

Original Paper

Bariatric Surgery for Morbid Obesity: Tehran Obesity Treatment Study (TOTS) Rationale and Study Design

Maryam Barzin¹; Farhad Hosseinpanah¹, MD; Mohammad Ali Motamedi¹, MD; Parvin Shapoori², MD; Peyman Arian³; Maryam Alsadat Daneshpour⁴, PhD; Golale Asghari⁵, MS; Ahmad Teymoornejad³, MS; Ali Eslamifar⁶, MD; Davood Khalili⁷, MD, PhD; Behzad Jodeiri³, MD; Shahram Alamdari⁸, MD; Fereidoun Azizi⁹, MD; Alireza Khalaj¹⁰, MD

¹Obesity Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran

²A Minimally Invasive Surgery Research Center, Rasoul-e-Akram Hospital, Iran University of Medical Sciences, Tehran, Islamic Republic of Iran

³Obesity Treatment Center, Faculty of Medicine, Shahed University, Tehran, Islamic Republic of Iran

⁴Cellular and Molecular Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran

⁵Nutrition and Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran

⁶Department of Clinical Research, Pasteur Institute of Iran, Tehran, Islamic Republic of Iran

⁷Prevention of Metabolic Disorders Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran

⁸Obesity Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran

⁹Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran

¹⁰Obesity Treatment Center, Department of Surgery, Shahed University, Tehran, Islamic Republic of Iran

Corresponding Author:

Alireza Khalaj, MD
Obesity Treatment Center
Department of Surgery
Shahed University
Keshavarz Blvd
31 Abdollah-zade St
Tehran, 141557435
Islamic Republic of Iran
Phone: 98 2188706676
Fax: 98 2188725936
Email: Khalaj@totc.ir

Abstract

Background: Obesity is a major health concern in the Middle East and worldwide. It is among the leading causes of morbidity, mortality, health care utilization, and costs. With bariatric surgery proving to be a more effective treatment option for overweight and obesity, the need for systematic assessment of different procedures and their outcomes becomes necessary. These procedures have not yet been described in detail in our region.

Objective: We aim to undertake a prospective study evaluating and comparing several surgical bariatric procedures in an Iranian population of morbid obese patients presenting to a specialized bariatric center.

Methods: In order to facilitate and accelerate understanding of obesity and its complications, the Tehran Obesity Treatment Study (TOTS) was planned and developed. This study is a longitudinal prospective cohort study in consecutive patients undergoing bariatric surgery. TOTS investigators use standardized definitions, high-fidelity data collection system, and validated instruments to gather data preoperatively, at the time of surgery, postoperatively, and in longer-term follow-up.

Results: This study has recruited 1050 participants as of September 2015 and is ongoing.

Conclusions: This study will ensure creation of high-level evidence to enable clinicians to make meaningful evidence-based decisions for patient evaluation, selection for surgery, and follow-up care.

(*JMIR Res Protoc* 2016;5(1):e8) doi: [10.2196/resprot.5214](https://doi.org/10.2196/resprot.5214)

KEYWORDS

obesity; overweight; weight loss; bariatric surgery

Introduction

Health Burden of Severe Obesity

Obesity is a growing health concern in Iran and is now a global pandemic. The latest World Health Organization (WHO) report on obesity indicates that the overweight and obese population is growing. In fact, the prevalence of obesity has nearly doubled worldwide since 1980, and more than 10% of the world's adult population is obese [1]. Although the obesity prevalence remained unchanged during the last 10 years in the United States [2], it is still high: 35.5% of the adult population in the United States is obese, which is defined as a body mass index (BMI) ≥ 30 , 15.5% have a BMI over 35, and 6.3% are morbidly obese (BMI ≥ 40) [3]. Obesity prevalence is on the rise in developing countries due to demographic, socioeconomic, and nutritional transitions [4], and Iran is no exception: 10.8% and 3.4% of the population are obese and morbidly obese, respectively [5].

Severe obesity is associated with comorbidities such as type 2 diabetes mellitus, hypertension, cardiovascular disease, degenerative joint disease, and sleep apnea [6,7]. It has a major impact on quality of life [8] and psychosocial health as well, and major depression is seen in 7% of this population [9].

Treatment of Severe Obesity

Over the past few decades, there has been a major change in trends of obesity treatment. Lifestyle modifications can, at best, induce a 5-10% weight loss and improve obesity-related morbidities to a limited extent [10]. However, advancements of bariatric surgery in less invasive and safer techniques, along with the evidence-supported superior results over lifestyle modifications, rendered surgery a better treatment option [11-13]. A recent meta-analysis found a 26 kg weight difference between surgical versus non-surgical treatment of morbidly obese patients in 1-2 years follow-up [14]. A Utah obesity study found this difference at 27% of initial body weight between the two groups after 6 years [15]. Results of the Swedish Obese Subjects study after 20 years of follow-up showed 18% mean weight loss for the surgical group, compared with 1% for the non-surgical [16]. Another meta-analysis including 161,756 patients showed BMI loss of 12-17 kg/m² after 5 years following bariatric surgery [17]. Overall, evidence now supports the choice of bariatric surgery over lifestyle changes for the treatment of severe obesity not only because of excess weight loss (EWL) reductions, but also because of significant benefits in terms of comorbidities and prolonged survival [13,18,19]. However, surgery is not without risks; perioperative mortality is estimated about 0.3%, and 30-day complication rate about 4.1% [20].

