Nutrition Care in Bariatric Surgery: An Academy Evidence Analysis Center Systematic Review

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ABSTRACT

Obesity continues to be a major public health crisis, both nationally and globally. Metabolic and bariatric surgery has been proven to be a safe and effective treatment for this multifactorial chronic disease. However, inconsistent and varied results in bariatric nutrition literature have prevented the implementation of standardized guidelines. The purpose of this Evidence Analysis Library systematic review is to provide an evidence-based summary of nutrition-related practices in bariatric surgery. The systematic review methodology of the Academy of Nutrition and Dietetics was applied. A total of 27 research studies were included, analyzed, and assessed for risk of bias by trained evidence analysts. The literature included in the systematic review was published from 2003 to 2015. Evaluation of the literature resulted in the development of five graded conclusion statements. Limited research demonstrates that registered dietitian nutritionists play a role in improving weight loss outcomes after bariatric surgery; further research is needed to understand the role of registered dietitian nutritionists in changing behaviors after bariatric surgery. Bariatric surgery results in significant reductions in resting metabolic rate and postoperative energy intake. There is no significant relationship between macronutrient distribution and postoperative weight loss. The graded conclusion statements provide registered dietitian nutritionists who practice in the field of bariatric nutrition with more insight and evidence that can guide and support their recommendations.
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OBESITY IS RECOGNIZED AS A disease and a major public health concern, both nationally and internationally. Despite more coordinated efforts to combat this chronic disease by sectors of health care, academia, research, and private organizations, national and global obesity rates continue to rise. Current statistics in the United States indicate >36% of the population, or 78.5 million adult Americans, suffer from obesity.[1] Global obesity prevalence is equally dire. Statistics collected by the World Health Organization demonstrate a tripling of global obesity since 1975.[2] The World Health Organization estimates that more than 650 million adult and 41 million children worldwide suffer from obesity.[2]

Obesity is defined as an excessive accumulation of fat that impairs health.[2,3] While body mass index (BMI; calculated as kg/m^2) is not a direct measure of body composition, it continues to be recognized as a population measure of body weight and is used by insurance companies as a primary criterion to determine candidacy for surgery. A BMI of ≥30 categorizes obesity. Obesity negatively affects multiple human physiologic systems and has a pathogenic effect leading to serious comorbidities, such as diabetes mellitus, hypertension, obstructive sleep apnea, cancer, heart disease, cognitive dysfunction, and many others.

The causes of obesity are progressive, multifactorial, and complicated and, as such, lifelong treatments are needed for the management of this chronic disease. Recognized treatment options include lifestyle modifications incorporating dietary, exercise, and behavioral components; pharmacologic therapy; and bariatric and metabolic surgery. The mechanisms of action of bariatric and metabolic surgery are classified as restrictive, malabsorptive, metabolic, or a combination of some or all of these mechanisms. Bariatric surgery dates back to the early 1950s and has evolved over time to become a safe and effective treatment for obesity. The purpose of this review is to provide an evidence-based summary of nutrition-related research in bariatric surgery.

The most prevalent bariatric surgery procedures performed in North America are the vertical sleeve gastrectomy (VSG) and the Roux-en-Y gastric bypass (RYGB). The mechanism of action of both RYGB and VSG is considered a combination of restrictive and metabolic effects.[4]

A strong argument for the efficacy of bariatric surgery rests on the metabolic effects that lead to positive resolution of comorbid conditions, as well as greater weight loss (often measured by percentage of total weight loss [TWL] or percentage of excess weight loss [EWL]). Bariatric surgery has been shown to result in 55% to 85% remission in type 2 diabetes mellitus, 68% to 79% remission of hypertension, and improvement in quality of life, as well as many other comorbid conditions.[5] In addition, long-term randomized controlled trials found patients undergoing RYGB and VSG have superior weight loss of 23% and 19% TWL, respectively, at 5 years compared to lifestyle interventions (5% TWL).[6]

