REVIEW

Nutritional Assessment and Preparation for Adult Bariatric Surgery Candidates: Clinical Practice

Shiri Sherf-Dagan,[1,2] Tali Sinai,[3,4] Ariela Goldenshluger,[5] Inbal Globus,[6] Yafit Kessler,[1,7] Chaya Schweiger,[8] and Tair Ben-Porat[9,10]

[1]Department of Nutritional Sciences, School of Health Sciences, Ariel University, Ariel, Israel; [2]Department of Nutrition, Assuta Medical Center, Tel Aviv, Israel; [3]Israel Center for Disease Control, Ministry of Health, Ramat Gan, Israel; [4]School of Nutritional Sciences, The Hebrew University of Jerusalem, Rehovot, Israel; [5]Department of Epidemiology and Preventive Medicine, School of Public Health, Sackler Faculty of Medicine, and Sylvan Adams Sports Institute, Tel-Aviv University, Tel Aviv, Israel; [6]Maccabi Healthcare Services, Tel Aviv, Israel; [7]Assia Medical Group, Assuta Medical Center, Tel Aviv, Israel; [8]Nutrition Service, Rabin Medical Center, Campus Beilinson, Petach Tiqva, Israel; [9]Department of Nutrition, Hadassah-Hebrew University Medical Center, Ein-Kerem Campus, Jerusalem, Israel; and [10]Department of Human Metabolism and Nutrition, Braun School of Public Health, Hebrew University, Jerusalem, Israel

ABSTRACT

Bariatric surgery (BS) has proven to be highly efficacious in the treatment of obesity and its comorbidities. However, careful patient selection is critical for its success. Thus, patients should undergo medical, behavioral, and nutritional assessment by a multidisciplinary team. From the nutritional point of view, BS candidates should undergo nutritional assessment, preparation, and education by a registered dietitian in the preoperative period. Currently, detailed specified and comprehensive information on these topics is lacking. The present narrative review aimed to summarize the available literature concerning both the preoperative nutritional assessment components and the preoperative nutritional preparation and education components of patients planning to undergo BS. Current literature indicates that proper management before BS should include a comprehensive nutritional assessment, in which it is advisable to perform a clinical interview to assess patients' medical background, weight management history, eating patterns and pathologies, oral health, physical activity habits, nutritional status, supplementation usage, BS knowledge, surgery expectations and anthropometric measurements. Nutritional preparation and educational strategies should include an individualized preoperative weight-loss nutrition program, improvement of glycemic control, micronutrients deficiencies correction, eating and lifestyle habits adaptation, physical activity initiation, and strengthening knowledge on obesity and BS. At this stage, more well-designed intervention and long-term cohort studies are needed in order to formulate uniform evidence-based nutritional guidelines for patients who plan to undergo BS, including populations at higher nutritional risk. Moreover, postoperative outcomes of presurgical nutritional intervention programs should be studied. *Adv Nutr* 2020;00:1–12.

Keywords: obesity surgery, nutrition evaluation, eating behaviors, dietary supplements, weight loss, oral health, glycemic control, physical activity, skeletal status

Introduction

Obesity is a recognized global disease that continues to be a risk factor for chronic medical conditions (1). Bariatric surgery (BS) has gained popularity in the last decades for the treatment of morbid obesity and its metabolic complications (2). However, some patients do not achieve the optimal outcome targets in terms of weight loss [i.e., achievement of ≥50% excess weight loss (EWL)], along with improvement in comorbidities and satisfaction (3). Moreover, it should also be noted that some patients regain a portion or all of their lost weight within a few years following surgery (4, 5). Presently, the leading types of bariatric procedures include sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), one anastomosis gastric bypass, adjustable gastric banding, and biliopancreatic diversion with (BPD-DS) or without (BPD) duodenal switch (2). Although there are currently no evidence-based protocols for choosing the most appropriate BS procedure type for the patients, in practice the choice is mostly based on individualized goals of therapy, patient preferences, existing comorbidities, personalized risk stratification, and the surgeon's medical opinion and experience (1, 6).

Author disclosures: The authors report no conflicts of interest.

Supplemental Table 1 is available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/advances.

Address correspondence to TB-P (e-mail: tairbp20@gmail.com).

Abbreviations used: BED, binge-eating disorder; BN, bulimia nervosa; BPD, biliopancreatic diversion; BPD-DS, biliopancreatic diversion with duodenal switch; BS, bariatric surgery; EWL, excess weight loss; HbA1c, glycated hemoglobin; NES, night eating syndrome; PTH, parathyroid hormone; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy; VLCD, very low-calorie diet; 25(OH)D, 25-hydroxyvitamin D.

The eligibility criteria to undergo BS are currently dependent on the patient's BMI and obesity-related comorbidities (1, 7, 8). Careful patient selection is critical to the success of BS (9). Thus, every patient who plans to undergo BS should undergo medical, behavioral, and nutritional assessment by a multidisciplinary team in order to evaluate his/her suitability to the surgery (1).

From the nutritional point of view, BS candidates should undergo preoperative nutritional evaluation, preparation, and education by a registered dietitian (8, 10–12).

Currently, detailed specified and comprehensive information on nutritional assessment, preparation, and education for BS candidates is lacking. Thus, the aim of the present narrative review is to summarize the scientific literature on preoperative nutritional assessment, preparation, and education of adult patients who plan to undergo BS. This review may assist medical teams, including and especially bariatric dietitians, to plan and perform proper management prior to BS.

Literature Search

A literature search was performed with the proposed line of searches for narrative reviews (13). The search included 3 electronic databases: PubMed, Google Scholar, and the Cochrane Library. Articles published up to May 2020 were selected. A combination of the relevant search terms of both BS and nutritional/clinical parameters was used (**Supplemental Table 1**). Reference lists of cited articles were also manually searched for additional relevant articles. The inclusion criteria were all types of articles with human subjects in English. The exclusion criteria were articles for which full text was not available and studies that focused on pediatric patients.

Current Status of Knowledge

Table 1 summarizes the recommended components of the presurgery nutritional assessment (1, 7, 11, 12, 14–22) and **Table 2** summarizes the recommended components of the preoperative nutritional preparation process (1, 11, 12, 17, 19, 20, 23–27).

Nutritional and clinical assessment

Eating behaviors.

Following BS, patients are expected to maintain various eating behaviors including dividing food intake into 4–6 meals throughout the day, consuming high-protein foods, chewing food slowly and thoroughly, ending meals when feeling "comfortably full," avoiding carbonated and high-calorie drinks, increasing water intake, separating liquids from solids, limiting consumption of calorie-dense foods and drinks, and avoiding binge eating, grazing, or snacking (11, 17, 25). However, poor eating habits were found to be prevalent among candidates for BS (17, 28–30) and maladaptive eating behaviors have been associated with poorer surgery outcomes (30–32). Therefore, detailed presurgical assessment of eating behaviors, including number and types of meals per day, liquid intake, eating patterns, eating pathologies, and eating pace, is crucial in order to learn and practice the needed behavioral changes before the surgery (11, 18, 28).

Special attention should be given to patients who restrict or avoid specific food groups, or to those who adhere to any dietary pattern that increases the risk of insufficient nutrient intake (33). Intervention should be made to help improve diet quality as needed. In cases where participants are found to be struggling to make the needed behavioral changes, more focus should be put on developing the needed coping skills (18). Presently, there is a lack of consensus regarding the definitions and methods to assess and address problematic eating behaviors prior to BS.

Eating disorders.

Accumulating evidence suggests that BS candidates are likely to present with eating disorders and/or problematic eating behaviors, and these problems may persist, be exacerbated, or even develop following the surgery (30). A recently published review found that a variety of often problematic eating behaviors appear more common among BS candidates as compared with nonobese populations (17). The literature suggests that 4–49% of candidates may present with binge eating disorder (BED; i.e., eating a large amount of food in a short time), 2–42% with night eating syndrome (NES), ∼3% with bulimia nervosa (BN), and 17–54% may meet the criteria for food addiction (17, 30, 34). However, variety in literature exists regarding the exact numbers of each eating disorder, with mixed findings related to gender (17). Screening for eating disorders should be done by the multidisciplinary team prior to the surgery and should be performed by qualified health professionals, including psychologists, social workers, psychiatrists, and dietitians (1, 7). According to the recently published position statement by the International Federation for the Surgery of Obesity and Metabolic Disorders, BED and NES are not considered as contraindications for BS, but untreated BN is considered a contraindication (7).