Results of Bariatric Surgical Procedures

There are various surgical procedures for the treatment of severe obesity. Roux-en-Y gastric bypass (RYGB), laparoscopic adjustable gastric banding (LAGB), laparoscopic sleeve gastrectomy (LSG), and biliopancreatic diversion with or without duodenal switch (BPD/BPD-DS) are the recommended and most commonly performed today [21]. Laparoscopic procedures are in general preferred over the open approach [11]. Newer techniques such as plication and mini-gastric or single loop gastric bypass are also emerging. Besides the variable effectiveness across procedures, each has risks and benefits.

In terms of effectiveness, since no single study has incorporated all the techniques, inference must be made through pooled data analyses. In general, BPD/BPD-DS results in more EWL (especially for patients with a very high BMI). RYGB and LSG have shown somewhat comparable results, although some studies have shown a significant advantage for RYGB [22]. LAGB comes after these techniques. Their effect on improvement of comorbidities follows the same order [23,24].

In terms of complication rate and safety, some studies have shown a significant difference between procedures. A meta-analysis of 85,048 patients found a 30-day mortality of 1.11% for BPD-DS, 0.16% for RYGB, and 0.06% for AGB [25]. Another study evaluating LSG found its rate between LAGB and RYGB to be 0.11%, 0.05%, and 0.14% respectively [22]. Overall complication rate is estimated between 4-25% [26]. Most common adverse effects after bariatric surgery are iron deficiency anemia after bypass operations (15%) and reoperations (8%) [14]. RYGB, among others, is associated with higher complication rates, while LAGB showed more reoperation rates, up to 35% according to a large cohort study [27].

There is still no universal agreement to recommend one procedure over another. Choice of the procedure depends on many factors such as the available expertise, risk stratification, patient preferences, and goal of therapy (weight loss vs glycemic control) [25].

Knowledge Gap

We aim to undertake a prospective study evaluating and comparing several surgical bariatric procedures in an Iranian population of morbidly obese patients presenting to a specialized bariatric center. As newer techniques such as LSG (as a stand-alone operation) and mini-gastric bypass are emerging and gaining popularity, their role in bariatric surgery needs to be evaluated before incorporation into general practice.

This is one of the very first studies of its kind in the Middle East and addresses the knowledge gap on the effectiveness,

safety, and efficacy of bariatric surgical techniques, including LSG, mini-bypass, and gastric plication [28].

Methods

Objectives and Study Variables

The main objectives of the study are to identify perioperative problems of morbidly obese patients; to assess and compare the effectiveness of different bariatric surgical techniques on metabolic syndrome and other obesity-related comorbidity, by measuring anthropometric indices, EWL rates, glucose homeostasis, blood pressure, lipid profile, hormone levels, and nutritional status; to assess the psychosocial aspects of obesity before and after the bariatric surgery, and long term, including quality of life and depression; and to explore the mechanisms and underlying pathophysiology in the field of obesity and its comorbidities through pathological, genetic, and molecular studies. The study variables are summarized in [Table 1](#).

Overall Study Design

Tehran Obesity Treatment Study (TOTS) is an ongoing, single-institution, prospective study commencing March 2013. The TOTS enrolls patients to undergo a bariatric procedure based on an individualized clinical decision plan. It is organized into 4 phases: preoperative evaluation, operation, short-term follow-up, and long-term follow-up.

Preoperative Evaluation

Baseline data collected by the research team includes demographic data, anthropometric indices, physical examination, quality of life score, psychological data, and physical activity levels. Patients are then referred for several assessments including cardiac and respiratory (including ECG, echocardiogram, chest x-ray, pulmonary function test, and/or polysomnography), gastrointestinal (endoscopy and/or barium meal and abdominal ultrasound), endocrine, and psychological assessments. Patient participation depends on approval by all the consultants. Blood and urine samples are collected preoperatively (see [Multimedia Appendix 1](#)). An obesity expert physician then assesses each individual's data. Written informed consent is obtained from all the participants, including minors and adolescents who are told fully about the study. After their approval for participation, written consent is obtained from their parents or guardians.

Operation

Patients undergo one of several different bariatric procedures. Detailed data regarding anesthesiology, operation, and recovery are collected.

Short-Term Follow-Up

Post-operative follow-up for complications of surgery as well as other issues are sought and documented. Data regarding

anthropometric indices and physical examination are collected at 1 month and 3 months after surgery. At the next visit 6 months postoperatively, a more detailed assessment, including blood samples, is done.

Long-Term Follow-Up

Patients are followed annually and reassessed on all baseline variables.

Subject Recruitment and Eligibility For Surgery

Severely obese patients presenting to the Tehran Obesity Treatment Center are examined by an obesity expert in the clinic to evaluate whether they meet the study inclusion criteria. Patients then attend a free-of-charge monthly comprehensive seminar in order to increase their awareness on the subject and promote active participation in the treatment plan. After providing written informed consent, patients proceed with individualized comprehensive sessions and decisions about suitability of surgery and the specific technique are made.

Inclusion criteria were 15-65 years old, BMI levels ≥ 40 kg/m² or $30 < \text{BMI} < 35$ kg/m² with a medical comorbidity/failure of intensive medical treatment for at least 1 year, acceptable surgical risk, and able and willing to provide informed consent and assure regular follow-up.

Exclusion criteria were obesity due to a treatable medical disease (eg, endocrine abnormality); any other medical, psychological, or social condition which, in the opinion of the investigators, would interfere with safe completion of the study protocol; high operative risk; contraindication to bariatric surgery or weight loss; active drug addiction; nursing, pregnant, or intending to become pregnant in the following year; and unable or unwilling to complete questionnaires or expected to experience difficulty with attendance of visits or completion of study.