While bariatric and metabolic surgery is a proven effective treatment for obesity, successful outcomes are contingent on the level of patient commitment, the professional interdisciplinary collaboration, and a patient-centered approach to care. One

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of the first Consensus Statements published by the National Institutes of Health promoted use of the multidisciplinary team approach to patient selection for bariatric surgery, with the team consisting of providers that specialize in the medical, clinical, dietetic, and psychosocial needs of the patient.[7] The registered dietitian nutritionist (RDN) plays a critical role in the patient selection process and onward, using the Nutrition Care Process for both preoperative and postoperative nutrition assessment, evaluation, intervention, and monitoring.[8] Education on the necessary dietary changes, eating patterns and habits, and the importance of vitamin and mineral supplementation is central to positive outcomes. The RDN can facilitate patient success by assessing a patient's nutritional status and readiness to change, addressing barriers to food tolerance, encouraging physical activity, and identifying social support by providing strategies and recommendations.[8] RDNs also play an important role in long-term success by providing follow-up and encouraging life-long participation in support groups.

One challenge that also provides opportunity in the field of bariatric nutrition is the lack of existing research that affects many evidence-based recommendations. Clinical practice guidelines have been published by the American Society for Metabolic & Bariatric Surgery (ASMBS)[9] individually, and in a collaboration with the American Association of Clinical Endocrinologists (AACE), The Obesity Society (TOS), and ASMBS[10]; however, gaps persist in the literature across many topics of concern. These gaps provide opportunities for RDNs to participate in research to contribute to better understanding of the nutrition needs of patients who have undergone bariatric and metabolic surgery. This update in the Evidence Analysis Library (EAL) for bariatric surgery describes graded conclusion statements of five questions based on a thorough systematic review of literature pertaining to postoperative medical nutrition therapy (MNT) and postoperative energy needs and intake. The graded conclusion statements provide the RDN practicing in the field of bariatric nutrition with more insight and evidence that can guide and support their recommendations.

REVIEW METHODOLOGY

In 2014, a panel of six volunteer workgroup members with relevant bariatric surgery clinical and/or research expertise was appointed by the Academy of Nutrition and Dietetics (Academy) Evidence-Based Practice Committee. In addition to the panel, the workgroup also included an Academy staff project manager and a lead analyst. The panel identified questions addressing major nutrition-related factors important in the management of bariatric surgery patients, including postoperative MNT and postoperative energy needs and intake. The workgroup conducted a systematic review following the Academy's methodology and completed its work via regularly scheduled teleconferences and a shared virtual workspace.[11] The complete bariatric surgery project can be found on the EAL website at: https://www.andeal.org/topic.cfm?menu=5308.

Literature Search

The systematic review focused on adults aged 19 years and older who underwent bariatric surgery. Only original, peer-reviewed studies, published in the English language, with publication dates from 1980 to 2015, and which had a dropout rate of <20% were included. For a comprehensive evaluation of the literature, the workgroup considered research utilizing multiple study designs, including randomized controlled trials, clinical controlled trials, cohort studies, large non-randomized observational studies, and case-control studies. Using these inclusion and exclusion criteria, the lead analyst conducted a search using PubMed. The search yielded a total of 338 records. The initial screening resulted in excluding 247 records. The full texts of the 89 remaining studies were assessed for eligibility, which resulted in inclusion of 27 studies in this systematic review (Figure 1).[12]

Relevant information was extracted by trained evidence analysts using a standardized online data extraction tool for each of the included studies (eg, study design, sample size, dropout rate, population, interventions, and outcomes of interest, such as weight loss, behavior change, energy intake, and energy needs). The workgroup and lead analyst then summarized the evidence in five conclusion statements (Figure 2), which were graded according to Academy's rating scale for strength of evidence.[11] The strength of evidence was assessed against five critical elements: quality (scientific rigor), consistency (findings across studies), quantity (number of studies/subjects), clinical impact (importance/magnitude of outcomes), and generalizability (to population of interest).