While presurgical evaluation of eating disorders is recommended in order to provide the necessary mental health support, established guidelines for assessment and how to proceed when an eating disorder is identified are limited and inconsistent (1, 35, 36). Structured diagnostic interviews are considered as the "gold standard" in assessing eating disorder conditions, but they are very time consuming and require highly skilled personnel (37). Some self-reported questionnaires are currently available, but they are not all validated among BS candidates (e.g., Eating Disorder Examination Questionnaire, the Binge Eating Scale, Questionnaire on Eating and Weight Patterns, Three Factor Eating Questionnaire) (37). However, minimization of problematic

TABLE 1 The recommended components of routine pre-surgery nutritional assessment[1]

Parameters	Measurements and evaluation strategies
Medical background	• Anamnesis should include comorbidities (e.g., diabetes mellitus, hypertension, sleep apnea), gastrointestinal symptoms, psychological background, substance use, sleep hygiene
Weight-management history	• Family history of obesity • Onset of obesity • Previous weight-loss regimens
Eating patterns	• Number and types of meals per day • Liquid intake • Eating patterns (e.g., vegetarian, lactose free, gluten free) • Dysregulated eating • Eating pace • Dietary restrictions including avoidance of certain food groups and/or aversion of certain foods • Evaluation of nutrients intake (energy, macronutrients and micronutrients intake by 24-h recall or food diary)
Eating pathologies	• Eating disorders assessment by multidisciplinary team using structured diagnostic interviews and/or self-reported validated questionnaires as needed
Anthropometric measurements	• Weight • Height • Waist circumference • Consider body-composition assessment by DXA or BIA if available
Nutritional status	• Screening for nutritional deficiencies • Tests should include at least: serum PTH, serum calcium, 25(OH)D, serum albumin, vitamin B-12, folate, blood cell count, iron, ferritin, transferrin, total iron binding capacity, electrolytes • Consider more extensive testing in patients undergoing malabsorptive procedures or with specific findings and at-risk patients (i.e., vitamins A, K, and E; thiamin; 24-h urine calcium excretion; zinc; and copper)
Supplementation use	• Type and dose of supplementation intake • Ability to swallow pills
Skeletal status	• DXA at spine and hip prior to malabsorptive surgeries (e.g., RYGB and BPD/BPD-DS) and in patients at higher risk[2]
Oral health	• General oral hygiene • Numbers of masticatory functional unities and chewing ability • If needed, consider referring to dentist for consultation
Physical activity habits	• Type, intensity, and frequency of exercise performance per week by specific questionnaires or objective measurements (e.g., pedometer) • Possible limitations and barriers to perform exercise • Mobility level by subjective assessment • Physical function assessment by validated methods such as the sit-to-stand test, hand grip, the 6-min walk test, or 12-min walk-to-run test
Bariatric surgery knowledge	• General knowledge of nutrition • Knowledge of surgical options and the optional side effects of the surgeries • Knowledge of the needed eating techniques and lifestyle habits • Knowledge of the risks of nutritional deficiencies, their consequences, and the high importance of adherence to supplementation regime following BS • Knowledge of the needed follow-up regime • It is recommended to use BS nutritional knowledge questionnaires if available
Surgery expectations	All the following should be determined if they are realistic: • Weight goal expectations • Expectations regarding the improvements in comorbidities • Expectations regarding the improvements in other life components

[1] BIA, bioelectrical impedance analysis; BPD, biliopancreatic diversion; BPD-DS, biliopancreatic diversion with duodenal switch; BS, bariatric surgery; PTH, parathyroid hormone; RYGB, Roux-en-Y gastric bypass; 25(OH)D, 25-hydroxyvitamin D.
[2] Women aged ≥65 y, men aged ≥70 y, and younger patients who have conditions associated with bone loss or low bone mass.

eating prior to surgery should be considered in specific cases (38).

Currently, there is inconsistent evidence regarding the association between preoperative eating disorders and postoperative weight loss (39, 40). This might be related to differences in study methodologies and differences in time of follow-up since the surgery (39). However, there is higher consistency for the association between the development or re-emergence of binge-eating symptoms postoperatively and worse surgical outcomes (40, 41). Binge eating is

TABLE 2 The recommended components of the presurgery nutritional preparation process[1]

Parameters	What should be included?
Adaptation of the needed eating and lifestyle habits	• Regular meal patterning by dividing food intake into 4–6 meals throughout the day and avoidance of meal skipping • Chewing food slowly and thoroughly • Emphasis on eating high-protein foods • Emphasis on solid foods in most of the meals to increase satiety • Ending meals when feeling "comfortably full" by attention to physiological hunger and satiety signals • Avoiding carbonated and high-calorie drinks, increasing water intake, and avoiding drinking during meals • Limiting consumption of calorie-dense foods and drinks, but increasing consumption of nutrient-dense foods • Emphasis on healthy eating
Micronutrients deficiencies correction	• Correct micronutrients deficiencies according to available guideline recommendations
Preoperative weight loss	• Preoperative weight-loss program according to the specific needs and circumstances of the patient
Improvement in glycemic control for patients with diabetes	• Presurgery glycemic control can be optimized by using dietary plan, physical activity, and pharmacotherapy when needed • Reasonable targets for diabetic patients preoperatively are HbA1c values of <7.0% • Reasonable targets for diabetic patients in cases of advanced macrovascular or microvascular complications, extensive comorbid condition, or long-lasting diabetes are HbA1c values of <8.0%
Physical activity initiation	• Providing physical activity program in terms of type, intensity, and frequency according to the patient's mobility level, functional abilities, cardiorespiratory fitness, barriers, and motivation
Strengthening knowledge on nutrition, obesity, and the BS process	Education regarding the following: • General knowledge on nutrition • Causes of obesity • Surgical options, potential complications, and the hospitalization process • Eating habits and dietary supplement regimen required for BS patients • Physical activity plan, stress management, and other lifestyle strategies for long-term success • The importance of long-term treatment plan by the BS multidisciplinary team • Expectations regarding weight loss, comorbidity improvement, and other life components should be discussed • Education may be delivered by personal appointments, live classroom sessions, phone-based support, video, website, slideshow, written materials, or by combinations of different approaches
Childbearing age women candidates for BS	• Nutritional counseling on recommended supplementations for women of childbearing age before BS, after BS, before conceiving, and during pregnancy • Referring to an obstetrician to discuss birth-control options

[1]The nutritional preparation and educational process should include all or some of the components listed in the table as needed. BS, bariatric surgery; HbA1c, glycated hemoglobin.

physically impossible immediately after surgery; however, loss of control over eating behavior or grazing can remain or evolve postoperatively and lead to less successful weight outcomes, vomiting, and related complications (41).

High-nutritional-risk candidates.

Presently, there are almost no formal nutritional contraindications for BS, although some populations may be considered at higher nutritional risk, including patients with untreated eating disorders (7, 38) or significant levels of food aversion, multiple nutritional deficiencies (42) or hypoalbuminemia (43), sarcopenic obesity (22), reduced bone density (21), poor oral hygiene (44), poor glycemic control (1), advanced kidney disease (45), and patients who underwent ≥1 BS in the past. Although there is paucity of literature regarding these populations in terms of nutritional assessment, preparation, and outcomes, in clinical practice they are often required to undergo more extensive nutritional assessment and may be referred for consultation with additional health professionals.

Anthropometric measurements.

Weight and BMI are the main anthropometric measures used in the BS field. However, it is also necessary to consider classifying patients on the basis of body-composition measures as these measures expand the understanding on the metabolic profile of the patients (22). MRI and computed tomography are considered to be "gold standards" for body-composition assessment, but DXA and bioelectrical impedance analysis are more widely available instruments to determine body composition (46). Presently, there are insufficient data to

determine the optimal BS procedure for a patient based on body composition (7). Moreover, accurate instruments to measure body composition are not available in all medical centers.

Nutritional deficiency screening and supplementation.

The high rate of micronutrient deficiencies among patients with severe obesity prior to BS has been previously reported (42, 47–58), with a higher rate among women as compared with men (42, 59–62), patients with higher BMI (60, 63), or specific ethnic groups (42, 59). Preoperative nutritional deficiency prevalences of 22–76% for vitamin D deficiency, 6–50.5% for iron deficiency, 24.2–39% for elevated parathyroid hormone (PTH), 0–56% for folate deficiency, and 15.8–19.6% for anemia were previously described (42, 47, 49, 50, 52, 53, 55, 57, 59, 60, 62, 64). Impaired presurgery nutritional status is found to be related to postoperative nutritional deficiencies and can be associated with further metabolic complications such as bone loss (11, 21, 47, 65, 66). Most available guidelines emphasize the need to correct preoperative nutritional deficiencies as part of the preparation process (11, 14, 16, 67–70) and some have suggested to combine a multivitamin supplement during the preoperative period (14). The preoperative nutritional screening parameters recommended by most guidelines include measurements of vitamin B-12, folate, blood cell count, iron, ferritin, transferrin, total iron binding capacity, electrolytes, albumin, calcium, PTH, and 25-hydroxyvitamin D [25(OH)D] (11, 14, 16, 42, 67–71), and several guidelines also recommend more extensive testing in the case of specific findings and/or at-risk-group patients, especially prior to malabsorptive procedures (16, 68–70). Additional preoperative measurements that have been recommended include thiamin; zinc; copper; vitamins A, K, and E (16, 68–70); and 24-h urinary calcium excretion (16, 42, 68–70).