Surgical Procedures

Bariatric procedures that are performed in this study include RYGB, LAGB, LSG, and mini-gastric bypass. Newer techniques such as gastric plication are also considered as a treatment option in suitable candidates. In order to record all aspects of the procedures from pre-op to postop, we broke down each of the surgical procedures into its components (eg, length of alimentary limb, pouch size) and structured a measuring scheme.

A single surgical team will perform all operations under general anesthesia, with the patient in the supine position. A standard 5-port laparoscopic technique with the bed in the reverse Trendelenburg position is used. Patients not suitable for laparoscopy will undergo a traditional laparotomy (see [Multimedia Appendix 1](#)).

Table 1. TOTS variables and their assessment.

Items ^a	Baseline	Discharge	1 month	3 months	6 months	12 months	Annually
Demographic & medical history^b							
Date of birth, sex, income, insurance	✓						
Marriage & education	✓						
Past medical history	✓						
Family history	✓						
Medications	✓	✓	✓	✓	✓	✓	✓
Behavioral & psychosocial assessment							
Diet and nutrition behavior	✓					✓	✓
Physical activity	✓					✓	✓
Quality of life	✓					✓	✓
Depression	✓					✓	✓
Smoking	✓						
Alcohol consumption	✓						
Drug abuse	✓						
Anthropometrics & physical examination							
Anthropometrics (height, weight, BMI, WC, HC, NC, wrist C)	✓		✓	✓	✓	✓	✓
Body composition (FM, FFM, LM)	✓		✓	✓	✓	✓	✓
General physical examination	✓		✓	✓	✓	✓	✓
Obesity-related comorbidities	✓		✓	✓	✓	✓	✓
Medical condition							
Cardiovascular (ECG, echocardiography)	✓					✓ ^c	✓ ^c
Respiratory (Chest X-ray, ABG, PFT, polysomnography)	✓					✓ ^c	✓ ^c
Gastrointestinal (endoscopy/barium meal, liver & gallbladder ultrasound)	✓				✓	✓ ^c	✓ ^c

Items ^a	Baseline	Discharge	1 month	3 months	6 months	12 months	Annually
Blood & urine assessments							
General blood biochemistry (CBC, LFT, LP)	✓				✓	✓	✓
Glucose homeostasis (FPG, HbA1C)	✓				✓	✓	✓
Hormonal assessment (TFT, PTH, Insulin)	✓					✓	✓
Micronutrients (Ca, P, Fe, Cu, Zn)	✓					✓	✓
Vitamins (D, B12)	✓					✓	✓
Inflammatory markers (CRP)	✓					✓	✓
24-hr urine albumin & creatinine	✓					✓ ^c	✓ ^c
Surgery							
General information (center, date, time, anesthetics)		✓					
Surgical procedure details		✓					
Additional/unprecedented procedures		✓					
Outcomes							
30-day surgical complications		✓	✓				
Long-term complications					✓	✓	✓
Re-admission ^d					✓	✓	✓
Reoperation					✓	✓	✓
EWL%			✓	✓	✓	✓	✓
Metabolic assessment			✓	✓	✓	✓	✓

^aWC: waist circumference; HC: hip circumference; NC: neck circumference; Wrist C: wrist circumference; FM: fat mass; FFM: fat-free mass; LM: lean mass; ECG: electrocardiography; ABG: arterial blood gas; PFT: pulmonary function test; CBC: complete blood count; LFT: liver function test; LP: lipid profile; FBG: fasting plasma glucose; HbA1C: hemoglobin A1C; TFT: thyroid function test; PTH: parathyroid hormone; CRP: C-reactive protein.

^b[Multimedia Appendix 1](#) for more information about the online forms.

^cIf necessary.

^dIncluding in-patient and out-patient care.

Data Collection & Quality Control Procedures

An electronic database for precise data collection was designed. Manuals of operations and procedures were also created to minimize technical variability. Data collectors including study investigators and surgeons underwent training and certification with respect to study protocols. Quality control procedures including frequent contacts and visits between the surgeon and clinical center staff help to ensure complete and accurate data collection. Investigators used validated and standardized instruments for objective and subjective measures. When not available, new instruments were created to meet the specific goals of the study (see [Multimedia Appendix 1](#)).

A brief summary of each outcome domain and standard forms and measures used to assess each of these domains, as well as the contact points at which they will be administered, are described below.

Clinical Endpoints

In order to evaluate the effectiveness of bariatric surgery on obesity and obesity-related comorbidities, all participants are interviewed by a trained physician to complete a standardized clinical history questionnaire. It covers risk factors for cardiovascular disease, hypertension, hyperlipidemia, diabetes, and familial history of non-communicable diseases, smoking habits, drug abuse, and alcohol consumption. A similar postoperative survey is completed as well. The physicians are required to undergo periodic evaluation according to written protocols and control procedures to ensure up-to-date and universal practice.

Physical Examination and Anthropometric Measurements

Physical examination aims to look for obesity-related conditions as well as general health status of the individual. Anthropometrics include weight, height, neck, waist, wrist, and hip circumference, measured according to WHO guidelines [29]. Body composition is assessed by a portable bioelectrical impedance analyzer and output data includes body weight (kg), impedance (ohms), fat mass (kg), fat-free mass (kg), total body water (kg), and percent body fat (%) (see [Multimedia Appendix 1](#)).

Behavioral and Psychosocial Factors

The TOTS investigators have hypothesized that pre-existing psychological and behavioral factors could influence the outcomes after bariatric surgery. These aspects, such as quality of life and depression, will be assessed at baseline and follow-up, and will include questions on preoperative weight loss practices and eating habits (including binge eating and eating beyond satiation), tobacco use (according to US Centers for Disease Control and Prevention) [30], alcohol use, history of psychiatric disorders, and counselor/therapist contact. The depressive symptoms will be assessed using the Persian-language version of Beck Depression Inventory, version 1 [31,32]. Moreover, quality of life will be assessed by the Iranian version of Short Form Health Survey (SF-36) that measures eight health-related concepts, including the physical, mental, and social aspects of health [33]. Physical activity levels are assessed using the Persian-translated long form of

International physical activity questionnaire (Persian IPAQ) [34]. The questionnaire measures all three forms of activities including leisure time, job, and household activities in the past week (see [Multimedia Appendix 1](#)).