Research Question Results

This systematic review found limited evidence regarding the effect of postoperative MNT on behavior change (Question 1.1).[13-15] Patients receiving MNT from an RDN for two to six visits during the first year post-surgery had significant EWL, ranging from 60% to 80% (equivalent to approximately 20% to 30% TWL), and significant reduction in BMI, ranging from 5% to 31% at 12 months (Question 1.2).[13-17] Undergoing bariatric surgery resulted in a clinically meaningful and statistically significant decrease in resting metabolic rate (RMR), as high as 26% at 1 year post-surgery, which was sustained at 2 years (Question 2).[18-27] As expected, there was a clinically meaningful and statistically significant reduction in postoperative self-reported energy intake, which was as high as 72% in the first 6 months after surgery, but only 28% to 38% at 4 and 5 years' post-surgery (Question 3).[13,15,19,28-32] No statistically significant relationship was found between postoperative macronutrient distribution and postoperative weight loss (Question 4).[13,14,31-35] A summary of questions, conclusion statements, and grades is available in Figure 2.

Question 1: Postoperative MNT

Question 1.1: MNT on Behavior Change

What Is the Effect of Postoperative MNT Provided by an RDN on Behavior Change in Adults Who Have Undergone Bariatric Surgery?

Conclusion Statement: Three studies (including RYGB, gastric band, and biliopancreatic diversion patients [with the majority of patients having undergone RYGB]) reported on the effect of MNT from an RDN on behavior change.[13-15] One study reported that MNT, provided as 15-minute in-person sessions with an RDN every other week for the first 4 months after

