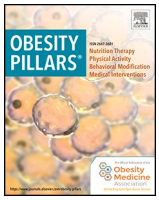
Obesity Pillars 13 (2025) 100154

Contents lists available at ScienceDirect

Obesity Pillars

journal homepage: www.journals.elsevier.com/obesity-pillars



Bariatric nutrition and evaluation of the metabolic surgical patient: Update to the 2022 Obesity Medicine Association (OMA) bariatric surgery, gastrointestinal hormones, and the microbiome clinical practice statement (CPS)

ARTICLE INFO

Keywords:
Bariatric nutrition assessment
Bariatric and metabolic surgery
Micronutrient deficiencies

ABSTRACT

Background: In 2022, the Obesity Medicine Association (OMA) published a Clinical Practice Statement (CPS) which provided an overview of bariatric surgery and related procedures, a discussion on gastrointestinal hormones and a review of the microbiome as it relates to patients with obesity. This update to the 2022 OMA CPS provides a focus on nutrition as it relates to the adult bariatric surgery patient, incorporating a detailed discussion on how to conduct a bariatric nutrition assessment and manage patients seeking metabolic and bariatric surgery (MBS) and postoperative nutrition care. In particular, the section on macronutrients, micronutrients, and bariatric surgery has been updated, highlighting practical approaches to nutrient deficiencies typically encountered in the bariatric surgery patient. Also included is a section on how to envision and develop an interdisciplinary team of medical providers with evidence-based nutrition knowledge and consistent information that improves the quality of nutrition care provided to MBS patients. This CPS adds to the series of OMA CPSs meant to provide guidance to clinicians in their care of patients with obesity.

Methods: The foundation of this paper is supported by scientific evidence in the medical literature and expert opinion derived from several bariatric nutrition resources, as well as from the 2022 OMA CPS focused on bariatric surgery.

Results: This OMA Clinical Practice Statement provides an overview of the current bariatric nutrition clinical guidelines and nutrition tools adapted for clinicians who may not have access to an MBS team or a registered dietitian knowledgeable about bariatric nutrition.

Conclusions: This evidence-based review of the literature includes an overview of current bariatric nutrition recommendations. It is intended to provide clinicians with more advanced knowledge and skills in nutrition assessment and management of the preoperative and post-surgical MBS patients. This CPS also addresses macronutrient and micronutrient deficiencies common in MBS patients, and treatment recommendations designed to help the clinician with clinical decision making.

1. Introduction/background

In 2022, the Obesity Medicine Association (OMA) published a Clinical Practice Statement (CPS) providing an overview of bariatric surgery and related procedures, a discussion on gastrointestinal hormones and a review of the microbiome as it relates to patients with obesity [1]. This update to the 2022 OMA CPS provides a focus on nutrition as it relates to the adult bariatric surgery patient, including how to conduct a bariatric macronutrient and micronutrient focused nutrition assessment, manage patients seeking metabolic and bariatric surgery (MBS), and collaborate on postoperative nutrition care with an interdisciplinary team of medical providers. Guidelines specific to subpopulations of patients, such as adolescents, patients with renal or liver disease, other special needs, or those undergoing endoscopic sleeve gastroplasty (ESG) are not addressed here.

Metabolic and bariatric surgery (MBS) is widely recognized as a highly effective treatment for the chronic disease of obesity. According to the American Society of Metabolic and Bariatric Surgery (ASMBS), MBS may reduce the risk of premature death in some patients by 30 %–50 % [2]. Typically, patients lose the most weight in 1–2 years post-surgery and demonstrate significant improvement in weight-related comorbidities including type 2 diabetes, hypertension, obstructive sleep apnea, dyslipidemia, cardiovascular disease, as well as metabolic dysfunction-associated with steatotic liver disease and metabolic dysfunction-associated steatohepatitis (MASLD/MASH) [2–5]. Most patients can anticipate a meaningful total weight loss of 25 %–45 % depending on MBS procedure type [6]. While the 2022 OMA CPS detailed for whom MBS is indicated, certain patient subpopulations should be considered for MBS and are mentioned here, including [2–5, 7].

https://doi.org/10.1016/j.obpill.2024.100154
Received 21 August 2024; Received in revised form 2 December 2024; Accepted 2 December 2024
Available online 5 December 2024

- MBS performed >2 years before total joint arthroplasty in those with class II/III obesity improves post-operative orthopedic outcomes
- MBS should be considered in individuals with heart failure before heart transplantation or before placement of left ventricular assist device (LVAD), because it is associated with a significant improvement of left ventricular ejection fraction (LVEF), improvement of functional capacity, and higher chances for receiving heart transplantation
- There are no age limits, but consideration to frailty should be reviewed
- In patients with severe obesity and an abdominal wall hernia requiring elective repair, MBS should be considered first to induce significant weight loss, and consequently reduce the rate of complications associated with hernia repair and increase durability of the repair
- MBS should be considered to help increase eligibility and access of individuals with Class III obesity to organ transplantation (kidney, lung, heart)
- MBS should be considered for individuals with Metabolic Dysfunction-Associated Steatotic Liver Disease (MASLD), Metabolic Dysfunction-Associated Steatohepatitis (MASH), and cirrhosis as surgery has been shown to improve liver histology, regress fibrosis, reduce hepatocellular carcinoma, and is associated with an 88 % reduction of risk from MASH progressing to cirrhosis [2–5].

The benefits of MBS also come with some nutritional risks. For example, different MBS procedures have significant variation in the amount of absorptive gastrointestinal tract and stomach partitioning. Approximately 80 % of the fundus is removed during a sleeve gastrectomy (SG), while leaving the pyloric sphincter and intestines intact [8]. More invasive procedures (i.e., Roux-en-Y gastric bypass (RYGB), distal RYGB, biliopancreatic diversion with duodenal switch (BPD-DS), single anastomosis duodenal-ileostomy with sleeve gastrectomy (SADI-S)), however, alter both the fundus and shorten the length of the small intestine leaving 75 cm–300 cm [9,10]. This remaining segment of the small intestine is called the 'common channel,' the location where the food mixes with digestive enzymes [9,10]. The total length of the bypassed or excluded portion of the small intestine in more invasive procedures may lead to higher rates of nutrient malabsorption compared to other less invasive procedures such as the SG or adjustable gastric lap-band (AGLB) [6,9,10]. Nutrition issues after MBS may include food intolerance, drug-nutrient interactions, reduction in food quantity or quality, and an increased gastrointestinal transit time of digested foods [10]. The role of gut hormones with decreased hunger and increased satiety represents an additional combination of factors that may impact the postoperative nutritional status of the patient and MBS outcomes [11].

As discussed by Shetye et al. [1] in the 2022 OMA CPS focused on bariatric surgery, "patients should undergo nutritional assessments by trained dietitians and receive educational support with an understanding that even with bariatric surgery, lifelong adherence to healthful nutrition" is crucial for achieving and sustaining weight loss and metabolic health. Nutritional assessments include both preoperative optimization and postoperative chronic nutrition care. According to Carter et al. [12], preoperative optimization for patients seeking MBS refers to: 1) the management of modifiable risks prior to surgery, 2) reducing risks during the perioperative phase, and 3) improving patient outcomes. These recommendations set forth by the ASMBS include preoperative nutrition optimization [12]. Specifically, registered dietitians (RDs) are typically responsible for conducting the initial preoperative MBS nutrition assessment and evaluation including a weight history, review of the eating behaviors and patterns, medication review, nutrition-focused physical exam, and an assessment of micronutrient status to support the patient before and after MBS [6,11,12].

This clinical practice statement aims to describe the steps in conducting a nutritional assessment and evaluation to identify and treat the most common nutritional deficiencies in patients seeking MBS and postoperatively. Specifically, bariatric nutrition tools for providers will be reviewed including food records, screening of eating behaviors, nutrient laboratory reports, and physical exam findings. Nutrition therapy options are also described for mild to more severe forms of vitamin and mineral deficiencies and protein malnutrition. Recommendations from the most recent MBS and OMA bariatric guidelines are incorporated into this review, along with current evidence-based literature and expert opinion [1,6,13].

Table 1
Metabolic and bariatric surgery healthcare providers [6].

Discipline	Role
MBS Surgeon	• Educates patients on the risks/benefits of MBS • Performs primary and revision MBS • Evaluates/corrects MBS complications
Bariatrician/Obesity Medicine	• Provides comprehensive medical management of obesity • Works collaboratively with the surgical team • Suggests solutions for patients who are either not ready for or do not qualify for MBS • Supports the patient's overall health
Registered Dietitians (RD)	• Conducts preoperative and postoperative nutritional assessments, education, and counseling • Provides medical nutrition therapy for eating disorders • Corrects nutrient deficiencies • Supports behavior modification • Conducts MBS support groups
Behavioral Health Specialists	• Evaluates patients for mental health issues • Screens for addictions and eating disorders • Provides counseling for emotional and psychological aspects of obesity • Supports behavior modification • Conducts MBS support groups
Nurse Practitioner/ Physician Assistant	• Provides ongoing patient care, education, and support
Exercise Physiologist/ Athletic Trainer	• Develops preoperative and postoperative personalized exercise programs
MBS Coordinator	• Supports MBSAQIP requirements for data gathering, dissemination and program coordination • Can be any licensed healthcare provider

MBS: metabolic and bariatric surgery; MBSAQIP: Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program.

Table 2
Key elements of a preoperative nutrition assessment and evaluation [6,12].

Document	Assess
Medical history	• Comorbidities, surgeries, allergies • Sleep history • Mental health status; psychosocial issues • Substance use (i.e., smoking, illicit drugs, alcohol)
Medication review	• Potential weight promoting medications
Weight history	• Weight history graph • Body composition analysis, if available (i.e., DEXA, BIA)
Eating behaviors/patterns [14]	• Maladaptive eating behaviors • Nutrition adequacy
Food insecurity [15]	• Adequate resources to purchase food • Food available
Physical activity [16]	• Functional capacity and limitations • Exercise behaviors
Micronutrient labs [6,17]	• Routine MBS labs by surgery type

DEXA: dual-energy x-ray absorptiometry; BIA: bioelectrical impedance analysis; MBS: metabolic and bariatric surgery.

2. Target audience

Physicians, nurse practitioners, physician assistants, RDs, behavioral health specialists, nurses, exercise specialists, and others are involved with providing preoperative and post-surgical care for patients with

Table 3
Preoperative nutrition screening for medications that may contribute to weight gain [18].