Dietary Assessment

Diet plays a central role in the pathophysiology of obesity, as well as obesity treatment. Maintenance of weight loss after bariatric procedures is mainly achieved through changing dietary habits. In order to assess the role of diet on obesity before and after surgical interventions, an expert nutritionist assesses dietary intake of the patients using three consecutive 24-hour recalls, on weekdays (we selected weekdays because weekends do not reflect the usual diet of a patient). Portion sizes of meals are converted to grams by using household measures [35]. Nutrient intakes are calculated according to the US Department of Agriculture and Iranian Food Composition Tables [36,37].

Blood and Urine Biochemical Assessment

Blood and urine samples are collected before and after the surgery at 6 and 12 months, and annually thereafter. After 12-14 hours overnight fast, multiple aliquots of blood are drawn for biochemical and future genetic/molecular assessments. A standard 24-h urine collection is advised for all participants (see [Multimedia Appendix 1](#)).

Genetics and Biomarkers

DNA obtained from consenting participants will be part of an ongoing research effort by our team to identify genes related to human obesity. Blood samples drawn from subjects before and after the surgery are stored for further studies (see [Multimedia Appendix 1](#)).

Health Care Utilization

Studies addressing cost-effectiveness of bariatric surgery have shown controversial results and have not yet reached a universal conclusion [38-41]. In order to assess the financial burden of obesity in our setting, a dataset is designed to measure and evaluate short- and long-term cost-effectiveness of bariatric surgery pre and postoperatively.

Complications Related to Surgery

To document the frequency of complications after these most common techniques, as well as newer techniques in this study, a dataset is designed to describe early (occurring within 30 days of surgery) and long-term complications and factors associated with those events. Early complications known to complicate abdominal surgery include gastrointestinal adverse events (eg, anastomotic leak), thromboembolism, sepsis, and acute kidney injury. Long-term complications include gastrointestinal complications, cardiovascular events, and surgical re-intervention [42].

Follow-Up

All participants are scheduled for follow-up visits by a multidisciplinary team (ie, surgeon, obesity specialist, endocrinologist, and dietitian) at 10 days, and at 1, 3, 6, and 12 months, and annually thereafter. A trained nurse will ask about related medical conditions by means of email or over the phone (including cardiovascular, metabolic, pulmonary, renal,

musculoskeletal, urologic, reproductive, and gastrointestinal outcomes), and if a related event is noticed, the research investigator will actively seek respective data. In the case of mortality, data will be collected based on the death certificate.

Approval

This study has been approved by the Human Research Review Committee of the Endocrine Research Center, Shahid Beheshti University of Medical Sciences, No. 2ECRIES 93/03/13.

Results

This study has recruited 1050 participants as of September 2015 and is ongoing. Mean age of the participants is 37.8 years, mean BMI of 43.7 kg/m², with 76.9% female. Detailed characteristics of the participants including their baseline anthropometrics and prevalence of comorbidities are presented in [Table 2](#).

Table 2. Baseline characteristics, anthropometrics, and laboratory values of the participants upon enrollment^a.

Variables ^b	Total (N=1050)	Female (N=807)	Male (N=243)	P value
Age, year, mean (SD)	37.8 (11.7)	38.6 (11.8)	35.2 (11)	.036
Age group, n (%)				<.001
<20	52 (4.2)	39 (4.1)	13 (4.9)	
20-29	229 (21.8)	162 (19.7)	67 (28.2)	
30-39	339 (32.8)	251 (31.8)	88 (36.7)	
40-49	241 (22.8)	197 (24.3)	44 (17.5)	
50-59	148 (14.7)	123 (15.8)	25 (10.9)	
60-69	39 (3.5)	34 (4.1)	5 (1.3)	
≥70	2 (0.2)	1 (0.1)	1 (0.4)	
Marital status, n (%)				.014
Single/never married	252 (24.1)	169 (25.2)	83 (37.6)	
Married	668 (61.7)	526 (62.7)	142 (58.4)	
Divorced	62 (6.2)	52 (6.4)	10 (4.1)	
Widowed	46 (3.6)	46 (5.7)	0	
Education, n (%)				.024
No education	10 (1.0)	7 (0.9)	3 (1.2)	
Primary school	27 (13.8)	23 (15.0)	4 (1.8)	
College	531 (50.7)	430 (52.2)	101 (45.9)	
University	448 (34.5)	321 (32.1)	127 (43.1)	
Employment status, n (%)				<.001
Unemployed	567 (54)	521 (64.6)	46 (18.9)	
Employed	458 (46)	261 (35.4)	197 (81.1)	
Smoking status, n (%)				<.001
Never smokers	819 (71.2)	661 (78.9)	158 (44.9)	
Current smokers	156 (15.4)	89 (11.2)	67 (30)	
Former smokers	143 (13.4)	80 (9.9)	63 (25.1)	
Hookah use, n (%)	163 (15.5)	91 (11.3)	72 (29.6)	.004
Alcohol consumption, n (%)	150 (14.3)	86 (10.7)	64 (26.3)	.004
Comorbidities, n (%)				
Hypothyroidism	186 (17.8)	169 (18.5)	17 (6.5)	<.001
Hypertension	174 (17.6)	137 (17.1)	37 (15.3)	
Dyslipidemia	168 (16.0)	137 (17.0)	31 (12.8)	
Arthritis	167 (15.9)	144 (17.8)	23 (9.5)	.039
Diabetes mellitus	158 (16.6)	127 (17.3)	31 (8.9)	
Cardiovascular disease	63 (6.0)	47 (5.8)	16 (6.6)	
Liver Enlargement	350 (92.1)	287 (72.4)	63 (83.5)	
Fatty liver	106 (27.5)	87 (27.4)	19 (27.5)	
Grade I	134 (35.2)	124 (41.4)	10 (17.1)	
Grade II	155 (40.7)	125 (41.6)	30 (45.4)	
Grade III	61 (16.2)	38 (17.0)	23 (33.3)	
Gallstones	34 (7.1)	30 (7.4)	4 (5.1)	

