

Nutritional Pyramid for Post-gastric Bypass Patients

Violeta L. Moizé · Xavier Pi-Sunyer · Heidi Mochari ·
Josep Vidal

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Abstract

Background Life-long nutrition education and diet evaluation are key to the long-term success of surgical treatment of obesity. Diet guidelines provided for bariatric surgery patients generally focus on a progression through dietary stages, from the immediate post-surgical period to 6 months after surgery. However, long-term dietary guidelines for those surgically treated for obesity are not readily available. Therefore, there is a need for dietary recommendations for meal planning and nutritional supplementation for bariatric surgery patients beyond the short-term, post-operative period. The purpose of this paper is to construct an educational tool to provide long-term nutritional and behavioral advice for the post-bariatric patient.

Methods The manuscript summarizes the current knowledge on dietary strategies and behaviors associated with beneficial nutritional outcomes in the long term of post-bariatric surgery patients.

Results Dietary and nutritional recommendations are presented in the form of a “bariatric food pyramid” designed to be easily disseminated to patients.

Conclusions The development of educational tools that are easy to understand and follow is essential for effective patient management during the surgery follow-up period. The pyramid can be used as a tool to help both therapists and patients to understand nutrition recommendations and thus promote a healthy long-term post-op dietary pattern based on high-quality protein, balanced with nutrient-dense complex carbohydrates and healthy sources of essential fatty acids.

Keywords Dietary pattern · Nutritional pyramid · Obesity · Gastric bypass

Introduction

Surgical treatment of severe obesity has increased dramatically over the past 10 years [1]. There are therefore a growing number of people in need of specific post-operative nutritional recommendations. As for the conventional treatment of obesity, the known nutritional requirements for post-op bariatric surgery patients include: (1) a negative energy balance during the weight-loss phase, and (2) sufficient protein intake [1, 2]. Moreover, nutritional supplementation also plays an important role both immediately after surgery, and also throughout the lifetime of the patient. Some nutritional guidelines for the post-bariatric patient have been published; however, they are mainly focused on short-term dietary recommendations [3]. However, it should be emphasized that life-long adjustments to eating behavior and physical activity are needed for successful weight loss and to prevent long-term complications [4–6].

V. L. Moizé · J. Vidal
Obesity Unit, Hospital Clinic i Universitari,
Barcelona, Spain

X. Pi-Sunyer
Obesity Research Center, St. Luke’s–Roosevelt Hospital,
Columbia University,
New York, USA

H. Mochari
The New York Presbyterian Hospital,
New York, USA

V. L. Moizé (✉)
Obesity Unit, Endocrinology Department,
Hospital Clinic Universitari,
Villarroel 170,
08036 Barcelona, Spain
e-mail: vmoize@clinic.ub.es

The purpose of this manuscript is to construct an educational tool for the long-term nutritional and behavioral advice for the post-bariatric patient. For our proposal, we have used a “pyramid” graphic. To construct the pyramid we have considered the notions published to date on life-long dietary recommendations for post-gastric bypass (GBP) patients.

Why the Pyramid?

Every 5 years since 1980, the United States Department of Agriculture (USDA) and the Department of Health and Human Services have jointly published the Dietary Guidelines for Americans. These guidelines provide the basis for U.S. federal nutrition policy and nutrition education activities. The pyramid graphic is a familiar means of illustrating how to select foods to create a balanced diet. Its original purpose was to convey two main ideas: variety and proportionality, both by pictures and by the size of the food group (<http://www.cnpp.usda.gov>). The idea is that anyone can follow the food guide pyramid easily, making it an effective educational tool that is available to all (therapists and patients alike). Over the years, the pyramid has been adapted to many special physiological situations, such as pregnancy, old age, infancy, etc. Since post-GBP patients have special nutritional needs, the original food pyramid could be adapted for use in the post-GBP population.