Drug Classification	Weight Gain	Weight Neutral/Loss
Anti-hypertensives	• Beta blockers • Calcium-channel blockers	• Angiotensin-converting enzyme (ACE) inhibitors • Angiotensin receptor blockers (ARB) • Diuretics • Nitrates
Diabetes agents	• All insulins • Sulfonylureas • Glitazones	• Alpha-glucosidase inhibitors DDP4 (i.e., sitagliptin, saxagliptin, linagliptin, alogliptin) • Glucagon-like peptide-1 (GLP1) • Glucagon-like-peptide-1/ glucose-dependent insulinotropic polypeptide (GLP1/GIP) • Metformin • Pramlintide • Sodium-glucose transport protein-2 (SGLT2)
Hormones	• Depo-provera • NuvaRing	• Norgestimate • Intrauterine device (IUD) • Nexplanon
Antidepressants	• Selective serotonin reuptake inhibitors (SSRIs) • Tricyclic antidepressants (TCAs) • Mirtazapine • Monoamine oxidase inhibitors (MAOIs)	• Benzodiazepines • Norepinephrine-dopamine reuptake inhibitors (NDRIs) • Serotonin-norepinephrine reuptake inhibitors (SNRIs) • Wellbutrin
Migraines	• Beta blockers • Amitriptyline • Gabapentin • Valproic acid	• Nortriptyline • Topamax • Ajovy • Aimovig • Botox • Butalbital/acetaminophen/ caffeine • Ubrelvy • Qulipta
Anti-psychotics	• 1st generation • 2nd generation	• Lamictal

obesity [6].

While RDs conduct preoperative and post-surgical nutrition assessments for MBS patients, a team-based and comprehensive approach to patient care is helpful to screen for nutritional concerns and improve outcomes. Table 1 identifies different clinical roles and responsibilities of those caring for MBS patients, either within an MBS program or referral to specialists within the community to coordinate comprehensive MBS patient care.

3. Preoperative nutrition assessment, evaluation and education

The number of preoperative nutrition visits by an RD is often set by the MBS program or by the patient's insurance requirements. The key elements of a preoperative nutrition assessment are included in Table 2 [6,12].

3.1. Medication review

Medications contributing to potential weight gain and excess intake of calories or drug-nutrient interactions should be considered in the preoperative and post-surgical nutrition assessment. Table 3 provides a list of common medications that may require adjustment to mitigate the risk of weight gain. A detailed list of medications that may contribute to weight gain is reported in the Obesity Algorithm: Obesity Medicine Association, 2024 [18].

3.2. Chronological weight history

Fig. 1 is a chronological weight history tool that tells the story of an individual's life circumstances associated with weight change over time [12,19]. More importantly, the weight graph gives the patient an opportunity to share feelings and events that may be associated with various types of abuse or neglect during childhood, transitions associated with physical activity, illness, medication changes, divorce, pregnancy, stressful employment, food insecurity and more [20]. A weight history graph is also useful in identifying dieting attempts that may have followed periods of disordered eating behaviors [19].

3.3. Eating behaviors/patterns

Patients interested in MBS should be screened for maladaptive eating patterns (i.e., a brief or extended history of binge-eating disorder, night eating syndrome, bulimia nervosa, previous anorexia nervosa, and other maladaptive eating behaviors) [12,20]. The primary objective of the evaluation is to identify risk factors or potential postoperative challenges that may contribute to poor MBS outcomes [12,20]. Although a history of disordered eating behaviors should be taken into consideration prior to MBS, such maladaptive eating conditions are not universal exclusion criteria for MBS [12,20]. Preoperative screening and treatment of disordered eating behaviors by both RDs and behavioral health specialists are critical components in preparing patients for MBS [12]. Table 4 describes the most common disordered eating behaviors reported in preoperative screening of patients [14].

In addition to screening for maladaptive eating behaviors, RDs also screen the preoperative diet for quality of food consumed, in addition to the frequency, location, and usual quantity of food consumed within a 24-h period [21]. This information is most often collected in food logs or 24-h food recalls that provide an overview of the eating environment, food availability, and the types of food contributing to macronutrient and micronutrient composition [21].

3.4. Physical activity [16]

An evaluation of physical activity, functional capacity, and limitations is an important aspect of a nutrition evaluation. Limitation of physical function can be identified in the clinic setting by a sit-to-stand test, hand grip, and visual cues such as wheelchairs, walkers, canes, and overall steadiness or balance [16,21]. A medical evaluation is recommended prior to beginning an exercise program to ensure the safety of the patient [6]. Once the patient is cleared to begin an exercise routine, the clinician may suggest physical activities with intensity and frequency according to the patient's cardiorespiratory health, functional capabilities, and mobility [16,21].

3.5. Micronutrient status and assessment recommendations

One of the critical elements in conducting a nutritional assessment in the MBS patient is understanding the function of the gastrointestinal tract and the absorption sites of the micronutrients. Fig. 2 identifies the length of each section of the small intestine and associated nutrient absorption, which is important for understanding how much of the small intestine is bypassed within the surgical procedure type. An increased risk of nutrient malabsorption occurs when the duodenum and the majority of the jejunum are bypassed in procedures such a distal RYGB, BPD/DS, or SADI-S [9,10]. Micronutrient depletion or deficiency documented by blood or plasma concentrations below the reference range may occur with no clinical signs or symptoms [13]. Patients may also be malnourished prior to an initial nutrition assessment due to historically poor dietary, prior efforts at dieting, or lack of compliance with multi- or bariatric vitamins associated with a prior MBS procedure [22].

Clinicians should be knowledgeable about the risk factors associated

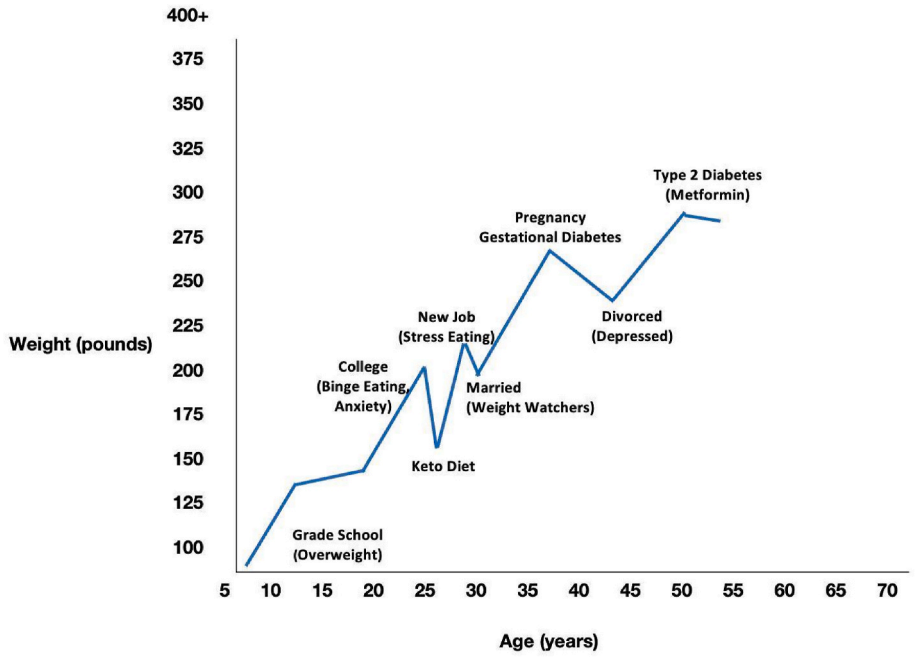


Fig. 1. Example of a chronological weight history graph.

Table 4
Preoperative screening criteria for eating disorders [14].

Disorder	Description
Binge-eating disorder	• Recurrent episodes of eating a large amount of food in a discrete time frame while experiencing a sense of lack of control and marked distress • Associated with 3 or more of the following: • Eating more rapidly, eating until uncomfortably full • Eating large amounts of food when not feeling physically hungry • Eating alone because of feeling embarrassed by how much one is eating; feeling disgusted, depressed or guilty afterwards • Occurs at least once a week for 3 months
Anorexia Nervosa	• Restriction of energy intake relative to requirements leading to low body weight • Intense fear of gaining weight
Bulimia Nervosa	• Recurrent episodes of binge-eating characterized by both of the following: • Eating a large amount in a discrete time, and • A sense of lack of control overeating during the episode • Recurrent inappropriate compensatory behaviors to prevent weight gain (self-induced vomiting, misuse of laxatives or diuretics, excessive exercise) • Occurs at least once a week for 3 months
Night Eating Syndrome	• Recurrent episodes of eating after awakening from sleep or excessive food consumption after the evening meal which are not explained by external influences (sleep-wake cycle, social norms), binge-eating disorder, another mental disorder, substance use or a medication effect • Awareness and recall of the eating are present

with common malnutrition states when screening preoperative MBS patients. Table 5 provides an overview of possible conditions that may be associated with suboptimal nutrition [6,11,12].

3.5.1. *Micronutrient diagnostic and biochemical reports*

Preoperative and post-surgery micronutrient laboratory reports can provide evidence of mild to severe nutrient deficiencies and excessive nutrient storage. Table 6 identifies some of the diagnostic factors and conditions associated with micronutrient screening [1,17].

3.5.2. *How accurate are micronutrient tests?*

Abnormal micronutrient laboratory tests paired with physical signs or neurological symptoms can provide an accurate nutritional assessment of nutrient stores [13,17]. Appropriate use and interpretation of micronutrient reports are essential for correct management of nutrition problems. However, misinterpretation of lab reports or lack of knowledge about other underlying acute or chronic conditions can cause unnecessary treatment or concern for the patient [24]. Clinicians should be aware of the following conditions that may impact micronutrient status [24,25].

- Elevated vitamin A may be associated with acute ingestion of ethanol or non-fasting state.
- Low zinc level can be influenced by infection, inflammation, stress, oral contraceptives or pregnancy.
- An elevated zinc level due to supplementation may interfere with copper absorption.
- An elevated copper level may be a response to infection, inflammation, stress, copper supplementation, oral contraceptives, or pregnancy.
- Serum copper may be reduced by corticosteroids, zinc, malnutrition, or malabsorption.
- Falsely high serum vitamin B12 levels may be observed in myeloproliferative disease, acute hepatitis, severe alcoholic liver disease, and cirrhosis [26].
- Taking high doses of supplements and not withholding supplements for at least 24 hours prior to blood draws may artificially elevate micronutrient levels.
- During an acute phase response to trauma, infection, or inflammation, iron and selenium levels may be reduced [23].