Variables ^b	Total (N=1050)	Female (N=807)	Male (N=243)	P value
Anthropometrics, mean (SD)				
Height, cm	163.5 (8.3)	161.2 (6.1)	175.5 (7.8)	<.001
Weight, kg (range 74-195)	118.6 (20.7)	114 (17.1)	142.6 (20.9)	<.001
BMI, kg/m ² (range 32.4-79.3)	43.9 (7.1)	43.8 (5.9)	46.2 (5.5)	.09
BMI group (kg/m²), n (%)				.054
25-29.9	9 (0.9)	8 (1)	1 (0.4)	
30-34.9	68 (6.3)	57 (7.4)	11 (4.4)	
35-39.9	243 (23.2)	197 (24.2)	46 (19.9)	
40-44.9	332 (32.1)	261 (32.5)	71 (30.7)	
45-49.9	235 (22.4)	176 (21.5)	59 (25.5)	
50-54.9	99 (9.3)	67 (8.2)	32 (13)	
55-59.9	42 (3.7)	24 (3.1)	18 (6.9)	
60-64.9	13 (1.3)	9 (1.2)	4 (1.7)	
65-69.9	7 (0.7)	6 (0.8)	1 (0.4)	
≥70	2 (0.2)	2 (0.3)	0 (0.0)	
Waist circumference, cm	125.1 (13.9)	122.5 (12.6)	138 (12.6)	<.001
Hip circumference, cm	133.6 (12.7)	133.5 (13)	134.4 (11.1)	.065
Neck circumference, cm	39.1 (3.9)	37.9 (2.8)	44.7 (3.4)	<.001
Wrist circumference, cm	17.9 (1.6)	17.6 (1.4)	19.5 (1.7)	<.001
SBP, mmHg	120.1 (16.7)	119.4 (16.6)	124.1 (16.5)	
DBP, mmHg	75.9 (11.8)	75.3 (11.6)	79 (12.7)	
Fat mass, %	49.8 (3.9)	50.6 (3.2)	46 (4.7)	<.001
Fat mass, kg	58.2 (11.9)	6.9 (10.8)	64.4 (15)	<.001
Fat free mass, kg	59 (11.4)	55.5 (7.5)	75.9 (12)	<.001
Laboratory values, mean (SD)				
FPG, mg/dl	107.9 (34.5)	109.4 (36.5)	99.6 (18.8)	<.001
HbA1C, %	5.6 (1)	5.6 (1.1)	5.6 (0.7)	.037
TG, mg/dl	152.7 (76)	150.3 (70.9)	164.8 (97.7)	
Cholesterol, mg/dl	192.4 (38)	193.5 (37.4)	186.6 (41.4)	.033
HDL, mg/dl	49.6 (10.9)	50.2 (10.8)	46.3 (10.5)	.001
LDL, mg/dl	112.5 (32.2)	113 (31.7)	109.6 (35.0)	
Hemoglobin, g/dl	13.5 (1.5)	13.2 (1.2)	15.2 (1.4)	<.001
Hematocrit, %	41.0 (3.9)	40.2 (3.2)	45.7 (3.5)	<.001
AST, U/l	23.4 (15.5)	21.8 (12.8)	29.2 (18.6)	.007
ALT, U/l	28.7 (21.3)	26.1 (15.5)	41.3 (31.3)	<.001
Alkaline phosphatase, IU/l	191.8 (57.7)	191.4 (56.5)	194 (63.8)	

^aFor continuous variables, *t* test was used. For categorical variables, Pearson chi-square test was used.

^bSBP: systolic blood pressure; DBP: diastolic blood pressure; FPG: fasting plasma glucose; HbA1C: hemoglobin A1C; TG: triglyceride; HDL: high-density lipoprotein; LDL: low-density lipoprotein; AST: aspartate aminotransferase; ALT: alanine aminotransferase

Discussion

The TOTS is a prospective longitudinal study evaluating many preoperative, operative, and post-operative aspects of bariatric surgery. High fidelity results are assured through the use of

standard validated instruments. Results of this study will provide a comprehensive understanding of this growing medical condition and its treatment and will empower clinicians with evidence-based recommendations regarding patient selection and evaluation, surgery options, and follow-up care.

Acknowledgments

This study was based upon a thesis project and funded by the Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran. The authors would like to express their gratitude to the patients participating in the study, as well as Tehran Obesity Treatment Center and hospitals staff and our study coordinators. They would also like to thank the LABS consortium for allowing the use of some of their data collection forms.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Supplemental information.