Dietary Macronutrient Pattern After GBP

The American Society for Metabolic and Bariatric Surgery published a review of the elements that are important for the nutritional care of the bariatric patient [7]. The paper focuses on pre-operative and short-term post-operative nutrition evaluation and follow-up. It does not provide specific recommendations regarding the macronutrient proportions of the diet a patient should follow in the long term to achieve, not only their expected weight loss after surgery, but also a healthy dietary pattern. Several observational studies have shown that the macronutrient intake post-GBP is approximately: 30% fat, 45% carbohydrate, and 25% protein [3, 8–10]. A recent randomized clinical trial showed no difference in first-year post-GBP weight loss between patients who were counseled to follow a high-protein, low-carbohydrate diet based on the South Beach Diet and those advised to follow a traditional American Heart Association low-fat diet [11]. Other post-bariatric-surgery studies have shown that dietary pattern is mainly determined by patients’ food preferences [8]. In summary, consensus has yet to be reached concerning the best

macronutrient pattern to follow for healthy weight loss after bariatric surgery

Negative Energy Balance

Successful weight loss after surgery largely relies on appropriate calorie restriction [12–15]. However, no universal standard for establishing energy requirements that optimize weight loss after bariatric surgery has been defined. The use of the Harris–Benedict equation to estimate caloric requirements has not been validated in the bariatric patient [16]. Moreover, maladaptive eating behavior has been cited as a primary cause of excessive caloric intake and inadequate weight loss after GBP [9].

Energy intake has been negatively correlated with weight loss, suggesting that energy intake plays a critical role in the success of bariatric surgery and must be controlled in the long term [9, 10, 12, 17]. Nonetheless, in clinical practice, the nutritionist should work together with the patient to estimate the appropriate daily caloric intake, taking into account variables such as: (1) physical activity (which increase overall metabolic rate), and (2) protein intake (to optimize this nutrient and prevent the use of protein simply as an energy source). Research conducted on patients who have undergone bariatric surgery has shown that energy intake reaches up to 2,000 kcal/day during long-term follow-up [12, 18–21]

Our proposal does not focus on specific energy intakes, but rather aims to provide the framework for an individualized energy restriction to ensure a negative energy balance while providing an adequate protein intake.

Adequate Protein Intake

Protein is one of the nutrients that are most important to monitor after bariatric surgery [22]. A review conducted by Bloomberg et al. showed that although protein deficiency can occur after standard GBP, it is far more common after predominantly malabsorptive procedures such as biliopancreatic diversion or distal GBP [23]. Brolin et al. [24] did not encounter cases of protein deficiency in GBP patients as long as 43 months after surgery. Nonetheless, they reported that dietary counseling and increased protein intake helped to prevent protein and micronutrient deficiencies. However, other lines of research have underscored the importance of protein intake on body composition changes after GBP. Importantly, GBP is accompanied by a larger loss of fat-free mass (FFM) when compared to other forms of caloric restriction [25]. An elevated protein intake has been demonstrated to influence body composition changes following weight loss in a way that spares FFM [26].

Daily protein intake recommendations after GBP vary considerably in the literature: from 0.8 to 2.1 g/kg ideal body weight [7, 20]. This wide range illustrates that the data published on this topic are far from conclusive. Clinicians have proposed that, to avoid protein malnutrition, protein intake should be at least 60–80 g daily [1, 27, 28]. However, it should be emphasized that intolerance to high-protein foods has been documented in the post-GBP patient. Many patients have problems with red meat and dry or tough poultry or pork [29]. This intolerance can still be present 7 years after surgery (with a prevalence as high as 50%) [30]. Thus, protein-deficient meals are common after GBP and this represents an additional challenge in achieving adequate protein intake after bariatric surgery and eventually may lead to chronic protein malnutrition [27].

Although it remains to be firmly proven, protein supplements have been suggested to be helpful in meeting the recommended protein intakes [31]. In cases of intolerance to meats other protein sources (e.g., eggs, fish, legumes with cereals, cheese, tofu) should be considered to enhance protein intake and prevent deficiency. It is important to consider that apart from animal protein sources, vegetal sources of protein need to be combined properly to meet all the essential amino-acid requirements of our bodies. Because protein is a satiating nutrient [32] (in comparison to carbohydrates), patients choosing high-protein foods are more likely to maintain a low-energy intake over time while they ensure they meet their protein needs.