3.5.3. *Preoperative lab recommendations for MBS patients*

Table 7 shows the ASMBS preoperative micronutrient labs recommended at baseline for each surgery type [6]. Patients should not take dietary supplements at least 24 hours in advance of blood draws to prevent an inaccurate assessment of nutrient stores [6,25].

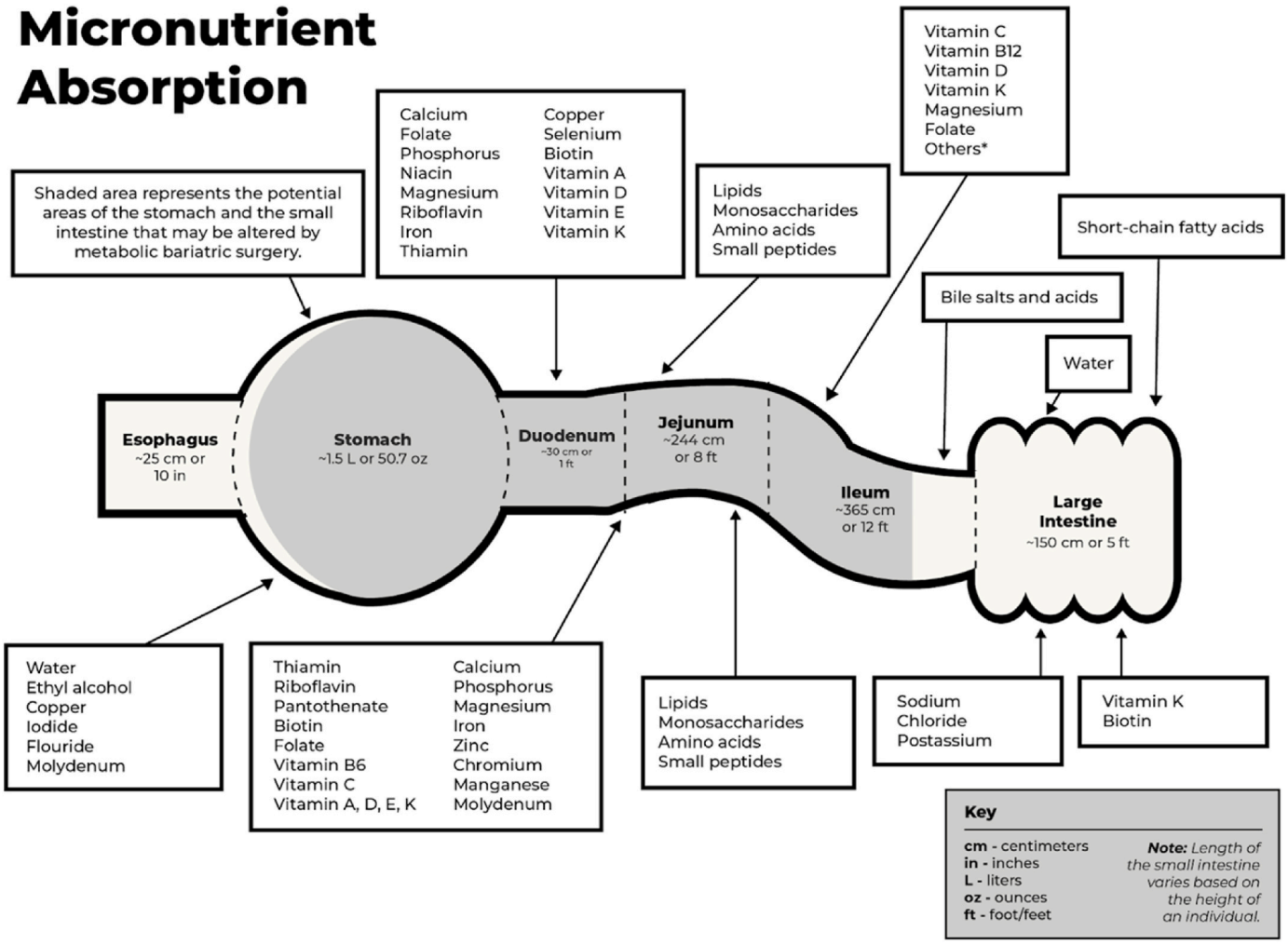


Fig. 2. Micronutrient absorption sites in the gastrointestinal tract.

Table 5
Common issues related to macronutrient and micronutrient deficiencies [6,11,12].

Anatomical, disease states, and environmental conditions that may lead to macronutrient and micronutrient deficiencies [6,11,12]
• Chronic medical comorbidities, including obesity
• Bariatric surgical complications
• Gastrointestinal surgeries
• Decreased caloric intake
• Very low-calorie diets, ketogenic diets, intermittent fasting/time restricted diets, or low carbohydrate diets [22]
• Inadequate quantity of a specific macronutrient (protein, carbohydrate, fat)
• Poor quality dietary intake (lack of variety of food items in the diet)
• Medications – drug/nutrient interactions (i.e., proton-pump inhibitors/B12, metformin/B12, diuretic/thiamin) [23]
• Food insecurity/poverty
• Insufficient funds for bariatric multivitamin mineral supplements
• Change in bowel habits, severe diarrhea
• Gastrointestinal infections (i.e., Clostridium difficile (C. diff.), small intestine bacterial overgrowth (SIBO))
• Crohn's disease, ulcerative colitis
• Depression, other mental health disorders that disrupt adequate oral intake
• Poor oral health and dentition
• Physical disabilities, mobility limitations
• Living alone, isolation

4. Selecting bariatric multivitamin mineral supplements and patient education

Selecting bariatric supplements begins with preoperative education for those patients seeking MBS. Bariatric RDs with MBS experience have the most knowledge and skill in recommending bariatric multivitamin (MVM) supplements based on the MBS procedure type, anatomical changes associated with absorption issues, and the patient's dietary preferences (i.e., gluten-free, egg-free, tree nuts, soy-free, peanut-free, artificial sweeteners) [6]. A bariatric-specific MVM supplement should include the minimum nutrient recommendations established by the ASMBS [6]. Evidence supports the use of specialized bariatric supplement preparations due to the bioavailable absorption properties, special formulations, disintegration properties, caking agents, solubility factors,

Table 6
Identifying micronutrient deficiencies [1,17].

Micronutrient	Laboratory analysis
Thiamin	• Test in whole blood stores, not plasma; *May be due to hypoalbuminemia
Vitamin B12	• Serum MMA (value > 0.4 μmol/L); *May be due to patients taking PPI
Vitamin A	• Deficiency = ↓ retinol binding protein + ↓ plasma retinol
Vitamin E	• Deficiency = ↓ plasma alpha-tocopherol
Vitamin D, Calcium	• Combination of tests to evaluate for deficiency = vitamin D25-OH, serum alkaline phosphatase, PTH, 24-h urinary calcium
Vitamin K	• Deficiency = ↓ DCP
Folate	• Deficiency = ↓ RBC folate, ↑ serum homocysteine and normal MMA
Iron, Ferritin	• Deficiency = ↓ iron (<50 μg/dL) + ↓ ferritin (<20 μg/dL) + ↑ TIBC (>45 μg/dL)
Zinc- screen before RYGB, BPD/DS	• Deficiency = ↓ serum or urinary zinc or RBC zinc
Copper- screen before RYGB, BPD/DS	• Screen serum copper and ceruloplasmin • Both are acute phase reactants and can be affected by inflammation, age, anemia, and medications [13]

MMA: methyl malonic acid, PPI: proton pump inhibitors, DCP: des-gamma carboxy prothrombin, TIBC: total iron-binding capacity, RYGB: Roux-en-Y-Gastric Bypass, BPD/DS: biliopancreatic diversion/duodenal switch; ↓: decrease; ↑: increase; RBC: red blood cell; PTH: parathyroid hormone.

Table 7
Recommended baseline laboratory assessment by metabolic bariatric surgery type [1,6].

Nutrient	Preferred test	Baseline prior to SG, RYGB	Baseline prior to SADI-S, BPD/DS
Vitamin A (retinol)	Retinol serum		x
Vitamin B1 (thiamin)	Whole blood thiamin	x	x
Vitamin B9 (folate)	Red blood cell folate	x	x
Vitamin B12 (cyanocobalamin)	B12 serum, methylmalonic acid (MMA) serum (provides early sign of B12 deficiency)	x	x
Vitamin D (D2, (ergocalciferol) or D3, (cholecalciferol))	25-OH Vit D	x	x
Vitamin E (A-Tocopherol)	Vit E serum		x
Vitamin K	Vit K serum		x
Calcium (citrate)	Calcium, ionized, serum	x	x
Copper	Copper, serum		x
Iron	Iron and iron binding capacity	x	x
Zinc	Zinc, serum		x

SG: sleeve gastrectomy; RYGB: roux-en y gastric bypass; BPD-DS: biliopancreatic diversion with duodenal switch; SADI-S: single anastomosis duodenal-ileostomy with sleeve gastrectomy; OH: hydroxy.

and combinations of the essential micronutrients in the correct amount to prevent deficiencies [27,28]. When educating patients on bariatric supplementation, the following questions should be addressed.

- What type of MBS procedure will be performed (i.e., remaining gastrointestinal functionality, amount of absorption surface area available, consideration of sufficient hydrochloric acid affecting solubility of substances)?
- Does the supplement meet the ASMBS recommendations? [6].
- What type of MVM formulation is best?
- Can the patient afford bariatric MVMs long-term?
- What are the side effects from bariatric MVM supplements?

Table 8
Pros and cons of multivitamin mineral supplement formulations [28].

Formulation	Pros	Cons
Transdermal Patches [29,30]	• No evidence to support transdermal patches in MBS patients	• Skin barrier, hair skin oils • Limited micronutrients • Limited human RCTs • Risk of skin irritation/ swelling • Gender, age, ethnicity • Deficiencies: B1, B12, Vit D • Not recommended for MBS patients
Tablets	• Inexpensive • Durable/long-lasting • Higher dosages • Can be split • Chewable	• More likely to cause irritation • Slower acting • Uneven disintegration • Less palatable
Capsules	• Fast acting • Tasteless • Tamper-resistant • Higher drug absorption	• Less durable • Shorter shelf-life • May contain animal products • Lower doses of micronutrients
Gummies/Soft Chews	• More palatable	• Fewer micronutrients than regular vitamins (tablets) • Limited shelf-life • Added sugar (4 g = 1 teaspoon) • Artificial sweeteners, coloring – GI symptoms
Liquid Vitamins, Microgels, Soft-gel Capsules	• Higher absorption rate compared to other supplement formulations	• Difficulty dosing • Taste/smell • Easy to spill • Compliance issues • Shorter shelf life • External elements - air, pH, light

RTCs: randomized controlled trials; GI: gastrointestinal tract.

