

Research and Practice Innovations

The Bariatric Surgery Patient: A Growing Role for Registered Dietitians

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ABSTRACT

Between 1998 and 2004, the total number of bariatric procedures increased almost 10-fold, from 13,386 procedures in 1998 to 121,055 in 2004. Current estimates suggest the number of bariatric operations will exceed 220,000 in 2010. Bariatric surgery encompasses several surgical techniques classified as restrictive or malabsorptive, based on the main mechanism of weight loss. Clinical studies and meta-analyses show that bariatric surgery decreases morbidity and mortality when compared with nonsurgical treatments. A successful long-term outcome of bariatric surgery is dependent on the patient's commitment to a lifetime of dietary and lifestyle changes. The registered dietitian (RD) is an important member of the bariatric team and provides critical instructions to help patients adhere to the dietary changes consistent with surgery. Referencing current literature, this article outlines the indications, contraindications, and types of bariatric surgery. The role of the RD for preoperative and postoperative nutrition assessment and medical nutrition therapy is highlighted. Management of long-term nutrition issues is also reviewed. The current recommendations include a multivitamin/mineral supplement plus vitamin B-12, calcium, vitamin D-3, iron, and folic acid. Given the increasing prevalence of obesity and bariatric surgery procedures, caring for patients who have undergone surgery will be an expanding role for the RD. Close postoperative follow-up and careful monitoring will improve the odds for successful surgical outcomes, and RDs play a very important part in this process.

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Nearly 5% of the US population, or approximately 10 million Americans, have a body mass index (BMI; calculated as kg/m^2) ≥ 40 (class 3 obesity) (1). Based on the current National Institutes of Health's (NIH) Guidelines, all of these are potential surgical candidates (2). According to the Agency for Healthcare Research and Quality, the total number of bariatric procedures increased almost 10-fold, from 13,386 procedures in 1998 to 121,055 in 2004 (3). Current estimates suggest the number of bariatric procedures will exceed 220,000 in 2010 (4). This article describes the indications, contraindications, and types of bariatric surgery and focuses on the registered dietitian's (RD's) role during preoperative and postoperative surgical periods.

INDICATIONS AND CONTRAINDICATIONS FOR BARIATRIC SURGERY

Indications for surgical treatment of obesity were outlined in 1991 by a National Institutes of Health Consensus Development Conference Panel (2). Adults with a BMI ≥ 40 or those with a BMI ≥ 35 who also have a high-risk comorbid condition (eg, uncontrolled diabetes, sleep apnea, obesity-related cardiomyopathy) or suffer obesity-related physical and functional impairment (eg, debilitating joint disease, severe interference with ambulation, job performance, or family functions) may be candidates for bariatric surgery. In addition, patients must have an acceptable risk for surgery and must have failed previous nonsurgical weight-loss interventions. Review of the literature shows that bariatric surgery in adolescents aged 12 to 18 years is safe and associated with considerable weight loss, correction of obesity comorbidities, and improved self-image and socialization (5,6).

Contraindications to bariatric surgery include patients with untreated major depression or psychosis, binge eating disorders, ongoing drug and alcohol abuse, severe cardiovascular disease with prohibitive operative risks, severe coagulopathy, or inability to comply with life-long postoperative nutritional requirements, including vitamin/mineral supplementation.

TYPES OF BARIATRIC SURGERY

Bariatric surgery encompasses several surgical techniques classified as restrictive or malabsorptive, based on the main mechanism of weight loss. The restrictive procedures limit caloric intake by drastically decreasing the stomach's capacity. The restrictive procedure most commonly used in the United States is the laparoscopic adjustable gastric band (7,8) (Figure 1). The band consists of a hollow silicone ring that is placed just a few centimeters below the cardia of the stomach, creating a 15- to 30-mL