[\[PDF File \(Adobe PDF File\), 282KB-Multimedia Appendix 1\]](#)

References

1. World Health Organization. Obesity and overweight, Fact sheet N° 311. 2015. WHO Media centre URL: <http://www.who.int/mediacentre/factsheets/fs311/en/> [accessed 2015-12-24] [WebCite Cache ID 6e0qYc8mX]
2. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA* 2014 Feb 26;311(8):806-814. [doi: [10.1001/jama.2014.732](https://doi.org/10.1001/jama.2014.732)] [Medline: [24570244](https://pubmed.ncbi.nlm.nih.gov/24570244/)]
3. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *JAMA* 2012 Feb 1;307(5):491-497. [doi: [10.1001/jama.2012.39](https://doi.org/10.1001/jama.2012.39)] [Medline: [22253363](https://pubmed.ncbi.nlm.nih.gov/22253363/)]
4. Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. *J Clin Endocrinol Metab* 2008 Nov;93(11 Suppl 1):S9-30. [doi: [10.1210/jc.2008-1595](https://doi.org/10.1210/jc.2008-1595)] [Medline: [18987276](https://pubmed.ncbi.nlm.nih.gov/18987276/)]
5. Kelishadi R, Alikhani S, Delavari A, Alaedini F, Safaie A, Hojatzadeh E. Obesity and associated lifestyle behaviours in Iran: findings from the First National Non-communicable Disease Risk Factor Surveillance Survey. *Public Health Nutr* 2008 Mar;11(3):246-251. [doi: [10.1017/S1368980007000262](https://doi.org/10.1017/S1368980007000262)] [Medline: [17625028](https://pubmed.ncbi.nlm.nih.gov/17625028/)]
6. Gregg EW, Cheng YJ, Narayan KMV, Thompson TJ, Williamson DF. The relative contributions of different levels of overweight and obesity to the increased prevalence of diabetes in the United States: 1976-2004. *Prev Med* 2007 Nov;45(5):348-352. [doi: [10.1016/j.ypmed.2007.07.020](https://doi.org/10.1016/j.ypmed.2007.07.020)] [Medline: [17889292](https://pubmed.ncbi.nlm.nih.gov/17889292/)]
7. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA* 1999 Oct 27;282(16):1523-1529. [Medline: [10546691](https://pubmed.ncbi.nlm.nih.gov/10546691/)]
8. Wadden TA, Sarwer DB, Womble LG, Foster GD, McGuckin BG, Schimmel A. Psychosocial aspects of obesity and obesity surgery. *Surg Clin North Am* 2001 Oct;81(5):1001-1024. [Medline: [11589242](https://pubmed.ncbi.nlm.nih.gov/11589242/)]
9. Ma J, Xiao L. Obesity and depression in US women: results from the 2005-2006 National Health and Nutritional Examination Survey. *Obesity (Silver Spring)* 2010 Feb;18(2):347-353. [doi: [10.1038/oby.2009.213](https://doi.org/10.1038/oby.2009.213)] [Medline: [19590500](https://pubmed.ncbi.nlm.nih.gov/19590500/)]
10. Ryan DH, Johnson WD, Myers VH, Prather TL, McGlone MM, Rood J, et al. Nonsurgical weight loss for extreme obesity in primary care settings: results of the Louisiana Obese Subjects Study. *Arch Intern Med* 2010 Jan 25;170(2):146-154. [doi: [10.1001/archinternmed.2009.508](https://doi.org/10.1001/archinternmed.2009.508)] [Medline: [20101009](https://pubmed.ncbi.nlm.nih.gov/20101009/)]
11. Buchwald H, Avidor Y, Braunwald E, Jensen MD, Pories W, Fahrbach K, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004 Oct 13;292(14):1724-1737. [doi: [10.1001/jama.292.14.1724](https://doi.org/10.1001/jama.292.14.1724)] [Medline: [15479938](https://pubmed.ncbi.nlm.nih.gov/15479938/)]
12. Christou NV, Sampalis JS, Liberman M, Look D, Auger S, McLean APH, et al. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. *Ann Surg* 2004 Sep;240(3):416-423; discussion 423. [Medline: [15319713](https://pubmed.ncbi.nlm.nih.gov/15319713/)]
13. Adams TD, Gress RE, Smith SC, Halverson RC, Simper SC, Rosamond WD, et al. Long-term mortality after gastric bypass surgery. *N Engl J Med* 2007 Aug 23;357(8):753-761. [doi: [10.1056/NEJMoa066603](https://doi.org/10.1056/NEJMoa066603)] [Medline: [17715409](https://pubmed.ncbi.nlm.nih.gov/17715409/)]
14. Gloy VL, Briel M, Bhatt DL, Kashyap SR, Schauer PR, Mingrone G, et al. Bariatric surgery versus non-surgical treatment for obesity: a systematic review and meta-analysis of randomised controlled trials. *BMJ* 2013;347:f5934 [FREE Full text] [Medline: [24149519](https://pubmed.ncbi.nlm.nih.gov/24149519/)]
15. Adams TD, Davidson LE, Litwin SE, Kolotkin RL, LaMonte MJ, Pendleton RC, et al. Health benefits of gastric bypass surgery after 6 years. *JAMA* 2012 Sep 19;308(11):1122-1131 [FREE Full text] [doi: [10.1001/2012.jama.11164](https://doi.org/10.1001/2012.jama.11164)] [Medline: [22990271](https://pubmed.ncbi.nlm.nih.gov/22990271/)]

