and 40 kg/m², only 20.3% had positive views of bariatric surgery, with few reporting that it is a safe (14.3%) and effective (28.5%) treatment for type 2 diabetes and less than 20% of patients were willing to be randomized to a surgical procedure for the treatment of diabetes (16.1%) or obesity (17.5%) [24]. Comparison between various studies, including the present one should be interpreted in the light of difference between them regarding patients` characteristics and cultural variations.

In the present study and in accordance with others [25], more educated patients were more likely to have positive attitude towards effectiveness of bariatric surgery in management of their blood glucose, mostly because they are more understandable of the bariatric surgery and complications from diabetes mellitus. However, in contrast to others [25,42] in the present study, patients treated with metformin were more likely than others to agree that bariatric surgery will change their nutritional habits, change their life style and they will achieve their ideal weight one year after bariatric surgery while in other studies, patients treated with insulin were more interested to undergo bariatric surgery. This might be attributed to lower compliance of patients on oral therapy than those on insulin therapy.

In agreement with others [25], patients with shorter duration of diabetes in the present study had more positive attitude towards bariatric surgery, because they are relatively healthier. Also, studies indicated that patients with shorter duration of diabetes who underwent bariatric surgery had the highest rates of diabetes remission [43,44].

Strengths and limitations

Up to our knowledge, this is a unique study of its kind that undertaken in Saudi Arabia to assess the attitude of obese type 2 dia-

betic patients towards weight reduction regimen and bariatric surgery in the management of both obesity and diabetes, However, the study included only patients attending primary care centers in one facility in Riyadh which could affect the generalizability of results over other settings.

Conclusion

Most of type 2 diabetic patients were not aware of intensive weight reduction programs; However, almost about half of them were willing to follow a weight reduction program. Most of the patients disagreed that weight reduction programs are enough to control their blood sugar. Majority of them agreed that addition of anti-diabetic medications to weight reduction programs is necessary and chronic use of anti-diabetic medications might cause complications in vital organs whereas only minority of them agreed that traditional therapy methods are better than medications.

A considerable proportion of patients in this study were unaware of bariatric surgery as a tool that can be used for treatment of obesity and diabetes. About one-fourth of them had undertaken bariatric surgery. Almost half of the type 2 diabetic patients agreed that bariatric surgery will change their nutritional habits, affect their blood sugar level and change their life style whereas less than half of them believed that they will achieve their ideal weight one year after bariatric surgery.

Some socio-demographic and diabetes-related factors were associated with attitude of the patients towards intensive weight reduction programs as well as bariatric surgery.

Recommendations

Based on the study's findings, the following are recommended

- Organizing educational activities for type 2 diabetic patients regarding different intensive weight reduction programs and bariatric surgery.
- Encourage obese type 2 diabetic patients to attempt these tools for control of both obesity and diabetes problems
- Nutritionists should play active role in selection of patients suitable for different intensive weight reduction programs.
- Well-prepared and good staffed places should be suitable to implement intensive weight reduction programs and bariatric surgery for suitable patients.
- Further larger study included patients from other facilities to have a more comprehensive image of the situation in Riyadh, Saudi Arabia as well as other places of the whole Kingdom of Saudi Arabia.

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