When selecting a bariatric product, patients should ensure that iron and calcium are not contained in the same supplement. Calcium, in the amount of 500 mg–600 mg, should be taken separately from a MVM containing iron, allowing at least 2 hours for adequate absorption of both iron and calcium ingestion [1,11,27,28]. If taken together, the elemental calcium will block iron absorption [17]. Also, patients should read the supplement label to ensure the proper zinc-to copper ratios follow the bariatric recommendations [6]. Table 8 identifies some of the characteristics associated with different types of MVM supplementation formulations.

4.1. *Vitamin and mineral recommendations for MBS patients*

The ASMBS clinical practice guidelines provide basic recommendations for clinicians to follow for preoperative and post-surgical patient care [6]. Certain procedures may require a higher level of supplementation (Table 9). In some cases, additional micronutrient supplementation may be required including iron, calcium, vitamin B12, vitamin D, or a B-complex formulation [1,6,31]. For patients with more invasive MBS procedures (i.e., distal RYGB, BPD-DS, SADI-S), a bariatric-specific MVM should include fat soluble vitamins (i.e., vitamins A, D, E, K) in a water-miscible or dry formulation to enhance intestinal absorption [6].

4.2. *Replenishing micronutrient deficiencies*

An individualized therapeutic approach to correcting mild to severe forms of micronutrient deficiencies is reported in Table 10. These recommendations follow the ASMBS guidelines and should be considered by clinicians when micronutrient deficiencies have been identified [1,6]. A range of therapeutic options, including length of time for treatment

Table 9
Minimum recommended micronutrient intake for metabolic bariatric surgery procedures [1,6].

Nutrient	Recommended supplementation SG or RYGB	Recommended supplementation BPD-DS, or SADI-S
Vitamin B1 (thiamin)	At least 12 mg oral daily	At least 12 mg oral daily
Vitamin B9 (folate, folic acid)	400 mcg oral daily (800 mcg oral daily for child-bearing women)	400 mcg oral daily (800 mcg oral daily for child-bearing women)
Vitamin B12 (cobalamin; cyanocobalamin synthetic form)	350 mcg oral daily	500 mcg oral daily
Vitamin A (retinol)	5000 IU (1500 mcg)/oral daily	10,000 IU (3000 mcg)/ oral daily
Vitamin D (D3, cholecalciferol)	3000 IU (75 mcg)/oral daily	3000 IU (75 mcg)/oral daily
Vitamin E (alpha-tocopherol)	15 mg oral daily	15 mg oral daily
Vitamin K (phylloquinone)	90 mcg oral daily	300 mcg oral daily
Calcium (citrate)	1200 mg oral daily	1800 mg oral daily
Copper	2 mg oral daily	2 mg oral daily
Iron	45 mg oral daily	45 mg oral daily
Zinc[a]	16–22 mg oral daily	16–22 mg oral daily
Vitamin B2 (riboflavin)	200 % DV, (2.6 mg)	200 % DV, (2.6 mg)
Vitamin B3 (niacin)	20 mg daily (125 % DV)	200 % DV, (F: 28 mg; M: 32 mg)
Vitamin B5 (pantothenic acid)	200 % DV, (10 mg)	200 % DV, (10 mg)
Vitamin B6 (pyridoxine)	4 mg daily	4 mg daily
Vitamin B7 (biotin)	200 % DV, (60 mcg)	200 % DV, (60 mcg)
Vitamin C	120 mg daily	180 mg daily

RYGB: roux-en y gastric bypass; SG: sleeve gastrectomy, BPD-DS: biliopancreatic diversion with duodenal switch, SADI-S: single anastomosis duodeno-ileostomy with sleeve gastrectomy; DV: daily value; mg: milligrams; mcg: micrograms; IU: international units; F: female; M: male.

[a] Zinc to copper ratio: 8–15 mg of zinc for every 1 mg of copper [1,6].

Table 10
American Society of Bariatric and Metabolic Surgery recommendations for micronutrient repletion [6].

Vitamin/ Mineral	Repletion Therapy Options
Thiamin	Oral therapy: 100 mg 2–3x/d IV therapy: 200 mg 3x/d or 500 mg 1-2x/d for 3–5 d; then 250 mg/ d for 3–5 d IM therapy: 250 mg 1x/d for 3–5 d or 100–250 mg monthly
Folate	Oral therapy: 1000 mg/d
Vitamin B12 [32]	Oral therapy: 1000 mg/d
Vitamin A	IM therapy: 50,000–100,000 IU/3 d *(with corneal changes).* then 50,000 IU/d IM for 2 weeks
Vitamin D	Oral therapy: 3000–6000 IU/d; or 50,000 IU/1–3x/weeks
Vitamin E	Oral therapy: 100–400 IU/d (alpha-tocopherol)
Vitamin K	Oral therapy: 1–2 mg/d IV therapy: 1–2 mg/week; Acute malabsorption: 10 mg week
Calcium	Oral therapy: BPD/DS: 1800–2400 mg/d calcium citrate SG, RYGB: 1200–1500 mg/d calcium citrate
Copper	Oral therapy: 3–8 mg/d copper gluconate or sulfate (mild-moderate deficiencies) IV therapy: 2–4 mg/d intravenous copper can be initiated for 6 d (severe deficiency)
Iron	Oral therapy: 150–200 mg/d elemental iron; 300 mg 2–3x/d in severe cases IV therapy: may consider IV iron in severe cases [33]
Zinc	Although there is insufficient evidence to support specific zinc replenishing recommendations, consider the following: 16–22 mg oral daily; *Zinc to copper ratio: 8–15 mg of zinc for every 1 mg of copper [1,6].

IV: intravenous; IM: intramuscular; mg: milligrams; IU: international units; d: day; RYGB: roux-en y gastric bypass; SG: sleeve gastrectomy, BPD-DS: biliopancreatic diversion with duodenal switch.

Table 11
General metabolic and bariatric surgery diet progression recommendations [1,6,11,34,35].

Diet stage	Suggested education for food texture progression
Clear Liquid Diet	• Post-op day 0 and 1: Clear liquids should be low in calories and added sugar (i.e., caffeine-free tea and coffee, soup broth, sugar-free sports drinks, flavored waters, clear liquid protein supplements, etc.); no carbonation or alcohol • Clear liquid phase should not last longer than 48 hours due to nutritional inadequacy • Limit or avoid caffeine • Sip liquids throughout the day, gradually increasing to 8+ oz per hour • Straws may be used to increase fluid intake
Full Liquid Diet	• Post-op day 2 through 7–14 days depending on the patient's condition • Continue with low-calorie, noncarbonated clear liquids (48–64 oz/day) • Full liquids should be high in protein, low in added sugar, lactose-free (soups, smoothies, meal replacements) • Start liquid or chewable bariatric multivitamin mineral supplements • Revisional procedures not impacting the pouch may skip the full liquid phase, start soft foods • ASMBS protein recommendation is a minimal protein intake of 60 g/d and up to 1.5 g/kg ideal weight/day [6]
Semisolid/Soft Textures	• Semisolid textures include smooth or pureed foods (i.e., Greek yogurt, cottage cheese, ricotta cheese, sugar-free pudding) then slowly advance into "soft" textured foods (mash with a fork) • A soft food stage typically begins 2–3 weeks after surgery • Avoid foods with skins, peels, fibrous components, and dense textures • Consume high protein foods during meals • Continue with 48–64 oz clear liquid daily
Regular Textures	• Regular textured foods start 4–6 weeks after surgery • Food tolerances will vary by texture of the food and eating behaviors (raw fruits, vegetables, dense/dry meats, breads, rice, pasta) • Continue with adequate hydration (48–64+ oz/day) • Consume protein foods 2–3 oz/3+ times a day • Take bariatric multivitamin mineral supplement and calcium citrate as recommended

is suggested. Although some MBS programs have developed their own protocols for correcting MBS nutrient deficiencies, Table 10 provides an overview of MBS evidence-based therapies commonly cited in the literature [1,6,11].

5. Postoperative nutrition care of the MBS patient

5.1. *Postoperative diet progression and nutrition therapy*

Postoperative nutrition care for bariatric surgery patients is a continuation of preoperative medical nutrition therapy typically managed by an RD [1,6]. The MBS postoperative eating pattern is often prescribed in stages from clear liquids to a regular diet progression that varies among surgical centers. Currently, there is no evidence to support a specific protocol of post-MBS diet progressions [6]. Most MBS protocols suggest a transition into different food textures, fluid, and protein recommendations, along with bariatric micronutrient supplementation [1,6,34]. The overall goal of a postoperative diet is to promote healing, weight loss, and to decrease the risk of gastrointestinal complications. The diet progression and recommendations should be modified according to the MBS procedure type and the patient's specific nutritional status [6,11,34,35]. (Table 11)

In addition, nutrition education should include [11,36].

- Reading food labels to limit added sugars, fats and highly processed ingredients
- Distinguishing between protein supplements and meal replacements

Table 12
Protein sources and general recommendations [35,37].

Complete Proteins	Incomplete Proteins
Animal-based proteins are complete proteins with all nine essential amino acids.	Plant-based proteins are considered incomplete proteins due to lacking one or more of the essential amino acids.
• Beef	• Beans (i.e., pinto, kidney, garbanzo)
• Poultry	• Lentils and split pea
• Pork	• Nuts and seeds
• Seafood & Fish	• Grains and rice
• Eggs	• Vegetables
• Dairy	

Protein Recommendations:

- A minimal protein intake of 60 g/d and up to 1.5 g/kg ideal weight/day should be adequate for most patients [6]
- Protein should be spread out throughout the day with meals and snack(s)
- Solid proteins such as beef, pork, and chicken will increase fullness and satiety for longer periods of time compared to liquid or soft forms of protein (i.e., protein shakes, yogurt, or cottage cheese)
- Protein foods with high bioavailability are absorbed and utilized more efficiently in the body (whey isolates, egg whites, red meat, poultry, fish)

- Establishing an eating schedule to prevent grazing behaviors
- Eating behaviors and food choices to prevent food intolerances and regurgitation
- Allowing 20–30 minutes for meals
- Recognizing different types of proteins within food sources for amino acid composition, sustained satiety, and absorption bioavailability.

5.2. *Protein intake*

Protein is a vital macronutrient that needs to be consumed in adequate quantity and of sufficient quality to support proper metabolic functioning and retention of muscle mass [37]. Table 12 provides some recommendations that can serve as a guide for the clinician and patient.