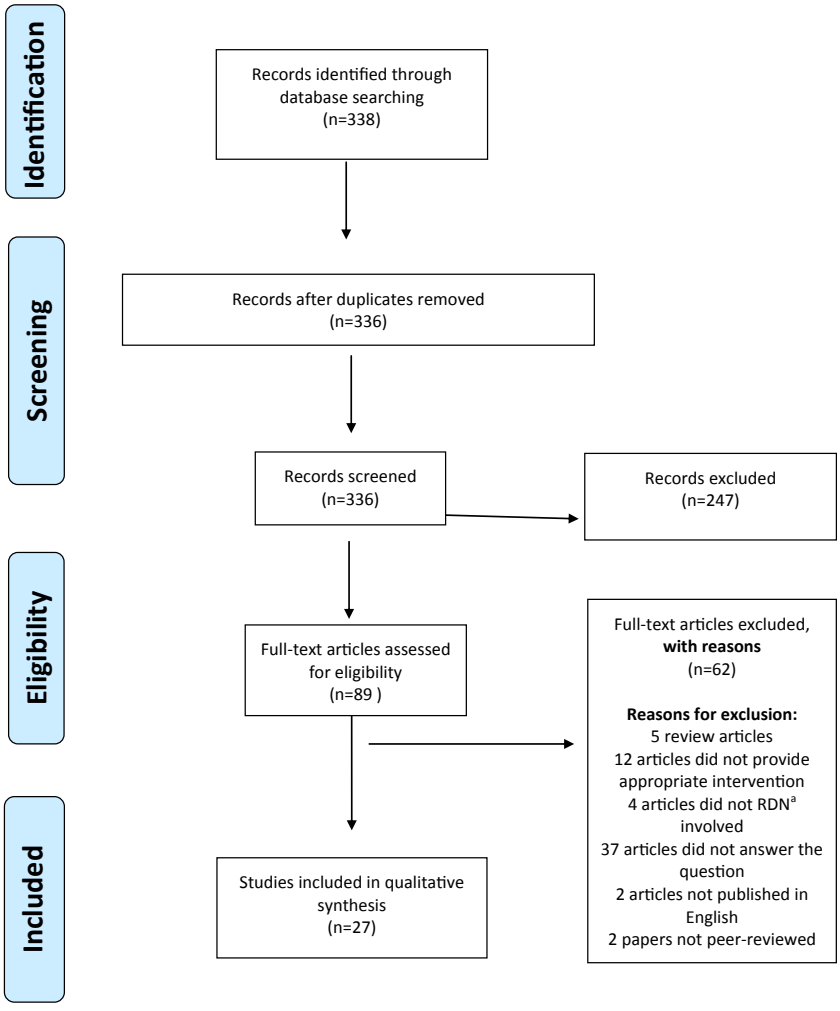

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2009 flow diagram of the search strategy and selection process used in the Evidence Analysis Library systematic review for bariatric surgery. [a]RDN=registered dietitian nutritionist. Flow diagram template adapted from Moher and colleagues.[12]

surgery, resulted in a significant increase in cognitive restraint (controlled eating) for up to 18 months compared with standard care.[13] However, two studies reported mixed results regarding the effect of MNT on increasing protein intake and physical activity.[14,15] **GRADE III**

Evidence/Rationale: In adults who have undergone bariatric surgery, three studies reported on the impact of postoperative MNT provided by an RDN on behavior change: Two neutral-quality randomized controlled trials[13,14] and one neutral-quality before-and-after study.[15] Two studies report mixed results regarding the effect of MNT on protein intake, with one study reporting that 80% of subjects met their protein intake goal,[15] while one study reported no significant differences in protein intake.[13] One study reports a significant increase in cognitive restraint for up to 18 months in the group receiving 15-minute in-person sessions with an RDN every other week for the first 4 months after surgery compared with standard care.[13] One study reports mixed results regarding the effect of MNT on physical activity. Even though all subjects received MNT, the low-fat diet group reported no statistically significant differences in physical activity between baseline and 1 year, while the low-carbohydrate, high-protein diet group reported a statistically significant increase in time spent per week in more than three and less than six metabolic equivalent units of physical activity during that time.[14]

Question 1.2: Postoperative MNT on Weight Loss

What Is the Effect of Postoperative MNT Provided by an RDN on Weight Loss in Adults Who Have Undergone Bariatric Surgery?

Conclusion Statement: Four studies (including RYGB, gastric band, VSG, and biliopancreatic diversion patients [with the majority of patients having undergone RYGB]) reported that patients receiving MNT from an RDN for two to six visits during the first year post-surgery had significant EWL, ranging from 60% to 80% (equivalent to approximately 20% to 30% TWL) and significant reduction in BMI, ranging from 5% to 31% at 12 months.[13-15,17] An MNT session duration of 90 minutes was reported in one study, which also demonstrated that a higher frequency and duration of MNT visits resulted in the greatest weight loss (80% vs 64% excess body weight loss at 1 year post-surgery) compared to those receiving standard care.[16] **GRADE II**

Evidence/Rationale: In adults who have undergone bariatric surgery, five studies reported on the effect of post-operative MNT provided by an RDN on weight outcomes: Three neutral-quality randomized controlled trials,[13,14,16] one neutral-quality retrospective cohort study,[17] and one neutral-quality before and after study.[15]

In the short term, one study reported that between groups of patients receiving either 15-minute in-person sessions with an RDN every other week for the first 4 months after surgery or the standard postoperative care without counseling, there were no statistically significant differences in weight loss, and the differences between groups remained statistically insignificant during 2 years of follow-up.[14] However, four studies reported that patients receiving MNT from an RDN for two[15] to six[16] visits during the first year post-surgery had a significant reduction in percentage of EWL, ranging from 60%[14] to 80%,[16] and in BMI, ranging from 5%[17] to 31%[15] after 12 months.