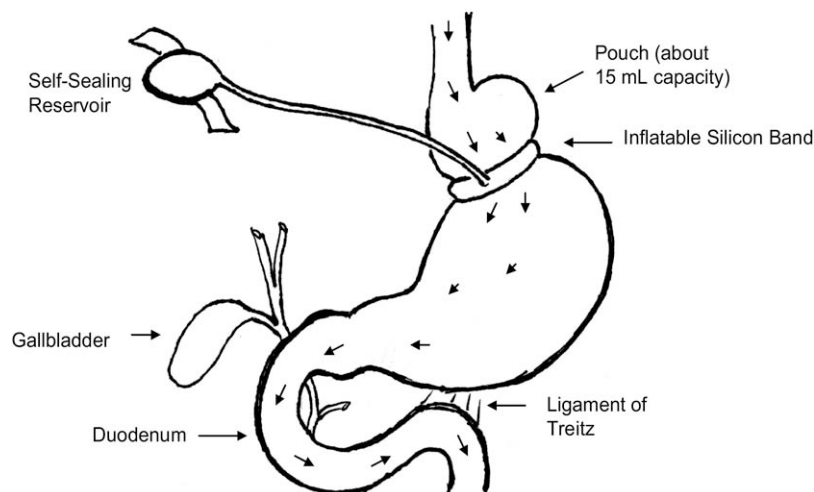


Figure 1. Laparoscopic adjustable gastric banding (LAP-BAND). An inflatable silicone band is placed around the gastric cardia to achieve a 15-mL gastric pouch with an adjustable outlet that is determined by the volume of fluid inserted into the band reservoir. The reservoir is placed in the subcutaneous tissue of the upper abdomen, and can be easily accessed with a syringe, under local anesthesia (the small arrows show the path of the ingested food).

gastric pouch. The band is connected to an infusion port placed in the subcutaneous tissue of the upper abdominal wall (9).

The malabsorptive procedures (jejunioileal bypass, biliopancreatic diversion, and duodenal switch) considerably shorten the length of the functional small intestine and cause nutrient malabsorption as the main mechanism of weight loss. Even though these procedures can achieve substantial weight loss, the benefit of this weight loss is often offset by the considerable metabolic complications, such as protein and calorie malnutrition, and various micronutrient deficiencies. Use of malabsorptive procedures is, therefore, limited (10).

The Roux-en-Y gastric bypass (RYGB), although mainly a restrictive procedure in which a small gastric pouch (20 to 30 mL) limits food intake, does have a clinically significant malabsorptive component because of the small bowel reconfiguration (Figure 2). In addition, there may be neuronal and gut hormonal changes as well, all of which provide additional mechanisms facilitating weight loss. RYGB is the most common bariatric surgery performed in the United States and is considered the “gold standard” because of greater weight loss than laparoscopic adjustable gastric banding and improved comorbidities (5,11-15).

ROLE OF THE RD

Bariatric surgery is only one point in the continuum of care for the obese patient. A successful long-term outcome of bariatric surgery is dependent on the patient’s understanding of the role of bariatric surgery in weight management and his or her commitment to a lifetime of dietary and lifestyle changes (16). Given the technical challenges of bariatric surgery and the complexity of the pre- and postoperative care, the *NIH Consensus Statement on Bariatric Surgery* advocates a team approach (2). This team usually includes a bariatric surgeon, a physi-

cian obesity specialist, a psychologist, a coordinator, a primary care physician, and an RD. The role of the RD is to perform dietary assessments and provide counseling to help patients undergo dietary changes consistent with surgery. In anticipation of surgery, the RD helps patients prepare their kitchens with the needed appliances (eg, food processor, blender, and standardized measuring cups and spoons) and appropriate foods for a transition diet upon discharge from the hospital. The RD also provides counseling for patients as they advance their diet during the early (3 months) postoperative period and, periodically thereafter, especially when the patient has difficulties meeting his or her nutritional goals (17).

PREOPERATIVE NUTRITION ASSESSMENT

All patients undergoing bariatric surgery will have a comprehensive preoperative evaluation by either the obesity specialist or the bariatric surgeon, which includes a medical history, physical examination, and diagnostic testing. This evaluation allows for estimation of the patient’s perioperative risk and aims to minimize this risk by optimizing the management of the patient’s comorbidities.

Educating patients about the nutritional therapy associated with bariatric surgery must be an integral part of bariatric patient care and should begin in the preoperative stage (18). Typically, the RD performs a nutrition assessment that provides additional data to guide the pre- and postoperative management. This assessment includes the patient’s weight history and previous weight-loss strategies; factors affecting weight issues such as work, social, and cultural information; dietary patterns and alcohol intake; nutritional and vitamin supplement use; physical activity and limitations; and readiness and motivation to make long-term lifestyle changes (19). With this information, the RD can identify barriers that may diminish long-term weight loss or result in postoperative