16. Sjöström L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. *J Intern Med* 2013 Mar;273(3):219-234 [FREE Full text] [doi: [10.1111/joim.12012](https://doi.org/10.1111/joim.12012)] [Medline: [23163728](https://pubmed.ncbi.nlm.nih.gov/23163728/)]
17. Chang S, Stoll CR, Song J, Varela JE, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. *JAMA Surg* 2014 Mar;149(3):275-287 [FREE Full text] [doi: [10.1001/jamasurg.2013.3654](https://doi.org/10.1001/jamasurg.2013.3654)] [Medline: [24352617](https://pubmed.ncbi.nlm.nih.gov/24352617/)]
18. Maggard MA, Shugarman LR, Suttorp M, Maglione M, Sugeran HJ, Sugarman HJ, et al. Meta-analysis: surgical treatment of obesity. *Ann Intern Med* 2005 Apr 5;142(7):547-559. [Medline: [15809466](https://pubmed.ncbi.nlm.nih.gov/15809466/)]
19. Sjöström L, Narbro K, Sjöström C, Karason K, Larsson B, Wedel H, Swedish Obese Subjects Study. Effects of bariatric surgery on mortality in Swedish obese subjects. *N Engl J Med* 2007 Aug 23;357(8):741-752. [doi: [10.1056/NEJMoa066254](https://doi.org/10.1056/NEJMoa066254)] [Medline: [17715408](https://pubmed.ncbi.nlm.nih.gov/17715408/)]
20. Longitudinal Assessment of Bariatric Surgery (LABS) Consortium, Flum DR, Belle SH, King WC, Wahed AS, Berk P, et al. Perioperative safety in the longitudinal assessment of bariatric surgery. *N Engl J Med* 2009 Jul 30;361(5):445-454 [FREE Full text] [doi: [10.1056/NEJMoa0901836](https://doi.org/10.1056/NEJMoa0901836)] [Medline: [19641201](https://pubmed.ncbi.nlm.nih.gov/19641201/)]
21. Mechanick JI, Youdim A, Jones DB, Timothy GW, Hurley DL, Molly MM, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient--2013 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery. *Surg Obes Relat Dis* 2013;9(2):159-191. [doi: [10.1016/j.soard.2012.12.010](https://doi.org/10.1016/j.soard.2012.12.010)] [Medline: [23537696](https://pubmed.ncbi.nlm.nih.gov/23537696/)]
22. Hutter MM, Schirmer BD, Jones DB, Ko CY, Cohen ME, Merkow RP, et al. First report from the American College of Surgeons Bariatric Surgery Center Network: laparoscopic sleeve gastrectomy has morbidity and effectiveness positioned between the band and the bypass. *Ann Surg* 2011 Sep;254(3):410-420; discussion 420 [FREE Full text] [doi: [10.1097/SLA.0b013e31822c9dac](https://doi.org/10.1097/SLA.0b013e31822c9dac)] [Medline: [21865942](https://pubmed.ncbi.nlm.nih.gov/21865942/)]
23. Colquitt JL, Pickett K, Loveman E, Frampton GK. Surgery for weight loss in adults. *Cochrane Database Syst Rev* 2014;8:CD003641. [doi: [10.1002/14651858.CD003641.pub4](https://doi.org/10.1002/14651858.CD003641.pub4)] [Medline: [25105982](https://pubmed.ncbi.nlm.nih.gov/25105982/)]
24. Demaria EJ, Winegar DA, Pate VW, Hutcher NE, Ponce J, Pories WJ. Early postoperative outcomes of metabolic surgery to treat diabetes from sites participating in the ASMBS bariatric surgery center of excellence program as reported in the Bariatric Outcomes Longitudinal Database. *Ann Surg* 2010 Sep;252(3):559-566; discussion 566. [doi: [10.1097/SLA.0b013e3181f2aed0](https://doi.org/10.1097/SLA.0b013e3181f2aed0)] [Medline: [20739857](https://pubmed.ncbi.nlm.nih.gov/20739857/)]
25. Buchwald H, Estok R, Fahrbach K, Banel D, Sledge I. Trends in mortality in bariatric surgery: a systematic review and meta-analysis. *Surgery* 2007 Oct;142(4):621-632; discussion 632. [doi: [10.1016/j.surg.2007.07.018](https://doi.org/10.1016/j.surg.2007.07.018)] [Medline: [17950357](https://pubmed.ncbi.nlm.nih.gov/17950357/)]
26. Arterburn DE, Courcoulas AP. Bariatric surgery for obesity and metabolic conditions in adults. *BMJ* 2014;349:g3961 [FREE Full text] [Medline: [25164369](https://pubmed.ncbi.nlm.nih.gov/25164369/)]
27. O'Brien PE, MacDonald L, Anderson M, Brennan L, Brown WA. Long-term outcomes after bariatric surgery: fifteen-year follow-up of adjustable gastric banding and a systematic review of the bariatric surgical literature. *Ann Surg* 2013 Jan;257(1):87-94. [doi: [10.1097/SLA.0b013e31827b6c02](https://doi.org/10.1097/SLA.0b013e31827b6c02)] [Medline: [23235396](https://pubmed.ncbi.nlm.nih.gov/23235396/)]
28. Puzifferri N, Roshek TB, Mayo HG, Gallagher R, Belle SH, Livingston EH. Long-term follow-up after bariatric surgery: a systematic review. *JAMA* 2014 Sep 3;312(9):934-942 [FREE Full text] [doi: [10.1001/jama.2014.10706](https://doi.org/10.1001/jama.2014.10706)] [Medline: [25182102](https://pubmed.ncbi.nlm.nih.gov/25182102/)]
29. Samuelson G. Physical Status: The Use and Interpretation of Anthropometry. WHO Technical Report Series. *Acta Pædiatrica* 1997;86(3):280.
30. Schoenborn CA, Adams PE. Health behaviors of adults: United States, 2005-2007. *Vital Health Stat* 10 2010 Mar(245):1-132 [FREE Full text] [Medline: [20669609](https://pubmed.ncbi.nlm.nih.gov/20669609/)]
31. BECK AT, WARD CH, MENDELSON M, MOCK J, ERBAUGH J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961 Jun;4:561-571. [Medline: [13688369](https://pubmed.ncbi.nlm.nih.gov/13688369/)]
32. Ghassemzadeh H, Mojtabai R, Karamghadiri N, Ebrahimkhani N. Psychometric properties of a Persian-language version of the Beck Depression Inventory--Second edition: BDI-II-PERSIAN. *Depress Anxiety* 2005;21(4):185-192. [doi: [10.1002/da.20070](https://doi.org/10.1002/da.20070)] [Medline: [16075452](https://pubmed.ncbi.nlm.nih.gov/16075452/)]
33. Ware JE, Gandek B. Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project. *J Clin Epidemiol* 1998 Nov;51(11):903-912. [Medline: [9817107](https://pubmed.ncbi.nlm.nih.gov/9817107/)]
34. Booth M. Assessment of physical activity: an international perspective. *Res Q Exerc Sport* 2000 Jun;71(2 Suppl):S114-S120. [Medline: [10925833](https://pubmed.ncbi.nlm.nih.gov/10925833/)]
35. Ghaffarpour MH, Kianfar H. The manual for household measures, cooking yields factors and edible portion of foods. Tehran, Iran: Keshavarzi Press; 1999.
36. Azar MS. Food Composition Table of Iran. Tehran, Iran: National Nutrition and Food Research Institute of Shaheed Beheshti University; 1980.
37. USDA National Nutrient Database for Standard Reference, Release 24. 2011. URL: <http://www.ars.usda.gov/Services/docs.htm?docid=8964> [accessed 2015-12-24] [WebCite Cache ID 6e0rSGiXI]