Skeletal status.

The main mechanisms for bone deterioration accompanied with BS include mechanical unloading, decreased absorption mostly of calcium and vitamin D, and hormonal changes (21, 72). It has previously been demonstrated that calcium absorption decreases after RYGB (73, 74) and BPD procedures (75–78). Impaired calcium absorption also appears after SG (79), and could be related to the reduction in gastric acidity (80) and to a low oral calcium intake postsurgery (81). Additionally, significant macronutrient deficiency and specifically protein depletion could negatively impact bone health following BS (82, 83).

Currently, there are almost no randomized controlled trials evaluating the strategies of optimizing patients' management before and after bariatric procedures with regard to the prevention of bone deterioration (84). Most proposed preoperative management approaches include biochemical assessment of 25(OH)D concentration, serum PTH, calcium, albumin, phosphorus, alkaline phosphatase, and 24-h urinary calcium excretion, with the treatment of vitamin D deficiency prior to the surgery (16, 21, 84). Furthermore, skeletal evaluation prior to BS should include performing DXA at the spine and hip prior to malabsorptive surgeries (e.g., RYGB and BPD/BPD-DS) and in patients at higher risk, such as women aged ≥65 y, men aged ≥70 y, and younger patients who have conditions associated with bone loss or low bone mass (21, 84).

Oral health.

Oral cavity changes among BS patients were found to be related to the development of dental caries and wear, hypersensitivity, and periodontal disease (85). It has been suggested that low calcium intake, increased frequency of regurgitation and gastroesophageal reflux, increased food intake at shorter intervals, and resultant oral pH imbalance were associated with increased development of oral complications such as dental caries, dental erosion, and increased salivary flow rate following BS (85). Although this topic has received only modest attention in the literature so far, some nutrition-promotion strategies for adequate oral hygiene were shown to be effective in the prevention of the main oral health problems in patients who underwent BS, including reduction in the quantity and frequency of consumption of foods and beverages with added sugar, avoidance of eating at night, diminishing consumption of acidic foods (e.g., citrus fruit and vinegar), and avoidance of a dry mouth by frequent drinking with small sips during the day (86). Moreover, it was recommended that, in case of regurgitation or vomiting, teeth should not be brushed immediately to avoid removing dissolved dental tissue (85, 86). In light of these findings, it is important to monitor oral status before and after the surgery. According to a study among candidates for BS, low socioeconomic status, advanced age, smoking, and diabetes were found to be related to impaired oral health (44). Thus, preventive assessment of oral health and education strategies should be implemented from the time of the preoperative period (87), and probably special attention should be paid to the populations at higher risk (44).

Patients scheduled for BS are encouraged to chew well and slowly in order to optimize the digestion process; reduce the incidence of common physiological complications after surgery such as vomiting, diarrhea, abdominal pain, or dumping syndrome (87, 88); and to prevent phytobezoar formation (89). It has been shown that having ≥8 masticatory functional unities, which means teeth that have an antagonist, is important for maintenance of efficient masticatory function (44, 88). Food texture should be adapted to the dental status and, in some cases, a rational approach would be to recommend mixed textures or soft foods (88). However, it is important to note that eating soft foods may cause frequent hunger, which, in turn, could enhance maladaptive eating behavior such as grazing, which is related to worse surgery outcomes (90).

Nutritional preparation

Preoperative weight loss.

Presurgery weight loss is often recommended in order to reduce liver volume by reducing its glycogen, water, and fatty deposits and to improve the technical aspects of the surgery (1, 20, 91). Moreover, weight loss during presurgery preparation programs might be seen as a proxy for adherence to the medical team's advice (18). Thus, many centers recommend a supervised weight-loss program (11, 92). However, data concerning the feasibility, effectiveness, duration, and the most appropriate macronutrient composition are not well established (11, 20, 93–95). Some methods suggested for the preoperative period include low-carbohydrate diets (11, 14), very-low-calorie diets (VLCDs), low-calorie diets, very-low-energy meal replacements, nutritional supplements such as omega-3 fatty acids, antiobesity drugs, and intragastric balloons (91, 94, 96).

A systematic review of the effects of VLCDs with 400–800 kcal/d for up to 12 wk on weight loss, liver size, and surgical complications during the preoperative period, which included 9 studies (3 randomized controlled trials and 6 observational studies; $n = 849$ patients), found weight loss of −2.8 to −14.8 kg, liver size reduction of −5% to −20%, and no significant effect on perioperative complications (94). Moreover, VLCDs were shown to be maximally beneficial in a 2- to 4-wk time frame (94). A systematic review that evaluated different methods to reduce liver volume prior to RYGB and included 7 observational studies which investigated the effect of low-calorie diets ($n = 169$ patients) concluded that preoperative diets with 456–1520 kcal/d for up to 12 wk reduced liver size by −5% to −20% (91). A systematic review that assessed feasibility and effectiveness of preoperative very-low-energy meal replacements for up to 16 wk on weight loss and surgical risks, which included 13 studies (2 randomized controlled trials and 11 observational studies; $n = 750$ patients) specifically in BS candidates, found weight loss of −3.1% to −27% and liver size reduction of −5.1% to −43.4% (96). Nevertheless, in a large-scale retrospective cohort study in 394,016 patients that assessed whether preoperative weight loss is associated with 30-d postoperative complications, weight loss prior to laparoscopic RYGB or SG was not found to be associated with increased readmission, reoperation, mortality, or another intervention (97).

According to the updated position statement on insurance-mandated preoperative weight-loss requirements published by the American Society for Metabolic and Bariatric Surgery, mandated preoperative weight loss is not supported by medical evidence and has not been shown to provide any benefit for surgery outcomes (95). Currently, well-designed randomized controlled trials and long-term prospective studies are needed in order to support the practice of weight-loss regimes presurgery (95). Moreover, the practices for super-obese patients or in cases of weight gain during the preparation process were almost not mentioned in the literature and should be better explored and defined. The bariatric medical team may recommend a preoperative weight-loss program according to the specific needs and circumstances of the patient (20, 95, 98). Caution should prevail when weight loss is achieved by inappropriate pathways, such as fasting or the use of nonapproved drugs or supplements (18).

Preoperative glycemic control.

Many diabetic patients awaiting BS have poor glycemic control (26). The achievement of optimal glycemic control preoperatively is important in order to reduce the lengths of hospital stay and the risks of wound infections and other complications following surgical procedures (1, 10, 26). Moreover, preoperative glycated hemoglobin (HbA1c) concentrations appear to predict the likelihood of diabetes remission post-BS (99). However, it is important to correctly classify diabetes subtype prior to the surgery to identify patients whose diabetes is unlikely to remit postsurgery (100). Reasonable targets for glycemic control preoperatively are an HbA1c value of <7.0% in general, but <8.0% in cases of advanced macrovascular or microvascular complications, extensive comorbid conditions, or long-lasting diabetes (1). Presurgery glycemic control can be optimized by adopting a healthy dietary plan, use of medical nutrition therapy, increased physical activity, and pharmacotherapy, when needed (1, 26). It is important to note that many antihyperglycemic medications may contribute to weight gain, but others may be weight-neutral or even cause weight reduction (26, 101). To date, studies investigating programs to improve glycemic control prior to BS are lacking. In a retrospective study in 75 BS candidates with poorly controlled type 2 diabetes (HbA1c values of 9.0% ± 1.2%) who were invited to participate in an interprofessional bariatric glycemic optimization program, which included individualized nutritional counseling and exercise prescription, adjustment of antihyperglycemic therapy, and weekly phone calls, 92% reached the target HbA1c values of ≤8.0% (26).

Preoperative physical activity.