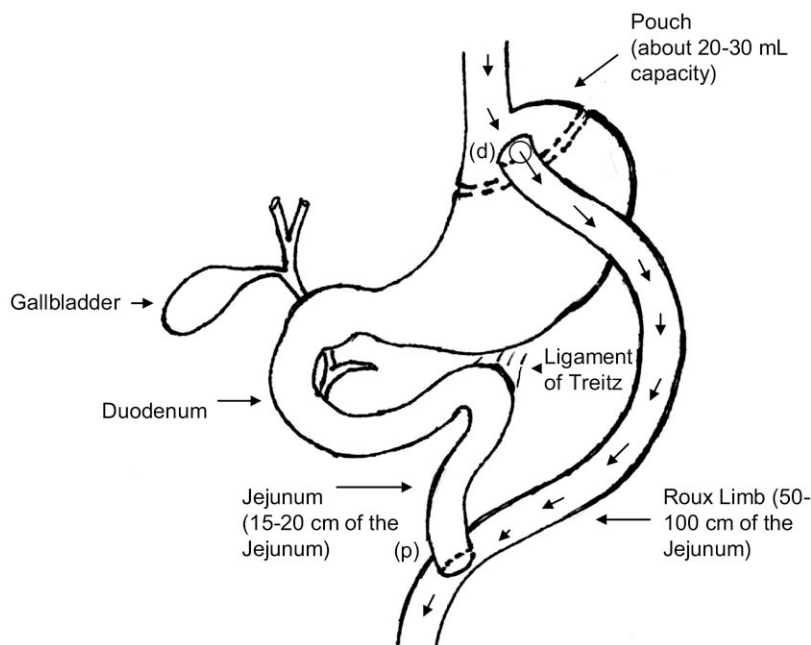


Figure 2. Roux-en-Y gastric bypass. The stomach is stapled just beneath the gastroesophageal junction. The small bowel (jejunum) is divided approximately 30 cm distal to ligament of Treitz. The distal cut end of the small bowel (d) is anastomosed to the proximal gastric pouch. The proximal cut end of the small bowel (p) is anastomosed to the limb 40 cm distal to the gastrojejunostomy (the small arrows show the path of the ingested food).

complications. The RD will work with the patient to develop preoperative dietary goals that will set a foundation for postoperative meal and snack patterns.

Recent studies of specific nutrients known to become deficient after bariatric surgery indicate that substantial deficiencies of some of these nutrients may also exist before surgery. In a retrospective study of 379 patients scheduled to undergo RYGB, deficiencies were noted for iron (44%), thiamin (29%), and 25-hydroxyvitamin D (68%) (20). Preoperative testing of iron status (iron, total iron-binding capacity, ferritin, transferrin), vitamin B-12, 25-hydroxyvitamin D, and parathyroid hormone is recommended, especially in patients undergoing a surgical procedure with a malabsorptive component (21).

Together, the RD and the patient can establish a preoperative nutritional plan until a surgery date has been scheduled. Examples of recommendations may include reducing intake of high-fat foods, using meal-replacement shakes for breakfast, packing lunch instead of eating fast food, reducing intake of sweets, snacking on fresh fruit, substituting one-half serving of a meal-replacement shake instead of an evening snack, and taking prescribed dietary supplements as indicated by the preoperative nutritional and laboratory tests and evaluations.

PREOPERATIVE WEIGHT-LOSS RECOMMENDATIONS

Patients who have lost 10% of their excess body weight in the few weeks prior to surgery are less likely to suffer from surgical complications (22). They have shorter operative time and hospital stays and reduced blood loss compared to those who do not lose weight prior to sur-

gery. Preoperative weight loss was also found to reduce the intraoperative need for conversion to open surgical technique (mainly because of a substantial decrease in liver size, which allows for better surgical access during the laparoscopic approach) (23). In addition, patients who were able to lose weight prior to surgery may have improved long-term weight-loss results (22,23). The choice for the preoperative weight-loss regimen (usually a very low-calorie diet with or without pharmacotherapy) should be based on clinical judgment and the patient's history of previous weight-loss interventions.

POSTOPERATIVE NUTRITION ASSESSMENT

The nutritional goals following bariatric surgery are to produce a substantial caloric deficit while maintaining an adequate intake of essential macro- and micronutrients. The amount of weight loss is usually larger after the malabsorptive surgical procedures; however, nutritional deficiencies follow the same trend (24).