A session duration of 90 minutes was reported in only one of the studies, demonstrating that a higher frequency and duration of MNT visits resulted in the greatest weight loss.[16] At this

Question No.	Question	Conclusion Statement	Grade
1.1. Postoperative MNT[a] on behavior change	What is the effect of postoperative MNT provided by an RDN[b] on behavior change in adults who have undergone bariatric surgery?	Three studies (including gastric bypass, gastric band, and biliopancreatic diversion patients [with the majority of patients having undergone gastric bypass]) reported on the effect of MNT from an RDN on behavior change. One study reported that MNT, provided as 15-min in-person sessions with an RDN every other week for the first 4 mo after surgery, resulted in a significant increase in cognitive restraint (controlled eating) for up to 18 mo compared with standard care. However, two studies reported mixed results regarding the effect of MNT on increasing protein intake and physical activity.	III
1.2. Postoperative MNT on weight loss	What is the effect of postoperative MNT provided by an RDN on weight loss in adults who have undergone bariatric surgery?	Four studies (including gastric bypass, gastric band, sleeve gastrectomy, and biliopancreatic diversion patients [with the majority of patients having undergone gastric bypass]) reported that patients receiving MNT from an RDN for two to six visits during the first year post-surgery had significant excess weight loss, ranging from 60% to 80%, and significant reduction in body mass index, ranging from 5% to 31%, at 12 mo. An MNT session duration of 90 min was reported in one study, which also demonstrated that a higher frequency and duration of MNT visits resulted in the greatest weight loss (80% vs 64% excess body weight loss at 1 y post-surgery) compared to those receiving standard care.	II
2.0. Postoperative energy needs	What is the effect of bariatric surgery on RMR[c] in adults?	A total of 10 studies, including gastric bypass and gastric band (with the majority of patients having undergone gastric bypass) reported a clinically meaningful and statistically significant decrease in RMR after bariatric surgery. Five studies reported a decrease ranging from 12% to 21% during the first 6 mo post-surgery, four studies reported a decrease ranging from 13.5% to 26% at 1 y, and one study reported that an approximately 20% reduction in RMR was sustained at 2 y. Ongoing research is needed regarding the effect of available bariatric surgical options on RMR.	I
3.0. Postoperative energy intake	What is the effect of bariatric surgery on energy intake in adults?	Eight studies (including gastric bypass, gastric band, sleeve gastrectomy, and biliopancreatic diversion patients [with the majority of patients having undergone gastric bypass]) reported a clinically meaningful and statistically significant reduction in self-reported energy intake after bariatric surgery. Six studies reported a	II

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Figure 2. Conclusion statements for the Academy of Nutrition and Dietetics Evidence Analysis Library evidence-based systematic review of nutrition care in bariatric surgery.

Question No.	Question	Conclusion Statement	Grade
		reduction ranging from 45% to 72% during the first 6 mo post-surgery, five studies reported a reduction ranging from 19% to 50% at 1 y post-surgery, four studies reported a reduction ranging from 30% to 62% at 2 y post-surgery, and one study reported a reduction ranging from 28% to 38% at 4 and 5 y post-surgery when compared with presurgical energy intake. These wide ranges may be due to the variation in methods used to measure energy intake. Ongoing research is needed regarding the effect of available bariatric surgical options on energy intake.	
4.0. Postoperative macronutrient intake	What is the relationship between postoperative macronutrient distribution and weight loss in adults who have undergone bariatric surgery?	Seven studies (including gastric bypass, gastric band, and sleeve gastrectomy, with the majority of patients having undergone gastric bypass) report that postoperative macronutrient distribution based on percentage of energy ranges from 35% to 50% from carbohydrates, 15% to 23% from protein, and 35% to 42% from fat, for a period of up to 5 y. While a particular postoperative macronutrient distribution may be associated with receiving MNT, postoperative dietary adherence and daily caloric intake, there was no statistically significant relationship between postoperative macronutrient distribution and postoperative weight loss. These ranges may be due to the variation in methods used to measure macronutrient distribution. Ongoing research is needed regarding the effect of available bariatric surgical options on macronutrient distribution.	II

[a]MNT=medical nutrition therapy.