6. Postoperative nutrition assessment & monitoring [6,11,34,35]

6.1. *ASMBS recommended schedule for post-MBS clinic visits [6]*

Most MBS programs conduct nutrition assessments with close monitoring of postoperative patients on multiple occasions during the first 12 months post-MBS. A trained bariatric RD usually visits with patients during their hospital stay to reinforce the discharge diet progression, which is often modified according to the type of MBS procedure [6]. Patients return to the outpatient clinic usually 1-week post-MBS, and then follow up with scheduled appointments at 1, 3, 6, 9, and 12 months depending on the MBS program requirements [6,11]. Micronutrient levels should be reevaluated according to the MBS procedure type and reviewed by the MBS team similar to the schedule in Table 13. Thereafter, patients should follow up with their MBS team or obesity medicine specialists annually, at the minimum.

6.2. *Post-surgical bariatric nutrition assessment tool*

At each follow up appointment, a general nutrition assessment and evaluation should be conducted. Table 14 is a general nutrition screening tool that can be used to identify overall nutritional adequacy and expose potential nutrition issues.

Further testing is recommended to diagnose protein malnutrition [11,41]. (Table 15)

7. Trouble-shooting nutrition-related concerns 0–12 months post-surgery

Some of the most common patient concerns following surgery include constipation, dehydration, diarrhea, nausea, vomiting, and lactose intolerance. Table 16 highlights common symptoms, potential triggers, and nutrition-related suggestions for providers.

8. Nutrition-related deficiencies

Nutrition-related deficiencies may appear anytime following MBS. However, for those patients who no longer follow up with the MBS team, an annual nutrition evaluation by their obesity medicine specialist or primary care provider is essential. Table 17 identifies some more common nutrition-related concerns and symptoms reported by patients more than one-year post-surgery. Refer to Tables 13 and 15 for annual nutrient assessment labs.

Table 18 may be used to identify physical findings that might be associated with signs of malnutrition. Physical signs of malnutrition can be very subtle, so providers should utilize laboratory data, when possible, to support their findings.

9. Protein-energy undernutrition (PEU)

Metabolic bariatric surgery, known for dietary changes and physiological alterations of the digestive tract, increases the risk for

Table 13
Postoperative micronutrient assessment schedule by procedure type [1,6,17,23].

Nutrient	Preferred test	SG, RYGB	SADI-S, BPD/DS
Vitamin A (retinol)	Retinol serum	Optional for RYGB	At least 1x w/in 1st yr; then annually
Vitamin B1 (thiamin)	Whole blood thiamin	1–3 mo; then every 3–6 mo during 1st yr; then annually	1–3 mo; then every 3–6 mo during 1st yr; then annually
Vitamin B9 (folate)	Red blood cell folate	Every 3–6 mo during 1st yr; then annually	1–3 mo; then every 3–6 mo during 1st yr; then annually
Vitamin B12 (cyanocobalamin)	B12 serum, methylmalonic acid (MMA) serum (provides early sign of B12 deficiency)	1–3 mo (if indicated); then every 3–6 mo during 1st yr; then annually	1–3 mo (if indicated); then every 3–6 mo during 1st yr; then annually
Vitamin D (D2 or D3)	25-OH Vit D	1–3 mo; then every 3–6 mo during 1st yr; then annually	1–3 mo; then every 3–6 mo during 1st yr; then annually
Vitamin E (A-tocopherol)	Vit E serum	Optional w/in 1st yr; then annually	Optional w/in 1st yr; then annually
Vitamin K	Vit K serum	Optional w/in 1st yr; then annually	Optional w/in 1st yr; then annually
Calcium (citrate)	Calcium, ionized, serum	Every 3–6 mo during 1st yr; then annually	Every 3–6 mo during 1st yr; then annually
Copper	Copper, serum	Optional	Optional
Iron	Ferritin with c-reactive protein; full iron panel (iron, transferrin, % saturation, total iron-binding capacity)	1–3 mo; then every 3–6 mo during 1st yr; then annually	1–3 mo; then every 3–6 mo during 1st yr; then annually
Zinc	Zinc, serum	Annually	Annually

SG: sleeve gastrectomy; RYGB: roux-en y gastric bypass; BPD-DS: biliopancreatic diversion with duodenal switch, SADI-S: single anastomosis duodeno-ileostomy with sleeve gastrectomy; OH: hydroxy; mo: month(s); 1^{sr}: first; yr: year.

Table 14
General nutrition assessment for post-metabolic bariatric surgery patients [6,11,34,35].

Consideration	Comment
Metabolic Bariatric Surgery Type	• Primary (type, date) • Revision (type, date) • Any complications associated with the procedure(s)
Food Intake (detailed food record) **Websites/Phone Apps:** www.Baritastic.com www.Supertracker.usda.gov www.CalorieKing.com www.MyFitnessPal.com www.FitDay.com www.LoseIt.com	• Composition and adequacy of food and nutrient intake • Energy intake, foods, beverages, alcohol • Macronutrient percentage distribution (protein, carbohydrates, fats) • Types of macronutrient foods • Food intolerances • Meal and snack patterns • Eating environment • Family and social environments • Meals away from home • Level of hunger/awareness of fullness
Oral Supplements	• Bariatric multivitamin mineral with or without iron • Calcium citrate • Iron (optional) • Additional fat-soluble supplementation (i.e., A, D, E, K), as needed • Barriers to accessing supplements
Medication Review Post-Surgery	• Weight changes associated with medication changes • Drug-nutrient interactions
Changes in Food Knowledge, Beliefs, Attitudes, Skills	• Support group participation • Family/social support
Eating Behaviors **Example: Hunger Scale Tool** [38] <——————————————————————————————————————>1. 2 3 4 5 6 7 8 9 10 1 Starving, feeling weak, dizzy 2 Very hungry, irritable, stomach growling loudly 3 Pretty hunger; stomach beginning to growl 4 Beginning to feel hungry 5 Satisfied, neither hungry nor full 6 Slightly full/pleasantly full 7 Slightly uncomfortable 8 Feeling stuffed. 9 Very uncomfortable, stomach aches 10 So full you feel sick, nausea	• Adherence to post-surgery diet recommendations • Binging/purging behaviors, food aversions, pica, bulimia, anorexia, nighttime eating syndrome • Emotional, habitual and other non-hunger triggers for eating • Behaviors associated with meals (meal duration, refusal to eat/drink, spitting out food, rumination, willingness to try new foods, taste/smell, mouth-feel concerns, overeating)
Access to Foods	• Food insecurity • Financial concerns • Meal prep
Physical Activity/Function	• Activity type, frequency, duration • Limitation of physical function
Anthropometric Measures	• Baseline and annual body composition analysis (i.e., DEXA, bioimpedance) [39] • Body mass index (height, weight) • Recent weight change • Total weight loss (lbs., kg) • Total weight loss (%) • Excess weight loss (lbs., kg) • Excess weight loss (%)
Indirect Calorimetry (if available)	• Establish caloric recommendations [40]
Biochemical and Micronutrient Labs	• Nutrient insufficiency, deficiency, or excess
Nutrition-Focused Physical Findings and Symptoms	• Overall appearance • Vital signs • Nausea, heartburn, reflux, or dysphagia • Nighttime cough • Abdominal pain or cramping • Body image concerns by the patient • Change in eyesight, hair, skin, nails, oral cavity, mucus membranes • Change in cognitive function, confusion, concentration • Change in motor movement or gait • Numbness or tingling in hands or feet • Burning sensation in feet • Edema • Gastrointestinal symptoms/bowel habits

DEXA: dual energy x-ray absorptiometry.

undernutrition and protein malnutrition [49].

Protein-energy malnutrition (PEM), currently known as protein-energy undernutrition (PEU), includes a deficiency of all macronutrients, but primarily protein, due to insufficient caloric intake [41]. Undernutrition may be recognized by an inadequate intake of nutrients, malabsorption, impaired metabolism, loss of nutrients due to diarrhea, or increased nutritional requirements [41,50,51]. Severe cases of undernutrition described as an excessive loss of adipose tissue and muscle, are a form of malnutrition occasionally seen in post-MBS patients [6,41,49]. Some post-MBS patients experience severe protein malnutrition and

Table 15
Physical assessment of protein status [41].

A nutrition-focused malnutrition diagnosis involves:
• Dietary history of the patient
• Anthropometric measures
• Nutrition-focused physical exam
• Micronutrient laboratory values to detect subclinical nutrient deficiencies
• Protein malnutrition in MBS patients without hepatic or renal failure, classified as mild to severe hypoalbuminemia:
• Serum albumin level <35 g/L (normal range 35–50 g/L) [5]
• Mild hypoalbuminemia: 30–35 g/L
• Moderate hypoalbuminemia: 25–30 g/L
• Severe hypoalbuminemia: <25 g/L, which is often associated with morbidity and mortality.

MBS: metabolic and bariatric surgery.

micronutrient deficiencies associated with more invasive bariatric procedures such as a proximal or distal RYGB, BPD/DS, or SADI-S [6,49]. Protein malnutrition and vitamin/mineral deficiencies develop from deficits of total caloric intake or insufficient specific macronutrient and micronutrient quantities essential for adequate nutritional status [41, 51]. Malnutrition severity in MBS patients ranges from subclinical micronutrient deficiencies to more physical signs of wasting with edema, hair loss, muscle and skin atrophy [41,49]. In MBS patients, protein malnutrition and micronutrient deficiency symptoms may develop slowly or very rapidly [6]. In general, signs of protein or micronutrient malnutrition depend on the patient's response to a particular MBS procedure, potential anatomical complications, severe diarrhea or dumping syndrome, gastrointestinal infections such as Clostridium difficile, food insecurity, disordered eating behaviors, or a combination of other wasting disorders (i.e., renal failure, heart disease, chronic obstructive pulmonary disease, cancer) [6,49]. Laboratory data should be collected if protein malnutrition is suspected (Table 15).

Protein malnutrition severity may need to be treated by correcting fluid and electrolyte levels with IV solutions [41]. Oral protein supplements and high bioavailable proteins in the diet, as typically prescribed by an RD, should be incorporated into the diet for mild to moderate form of protein malnutrition. The general protein recommendation for most post-MBS patients is at least 60 g of high quality protein/day or up to 1.5 g/kg of ideal body weight/day [6]. Severe cases of hypoalbuminemia may require 2 g of high-quality protein/kg body weight/day [41].