Physical activity constitutes one of the pillars of a healthy lifestyle and it has an important contribution before and after BS (102). Engaging in physical activity after BS was associated with higher quality of life (20), improved insulin sensitivity (103, 104), reduced detrimental effect on bone mass (21, 105), and better body composition (106, 107), although the effect on higher weight-loss outcomes is questionable (108–110). Candidates for BS are a population at risk of a sedentary lifestyle, thus beginning active habits prior to surgery may be beneficial (111–113). Although evidence on the effects of preoperative engagement in physical activity is scarce and inconsistent, overall it appears that preoperative physical activity improved physical fitness (114–116), glycemic control, and lipid profile (102). Furthermore, it has been shown that early intervention with physical activity prior to the surgery was associated with higher postoperative physical activity level (111, 115, 117).

The multidisciplinary team and physical activity specialists should discuss with BS candidates the possibility

of beginning exercise prior to surgery and reap its benefits. Addressing barriers to exercise may assist patients in performing physical activity. Thus, it is recommended to discuss with BS candidates the potential barriers to exercise, including body pain, physical limitations, lack of self-confidence and motivation, shame, environmental factors, and restricted resources (118). Patients who are willing to exercise should receive medical authorization for this purpose first, while medical tests such as pulmonary function or cardiac stress tests might be considered in accordance with the patient's medical condition (69). It is suggested to assess the mobility level of patients by subjective assessment in order to recommend appropriate physical activity in terms of type, frequency, and intensity (20). Physical function assessment should be done by using validated tools such as the sit-to-stand test (20), hand-grip-strength test (119), and the 6-min walk test or 12-min walk-to-run test (20). It has been recommended to advise candidates for BS to initiate an exercise program that combines aerobic exercises (20, 120) and resistance exercises (117), according to their individual abilities (120). It is recommended to gradually increase the volume of exercise in order to reduce injury risk. In order to increase difficulty, it has been advised to first increase the duration and frequency of the exercise and later the intensity (121). Low-impact activities that do not involve purposeful collision or contact have a lower risk for injury (e.g., walking, bicycling or riding a stationary bike, dancing, and swimming). For patients with a history of joint pain or musculoskeletal problems, exercise types such as cycling or swimming, with a lower impact on body-weight load, should be suggested (20). The recommendations for substantial health benefits from physical activity are the same as for the general population, and are based on the American College of Sports Medicine (120). However, the general advice for adults, especially those with chronic conditions, is to engage in regular physical activity and to reduce their sedentary lifestyle.

BS nutritional knowledge.

Transfer of nutritional and behavioral knowledge from a registered dietitian to patients who plan to undergo BS is considered to be a standard of care in BS practice (23).

Currently, it appears that there is no gold-standard tool for the assessment of BS nutrition knowledge among BS candidates, although some questionnaires have been suggested (19, 23, 122–124). The Eating After BS questionnaire, scored on a 0- to 89-point scale, was developed by a local expert panel from Canada and went through a process of face validity. The mean Eating After BS questionnaire score presurgery among 119 BS candidates was 46.9 ± 14.4 (23). Our group previously developed the BS Nutritional Knowledge Questionnaire, scored on a 0–100-point scale, which went through a process of face, content, and construct validity (19). The mean BS nutrition knowledge score with this tool among 200 BS candidates was 64.5 ± 13.4 (19). These findings suggest that the level of knowledge among BS candidates could be relatively low.

A major component of the preoperative process involves comprehensive patient education regarding causes of obesity, surgical options, the hospitalization process, potential medical and nutritional complications, expectations, eating habits required for BS patients, the dietary supplement regimen needed following the surgery, physical activity plan, stress management, other lifestyle strategies for long-term success, and the importance of the long-term treatment plan by the multidisciplinary team (1, 10, 16, 24, 25, 125). Presurgery, weight-loss expectations should be discussed with all patients and be relevant to the acceptable average EWL according to the planned BS procedure (5, 9, 11, 19, 24, 126). For patients undergoing secondary surgeries, poorer weight outcomes are expected and should be discussed with patients (127, 128).

Education can be delivered by personal appointments, live classroom sessions, phone-based support, video, website, slideshow, written materials, or by combinations of different approaches (24). However, standardization is missing and the optimal type or timing for education intervention presurgery remains inconclusive among centers in terms of curriculum, length of program, frequency of sessions, teaching methods, and educators (24).

Digital communication methods such as online-education programs may be utilized to increase patient engagement and minimize barriers such as time, distance, and expenses (5, 24, 129). To date, these technologies remain underutilized in BS and research on preparation for BS by digital communication tools has received only modest attention so far (130). Most published data concentrated on specific parameters such as presurgery psychosocial interventions (131), physical activity intervention by telehealth (116), and the impact of video lectures as compared with booklets (19, 123, 132) or learning sessions with online courses (133). One study in 20 BS candidates used a mobile technology that included encouraging messages and video-based education modules to prepare patients for BS and found positive trends of behavior changes and weight loss prior to the surgery (122).

Childbearing-age women who are candidates for BS.

The majority of patients undergoing BS are women of childbearing age (27, 134). A substantial proportion of women willing to undergo surgery are those seeking a future pregnancy (135). Since both obesity and BS have a great effect on fertility and pregnancy outcomes (1, 27, 136), it is important to advise BS women candidates both on the positive effects and potential risks (137). Thus, there is high importance of nutritional counseling for all women candidates of BS in order to educate and prepare them for the effect of the surgery on fertility and pregnancy outcomes, the need of close management by a multidisciplinary team before and during pregnancy, frequent nutritional screening for vitamin and mineral status, and the importance of adherence to the supplementation regime including the adaptations for pregnancy regarding specific micronutrients such as folic acid, vitamin A, iron, and iodine (11, 16, 27, 138).

For women of childbearing age, a consultation with an obstetrician to discuss birth-control options is important preoperatively as pregnancy should be discouraged within the first 12–18 mo following surgery to ensure that pregnancy does not occur during the rapid weight-loss period, which could affect fetal growth (1, 14, 27, 139). It has been shown that only 39% of surgeons discuss contraception use with BS patients and only 25% routinely refer patients for contraceptive advice given by a reproductive health specialist (140). Changes in the absorption pathways may occur postsurgery, affecting oral contraceptive absorption, especially following malabsorptive procedures (1, 141), but also to some degree after SG (135).

Furthermore, it is recommended for women of childbearing age who undergo BS to have a daily oral intake of 800–1000 μg folic acid to reduce the risk of neural tube defects (16), although other guidelines recommend higher doses in specific cases (14, 142). Additionally, since anemia during pregnancy is common in women with a history of BS, this issue also requires special attention both for prevention and treatment among women of childbearing age who are candidates for BS (143).

Conclusions

Nutrition preparation before BS is an important component of achieving optimal outcome targets, in terms of weight loss and prevention of nutritional complications. This preparation should include a comprehensive assessment of the nutritional and medical status as well as health-related behaviors of the candidates by a registered dietitian, followed by appropriate counseling and intervention, and the provision of relevant knowledge about the surgery. The main focus in the preoperative period should be on eating habits, nutritional status balance, lifestyle changes, and knowledge acquisition. In addition, personalized weight-loss management, intervention-targeted glycemic control, and physical activity engagement are recommended. Presently, there are almost no formal nutritional contraindications to BS, but some populations may be considered at higher nutritional risk. Special guidance should be given to those women who are within the reproductive age range and who wish to conceive in order to enable a healthy pregnancy and proper development of the fetus.

At this stage, more well-designed intervention and long-term cohort studies are needed in order to formulate uniform evidence-based nutritional guidelines for patients who plan to undergo BS, including for populations at higher nutritional risk. In addition, postoperative outcomes of presurgical nutritional intervention programs should be studied.

Acknowledgments

The authors' responsibilities were as follows—SS-D and TB-P: designed the manuscript; SS-D, TS, AG, IG, YK, CS, and TB-P: wrote the manuscript; and all authors: read and approved the final manuscript.