[b]RDN=registered dietitian nutritionist.

[c]RMR=resting metabolic rate.

Figure 2. *(continued)* Conclusion statements for the Academy of Nutrition and Dietetics Evidence Analysis Library evidence-based systematic review of nutrition care in bariatric surgery.

frequency and duration of MNT, participants in the intervention group lost 80% of their preoperative excess body weight compared to those receiving standard care (80% vs 64%; $P<0.001$) at 1 year post-surgery.[16]

Question 2.0: Postoperative Energy Needs

What Is the Effect of Bariatric Surgery on RMR in Adults?

Conclusion Statement: A total of 10 studies including RYGB and gastric band (with the majority of patients having undergone RYGB) reported a clinically meaningful and statistically significant decrease in RMR after bariatric surgery.[18-27] Five studies reported a decrease ranging from 12% to 21% during the first 6 months post-surgery,[19,22,23,26,27] four studies reported a decrease ranging from 13.5% to 26% at 1 year,[20,21,24,25] and one study reported that an approximately 20% reduction in RMR was sustained at 2 years.[18] Ongoing research is needed regarding the effect of available bariatric surgical options on RMR. **GRADE I**

Evidence/Rationale: A total of 10 studies reported on the effect of bariatric surgery on RMR in adults: 1 positive-quality case-control study,[18] 1 neutral-quality case-control study,[22] 1 neutral-quality non-randomized controlled trial,[27] and 7 before-and-after studies—4 positive-quality[19–21,24] and 3 neutral-quality.[23,25,26] In five studies measuring RMR during the first 6 months post-surgery, there was a significant decrease in RMR, ranging from 12%[22] to 21%.[19] After 1 year post-surgery, five studies measuring RMR found a significant decrease in RMR, ranging from 13.5%[24] to 26%,[21] and this reduction in RMR of approximately 20% was sustained at 2 years.[18]

Question 3.0: Postoperative Energy Intake

What Is the Effect of Bariatric Surgery on Energy Intake in Adults?

Conclusion Statement: Eight studies (including RYGB, gastric band, VSG, and biliopancreatic diversion patients [with the majority of patients having undergone RYGB]) reported a clinically meaningful and statistically significant reduction in self-reported energy intake after bariatric surgery.[13,15,19,28-32] Six studies reported a reduction ranging from 45% to 72% during the first 6 months post-surgery,[13,19,28,29,31,32] five studies reported a reduction ranging from 19% to 50% at 1 year post-surgery,[13,15,28,31,32] four studies reported a reduction ranging from 30% to 62% at 2 years post-surgery,[13,30-32] and one study reported a reduction ranging from 28% to 38% at 4 and 5 years post-surgery,[31] when compared with presurgical energy intake. These wide ranges may be due to the variation in methods used to measure energy intake. Ongoing research is needed regarding the effect of available bariatric surgical options on energy intake. **GRADE II**

Evidence/Rationale: Eight studies reported on the effect of bariatric surgery on energy intake in adults: one neutral-quality randomized controlled trial,[13] three positive-quality before-and-after studies,[19,28,31] and four neutral-quality before-and-after studies.[15,29,30,32]

In six studies comparing presurgical energy intake with energy intake during the first 6 months post-surgery, there was a significant decrease in energy intake, generally ranging from 45% to 72%.[13,19,28,29,31,32] In five studies comparing presurgical energy intake to that at 1 year post-surgery, there was a significant decrease in energy intake generally ranging from 30% to 50%,[13,28,31,32] with one study reporting a post-surgical decrease in energy intake as low as 19%.[15] Energy intake at 2 years post-surgery found a significant decrease in energy intake, generally ranging from 30% to 45%,[13,31,32] with one study reporting a post-surgical decrease in energy intake as high as 62%.[30] One study found a decrease in energy intake generally ranging from 28% to 38% when comparing presurgical energy intake to that at 4 and 5 years post-surgery.[31]

Question 4.0: Postoperative Macronutrient Intake

What Is the Relationship Between Postoperative Macronutrient Distribution and Weight Loss in Adults Who Have Undergone Bariatric Surgery?