Proteins are absorbed mainly in the jejunum and midileum. The malabsorptive bariatric procedures that bypass these gut areas increase the risk of protein malnutrition. Nonetheless, restrictive procedures may also lead to protein malnutrition because of substantially reduced food intake. The clinical signs of protein malnutrition include edema, alopecia, and low serum albumin level (<3.5 g/dL). Testing patients' serum albumin concentration is considered to be an effective and convenient method of monitoring protein nutritional status. The incidence of protein malnutrition in purely restrictive pro-

cedures is very low (0% to 2%), but has been found in 13% of patients after RYGB (25,26).

Iron deficiency is among the most common nutritional problems following bariatric surgery. Decreased ability to convert the dietary Fe^{3+} into the more absorbable Fe^{2+} form (due to low gastric acid production) and the bypassing of the duodenum and proximal jejunum (which are the main sites of iron absorption) are the primary mechanisms leading to iron deficiency. Up to 50% of RYGB patients have iron deficiency at 4 years, and it is two times more common in females compared to males (27). The prevalence of iron deficiency is even higher after jejunoileal bypass and duodenal switch procedures (28). Measurement of serum ferritin is the single best diagnostic test for iron deficiency and is the first test to show abnormal results. Occurrence of microcytic anemia is typically a late finding and denotes severe iron deficiency.

Calcium and vitamin-D deficiencies are also commonly encountered in the bariatric patient (29). Calcium is absorbed primarily in the duodenum and proximal jejunum, and absorption is facilitated by the presence of gastric acid secretion and vitamin D. Calcium status can be monitored by serum total calcium concentration, but calcium levels may be normal even in deficiency states. Even before surgery, up to 25% of obese patients have subclinical calcium deficiency (elevated parathyroid hormone with normal calcium), and 50% are vitamin-D-deficient (30).

Vitamin D is primarily absorbed in the jejunum and ileum. Being liposoluble, the absorption of vitamin D requires adequate mixing and action of pancreatic and biliary secretions. After surgery, the procedures with a malabsorptive component cause considerably more vitamin-D deficiency compared to the restrictive procedures. The best marker for vitamin-D deficiency is serum 25-hydroxyvitamin-D levels. Low vitamin-D and calcium levels trigger secondary hyperparathyroidism, which can be suspected by the increased levels of parathyroid hormone (31). All these nutritional and metabolic changes accelerate bone loss after bariatric surgery (29). Up to 5,000 IU/day vitamin D may be necessary to treat vitamin-D deficiency associated with RYGB (32).

Vitamin B-12 is almost entirely absorbed in the terminal ileum in presence of the intrinsic factor, which is secreted from the antrum of the stomach. Adequate gastric and pancreatic enzyme secretion and mixing are required to release vitamin B-12 from food and the binding protein, so that vitamin B-12 becomes available to bind with intrinsic factor for absorption in the ileum. The human body stores substantial amounts of vitamin B-12 (about 2,000 μg), but after 3 years, deficiency occurs in approximately one third of patients who have undergone gastric bypass surgery (28). Folic-acid deficiency is less common because this vitamin is absorbed throughout the small intestine. When seen, the deficiency is largely a result of severely reduced dietary intake. Purely restrictive procedures are generally not associated with vitamin B-12 or folic-acid deficiencies. Serum levels of vitamin B-12 and folic acid are used to monitor nutritional status of these vitamins.

Thiamin is absorbed primarily in the duodenum, mostly in the more acidic environment of its proximal portion. The pathogenesis of thiamin deficiency is be-

lieved to result from a decrease in acid production (resulting from a decreased gastric capacity) and restriction of food intake, in the context of profuse and protracted vomiting (33). Symptomatic thiamin deficiency in bariatric patients is rare, but can occur even with restrictive procedures. The clinical presentation of thiamin deficiency most often consists of Wernicke's encephalopathy, which presents as altered mental status, ataxic gait, double vision, nystagmus, and acute polyneuropathy with paralysis (34,35). Clinical recognition of this syndrome may be lifesaving because the symptoms respond very well to prompt intravenous administration of thiamin.

OTHER VITAMINS AND MINERALS

Low serum levels of vitamins A, K, and E were noticed after bariatric surgery, but clinical manifestations of such deficiencies have not yet been described. No clinical complications from lack of vitamin C, magnesium, or selenium have been reported. Cases of zinc deficiency were found to occur following malabsorptive procedures and usually manifest as alopecia. It is important to emphasize to patients that nutritional deficiencies following bariatric surgery can be avoided or corrected by routine laboratory monitoring, adequate dietary intake, and supplementation (36).