References

1. Mechanick JI, Apovian C, Brethauer S, Garvey WT, Joffe AM, Kim J, Kushner RF, Lindquist R, Pessah-Pollack R, Seger J, et al. Clinical practice guidelines for the perioperative nutrition, metabolic, and nonsurgical support of patients undergoing bariatric procedures—2019 update: cosponsored by American Association of Clinical Endocrinologists/American College of Endocrinology, The Obesity Society, American Society for Metabolic & Bariatric Surgery, Obesity Medicine Association, and American Society of Anesthesiologists. Surg Obesity Relat Dis 2020;16(2):175–247.
2. Angrisani L, Santonicola A, Iovino P, Vitiello A, Higa K, Himpens J, Buchwald H, Scopinaro N. IFSO worldwide survey 2016: primary, endoluminal, and revisional procedures. Obes Surg 2018;28(12):3783–94.
3. Sherf-Dagan S, Schechter L, Lapidus R, Sakran N, Goitein D, Raziel A. Perceptions of success in bariatric surgery: a nationwide survey among medical professionals. Obes Surg 2018;28(1):135–41.
4. Lauti M, Kularatna M, Hill AG, MacCormick AD. Weight regain following sleeve gastrectomy—a systematic review. Obes Surg 2016;26(6):1326–34.
5. McGrice M, Don Paul K. Interventions to improve long-term weight loss in patients following bariatric surgery: challenges and solutions. DMSO 2015;8:263–74.
6. Neff KJ, Olbers T, le Roux CW. Bariatric surgery: the challenges with candidate selection, individualizing treatment and clinical outcomes. BMC Med 2013;11:8.
7. De Luca M, Angrisani L, Himpens J, Busetto L, Scopinaro N, Weiner R, Sartori A, Stier C, Lakdawala M, Bhasker AG, et al. Indications for surgery for obesity and weight-related diseases: position statements from the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO). Obes Surg 2016;26(8):1659–96.
8. Di Lorenzo N, Antoniou SA, Batterham RL, Busetto L, Godoroja D, Iossa A, Carrano FM, Agresta F, Alarcon I, Azran C, et al. Clinical practice guidelines of the European Association for Endoscopic Surgery (EAES) on bariatric surgery: update 2020 endorsed by IFSO-EC, EASO and ESPCOP. Surg Endosc 2020, 34(6):2332–58.
9. Sudlow A, le Roux CW, Pournaras DJ. The metabolic benefits of different bariatric operations: what procedure to choose? Endocrine Connections 2020;9(2):R28–35.
10. Schlottmann F, Nayyar A, Herbella FAM, Patti MG. Preoperative evaluation in bariatric surgery. J Laparoendosc Adv Surg Tech A 2018;28(8):925–9.
11. Sherf Dagan S, Goldenshluger A, Globus I, Schweiger C, Kessler Y, Kowen Sandbank G, Ben-Porat T, Sinai T. Nutritional recommendations for adult bariatric surgery patients: clinical practice. Adv Nutr 2017;8(2):382–94.
12. Parrott JM, Craggs-Dino L, Faria SL, O'Kane M. The optimal nutritional programme for bariatric and metabolic surgery. Curr Obes Rep 2020;9(3):326–38.
13. Ferrari R. Writing narrative style literature reviews. Medical Writing 2015;24(4):230–5.
14. BOMSS Guidelines on peri-operative and postoperative biochemical monitoring and micronutrient replacement for patients undergoing bariatric surgery [Internet]. 2014. Available from: http://www.bomss.org.uk/wp-content/uploads/2014/09/BOMSS-guidelines-Final-version1Oct14.pdf. [Accessed 2016 Sep 4]
15. Edwards-Hampton SA, Wedin S. Preoperative psychological assessment of patients seeking weight-loss surgery: identifying challenges and solutions. Psychol Res Behav Manag 2015;8:263–72.
16. Parrott J, Frank L, Rabena R, Craggs-Dino L, Isom KA, Greiman L. American Society for Metabolic and Bariatric Surgery integrated health nutritional guidelines for the surgical weight loss patient 2016 update: micronutrients. Surg Obes Relat Dis 2017;13(5):727–41.
17. Opolski M, Chur-Hansen A, Wittert G. The eating-related behaviours, disorders and expectations of candidates for bariatric surgery. Clin Obesity 2015;5(4):165–97.

18. Zickgraf HF, Stefano EC, Rigby A. Development of the Weight Management Skills Questionnaire in a prebariatric surgery sample. Obes Surg 2020;30(2):603–11.
19. Sherf-Dagan S, Hod K, Mardy-Tilbor L, Gliksman S, Ben-Porat T, Sakran N, Zelber-Sagi S, Goitein D, Raziel A. The effect of pre-surgery information online lecture on nutrition knowledge and anxiety among bariatric surgery candidates. Obes Surg 2018;28(7):1876–85.
20. Tabesh MR, Maleklou F, Ejtehadi F, Alizadeh Z. Nutrition, physical activity, and prescription of supplements in pre- and post-bariatric surgery patients: a practical guideline. Obes Surg 2019;29(10):3385–400.
21. Ben-Porat T, Elazary R, Sherf-Dagan S, Goldenshluger A, Brodie R, Mintz Y, Weiss R. Bone health following bariatric surgery: implications for management strategies to attenuate bone loss. Adv Nutr 2018;9(2):114–27.
22. De Lorenzo A, Soldati L, Sarlo F, Calvani M, Di Lorenzo N, Di Renzo L. New obesity classification criteria as a tool for bariatric surgery indication. World J Gastroenterol 2016;22(2):681–703.
23. Taube-Schiff M, Chaparro M, Gougeon L, Shakory S, Weiland M, Warwick K, Plummer C, Sockalingam S. Examining nutrition knowledge of bariatric surgery patients: what happens to dietary knowledge over time? Obes Surg 2016;26(5):972–82.
24. Groller KD. Systematic review of patient education practices in weight loss surgery. Surg Obes Relat Dis 2017;13(6):1072–85.
25. Moize VL, Pi-Sunyer X, Mochari H, Vidal J. Nutritional pyramid for post-gastric bypass patients. Obes Surg 2010;20(8): 1133–41.
26. Houlden RL, Yen JL, Moore S. Effectiveness of an interprofessional glycemic optimization clinic on preoperative glycated hemoglobin levels for adult patients with type 2 diabetes undergoing bariatric surgery. Can J Diabetes 2018;42(5):514–9.
27. Ciangura C, Coupaye M, Deruelle P, Gascoin G, Calabrese D, Cosson E, Ducarme G, Gaborit B, Lelievre B, Mandelbrot L, et al. Clinical practice guidelines for childbearing female candidates for bariatric surgery, pregnancy, and post-partum management after bariatric surgery. Obes Surg 2019;29(11):3722–34.
28. Oved I, Vaiman IM, Hod K, Mardy-Tilbor L, Torban Y, Sherf Dagan S. Poor health behaviors prior to laparoscopic sleeve gastrectomy surgery. Obes Surg 2017;27(2):469–75.
29. Jastrzebska-Mierzynska M, Ostrowska L, Hady HR, Dadan J. Dietary habits of obese patients qualified for bariatric procedures. Rocz Panstw Zakl Hig 2014;65(1):41–7.
30. Conceicao EM, Utzinger LM, Pisetsky EM. Eating disorders and problematic eating behaviours before and after bariatric surgery: characterization, assessment and association with treatment outcomes. Eur Eat Disorders Rev 2015;23(6):417–25.
31. Miller-Matero LR, Bryce K, Saulino CK, Dykhuis KE, Genaw J, Carlin AM. Problematic eating behaviors predict outcomes after bariatric surgery. Obes Surg 2018;28(7):1910–5.
32. Zarshenas N, Tapsell LC, Neale EP, Batterham M, Talbot ML. The relationship between bariatric surgery and diet quality: a systematic review. Obes Surg 2020;30(5):1768–92.
33. Sherf-Dagan S, Hod K, Buch A, Mardy-Tilbor L, Regev Z, Ben-Porat T, Sakran N, Goitein D, Raziel A. Health and nutritional status of vegetarian candidates for bariatric surgery and practical recommendations. Obes Surg 2018;28(1):152–60.
34. de Zwaan M, Marschollek M, Allison KC. The night eating syndrome (NES) in bariatric surgery patients. Eur Eat Disorders Rev 2015;23(6):426–34.
35. LeMont D, Moorehead M, Parish M, Reto CS, Ritz SJ. Suggestions for the pre-surgical psychological assessment of bariatric surgery candidates. Am Soc Bariatric Surg 2004;129.
36. Devlin MJ, Goldfein JA, Flancbaum L, Bessler M, Eisenstadt R. Surgical management of obese patients with eating disorders: a survey of current practice. Obes Surg 2004;14(9):1252–7.
37. Parker K, Brennan L. Measurement of disordered eating in bariatric surgery candidates: a systematic review of the literature. Obesity Res Clin Pract 2015;9(1):12–25.
38. David LA, Sijercic I, Cassin SE. Preoperative and post-operative psychosocial interventions for bariatric surgery patients: a systematic review. Obes Rev 2020;21(4):e12926.
39. Wimmelmann CL, Dela F, Mortensen EL. Psychological predictors of weight loss after bariatric surgery: a review of the recent research. Obesity Res Clin Pract 2014;8(4):e299–313.
40. Williams-Kerver GA, Steffen KJ, Mitchell JE. Eating pathology after bariatric surgery: an updated review of the recent literature. Curr Psychiatry Rep 2019;21(9):86.
41. Smith KE, Orcutt M, Steffen KJ, Crosby RD, Cao L, Garcia L, Mitchell JE. Loss of control eating and binge eating in the 7 years following bariatric surgery. Obes Surg 2019;29(6):1773–80.
42. Ben-Porat T, Weiss R, Sherf-Dagan S, Nabulsi N, Maayani A, Khalaileh A, Abed S, Brodie R, Harari R, Mintz Y, et al. Nutritional deficiencies in patients with severe obesity before bariatric surgery: what should be the focus during the preoperative assessment? J Acad Nutr Diet 2019;120(5):874–84.
43. Fieber JH, Sharoky CE, Wirtalla C, Williams NN, Dempsey DT, Kelz RR. The malnourished patient with obesity: a unique paradox in bariatric surgery. J Surg Res 2018;232:456–63.
44. Passeri CR, Andrade JA, Tomal KT, Pracucho EM, Campos LP, Sales-Peres SH. Masticatory function of obese candidates to bariatric surgery from distinct socioeconomic classes. Arq Bras Cir Dig 2016;29(Suppl 1):53–8.
45. Ben-Porat T, Weiss-Sadan A, Rottenstreich A, Sherf-Dagan S, Schweiger C, Yosef-Levi IM, Weiner D, Azulay O, Sakran N, Harari R, et al. Nutritional management for chronic kidney disease patients who undergo bariatric surgery: a narrative review. Adv Nutr 2019;10(1):122–32.
46. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyere O, Cederholm T, Cooper C, Landi F, Rolland Y, Sayer AA, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16–31.
47. Ben-Porat T, Elazary R, Yuval JB, Wieder A, Khalaileh A, Weiss R. Nutritional deficiencies after sleeve gastrectomy: can they be predicted preoperatively? Surg Obes Relat Dis 2015;11(5):1029–36.
48. Moize V, Deulofeu R, Torres F, de Osaba JM, Vidal J. Nutritional intake and prevalence of nutritional deficiencies prior to surgery in a Spanish morbidly obese population. Obes Surg 2011;21(9):1382–8.
49. Peterson LA, Cheskin LJ, Furtado M, Papas K, Schweitzer MA, Magnuson TH, Steele KE. Malnutrition in bariatric surgery candidates: multiple micronutrient deficiencies prior to surgery. Obes Surg 2016;26(4):833–8.
50. Lefebvre P, Letois F, Sultan A, Nocca D, Mura T, Galtier F. Nutrient deficiencies in patients with obesity considering bariatric surgery: a cross-sectional study. Surg Obes Relat Dis 2014;10(3):540–6.
51. Ewang-Emukowhate M, Harrington DJ, Botha A, McGowan B, Wierzbicki AS. Vitamin K and other markers of micronutrient status in morbidly obese patients before bariatric surgery. Int J Clin Pract 2015;69(6):638–42.
52. Schweiger C, Weiss R, Berry E, Keidar A. Nutritional deficiencies in bariatric surgery candidates. Obes Surg 2010;20(2):193–7.
53. Sherf Dagan S, Zelber-Sagi S, Webb M, Keidar A, Raziel A, Sakran N, Goitein D, Shibolet O. Nutritional status prior to laparoscopic sleeve gastrectomy surgery. Obes Surg 2016;26(9):2119–26.
54. Gobato RC, Seixas Chaves DF, Chaim EA. Micronutrient and physiologic parameters before and 6 months after RYGB. Surg Obes Relat Dis 2014;10(5):944–51.
55. Sanchez A, Rojas P, Basfi-Fer K, Carrasco F, Inostroza J, Codoceo J, Valencia A, Papapietro K, Csendes A, Ruz M. Micronutrient deficiencies in morbidly obese women prior to bariatric surgery. Obes Surg 2016;26(2):361–8.
56. de Luis DA, Pacheco D, Izaola O, Terroba MC, Cuellar L, Cabezas G. Micronutrient status in morbidly obese women before bariatric surgery. Surg Obes Relat Dis 2013;9(2):323–7.
57. van Rutte PW, Aarts EO, Smulders JF, Nienhuijs SW. Nutrient deficiencies before and after sleeve gastrectomy. Obes Surg 2014;24(10):1639–46.