Conclusion Statement: Seven studies (including RYGB, gastric band, and VSG, with the majority of patients having undergone RYGB) report that postoperative macronutrient distribution based on percentage of energy ranges from 35% to 50% from carbohydrates, 15% to 23% from protein, and 35% to 42% from fat, for a period of up to 5 years.[13,14,31-35] While a particular postoperative macronutrient distribution may be associated with receiving MNT, postoperative dietary adherence, and daily caloric intake, there was no statistically significant relationship between postoperative macronutrient distribution and postoperative weight loss. These ranges may be due to the variation in methods used to measure macronutrient distribution. Ongoing research is needed regarding the effect of available bariatric surgical options on macronutrient distribution. **GRADE II**

Evidence/Rationale: In adults who have undergone bariatric surgery, seven studies reported on the relationship between postoperative macronutrient distribution and weight loss: two neutral-quality randomized controlled trials,[13,14] one positive-quality before-and-after study,[31] two neutral-quality before-and-after studies,[32,35] and two neutral-quality cross-sectional studies.[33,34]

All seven studies report that postoperative macronutrient distribution based on percentage of energy generally ranges from 35% to 50% from carbohydrate, 15% to 23% from protein, and 35% to 42% from fat, for a period of up to 5 years. There was no statistically significant relationship reported between postoperative macronutrient distribution and postoperative weight loss. Faria and colleagues[33] reported that while patients who reported eating sweets more often consumed significantly more total calories and more calories from carbohydrates than patients who reported eating sweets less often; the difference in percentage of EWL was not significant between groups. Forbush and colleagues[34] reported that the effects of total protein, total fat, and total carbohydrate on percentage EWL and maintenance of weight loss were not significant. Moize and colleagues[31] reported that energy intake, baseline weight, and time period (but not the proportion of different macronutrients or the type of surgery) independently predicted the percentage of EWL over time. Ortega and colleagues[35] reported that there were no significant differences in percentage excess of BMI loss regarding components of diet. Sarwer and colleagues[32] reported that the percentage of calories from protein was positively associated with changes in postoperative dietary adherence. In a later publication, Sarwer and colleagues[13] reported that patients who received dietary counseling had lower mean

consumption of fat and greater mean protein consumption and achieved greater weight loss compared with those who received standard care; but these differences were not statistically significant. Swenson and colleagues[14] reported that both groups randomized to either a low-fat diet or a low-carbohydrate, high-protein diet for 1 year demonstrated significant and similar weight loss by reduction in BMI and by excess body weight lost.

SUMMARY

Five practice-driven questions were answered using a systematic review. These questions include the effect of postoperative MNT provided by an RDN on behavior change and weight loss in adults who have undergone bariatric surgery, the effect of bariatric surgery on RMR and postoperative energy intake in adults, and the relationship between postoperative macronutrient distribution and weight loss in adults who have undergone bariatric surgery.

While research demonstrates that RDNs play a role in improving weight loss outcomes after bariatric surgery, further research is needed to understand the role of RDNs in changing behaviors after bariatric surgery. Bariatric surgery results in a clinically meaningful and statistically significant reduction in RMR, which is sustained for up to 2 years postoperatively.[18] It also results in a clinically meaningful and statistically significant reduction in postoperative energy intake, which is sustained for up to 5 years postoperatively.[31] There is no statistically significant relationship between macronutrient distribution and postoperative weight loss. Reported ranges of macronutrient distribution are 35% to 50% from carbohydrates, 15% to 23% from protein, and 35% to 42% from fat, and have been reported for up to 5 years postoperatively.[13,14,31-35]

Bariatric surgery continues to grow in popularity and has demonstrated its efficacy in the treatment of obesity. In a field that is lacking nationally standardized MNT guidelines, this systematic review provides guidance for nutrition-related practices. It is a supplement to guidelines published by organizations such as ASMBS, TOS, and AACE.[9,10] It provides further support for the role of the RDN as an integral member of the bariatric surgery team.