POSTOPERATIVE MEDICAL NUTRITION THERAPY

Postoperative suggestions for dietary advancement and supplementation for bariatric surgery patients are outlined in Figure 3. Although there are no strict dietary guidelines after bariatric surgery, the recommendations are to follow a meal pattern that calls for gradual progression of food consistency over weeks or months (37,38). Patients are typically advised to follow a clear-liquid diet for 1 or 2 days after surgery and advance to full liquids while keeping the feeding volume small during the first week. During this week, meals are limited to no more than $\frac{1}{4}$ cup per serving, four to six times per day. Week 2 postoperatively, patients can begin adding pureed foods, with an emphasis on including higher-protein foods and slowly increasing the volume of food. Semi-solid/soft foods are added as tolerated, usually in the second week after surgery, and patients should be reminded to chew each small bite thoroughly.

Foods not well-tolerated during the first few months after surgery include red meat, chicken, and turkey (except when finely minced), white-flour products, foods high in sugar or fat, and raw fruits and vegetables with high fibrous consistency (eg, celery stalks, corn, artichokes, tomatoes, pineapple, oranges). Guidelines for continued weight loss should be reviewed and may include keeping portions small, no beverages 30 minutes before eating and 30 to 60 minutes after eating, ingesting at least 60 g protein per day to avoiding protein malnutrition, eating at scheduled times and avoiding grazing, allowing 30 minutes for each meal and chewing food well, and incorporating physical activity on most days of the week (39). At 2 months postoperatively, patients can eat approximately 1 cup of food per meal, averaging 60 to 80 g protein every day, and drink 48 oz water.

Time post-operation	Suggested Dietary Advancement after Bariatric Surgery
Days 1-2	<ul style="list-style-type: none"> ● Clear liquids (sugar-free, noncarbonated, caffeine-free) ● Sip liquids as tolerated and advance to 48 fluid oz/day
Days 3-7	<ul style="list-style-type: none"> ● Always avoid drinking liquids with a straw to reduce intake of air ● Continue clear liquids (sugar-free, noncarbonated, caffeine-free) ● 48-64 fluid oz/day (half as clear liquids) ● Start full liquids (nonfat milk, soy milk, plain or blended yogurt, blended soups) ● May add whey and soy protein powder to full liquids (Limit to <20 g protein/serving) ● Start chewable multivitamin and mineral supplement (1 tab twice daily)
Weeks 2-3	<ul style="list-style-type: none"> ● Increase clear liquids to 48-64 fluid oz/day ● Replace full liquids with solid soft, moist, pureed, ground, low-fat, high-protein foods (eggs, low-fat cottage cheese, fish, poultry, lean meat, cooked beans) ● Consume four to six meals/day (limit portion size ~$\frac{1}{4}$ cup) ● Consume protein first (at least 60 g/day)
Weeks 4-6	<ul style="list-style-type: none"> ● Advance diet as tolerated: add well-cooked soft vegetables, soft and/or peeled or canned fruits (no sugar added) ● Add one soft, moist, solid food/meal/day as tolerated ● Consume four to six meals/day (limit portion size ~$\frac{1}{2}$ cup) ● Consume protein first (60-80 g/day) ● Avoid dehydration by consuming 48-64 fluid oz/day of clear liquids (sugar-free, noncarbonated, caffeine-free) ● No beverages 30 minutes before eating and 30 to 60 minutes after eating ● Chew foods well
Week 7 and beyond	<ul style="list-style-type: none"> ● Daily caloric needs are based on height, weight, and age ● Consume a balanced diet consisting of lean protein, fruits, vegetables, and whole grains ● Avoid raw fruits and vegetables with high fibrous consistency (celery stalks, corn, artichokes, tomatoes, pineapple, orange); may consume these pureed, or well cooked ● Consume three meals and two snacks/day (limit portion size ~1 cup) ● 48-64 fluid oz/day of clear liquids (noncarbonated, calorie-free, caffeine-free) ● No beverages 30 minutes before eating and 30 to 60 minutes after eating ● Chew foods well
Source: Doina Kulick, MD, MS, FACP, University of Nevada School of Medicine, 2009, used with permission.	

Figure 3. Suggested dietary advancement after bariatric surgery.