Low Fat Intake

There are no data regarding the prevalence of fat intolerance after GBP. A low-fat, reduced-energy diet is the best studied weight-loss dietary strategy and is most frequently recommended by governing health authorities [33]. Fat intake during the first year after surgery ranges between 30.2% and 41.7% [10, 12, 18, 19, 34]. A survey of post-GBP dietary patterns showed that patients who do not regain weight typically avoid foods with a high fat content as well as those with a high total calorie content [30]. Regarding quality of fat, diet should ensure essential fatty acids in order to reduce the risk of cardiovascular disease [35]. In the absence of better evidence, we propose to keep fat intake post-GBP in the lower range of the above-mentioned observational studies. Attention should be paid not only to the quantity but also to the quality of fat consumed. Fish oil is a good source of *n*-3 fatty acids. Concerning oil, we recommend olive oil as the main source, nonetheless, because sunflower and corn oils contain very little *n*-3 fatty acid (FA; <1%) and can therefore result in an *n*-3 FA deficiency, soybean, linseed,

and canola oils, which contain relatively high amounts of both *n*-3 and *n*-6 FA, are a good choice and can also be included in the diet [36].

Restricted Carbohydrate Intake

No specific recommendations on the proportion of dietary carbohydrate intake were made in the recent guidelines for the nutritional support of the bariatric patient issued by The American Association of Clinical Endocrinologists, The Obesity Society, and The American Society for Metabolic and Bariatric Surgery. As mentioned above, several observational studies have shown that the carbohydrate intake post-GBP is approximately 45% [3, 8–10]. Although there is no general agreement, some authors have proposed that a negative correlation exists between the average monthly weight loss and carbohydrate intake following GBP [37]. Similarly, Colleen et al. [38] identified six common habits among the patients who successfully maintained at least 74% of their initial post-surgery weight loss. One of these was eating only two servings of bread/starch a day. However, they did not establish the amount of food considered as a serving, which makes it difficult to translate this finding into a recommendation. The American Diabetes Association recommends 130 g of carbohydrate/day as a minimum requirement for type 2 DM. Regarding types of CHO, there is no clear evidence to suggest that complex CHO are not well tolerated in the post-bariatric surgery population. Nonetheless, it has been reported that bread, rice, doughy-textured starches, and pasta may be poorly tolerated after GBP [39]. Moreover, as reviewed below, avoiding simple sugars and increasing intake of fiber and complex carbohydrates may help to prevent the occurrence of dumping syndrome [40]. Taken together, the above-mentioned data would suggest that 40–45% daily calories coming from carbohydrates from individualized dietary sources and a dietary fiber intake of about 14 g/1,000 calories consumed [41] would be adequate for the post-GBP patient.

Sugar and Concentrated Sweets

Dumping syndrome is the effect of alterations in the motor functions of the stomach, including disturbances in the gastric reservoir and its transporting activity. Dumping syndrome occurs in 25–50% of patients after gastric surgery but only 5–10% of them develop clinically significant symptoms [40]. Sensitivity to sugar after surgery can vary widely among patients. The nutritionist should evaluate a patient's tolerance, taking into account the fact that some sources containing natural sugar, such as fresh fruit, dairy products, or vegetables, are well tolerated [17]. Dumping symptoms can be overcome in

most cases by dietary modifications such as avoiding simple sugar intake (e.g., candy, cookies, sodas, sport drinks, sweets) in favor of complex carbohydrates (e.g., unsweetened cereals, pasta, potatoes, fresh fruit, and vegetables). Milk and dairy products with large amounts of added sugar (e.g., milkshakes, sweetened yogurt, chocolate milk) are generally not well tolerated either and should be avoided or replaced by unsweetened dairy products. Food intake distributed into six meals a day is recommended. Other measures can help prevent dumping symptoms, such as avoiding fluid intake during meals [42]. Supplementation of dietary fiber with meals has proved to be effective in the treatment of hypoglycemic episodes [43]. Besides the established association between the intake of sweets and dumping syndrome, the high calorie content of sweets and their lack of nutrients mean that they are not recommended in the long-term post-GBP diet.