58. Toh SY, Zarshenas N, Jorgensen J. Prevalence of nutrient deficiencies in bariatric patients. Nutrition 2009;25(11–12):1150–6.
59. Lee PC, Ganguly S, Dixon JB, Tan HC, Lim CH, Tham KW. Nutritional deficiencies in severe obesity: a multiethnic Asian cohort. Obes Surg 2019;29(1):166–71.
60. Asghari G, Khalaj A, Ghadimi M, Mahdavi M, Farhadnejad H, Valizadeh M, Azizi F, Barzin M, Hosseinpanah F. Prevalence of micronutrient deficiencies prior to bariatric surgery: Tehran Obesity Treatment Study (TOTS). Obes Surg 2018;28(8):2465–72.
61. Al-Mutawa A, Al-Sabah S, Anderson AK, Al-Mutawa M. Evaluation of nutritional status post laparoscopic sleeve gastrectomy-5-year outcomes. Obes Surg 2018;28(6):1473–83.
62. Al-Mutawa A, Anderson AK, Alsabah S, Al-Mutawa M. Nutritional status of bariatric surgery candidates. Nutrients 2018;10(1).67
63. Krzizek EC, Brix JM, Herz CT, Kopp HP, Schernthaner GH, Schernthaner G, Ludvik B. Prevalence of micronutrient deficiency in patients with morbid obesity before bariatric surgery. Obes Surg 2018;28(3):643–8.
64. Damms-Machado A, Friedrich A, Kramer KM, Stingel K, Meile T, Kuper MA, Konigsrainer A, Bischoff SC. Pre- and postoperative nutritional deficiencies in obese patients undergoing laparoscopic sleeve gastrectomy. Obes Surg 2012;22(6):881–9.
65. Frame-Peterson LA, Megill RD, Carobrese S, Schweitzer M. Nutrient deficiencies are common prior to bariatric surgery. Nutr Clin Pract 2017;32(4):463–9.
66. Bal BS, Finelli FC, Shope TR, Koch TR. Nutritional deficiencies after bariatric surgery. Nat Rev Endocrinol 2012;8(9):544.
67. Stein J, Stier C, Raab H, Weiner R. Review article: the nutritional and pharmacological consequences of obesity surgery. Aliment Pharmacol Ther 2014;40(6):582–609.
68. Thibault R, Huber O, Azagury DE, Pichard C. Twelve key nutritional issues in bariatric surgery. Clin Nutr 2016;35(1):12–7.
69. Mechanick JI, Youdim A, Jones DB, Garvey WT, Hurley DL, McMahon MM, Heinberg LJ, Kushner R, Adams TD, Shikora S, 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. Obesity (Silver Spring) 2013;21(Suppl 1):S1–27.
70. Heber D, Greenway FL, Kaplan LM, Livingston E, Salvador J, Still C. Endocrine and nutritional management of the post-bariatric surgery patient: an Endocrine Society Clinical practice guideline. J Clin Endocrinol Metab 2010;95(11):4823–43.
71. Mechanick JI, Kushner RF, Sugerman HJ, Gonzalez-Campoy JM, Collazo-Clavell ML, Spitz AF, Apovian CM, Livingston EH, Brolin R, Sarwer DB, et al. American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. Obesity (Silver Spring) 2009;17(Suppl 1):S1–70.
72. Gregory NS. The effects of bariatric surgery on bone metabolism. Endocrinol Metab Clin North Am 2017;46(1):105–16.
73. Schafer AL, Weaver CM, Black DM, Wheeler AL, Chang H, Szefc GV, Stewart L, Rogers SJ, Carter JT, Posselt AM, et al. Intestinal calcium absorption decreases dramatically after gastric bypass surgery despite optimization of vitamin D status. J Bone Miner Res 2015;30(8):1377–85.
74. Riedt CS, Brolin RE, Sherrell RM, Field MP, Shapses SA. True fractional calcium absorption is decreased after Roux-en-Y gastric bypass surgery. Obesity 2006;14(11):1940–8.
75. Balsa JA, Botella-Carretero JI, Peromingo R, Zamarron I, Arrieta F, Munoz-Malo T, Vazquez C. Role of calcium malabsorption in the development of secondary hyperparathyroidism after biliopancreatic diversion. J Endocrinol Invest 2008;31(10):845–50.
76. Newbury L, Dolan K, Hatzifotis M, Low N, Fielding G. Calcium and vitamin D depletion and elevated parathyroid hormone following biliopancreatic diversion. Obes Surg 2003;13(6):893–5.
77. Ceriani V, Cetta F, Pinna F, Pontiroli AE. Abnormal calcium, 25(OH)vitamin D, and parathyroid hormone after biliopancreatic diversion; correction through elongation of the common tract and reduction of the gastric pouch. Surg Obes Relat Dis 2016;12(4):805–12.
78. Slater GH, Ren CJ, Siegel N, Williams T, Barr D, Wolfe B, Dolan K, Fielding GA. Serum fat-soluble vitamin deficiency and abnormal calcium metabolism after malabsorptive bariatric surgery. J Gastrointest Surg 2004;8(1):48–55; discussion 4-5.
79. Carrasco F, Basfi-Fer K, Rojas P, Csendes A, Papapietro K, Codoceo J, Inostroza J, Krebs NF, Westcott JL, Miller LV, et al. Calcium absorption may be affected after either sleeve gastrectomy or Roux-en-Y gastric bypass in premenopausal women: a 2-y prospective study. Am J Clin Nutr 2018;108(1):24–32.
80. Kopic S, Geibel JP. Gastric acid, calcium absorption, and their impact on bone health. Physiol Rev 2013;93(1):189–268.
81. Aarts EO, Janssen IM, Berends FJ. The gastric sleeve: losing weight as fast as micronutrients? Obes Surg 2011;21(2):207–11.
82. Hage MP, El-Hajj Fuleihan G. Bone and mineral metabolism in patients undergoing Roux-en-Y gastric bypass. Osteoporos Int 2014;25(2):423–39.
83. Verger EO, Aron-Wisnewsky J, Dao MC, Kayser BD, Oppert JM, Bouillot JL, Torcivia A, Clement K. Micronutrient and protein deficiencies after gastric bypass and sleeve gastrectomy: a 1-year follow-up. Obes Surg 2016;26(4):785–96.
84. Gagnon C, Schafer AL. Bone health after bariatric surgery. JBMR Plus 2018;2(3):121–33.
85. da Silva Azevedo ML, Silva NR, da Costa Cunha Mafra CA, Lins R, Dantas EM, de Vasconcelos Gurgel BC, de Aquino Martins ARL. Oral health implications of bariatric surgery in morbidly obese patients: an integrative review. Obes Surg 2020;30(4):1574–9.
86. Porcelli ICS, Corsi NM, Fracasso MLC, Pascotto RC, Cardelli AAM, Poli-Frederico RC, Nasser D, Maciel SM. Oral health promotion in patients with morbid obesity after gastroplasty: a randomized clinical trial. Arq Bras Cir Dig 2019;32(2):e1437.
87. de Moura-Grec PG, Yamashita JM, Marsicano JA, Ceneviva R, de Souza Leite CV, de Brito GB, Brienze SL, de Carvalho Sales-Peres SH. Impact of bariatric surgery on oral health conditions: 6-months cohort study. Int Dent J 2014;64(3):144–9.
88. Godlewski AE, Veyrune JL, Nicolas E, Ciangura CA, Chaussain CC, Czernichow S, Basdevant A, Hennequin M. Effect of dental status on changes in mastication in patients with obesity following bariatric surgery. PLoS One 2011;6(7):e22324.
89. Ben-Porat T, Sherf Dagan S, Goldenshluger A, Yuval JB, Elazary R. Gastrointestinal phytobezoar following bariatric surgery: systematic review. Surg Obes Relat Dis 2016;12(9):1747–54.
90. Pizato N, Botelho PB, Goncalves VSS, Dutra ES, de Carvalho KMB. Effect of grazing behavior on weight regain post-bariatric surgery: a systematic review. Nutrients 2017;9(12):1322.
91. van Wissen J, Bakker N, Doodeman HJ, Jansma EP, Bonjer HJ, Houdijk AP. Preoperative methods to reduce liver volume in bariatric surgery: a systematic review. Obes Surg 2016;26(2):251–6.
92. Kim JJ. Evidence base for optimal preoperative preparation for bariatric surgery: does mandatory weight loss make a difference? Curr Obes Rep 2017;6(3):238–45.
93. Schiavo L, Sans A, Scalera G, Barbarisi A, Iannelli A. Why preoperative weight loss in preparation for bariatric surgery is important. Obes Surg 2016;26(11):2790–2.
94. Holderbaum M, Casagrande DS, Sussenbach S, Buss C. Effects of very low calorie diets on liver size and weight loss in the preoperative period of bariatric surgery: a systematic review. Surg Obes Relat Dis 2018;14(2):237–44.
95. Kim JJ, Rogers AM, Ballem N, Schirmer B. ASMBS updated position statement on insurance mandated preoperative weight loss requirements. Surg Obes Relat Dis 2016;12(5):955–9.
96. Ross LJ, Wallin S, Osland EJ, Memon MA. Commercial very low energy meal replacements for preoperative weight loss