ADDRESSING DUMPING SYNDROME

Patients who complain of nausea, cramping, diaphoresis, diarrhea, dizziness, or palpitations after eating are likely to have dumping syndrome, which initially occurs in 70% to 76% of patients with RYGB (40). Dumping syndrome can be separated into early and late forms, depending on the relationship of the symptoms to the time elapsed after the meal. Symptoms of early dumping occur within 10 to 30 minutes after eating. They result from accelerated gastric emptying of hyperosmolar content into the small bowel, followed by fluid shifts from the intravascular compartment into the intestinal lumen (41). These events are believed to be responsible for gastrointestinal symptoms such as nausea, bloating, abdominal cramps, and explosive diarrhea. The majority of patients have early dumping.

Late-dumping syndrome occurs 1 to 3 hours after eating and it is characterized predominantly by systemic vascular symptoms, including flushing, dizziness, palpitations, and lightheadedness. Physical examination of these patients may reveal profound orthostatic changes. Late dumping occurs in approximately 25% of patients with early dumping syndrome. Late dumping is considered to be the consequence of hypoglycemia from an exaggerated release of insulin (42,43). A detailed food his-

tory, with particular attention to the intake of foods with a high content of sugar is critical for the RD to obtain from any patient presenting with these symptoms. Dumping syndrome usually responds to dietary interventions that include reduction of carbohydrate intake (especially simple sugars), avoidance of liquids for at least 30 minutes after a solid meal, and small portion sizes.

LONG-TERM NUTRITIONAL ISSUES

Long term, patients should be advised to spend at least 30 minutes eating each meal and to take their time to chew foods well. They should slowly sip their fluids between meals (8 oz fluids during 30 to 40 minutes), but not 30 minutes before or 30 to 60 minutes after eating. Low-fat, low-sugar foods and beverages are tolerated best and at least 60 g protein daily should be ingested to avoid malnutrition.

Patients should follow-up with the physician obesity specialist or primary care physician at 1, 3, 6, and 12 months after surgery, and on annual basis thereafter (44). Visits with the RD and behavioral therapist are recommended any time patients have difficulty maintaining their dietary goals or regain weight (16). Annual visits focus on building long-term healthful dietary be-

havior, continuing physical activity, and monitoring and correcting potential nutritional deficiencies (16). Routine blood tests at annual postoperative visits include a complete blood count and chemistry panel including liver enzymes, lipid panel, hemoglobin A1c, ferritin, iron, total iron-binding capacity, total iron-binding capacity saturation, vitamin B-12, 25-hydroxyvitamin D, and intact parathyroid hormone. Bone-density scan and other laboratory tests should be done based on clinical judgment. Patients who have undergone gastric bypass are routinely prescribed supplements for the rest of their lives to aggressively prevent the associated nutrient deficiencies. The current recommendations for routine vitamin/mineral supplementation are (21,36,45):

- a standard adult or prenatal type of multivitamin/mineral supplement (1 tablet twice daily, preferably chewable or liquid preparations);
- calcium citrate: 1,200 to 1,500 mg/day;
- vitamin D-3: 1,000 to 2,000 IU/day;
- vitamin B-12: 500 µg/day orally or 1,000 µg/month intramuscularly;
- folic acid: 400 µg/day; and
- elemental iron: 65-80 mg/day (preferably with vitamin C).

Iron and calcium should be taken about 4 hours apart to improve absorption.

Patients with gastric banding do not require routine folic acid, vitamin B-12, or iron supplements. Patients with pre- and/or postoperative diagnosed nutritional deficiencies are treated beyond these recommendations.

CONCLUSION

Bariatric surgery was introduced in the mid-1950s and, until 20 years ago, was limited to a small number of cases as an empirical approach to obesity management. The dramatic increase in the incidence of obesity during the last 3 decades has produced an unprecedented increase in the number of bariatric surgery procedures. However, surgery represents only one point in the continuum of care for the obese patient. The long-term outcome of bariatric patients relies on their adherence to lifetime dietary and physical activity changes. A comprehensive team approach provides the best care to these patients and RDs play an important and growing role in this process. Because of the pre- and postoperative dietary issues, RDs can assess, monitor, and counsel patients in order to improve adherence and reduce the risk of nutrient deficiencies. However, many of the current dietary and nutrition recommendations for the bariatric patient are based on expert opinion or observational studies (46). Therefore, this is an opportunity for future research to provide more evidence-based recommendations for best practice in the nutrition evaluation and management of the bariatric patient.

STATEMENT OF POTENTIAL CONFLICT OF INTEREST: No potential conflict of interest was reported by the authors.

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