Micronutrients

It has been suggested that nutritional deficiencies are common in the obese population before surgery and frequently go untreated [44]. As previously reported, the intake of selected micronutrients may remain below the RDA and RDI after surgery [10]. Poor eating habits, low nutrient-dense food choices, food intolerance, and restricted portion size can all contribute to reduced micronutrient intake. Bariatric surgical procedures, such as GBP, may induce malabsorption and can frequently result in nutritional deficiencies [17]. A combination of the prevalence of nutritional deficiencies preoperatively, malabsorption and decreased intake following bariatric surgery may render patients prone to severe micronutrient deficiencies. Iron, calcium, vitamin D, vitamin B₁₂, and folate are the most common deficiencies observed after GBP [17]. After surgery, the prevalence of micronutrient deficiencies varies depending on pre-operative nutritional status [44], the type of surgery and degree of malabsorption [17], the post-operative period when it is observed [17], and the patient's dietary pattern or individual food tolerance [6]. In order to ensure micronutrients a multivitamin–mineral supplement is recommended for life after surgery [17, 45, 46]. The dose and duration of such nutritional supplementation are not yet well established [1, 7]. Supplements of iron, calcium, vitamin D, vitamin B₁₂, and folate are recommended in the perioperative period and for life. During follow-up, more individually tailored supplementation can be added as necessary; including supplements of zinc, magnesium, and vitamin B₆ [1, 7, 47, 48]. Regardless of the specific prescription, attention should be paid to supplementation adherence given that this is a key factor in the management of nutritional deficiencies [29].

Hydration

After GBP, liquid requirements are difficult to ensure; mainly due to an overall decreased food and liquid intake [29]. Some patients are unable to drink large amounts of liquids at one time, at least initially after surgery. These patients should be advised to sip fluids frequently throughout the day to prevent dehydration [28]. Colleen et al. [38] found that water is preferable to carbonated beverages as they can cause discomfort. Even when fluid intake is difficult soon after surgery, patients should be encouraged to drink about 1.8 l a day [1, 29] of non-caffeinated liquids. It should also be borne in mind that, even though vomiting and diarrhea are uncommon after GBP, they may exacerbate dehydration. If present, dehydration can be a health concern in post-op bariatric patients and favor the development of gallstones [6].

Developing the Food Pyramid for Post-GBP Patients

Base of the Pyramid

This is where we propose to locate the need for nutritional supplementation: including vitamin and mineral supplements at the base level. Studies have demonstrated that vitamin and mineral supplementation on a daily basis help prevent deficiencies [47, 48]. We have adopted current guidelines for nutritional supplementation [1, 7]. The discussion regarding the optimal doses of nutritional supplementation is beyond the scope of the present proposal. By locating supplementation at the base of the pyramid we would like to emphasize the special attention that should be paid to reinforce supplement adherence [29]. We also include physical activity at this level. A prospective study performed on 100 RYGBP surgery patients shows that individuals who progress from being inactive before bariatric surgery to being highly active 1 year following surgery have better weight-loss outcomes than those who continue to be inactive. Individuals who became or continued to be highly active after surgery had greater improvements in mental health related quality of life than those who remained inactive post-operatively [49] (Fig. 1).