in obese patients: a systematic review. Obes Surg 2016;26(6):1343–51.
97. Tewksbury C, Crowley N, Parrott JM, Andromalos L, Isom KA, Smith E, Allison KC. Weight loss prior to bariatric surgery and 30-day mortality, readmission, reoperation, and intervention: an MBSAQIP analysis of 349,016 cases. Obes Surg 2019;29(11):3622–8.
98. Brethauer S. ASMBS position statement on preoperative supervised weight loss requirements. Surg Obes Relat Dis 2011;7(3):257–60.
99. Aminian A, Brethauer SA, Andalib A, Nowacki AS, Jimenez A, Corcelles R, Hanipah ZN, Punchai S, Bhatt DL, Kashyap SR, et al. Individualized metabolic surgery score: procedure selection based on diabetes severity. Ann Surg 2017;266(4):650–7.
100. Pilla SJ, Maruthur NM, Schweitzer MA, Magnuson TH, Potter JJ, Clark JM, Lee CJ. The role of laboratory testing in differentiating type 1 diabetes from type 2 diabetes in patients undergoing bariatric surgery. Obes Surg 2018;28(1):25–30.
101. Hurren KM, Dunham MW. Understanding the impact of commonly utilized, non-insulin, glucose-lowering drugs on body weight in patients with type 2 diabetes. Expert Opin Pharmacother 2018;19(10):1087–95.
102. Pouwels S, Wit M, Teijink JA, Nienhuijs SW. Aspects of exercise before or after bariatric surgery: a systematic review. Obes Facts 2015;8(2):132–46.
103. Coen PM, Menshikova EV, Distefano G, Zheng D, Tanner CJ, Standley RA, Helbling NL, Dubis GS, Ritov VB, Xie H, et al. Exercise and weight loss improve muscle mitochondrial respiration, lipid partitioning, and insulin sensitivity after gastric bypass surgery. Diabetes 2015;64(11):3737–50.
104. Coen PM, Tanner CJ, Helbling NL, Dubis GS, Hames KC, Xie H, Eid GM, Stefanovic-Racic M, Toledo FG, Jakicic JM, et al. Clinical trial demonstrates exercise following bariatric surgery improves insulin sensitivity. J Clin Invest 2015;125(1):248–57.
105. Campanha-Versiani L, Pereira DAG, Ribeiro-Samora GA, Ramos AV, de Sander Diniz MFH, De Marco LA, Soares MMS. The effect of a muscle weight-bearing and aerobic exercise program on the body composition, muscular strength, biochemical markers, and bone mass of obese patients who have undergone gastric bypass surgery. Obes Surg 2017;27(8):2129–37.
106. Vatier C, Henegar C, Ciangura C, Poitou-Bernert C, Bouillot JL, Basdevant A, Oppert JM. Dynamic relations between sedentary behavior, physical activity, and body composition after bariatric surgery. Obes Surg 2012;22(8):1251–6.
107. Aills L, Blankenship J, Buffington C, Furtado M, Parrott J. ASMBS allied health nutritional guidelines for the surgical weight loss patient. Surg Obes Rel Dis 2008;4(5 Suppl):S73–108.
108. Egberts K, Brown WA, Brennan L, O'Brien PE. Does exercise improve weight loss after bariatric surgery? A systematic review. Obes Surg 2012;22(2):335–41.
109. Carretero-Ruiz A, Olvera-Porcel MDC, Cavero-Redondo I, Alvarez-Bueno C, Martinez-Vizcaino V, Ferrer-Marquez M, Soriano-Maldonado A, Arter EG. Effects of exercise training on weight loss in patients who have undergone bariatric surgery: a systematic review and meta-analysis of controlled trials. Obes Surg 2019;29(10):3371–84.
110. Bellicha A, Ciangura C, Poitou C, Portero P, Oppert JM. Effectiveness of exercise training after bariatric surgery—a systematic literature review and meta-analysis. Obes Rev 2018;19(11):1544–56.
111. Bond DS, Thomas JG, Vithiananthan S, Unick J, Webster J, Roye GD, Ryder BA, Sax HC. Intervention-related increases in preoperative physical activity are maintained 6-months after bariatric surgery: results from the Bari-active trial. Int J Obes 2017;41(3):467–70.
112. Bond DS, Jakicic JM, Vithiananthan S, Thomas JG, Leahey TM, Sax HC, Pohl D, Roye GD, Ryder BA, Wing RR. Objective quantification of physical activity in bariatric surgery candidates and normal-weight controls. Surg Obes Relat Dis 2010;6(1):72–8.
113. King WC, Chen JY, Bond DS, Belle SH, Courcoulas AP, Patterson EJ, Mitchell JE, Inabnet WB, Dakin GF, Flum DR, et al. Objective assessment of changes in physical activity and sedentary behavior: pre- through 3 years post-bariatric surgery. Obesity 2015;23(6):1143–50.
114. Baillot A, Mampuya WM, Dionne IJ, Comeau E, Meziat-Burdin A, Langlois MF. Impacts of supervised exercise training in addition to interdisciplinary lifestyle management in subjects awaiting bariatric surgery: a randomized controlled study. Obes Surg 2016;26:2602.
115. Baillot A, Vallee CA, Mampuya WM, Dionne IJ, Comeau E, Meziat-Burdin A, Langlois MF. Effects of a pre-surgery supervised exercise training 1 year after bariatric surgery: a randomized controlled study. Obes Surg 2018;28(4):955–62.
116. Baillot A, Boissy P, Tousignant M, Langlois MF. Feasibility and effect of in-home physical exercise training delivered via telehealth before bariatric surgery. J Telemed Telecare 2017;23(5):529–35.
117. Bond DS, Vithiananthan S, Thomas JG, Trautvetter J, Unick JL, Jakicic JM, Pohl D, Ryder BA, Roye GD, Sax HC, et al. Bari-Active: a randomized controlled trial of a preoperative intervention to increase physical activity in bariatric surgery patients. Surg Obes Relat Dis 2015;11(1):169–77.
118. Zabatiero J, Hill K, Gucciardi DF, Hamdorf JM, Taylor SF, Hagger MS, Smith A. Beliefs, barriers and facilitators to physical activity in bariatric surgery candidates. Obes Surg 2016;26(5):1097–109.
119. Hansen D, Decroix L, Devos Y, Nocca D, Cornelissen V, Dillemans B, Lannoo M. Towards optimized care after bariatric surgery by physical activity and exercise intervention: a review. Obes Surg 2020;30(3):1118–25.
120. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, Nieman DC, Swain DP. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 2011;43(7):1334–59.
121. US Department of Health and Human Services. Physical activity guidelines for Americans. 2nd ed. Washington (DC): US Department of Health and Human Services; 2018. [cited 2020 Apr 24] [Internet]. Available from: https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf.
122. Mundi MS, Lorentz PA, Grothe K, Kellogg TA, Collazo-Clavell ML. Feasibility of smartphone-based education modules and ecological momentary assessment/intervention in pre-bariatric surgery patients. Obes Surg 2015;25(10):1875–81.
123. Arterburn DE, Westbrook EO, Bogart TA, Sepucha KR, Bock SN, Weppner WG. Randomized trial of a video-based patient decision aid for bariatric surgery. Obesity 2011;19(8):1669–75.
124. Madan AK, Tichansky DS. Patients postoperatively forget aspects of preoperative patient education. Obes Surg 2005;15(7):1066–9.
125. Jastrzebska-Mierzynska M, Ostrowska L, Wasiluk D, Konarzewska-Duchnowska E. Dietetic recommendations after bariatric procedures in the light of the new guidelines regarding metabolic and bariatric surgery. Rocz Panstw Zakl Hig 2015;66(1):13–9.
126. Lee WJ, Lin YH. Single-anastomosis gastric bypass (SAGB): appraisal of clinical evidence. Obes Surg 2014;24(10):1749–56.
127. Conceicao E, Pinto-Bastos A, de Lourdes M, Brandao I, Teixeira C, Machado PPP. Psychological, behavioral, and weight-related aspects of patients undergoing reoperative bariatric surgery after gastric band: comparison with primary surgery patients. Surg Obes Relat Dis 2018;14(5):603–10.
128. De Luca M, Tie T, Ooi G, Higa K, Himpens J, Carbajo MA, Mahawar K, Shikora S, Brown WA. Mini Gastric Bypass-One Anastomosis Gastric Bypass (MGB-OAGB)-IFSO position statement. Obes Surg 2018;28(5):1188–206.
129. Messiah SE, Sacher PM, Yudkin J, Ofori A, Qureshi FG, Schneider B, Hoelscher DM, de la Cruz-Munoz N, Barlow SE. Application and effectiveness of eHealth strategies for metabolic and bariatric surgery patients: a systematic review. Digital Health 2020;6:205520761989898.
130. Coldebella B, Armfield NR, Bambling M, Hansen J, Edirippulige S. The use of telemedicine for delivering healthcare to bariatric surgery patients: a literature review. J Telemed Telecare 2018;24(10):651–60.