Strengths and Limitations

A demonstrable strength of this project is the well-defined and rigorous methodology used to conduct the systematic review. While this document provides an evidence-based summary of nutrition-related practices and outcomes in bariatric surgery, it does not provide guidelines for pre- or postoperative nutrition management. Readers should refer to guidelines from ASMBS, TOS, and AACE for this information.[9,10] When using these guidelines, the level of evidence for best-practice recommendations should be taken into account in clinical practice.

Limitations of this project include the inconsistencies in methodology and reported outcomes in the reviewed literature. Studies on macronutrient intake, for example, used different dietary assessments to determine macronutrient intake, including validated food frequency questionnaires, researcher-developed questionnaires, 24-hour recall, and food records. Weight outcomes were reported in a variety of ways, including BMI unit loss, percent BMI loss, percent weight loss, EWL, and TWL; these weight outcomes are not comparable across studies. Some studies measured a variable of interest but did not relate it to any weight loss outcome, preventing relationships from being discovered. Finally, there were wide variations in findings on some outcome variables. For example, changes in energy intake from protein ranged from 19% to 50%, making it difficult to apply the findings in practice.

The systematic review process also revealed a lack of research related to the role of the RDN in pre- and post-surgery MNT. Studies that did include MNT often did not detail how the RDN was involved, leaving only five studies to be included in Questions 1.1 and 1.2 regarding MNT. Finally, not all surgery types were equally represented in the literature. A majority of studies included RYGB patients and very few studies included VSG patients. As the effects of these two surgery types are not the same from a physical or physiological stand point, it may not be appropriate to extrapolate conclusions regarding one surgery type to others. With VSG increasing in popularity, it is important to be able to identify short- and long-term effects of this surgery.

IMPLICATIONS FOR PRACTICE

While more research is needed regarding MNT for patients that have undergone bariatric surgery, the RDN is still expected to employ the techniques of nutritional diagnosis, therapy, and counseling.[36] The 2013 AACE/TOS/ASMBS Clinical Practice Guidelines recommend evaluation of nutrition and behavior change before surgery, in addition to frequent postoperative visits with the patient's health care team.[10] Preoperative weight loss and glycemic control in patients with diabetes is related to better postoperative outcomes.[10] Consultation with the RDN for the postoperative diet and recommended eating habits is also necessary.[10,37,38]

As patients lose weight postoperatively, RMR and energy intake decrease, requiring adjustments to energy requirements. RDNs must consider this long-term decrease in energy needs. Provided that indirect calorimetry is not always available in practice, use of the Mifflin St Jeor equation is applicable; however, actual needs may not be consistent with metabolic calculations.[39] Decreased energy intake after surgery promotes weight loss and equilibrates decreased RMR.

RDNs need to consider the carbohydrate, protein, and fat requirements for patients in the short- and long-term after surgery. Long-term, carbohydrate intake is typically in the lower end of the Acceptable Macronutrient Distribution Range and fat intake is typically consumed at levels greater than the Acceptable Macronutrient Distribution Range. Protein intake is a priority but evidence is not strong enough to recommend intake greater than the Acceptable Macronutrient Distribution Range. Nutrient-dense foods and vitamin and mineral supplementation are recommended in order to compensate for decreased energy needs and appetite, as well as altered absorption after specific bariatric procedures.

MNT provided by an RDN includes patient-centered, evidence-based nutrition recommendations (eg, energy recommendations, macro- and micronutrient needs, and guidance for

obesity-related conditions). Overall, practice applications are consistent with best practice guidelines and the EAL, but more research is needed to highlight the expertise of the RDN.

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