First Level of Pyramid: High-Protein, Low-Fat Food Sources

The food groups shown here have a high protein content and should be encouraged as the main food choices for daily intake. In order to control calorie intake, high-protein low-fat food choices are recommended. Protein can be from animal sources, such as lean meat and fish or low-fat dairy products, and also from vegetables sources, such as legumes combined with cereals, tofu, or seitan to provide

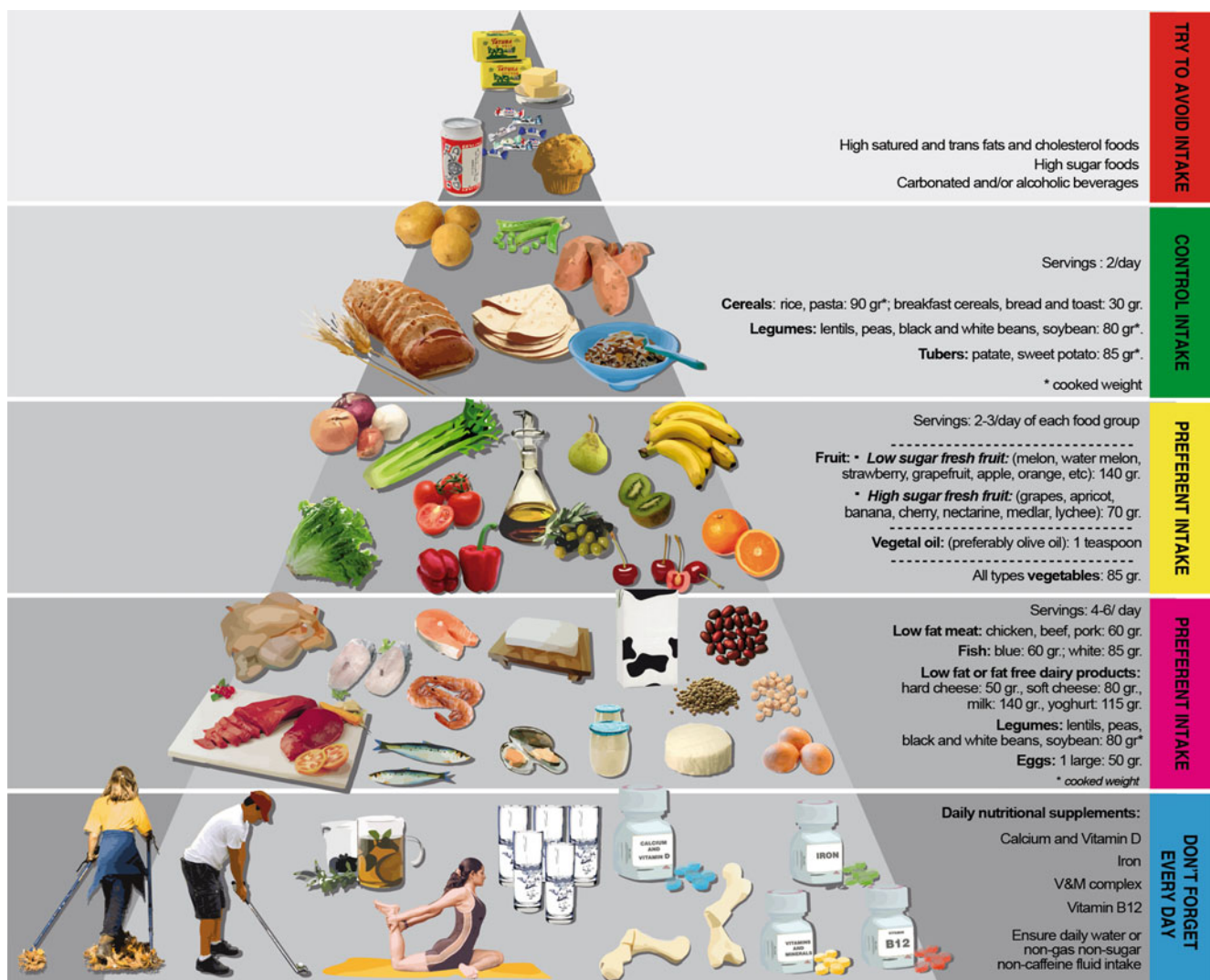


Fig. 1 Nutritional Pyramid for Post-gastric Bypass Patients

high-biologic value protein. If tolerated, we recommend four to six servings of protein-rich foods per day, otherwise supplements should be used [7]. Serving sizes and grams of protein per serving are shown in Table 1.