10. Factors associated with slow weight loss after metabolic and bariatric surgery

Rate of weight loss in the immediate postoperative phase varies significantly between individuals with severe obesity. When discussing the rate of weight loss during the first-year post-MBS and beyond with patients, consider the following factors in Table 19, and a description of problematic eating behaviors in Table 20.

Maladaptive eating behaviors described in patients after MBS may be the same or differ from those eating behaviors identified in the preoperative screening in Table 4. Table 20 describes some of the more common types of maladaptive eating behaviors reported in postoperative MBS patients, some of which may be associated with slow weight loss or gradual recurrent weight gain.

11. Recurrent weight gain

A proportion of patients experience clinically significant recurrent weight gain following MBS. Anatomic complications such as slippage of the gastric band, gastro-gastric fistulas, dilated gastric fundus, an enlarged gastric pouch, or gastro-jejunal stoma may lead to recurrent weight gain [52,55]. Insufficient physiological changes to the gut microbiome, inadequate adaptation of gastrointestinal hormones, and adaptation of the body's neurohormonal energy regulation that favors return to a previously determined set point are partially responsible as well [1]. However, more common causes of recurrent weight gain in post-MBS patients appear to be maladaptive eating behaviors (i.e., loss of control eating, grazing behaviors), returning to old eating habits due to socioeconomical factors, plus noncompliance to dietary recommendations [52–55].

Physical inactivity, stressful environment, history of depression, and changes in hormones that regulate energy intake have also been shown to increase appetite, enhance food cravings, and ultimately increase caloric intake [52–55]. Therefore, the major maladaptive behavior leading to recurrent weight gain post-operatively appears to be a combination of physiological factors, increased caloric intake due to increased appetite, excessive eating, inadequate physical activity, hormonal changes, and psychosocial stressors [52–55].

Table 21 shows the top 10 takeaway messages regarding bariatric nutrition and the MBS patient.

12. Limitations and acknowledgements

The authors acknowledge that MBS programs vary with institution protocols and bariatric nutrition recommendations for preoperative and post-surgical patients. The authors also recognize that patients receive much of their information from social media and the internet, which challenges both the provider and our efforts to promote evidence-based nutrition messages. As newer modifications of the current MBS procedures continue to evolve, so will our understanding of nutrition absorption sites, prevention of nutrient deficiencies, and our ability to assess and manage MBS patients with nutrition complications and challenges. Guidelines specific to subpopulations of patients, such as pediatric or older patients, those with renal or liver disease or other special needs, by ethnicity or race, or those who undergo endoscopic bariatric procedures such as endoscopic sleeve gastroplasty, are beyond the scope of this CPS but would make an excellent topic for a follow up CPS related to this topic. Future research in these specific areas is also needed.

13. Conclusion

This Obesity Medicine Association Clinical Practice Statement on metabolic and bariatric surgery nutrition therapy, an update to the 2022 OMA CPS focused on bariatric surgery [1], is designed to assist clinicians in caring for patients seeking bariatric surgery and postoperative nutritional management. Evidence-based nutrition recommendations for MBS procedures are provided to help clinicians in identifying and managing patients at risk for nutritional deficiencies preoperatively and post-surgery. Post-MBS patients should be evaluated annually at minimum, if not more frequently, to promote optimal nutritional health. Treating the disease of obesity involves more than just weight loss; it is about improving the quality of life of those individuals with obesity by educating patients on healthy eating and lifestyle behaviors.

Three Takeaway Messages.

1. Perioperative optimization for patients seeking MBS includes the management of modifiable risks prior to and after surgery, reducing

Table 16
Nutrition-related suggestions for patients 0–12 months post MBS with common symptoms and concerns [6,11,42–46].

Symptom	Potential Triggers	Nutrition-related suggestions
Constipation	• Liquid diet phase • Insufficient fluids • Narcotic use • Low fiber intake • Oral iron supplements • Proton pump inhibitors • Low physical activity	• Increase fluids (48–64+ oz/day) • Increase soluble and insoluble fiber (fruits, vegs, whole grains) to 25–30 gm/day • Increase physical activity to at least 150 min/day • Take lowest dose of iron necessary • Stool softener or laxative may be necessary • If symptoms persist, patients should contact their medical provider or go directly to the emergency department
Dehydration	• Lack of sensing thirst • Nausea/vomiting • Insufficient fluid intake • Severe diarrhea • Diuretic medications	• Encourage patients to drink 48–64+ oz/day of low calorie or sugar-free liquids between meals • Assess if intravenous (IV) hydration is necessary • IV hydration with dextrose or other sugar solutions should contain thiamin [6,47,48]. • Antiemetic may alleviate nausea/vomiting symptoms while hydration is restored [6, 47]
Diarrhea	• Food choices • Caffeine • Medications • Dietary habits • Altered GI function (length of common channel)	• Limit high sugar, high fat and spicy foods • Decrease fluids consumed at meals • Limit foods with lactose (i.e., cow's milk, ice cream, some yogurts, cheeses, cottage cheese) • Limit sugar-free products and sugar alcohols • Increase awareness of food items that may lead to food intolerances • Eat slowly, chew thoroughly • Limit caffeine intake • Review new medications that may contribute to diarrhea (i.e., metformin, omeprazole) • *Clostridium difficile* infection or small intestinal bacterial overgrowth (SIBO) may also need to be ruled out if diarrhea persists
Nausea	• Narcotics • Dehydration • Dietary habits • Food choices	• Prevent overeating • Consume adequate fluids, 48–64 oz/day (no carbonation) • Chew foods thoroughly, eat slowly • Limit foods that may cause dumping syndrome (candies, baked goods, sugary drinks) • Limit foods with lactose • In some cases of nausea, antiemetics may be necessary
Vomiting/ Regurgitation	• Not chewing food • Eating too quickly • Swallowing difficulty • Alter GI function	• Return to full liquids or semi-soft foods for 1–2 days • Small bites, chew foods thoroughly, eat slowly • Prevent overeating, stop eating when comfortable • Consume moist foods (especially moist meats) • Sip only small amounts of beverages with meals • Patients should be assessed for symptoms of heartburn or gastroesophageal reflux disorder • If vomit is bright red or dark brown, patients should contact their medical provider immediately
Foods get "stuck" [35]	• Not chewing food • Obstructive food textures (i.e., tough/dry meats and poultry, fibrous fruits/ vegetables, sticky foods (peanut butter) or 'doughy' foods (breads/ pasta)	• Modify eating behaviors • Choose foods that will prevent a fear of eating or concerns with foods becoming lodged in the throat • Take sips of water
Abdominal distension/ flatulence	• Cruciferous vegetables (Brussel sprouts, cabbage, broccoli) • Beans, lentils • Carbonation • Artificial sweeteners • Lactose • Fatty foods	• Prevent overeating • Consider FODMAP diet • Sip only small amounts of fluids with meals • No carbonated beverages • Increase physical activity • Limit sugar alcohols (sorbitol) • Limit foods with lactose • Limit fatty foods • Eat slow, chew well • Limit foods that may cause dumping syndrome
Lactose intolerance	• Foods with lactose • Not reading labels	• Limit lactose-containing products, including protein shakes • Consume lactose-free milk or alternative milk products (almond, rice, soy milk) • Consider whey protein isolates or soy-based protein alternative protein products • Use lactase enzyme tablets or drops • Foods with less lactose (i.e., low-fat yogurt, hard cheeses, kefir)
Dumping syndrome **Symptoms** • Diarrhea • Nausea • Vomiting • Pain • Abdominal cramps • Bloating • Epigastric fullness • Sweating • Headache • Flushing • Lightheadedness • Rapid heart rate • Strong desire to lie down	• High sugar or simple carbohydrate intake as opposed to complex or low glycemic carbohydrates and fiber sources • Altered GI function (length of common channel)	• Consume water and low calorie or calorie-free beverages • Limit concentrated sweets and foods with added sugars (sucrose, honey, high-fructose corn syrup) • Limit high fat foods • Consume high fiber/low glycemic carbohydrates with protein and fat in a meal • Decrease portion sizes and the amount of food consumed at meals

(*continued on next page*)

Table 16 (*continued*)

Symptom	Potential Triggers	Nutrition-related suggestions
		• Limit excessive consumption of fluids with meals
Dizziness, Lightheadedness, or Headaches	• Not enough calories • Dehydration, leading to hypotension and orthostasis • Low electrolytes • Irregular eating episodes • Dumping syndrome • Need medications rechecked • Hypoglycemia	• Drink plenty of water • Low-calorie fluids with electrolytes (i.e., electrolyte-enhanced waters or electrolyte-enhanced sports drinks) to prevent dehydration • Add salt to foods • Drink regular bouillon/broth • Adequate food intake • Eat on a regular schedule (about every 3 hours) • Contact the physician or go to the emergency department to be assessed for dehydration • Limit concentrated sugars • Limit drinking while eating • Most patients require reduction in or discontinuation of hypertension and diabetes-related medications after surgery
Fatigue or General Weakness	• Not enough calories • No eating schedule • Insufficient fluids • Not enough sleep • Sedentary • Hypotension • Hypoglycemia	• Drink plenty of fluids • Limit caffeine • Sleep on a regular schedule • Stay physically active • Consume adequate calories, protein, and carbohydrate (fruits/vegetables) • Eat on a schedule • Take daily bariatric vitamin/mineral supplements • Most patients require reduction in or discontinuation of hypertension and diabetes-related medications after surgery
Heartburn	• Too long between meals • Excessive fullness • Caffeine hidden in beverages • Sensitivity to certain foods • Alcohol • Over the counter or prescribed medications	• Increase frequency of meals or snacks • Prevent overeating • Limit or avoid caffeine • Limit spicy foods • Limit use of aspirin or other nonsteroidal anti-inflammatory drugs • Be aware of food temperatures (too hot or cold) • Prevent lying down immediately after eating • Limit alcoholic beverages • Monitor adherence to proton pump inhibitors • Determine if medications are associated with symptoms
Leg Cramps	• Poor quality diet, • Not taking bariatric supplements • Insufficient hydration • Sedentary	• Eat a well-balanced diet • Take bariatric multivitamins + calcium citrate supplements daily • Increase physically active • Increase fluid intake
High-Vitamin B12 Levels	• Excessive B12 intake • Taking B12 supplement prior to lab draw	• Take vitamin B12, 1 or 2 times per week instead of daily • Do not take vitamin B12 or bariatric supplements 24 hours prior to blood draws
Excessive Hair Loss	• Stress from bariatric surgery and rapid weight loss	• Hair shedding or hair loss is normal [45] • Take bariatric multivitamin mineral supplements as recommended • Check micronutrient levels if hair loss persists longer than 6 months • Do not recommend special shampoos, extra protein, biotin or zinc supplements beyond bariatric supplementation [6].
Weight Maintenance	• Weight stabilization • Prevention of recurrent weight gain	• Assess diet adequacy • Adjust calories to maintain weight • Reinforce behavioral strategies (self-monitoring of diet, physical activity, weight) [36]
Pregnancy	• Vomiting/dehydration • Nutrition adequacy • Supplementation	• Recommendation: wait 12–18 months post-MBS before conception [11] • Follow-up by MBS RD [11] • At least 1 nutrition visit per trimester [11]

FODMAP: fermentable oligo-, di-, monosaccharides and polyols.

risks during the perioperative phase, and improving patient outcomes post-MBS.
2. Micronutrient depletion or deficiency documented by blood or plasma concentrations below the reference range may occur with few if any clinical signs or symptoms.
3. The development of an interdisciplinary team of medical providers with evidence-based nutrition knowledge and consistent information improves the quality of nutrition care provided to MBS patients.