131. Cassin SE, Sockalingam S, Du C, Wnuk S, Hawa R, Parikh SV. A pilot randomized controlled trial of telephone-based cognitive behavioural therapy for preoperative bariatric surgery patients. Behav Res Ther 2016;80:17–22.
132. Eaton L, Walsh C, Magnuson T, Schweitzer M, Lidor A, Nguyen H, Steele K. On-line bariatric surgery information session as effective as in-person information session. Surg Obes Relat Dis 2012;8(2):225–9; discussion 9.
133. Pottier E, Boulanouar L, Bertrand M, Estrade A, Croiset A, Martineau C, Plantec JY, Escourou B, Ritz P. A MOOC about bariatric surgery improves knowledge and promotes patients' soft skills. Obes Surg 2020;30:(4):1600–4.
134. Menke MN, King WC, White GE, Gosman GG, Courcoulas AP, Dakin GF, Flum DR, Orcutt MJ, Pomp A, Pories WJ, et al. Contraception and conception after bariatric surgery. Obstet Gynecol 2017;130(5):979–87.
135. Goldenshluger A, Elazary R, Ben Porat T, Farhat HG, Levin G, Rottenstreich A. Knowledge, attitudes, and behaviors of women during pregnancy after bariatric surgery. Surg Obes Relat Dis 2020;16(7):925–30.
136. Garvey WT, Mechanick JI, Brett EM, Garber AJ, Hurley DL, Jastreboff AM, Nadolsky K, Pessah-Pollack R, Plodkowski R. American Association of Clinical Endocrinologists and American College of Endocrinology comprehensive clinical practice guidelines for medical care of patients with obesity. Endocr Pract 2016;22(Suppl 3):1–203.
137. Guelinckx I, Devlieger R, Vansant G. Reproductive outcome after bariatric surgery: a critical review. Hum Reprod Update 2008;15(2):189–201.
138. Harreiter J, Schindler K, Bancher-Todesca D, Gobl C, Langer F, Prager G, Gessl A, Leutner M, Ludvik B, Luger A, et al. Management of pregnant women after bariatric surgery. J Obesity 2018;2018:1.
139. Shawe J, Ceulemans D, Akhter Z, Neff K, Hart K, Heslehurst N, Stotl I, Agrawal S, Steegers-Theunissen R, Taheri S, et al. Pregnancy after bariatric surgery: consensus recommendations for periconception, antenatal and postnatal care. Obes Rev 2019;20(11):1507–22.
140. Ben Porat T, Yuval JB, Elchalal U, Shushan A, Sakran N, Elazary R, Rottenstreich A. Reproductive health counseling, attitudes, and practices: a cross-sectional survey among bariatric surgeons. Surg Obes Relat Dis 2019;15(12):2101–6.
141. Azran C, Wolk O, Zur M, Fine-Shamir N, Shaked G, Czeiger D, Sebbag G, Kister O, Langguth P, Dahan A. Oral drug therapy following bariatric surgery: an overview of fundamentals, literature and clinical recommendations. Obes Rev 2016;17(11):1050–66.
142. Vitner D, Harris K, Maxwell C, Farine D. Obesity in pregnancy: a comparison of four national guidelines. J Maternal-Fetal Neonatal Med 2019;32(15):2580–90.
143. Rottenstreich A, Elazary R, Goldenshluger A, Pikarsky AJ, Elchalal U, Ben-Porat T. Maternal nutritional status and related pregnancy outcomes following bariatric surgery: a systematic review. Surg Obes Relat Dis 2019;15(2):324–32.