Second Level of Pyramid: High-Fiber, Low-Calorie Foods

During the first year after surgery, fruit and vegetables should be controlled because they have been associated with increased satiety, which could lead the patient to decrease the intake of other nutrient-rich foods (such as meat, fish, legumes, etc.). However, in the long-term, fruit, vegetables, and legumes are good options, particularly for those patients whose caloric intake increases too much. In long-term follow-up, many patients have reported eating two servings of fruit and two to three servings of vegetables per day [10]; in accordance with the USDA health recommendations (www.health.gov/DietaryGuidelines/).

To the best of our knowledge, there are no data relating the number of servings and consumption of each of these foods to food tolerance, constipation and/or weight-loss success after surgery. However, our recommendation includes two to three servings of fruit and two to three servings of vegetables per day. Because of their different caloric contents, we differentiate in the pyramid between fruits with low- and those with high-sugar content. Since oil is high in fat, its consumption should be limited to two to three servings per day. When recommending vegetable oils, we particularly highlight the known beneficial effects of olive oil [50]. Serving sizes and grams per serving for this level of the pyramid are shown in Table 1.

Third Level of Pyramid: Grains and Cereals

In accordance with reports published in the literature, and in order to maintain controlled protein and calorie intake,

Table 1 Food groups: serving sizes and grams of protein per serving

For a 1200-kcal diet and 60g of protein, the amounts shown below are needed:

Food group	Servings day = (d) week = (w)	Type of food	Grams of food/ serving ^a	Grams of protein/ serving ^b	Tips
Protein	4-6/d	Meat			Avoid fatty meats.
		Chicken	60	15–19	
		Beef	60	15–20	
		Pork	60	13–19	Chose oily fish at least 3 days/week
		Fish			
		Oily fish	60	13–18	
		White fish	85	16–23	Choose low-fat/fat-free, calcium rich dairy products
		Dairy products			
		Hard cheese	50	11–13.5	
		Soft cheese	80	8–12	
		Milk	140	4–5	
Yogurt	115	4–7	Mix beans with cereals. Add to enrich soups		
Legumes	80	6–8			
Eggs	50 (a large unit)	6			
Fruit	2-3/d	Low-sugar fresh fruit (melon, water melon, strawberry, grapefruit, apple, orange, pear, etc.)	140	1	Choose low-sugar fruits more frequently as a good source of vitamins and fiber.
		High-sugar fresh fruit (grapes, apricot, banana, cherry, nectarine, medlar, lychee)	70	0.75	
Vegetables	2-3/d	All types	85	1–3	Use vegetables to increase satiety and as a good source of fiber.
Grain	2/d	Rice, pasta	90	2–5	Chose whole grains over processed grains
		breakfast cereals, bread and toast	30	2–4	
		Legumes	80	6–8	
		Tubers	85	2–4	
Oil	2–3/d	Olive oil	6 (one teaspoon)	0	Select only vegetable oils, preferably olive oil, which are lower in saturated fat.
		Sunflower oil	6 (one teaspoon)	0	

^a Cooked weight

^b Source: USDA National Nutrient Database for Standard Reference. Nutrient values and weights are for edible portion; ranges are rounded to the nearest gram

we recommend two servings per day of whole grains and cereals. Recommendations for these energy sources should be individual and based on patient tolerance, based on report suggesting that certain types of dietary sources of carbohydrates are more likely to be poorly tolerated [39]. Serving sizes and grams of protein per serving are shown in Table 1.

Fourth Level of Pyramid: High-Calorie Foods; Fats and Sweets are Energy-Dense Foods

Beverages containing sugar and other high-sugar products such as candies, pastries, cakes, and cookies (which are also high in saturated and trans fats) should be controlled because they are energy-dense nutrients in

addition to having deleterious effects. Fatty meats and fat supplements (such as butter or cream) should be avoided. High-calorie foods and beverages could limit weight loss to a rate below that expected. Patients who successfully avoid sweets, ice cream, and salty junk foods almost invariably have satisfactory maintenance of weight-loss post-op [11]. Grams of food in each serving are shown in Table 1.