14. Author contributions

The concept of the submission was suggested by the authors of the 2022 OMA CPS entitled "Obesity Medicine Association (OMA) Bariatric surgery, gastrointestinal hormones, and the microbiome Clinical Practice Statement (CPS) 2022" and the OMA Bariatric Medical Surgery Committee. SBD wrote the first draft, with input from KF, RP. SBD, KF reviewed and edited the draft.

Ethics review

This OMA Clinical Practice Statement manuscript was peer-reviewed and approved by the OMA Board of Trustee members prior to publication. Edits were made in response to reviewer comments and the final revised manuscript was approved by the authors prior to publication. Fictious case studies were used. This submission did not involve human test subjects or volunteers. Responsibility for editorial decisions and peer review process for this article was delegated to non-author Editors or non-author Associate Editors.

Table 17
Most common nutrition diagnoses for patients more than 1-year post-surgery [11,47].

Common Nutrition Diagnoses
• Inadequate vitamin or mineral intake
• Altered nutrition-related laboratory values
• Excessive oral intake (meal, snacking frequency)
• Altered gastrointestinal function
• Dumping syndrome
• Hypoglycemia
• Constipation
• Diarrhea
• Malabsorption
• Lactose intolerance
• Limited adherence to nutrition-related recommendations
• Undesirable food choices
• Unintended weight gain
• Disordered eating patterns and behaviors
• Lack of physical activity
• Lack of self-monitoring behaviors (food records, exercise)

Table 18
Micronutrient associated signs and symptoms of nutrient deficiency [1,17,23].

Nutrient	Signs and Symptoms Associated with Nutrient Deficiency
Vitamin A (retinol)	Night blindness due to corneal keratinization or necrosis, metabolic dysfunction of adipocyte, glucose
Vitamin B1 (thiamin)	Beriberi, weakness, Wernicke-Korsakoff encephalopathy, heart failure, edema, anorexia, nausea/vomiting
Vitamin B9 (folate)	Megaloblastic anemia, anorexia, fetal neural tube defects (if preconception deficiency)
Vitamin B12 (cyanocobalamin)	Macrocytic anemia, peripheral neuropathy, glossitis, diarrhea, headaches, neuropsychiatric disturbances
Vitamin D (D2 or D3)	Decreased bone mineralization, osteopenia, secondary hyperparathyroidism, hypocalcemia
Vitamin E (A-Tocopherol)	Hyporeflexia, decreased night vision, loss/decreased vibratory sense, limb and truncal ataxia, profuse muscle gaze, cardiac arrhythmias, reduced cognition
Vitamin K	Bleeding disorders, bruising, increased risk for bleeding
Calcium (citrate)	Decrease bone mineralization, osteopenia, secondary hyperparathyroidism, tetany (i.e., muscle contractions, spasms, or paresthesia)
Copper	Anemia, neutropenia
Iron	Microcytic and hypochromic anemia, fatigue, weakness, tachycardia, dyspnea, pallor, cold intolerance, koilonychia (brittle spoon-shaped nails), glossitis
Selenium	Impaired immune function, cardiovascular effects, reproductive/fertility problems, thyroid dysfunction, neurological symptoms, and musculoskeletal abnormalities
Zinc	Dermatitis, impaired wound healing, impaired taste, decreased immune function
Vitamin B2 (riboflavin)	Dermatitis, cheilosis and angular stomatitis (cracks or lesions on the lips or at the corners of the mouth), sore throat, inflammation and redness of the tongue ("magenta tongue")
Vitamin B3 (niacin)	Pellagra, 4Ds = diarrhea, dermatitis in sun exposed areas with scaling and keratosis, dementia, death
Vitamin B5 (pantothenic acid)	Impaired metabolism of carbohydrates, proteins and fatty acids, paresthesias
Vitamin B6 (pyridoxine)	Skin eruptions, atrophic glossitis, angular cheilitis, conjunctivitis, sideroblastic anemia, somnolence, confusion, peripheral neuropathy
Vitamin B7 (biotin)	Hair loss, conjunctivitis, scaly rash, anemia, central nervous system disorders
Vitamin C	Scurvy, bleeding gums, loose teeth, bruising, perifollicular hemorrhage, poor wound healing, fatigue

Table 19
Factors associated with slow weight loss after MBS [1,52].

Factors	Consideration
Anatomical or surgical factors	• Large gastro-jejunal stoma diameter • Gastric pouch dilation • Gastro-gastric fistula
Social demographics and anthropometrics	• Low socio-economic status • Working in food-related jobs • Higher preoperative body max index value (i.e., limited mobility)
Underlying disease and past medical history	• Diabetes • Blood pressure • Hyperlipidemia • Revision surgery due to history of MBS • Childhood obesity • Slow resting metabolic rate [40] • Sarcopenic obesity [39]
Eating behaviors	• Grazing • Binge eating • Loss of control eating • Nocturnal eating syndrome • Emotional eating • High calorie food choices and large portion sizes
Social support	• Lack of support from family or friends • Support group attendance
Psychological factors	• Depression • Anxiety • Alcohol or substance abuse • Personality disorder • Low self-esteem
Self-adherence to MBS recommendations	• Motivation to track food intake (food logs) • Tracking physical activity • Monitoring body weight change
Physical inactivity	• No routine exercise measured by frequency and duration • Physical limitations inhibiting adequate activity
Medications	• Medications associated with mental health, heart disease, blood pressure, steroids
Gastrointestinal hormones	• Maladaptive ghrelin, gastrin, amylin, glucagon, cholecystokinin, glucagon like peptide 1, oxyntomodulin, peptide YY (amongst others) secretion
Gut microbiome	• Insufficient nutrient metabolism and absorption

Evidence

The content of this manuscript is supported by citations, which are listed in the References section.

Conclusions and recommendations

This Clinical Practice Statement is intended to be an educational tool that incorporates the current medical science and the clinical experiences of obesity specialists. The intent is to better facilitate and improve the clinical care and management of patients with obesity. This Clinical Practice Statement should not be interpreted as "rules" and/or directives regarding the medical care of an individual patient. The decision regarding the optimal care of the patient with obesity is best reliant upon a patient-centered approach, managed by the clinician tasked with directing an individual treatment plan that is in the best interest of the individual patient.

Table 20
Postoperative characteristics of disordered eating behaviors [14,52–54].

Type	Characteristics
Anorexia Nervosa	• Rare, but reported in post-bariatric surgery patients • Extremely low weight • Moderate to severe dietary restriction • Intense fear of gaining weight • Unrealistic perception of body weight and image • Anatomical reason for excessive weight loss and an inability to consume foods
Loss of Control	• Patients feel a 'loss of control' in their eating behaviors; similar to a binge eating episode • Less food is consumed during eating episodes due to gastric restriction • Post-surgery patients may experience less weight loss or weight recurrence due to excess caloric intake
Night Eating Syndrome	• Described in MBS patients as 'regular evening hyperphagia' [53] • Awakening during the night to eat due to hunger or habit
Grazing, Picking, Nibbling	• Common among post-surgery patients • Small or modest amounts of food consumed in a repetitive or unplanned behavior [53] • Eating episodes not associated with hunger or satiety • Often associated with small amounts of high caloric foods or beverages • Associated with inhibiting weight loss and weight recurrence
Dumping, Chewing/ Spitting	• Dumping often associated with consuming sweets or dairy products followed by physical symptoms, including abdominal pain and diarrhea [53] • Cases of self-induced dumping for weight control have been reported • Chewing and spitting behaviors are associated with pleasurable taste of foods follow by patients afraid to swallow (i.e., a form of restrictive eating disorder) certain kinds of meat, sweets or pasta [53]
Pica [14]	• Consuming non-food substances for at least one month • Ingested items might include dirt, raw starches, ice (pagophagia), charcoal, ash, paper, chalk, cloth, baby powder, coffee grounds, and eggshells

Table 21
Top 10 takeaway messages: bariatric nutrition and MBS patients [1,6,12].

Bariatric nutrition and MBS patients

1. Preoperative optimization for patients seeking MBS refers to the management of modifiable risks prior to surgery, reducing risks during the perioperative phase, and improving patient outcomes.
2. The characteristics of post-MBS maladaptive eating behaviors most often include grazing, chewing/spitting, loss of control, nibbling and picking.
3. Most patients can anticipate a meaningful total weight loss of 25 %–45 % depending on MBS procedure type.
4. The MBS postoperative diet is typically prescribed in stages from clear liquids to a regular diet that varies among surgical centers.
5. An increased risk of nutrient malabsorption occurs when the duodenum and most of the jejunum are bypassed in procedures such a distal RYGB, BPD/DS, or SADI-S.
6. For patients with more invasive MBS procedures (i.e., distal RYGB, BPD-DS, SADI-S), a bariatric-specific MVM should include fat soluble vitamins (i.e., vitamins A, D, E, K) in a water-miscible or a dry formulation to enhance intestinal absorption.
7. The 'common channel' is the location where the food mixes with digestive enzymes.
8. Calcium, in the amount of 500 mg–600 mg, should be taken separately from a MVM containing iron, allowing at least 2 hours for adequate absorption of both iron and calcium ingestion.
9. Patients should not take dietary supplements at least 24 hours in advance of blood draws to prevent an inaccurate assessment of nutrient stores.
10. Micronutrient depletion or deficiency documented by blood or plasma concentrations below the reference range may occur with no clinical signs or symptoms.