38. Makary MA, Clark JM, Clarke JM, Shore AD, Magnuson TH, Richards T, et al. Medication utilization and annual health care costs in patients with type 2 diabetes mellitus before and after bariatric surgery. *Arch Surg* 2010 Aug;145(8):726-731. [doi: [10.1001/archsurg.2010.150](https://doi.org/10.1001/archsurg.2010.150)] [Medline: [20713923](https://pubmed.ncbi.nlm.nih.gov/20713923/)]
39. Weiner JP, Goodwin SM, Chang H, Bolen SD, Richards TM, Johns RA, et al. Impact of bariatric surgery on health care costs of obese persons: a 6-year follow-up of surgical and comparison cohorts using health plan data. *JAMA Surg* 2013 Jun;148(6):555-562. [doi: [10.1001/jamasurg.2013.1504](https://doi.org/10.1001/jamasurg.2013.1504)] [Medline: [23426865](https://pubmed.ncbi.nlm.nih.gov/23426865/)]
40. Picot J, Jones J, Colquitt JL, Loveman E, Clegg AJ. Weight loss surgery for mild to moderate obesity: a systematic review and economic evaluation. *Obes Surg* 2012 Sep;22(9):1496-1506. [doi: [10.1007/s11695-012-0679-z](https://doi.org/10.1007/s11695-012-0679-z)] [Medline: [22926715](https://pubmed.ncbi.nlm.nih.gov/22926715/)]
41. Bleich SN, Chang H, Lau B, Steele K, Clark JM, Richards T, et al. Impact of bariatric surgery on health care utilization and costs among patients with diabetes. *Med Care* 2012 Jan;50(1):58-65 [FREE Full text] [doi: [10.1097/MLR.0b013e3182290349](https://doi.org/10.1097/MLR.0b013e3182290349)] [Medline: [22167064](https://pubmed.ncbi.nlm.nih.gov/22167064/)]
42. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg* 2009 Aug;250(2):187-196. [doi: [10.1097/SLA.0b013e3181b13ca2](https://doi.org/10.1097/SLA.0b013e3181b13ca2)] [Medline: [19638912](https://pubmed.ncbi.nlm.nih.gov/19638912/)]

Abbreviations

BMI: Body Mass Index

BPD/BPD-DS: biliopancreatic diversion with or without duodenal switch

EWL: excess weight loss

LAGB: laparoscopic adjustable gastric banding

LSG: laparoscopic sleeve gastrectomy

RYGB: Roux-en-Y gastric bypass

TOTS: Tehran Obesity Treatment Study

Edited by G Eysenbach; submitted 08.10.15; peer-reviewed by K Kazonuri; accepted 26.11.15; published 20.01.16

Please cite as:

Barzin M, Hosseinpanah F, Motamedi MA, Shapoori P, Arian P, Daneshpour MA, Asghari G, Teymoornejad A, Eslamifar A, Khalili D, Jodeiri B, Alamdari S, Azizi F, Khalaj A

Bariatric Surgery for Morbid Obesity: Tehran Obesity Treatment Study (TOTS) Rationale and Study Design

JMIR Res Protoc 2016;5(1):e8

URL: <http://www.researchprotocols.org/2016/1/e8/>

doi: [10.2196/resprot.5214](https://doi.org/10.2196/resprot.5214)

PMID: [26792554](https://pubmed.ncbi.nlm.nih.gov/26792554/)

©Maryam Barzin, Farhad Hosseinpanah, Mohammad Ali Motamedi, Parvin Shapoori, Peyman Arian, Maryam Alsadat Daneshpour, Golale Asghari, Ahmad Teymoornejad, Ali Eslamifar, Davood Khalili, Behzad Jodeiri, Shahram Alamdari, Fereidoun Azizi, Alireza Khalaj. Originally published in JMIR Research Protocols (<http://www.researchprotocols.org>), 20.01.2016. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Research Protocols, is properly cited. The complete bibliographic information, a link to the original publication on <http://www.researchprotocols.org>, as well as this copyright and license information must be included.