Other Considerations

It has been suggested that certain non-food related behavior is an essential component of long-term success after surgery [3, 27, 28, 38, 51] and examples of such behavior are

Table 2 Non-food-related behaviors as key components of long-term success after surgery

Eating three well-balanced meals and two snacks daily
Drinking water and avoiding carbonated water and other carbonated beverages of any kind
Chewing food completely and eating foods in small volumes
Eating slowly: patients need to eat for 20 minutes or more to avoid bolus eating and to allow the feeling of satiety to occur
Following prescribed serving sizes to avoid overeating
Taking daily vitamin and mineral supplements as well as iron, calcium, and vitamin D supplements
Avoiding overcooked foods and leftovers (foods get more dehydrated).
Avoiding drinking and eating at the same time: patient should be instructed to drink half an hour before and after meals, but not with meals. This can cause vomiting or diarrhea and make individuals feel hungry much more quickly after a meal [45] leading to grazing between meals

summarized in Table 2. Some other attitudes which have been studied in those considered to be unsuccessful patients include a lack of exercise, poorly balanced meals, constant grazing and snacking [52], and drinking carbonated and/or high-sugar-content beverages [38].

From the Food Pyramid After GBP to Macronutrient Intake

The macronutrient recommendations contained in the pyramid need to be translated into daily intakes. A sample menu and its nutrition information following the new food post-bariatric-surgery pyramid that is proposed

is presented in Table 3. Based on the pyramid, daily menus can be adapted to patient preferences, tolerance, and needs.

Summary

Eating behavior after bariatric surgery has been studied since the 1980s. However, the lack of studies focusing on eating behavior, nutritional status, and successful weight loss after surgery has delayed guidelines for GBP patients. The existing data suggest that patients require a multidisciplinary approach to accomplish all the changes they are required to make after surgery. Patients need an individualized dietetic approach, both before and after surgery, and long-term support in order to establish a more appropriate eating pattern. The interdisciplinary team must ensure that the patient understands the surgical procedure and the need for changes in eating habits and food choices, and that the patient receives strong social support. The patient should commit for long-term care with a team. Continued support through communication and monitoring is needed in order to minimize complications and encourage successful weight loss after surgery. The development of educational tools that are easy to understand and follow is essential in the management of the patient during the follow-up period, using either an individual or a group approach.

In this manuscript, we have attempted to develop an educational tool, based on the few studies and reviews that are available in the literature. We hope that it can also be used as a tool to help both therapists and patients to understand nutrition recommendations to promote a healthy long-term post-op dietary pattern based on high-quality

Table 3 Sample menu

Meal	Sample of food	Portion size ^a
Breakfast 1	Skimmed milk	140 gr.
Breakfast 2	Natural orange juice	140 gr.
	[Multigrain] Toast	30 gr.
	Turkey breast	60 gr./ 2 thin slices
	Low-fat cheese	30 gr./ 1 slice
Lunch	Calamari	30 gr.
	Shrimp	60 gr.
	Brown rice	90 gr.
	Olive oil	1 1/2 teaspoon
	Strawberries	140 gr.
Afternoon snack	Yogurt [plain/no added sugar]	115 gr.
Dinner	Green beans	85 gr.
	Eggs	1 large
	Olive oil	1 1/2 teaspoon
	Apple (fresh fruit)	140 gr.

Nutritional information (analysis source: Dietsource[®] Nestle): kcal=1,109.3; prot, 70.0 (25%); fat, 40.0 (33%); CHO, 117.0 g (42%)

gr. grams

^a Cooked weight

protein balanced with nutrient-dense complex carbohydrates and healthy sources of essential fatty acids. We believe that given the growing number of people undergoing bariatric surgery, an adaptation of the food pyramid may be helpful in this clinical setting.

Conflict of interest statement The authors declare that they have no conflict of interest.

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