MBS: metabolic and bariatric surgery; RYGB: roux-en y gastric bypass; SG: sleeve gastrectomy, BPD-DS: biliopancreatic diversion with duodenal switch, SADI-S: single anastomosis duodeno-ileostomy with sleeve gastrectomy; MVM: multivitamin mineral.

Updating

It is anticipated that sections of this Clinical Practice Statement may require future updates. The timing of such an update will depend on decisions made by the Obesity Pillars Editorial team, with input from the OMA members and OMA Board of Trustees.

Disclaimer and limitations

In areas regarding inconclusive or insufficient scientific evidence, the authors used their professional judgment. This Clinical Practice Statement is intended to represent the state of obesity medicine at the time of publication. Thus, this Clinical Practice Statement is not a substitute for maintaining awareness of emerging new science. Finally, decisions by practitioners to apply the principles in this Clinical Practice Statement are best made by considering local resources, individual patient circumstances, patient agreement, and knowledge of federal, state, and local laws and guidance.

Transparency

Since 2022, the Obesity Medicine Association Clinical Practice Statements have represented a diverse range of clinicians, allied health professionals, clinical researchers, and academicians. The authors reflect a multidisciplinary and balanced group of experts in obesity science, patient evaluation, and clinical treatment.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work the authors did not use AI.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interests

Sue Benson-Davies: Obesity Pillars Associate Editor.
Kirsten Frederiksen: None.
Rutuja Patel: None.

Acknowledgement

The authors would like to thank Mary Dagen for proofreading earlier drafts of the manuscript.

Appendix A. Supplemental Cases [1,6,11,13,17,21,32]

The following supplementary cases illustrate recommendations made in this article.

Case 1: Pre-Bariatric Surgery Vitamin B12 Deficiency and Its Management

1.1. A 42-year-old female presented to the medical weight management clinic for evaluation

She had a body mass index (BMI) of 42 kg/m^2, a history of hypertension, type 2 diabetes, and obstructive sleep apnea. Due to the patient's BMI and comorbidities, the patient was referred for vertical sleeve gastrectomy surgery. Pre-surgical evaluation including labs were performed.

The patient's laboratory workup revealed.

- Hemoglobin: 10.8 g/dL (normal: 12–16 g/dL)
- Mean corpuscular volume (MCV): 104 fL (normal: 80–100 fL)
- Serum vitamin B12: 190 pg/mL (normal: 200–900 pg/mL)
- Serum homocysteine: elevated at 20 μmol/L
- Serum methylmalonic acid (MMA): elevated at 0.6 μmol/L
- Stool hemoccult testing negative for occult blood

The patient exhibited mild fatigue but did not have any neurological symptoms or visible skin changes. The patient denied a history of gastrointestinal bleeding, melena, hematochezia, hematemesis, gastroesophageal reflux, alcohol use, chronic use of a proton pump inhibitor or antihistamine medication but had been on metformin for about two years. Metformin is known to reduce or block the absorption of Vitamin B12 in the terminal ileum. A diagnosis of vitamin B12 deficiency was made based on the low serum B12 levels and elevated MMA and homocysteine levels.

Management. .

1.2. Preoperative Optimization

Metformin was discontinued and blood glucose was monitored closely prior to surgery. Given the patient's upcoming bariatric surgery, prompt correction of vitamin B12 deficiency was important to avoid potential postoperative complications, such as neuropathy or worsening anemia and fatigue. After the initial course of intramuscular (IM) vitamin B12 injections, the plan included reassessment of serum B12 levels and continuing monthly IM injections for 6 months, after which the guideline recommendations of 1000 mcg vitamin B12 daily taken orally for repletion were to be considered.

1.2.1. Vitamin B12 Supplementation. The patient was started on IM injections of cyanocobalamin 1000 mcg weekly for 4 weeks, then 1000 mcg monthly for 6 months. IM injections were chosen due to potential issues with oral absorption in patients with obesity and the need for rapid repletion.

1.2.2. Iron and Folate Assessment. The patient's hemoglobin level suggested a potential concurrent iron deficiency, so additional labs for serum ferritin, iron, and folate were ordered. Folate and iron levels were normal, but ferritin was low, and the patient was also started on iron supplementation. The patient was advised to take ferrous sulfate 65 mg tablets daily for 3 months until her ferritin levels were above 100 mg/L.

After 4 weeks of IM B12 injections, the patient's serum B12 levels normalized to 500 pg/mL. Serum B12 levels were checked just prior to her next injection so as not to confound the improvement with recent dosing. Her hemoglobin increased to 12.2 g/dL. She reported improved energy levels and no adverse effects from the supplementation. Due to a significant reduction in nutrient intake as preparation for bariatric surgery, blood glucose levels normalized and no additional glucose lowering agent was required. The patient proceeded with sleeve gastrectomy without complications.

1.2.3. Long-term monitoring and recommendations. Following bariatric surgery, the patient will require lifelong monitoring of vitamin B12 levels due to the risk of malabsorption. The guidelines suggest 1, 3, 6, 12 months post SG, and then yearly.

The patient will continue monthly IM B12 injections for 6 months postoperatively, after which transition to oral supplementation will be considered based on her clinical status and absorption capacity.

1.3. Conclusion

This case highlights the importance of preoperative screening for vitamin B12 deficiency in bariatric surgery candidates and demonstrates that prompt correction with IM B12 injections can improve outcomes. Understanding the underlying etiology for the nutrient deficiency is also important for reducing risk of recurrence. Postoperative follow-up and continued supplementation are key to preventing long-term complications associated with B12 deficiency.

Case 2: Vitamin A Deficiency in a Post-Bariatric Surgery Patient

2.1. A 53 year-old female reported to the medical weight management clinic for weight recurrence

She had a history of obesity, underwent Roux-en-Y gastric bypass (RYGB) in 2011, had a pre surgery weight of 400 pounds, nadir weight of 175 pounds and weight settlement to 240 pounds, stable for the past 10 years. She maintained a 39 % total body weight loss (TBWL) for over 10 years. For the preceding 3 months, she noted trouble with night vision while driving and very dry skin despite using more moisturizing creams. She reported poor adherence to her prescribed multivitamin supplementation and admitted to occasional lapses in dietary intake, with a preference for low-fat foods and difficulty tolerating vegetables and meat due to early satiety.

The patient's surgical history was uncomplicated, and she did not report any other new health concerns aside from the vision and skin issues. Physical examination revealed dry, scaly skin, particularly on the extremities. There were no signs of conjunctival or corneal abnormalities on examination, but the patient did report progressive difficulty seeing in dim light. Visual acuity testing was normal.

The patient's laboratory workup revealed.

- Serum vitamin A (retinol): 18 μg/dL (normal: 20–60 μg/dL)
- Serum prealbumin: 15 mg/dL (normal: 15–36 mg/dL)
- Liver function tests: normal
- Vitamin D and calcium levels: normal

A diagnosis of vitamin A deficiency was made based on the low serum retinol levels and the patient's clinical symptoms, particularly night blindness. A nutrient-poor diet, malabsorptive state post RYGB, and lack of adequate supplementation with multivitamins specific for post-bariatric surgery patients were considered the etiology for this patient's vitamin A deficiency.

Management. .

2.2. Post-operative optimization

2.2.1. Vitamin A Supplementation. Given the severity of the symptoms, the patient was started on high-dose oral vitamin A supplementation

(50,000 IU daily for 2 weeks) with a plan to taper to a maintenance dose (10,000 IU daily) after 2 weeks. Oral supplementation was chosen due to the patient's ability to absorb fat-soluble vitamins despite her malabsorptive procedure. Regular monitoring of serum retinol and liver function tests were planned to avoid hypervitaminosis A, especially due to the fat-soluble nature of vitamin A and potential for the buildup of excessive stores in fat tissue over time.

2.2.2. Dietary Counseling. The patient was referred to a dietitian to address the nutritional challenges post-surgery. Counseling focused on increasing dietary sources of vitamin A (e.g., liver, eggs, fortified dairy products, and orange-colored vegetables like carrots and sweet potatoes), as well as strategies to tolerate these foods despite early satiety. The dietitian also reviewed the importance of consistent and appropriate multivitamin use, with particular attention to the inclusion of fat-soluble vitamins.

2.2.3. Long-term monitoring and recommendations. The patient was advised to continue follow-up every 3–6 months to assess her vitamin A status and other fat-soluble vitamins (D, E, K), as deficiencies are common after RYGB. Ophthalmology referral was considered if her night blindness did not improve with supplementation.

After 4 weeks of high-dose vitamin A supplementation, the patient reported significant improvement in her night vision and dry skin. Repeat serum vitamin A levels increased to 40 μg/dL, and no signs of vitamin A toxicity were present. She was transitioned to a maintenance dose of 10,000 IU daily and advised to continue her bariatric multivitamin regimen consistently. Her immune function improved, with fewer respiratory infections noted over the following months.

2.3. Conclusion

Vitamin A deficiency is a known complication of bariatric surgery, particularly in malabsorptive procedures such as Roux-en-Y gastric bypass (RYGB) or biliopancreatic diversion with duodenal switch (BPD-DS). Vitamin A is essential for vision, immune function, and epithelial integrity, and deficiency can lead to significant clinical symptoms. This case describes a patient with vitamin A deficiency following bariatric surgery and the management strategy employed to reverse the deficiency and associated symptoms.

Case 3: Calcium Deficiency in a Post-Bariatric Surgery Patient

3.1. A 48-year-old female, who underwent Roux-en-Y gastric bypass (RYGB) 18 months prior, presented to the clinic with complaints of muscle cramps, joint pain, and fatigue

She also reported occasional numbness and tingling in her fingers and toes. Despite following her prescribed multivitamin regimen, she admitted to inconsistently taking her calcium and vitamin D supplements.

The patient had experienced significant weight loss since surgery, with her BMI decreasing from 42 kg/m^2 to 28 kg/m^2. Her dietary intake was reported as predominantly plant-based, with low intake of dairy products or calcium-rich foods due to difficulty with portion sizes and gastrointestinal intolerance to some foods postoperatively. Physical examination revealed a positive Chvostek's sign (indicating neuromuscular irritability associated with hypocalcemia) and muscle tenderness in the lower extremities without focal deficits.

The patient's laboratory workup revealed.

- Serum calcium: 7.8 mg/dL (normal: 8.5–10.5 mg/dL)
- Ionized calcium: 3.9 mg/dL (normal: 4.6–5.3 mg/dL)
- Serum parathyroid hormone (PTH): 120 pg/mL (normal: 10–65 pg/mL)
- Serum 25-hydroxy vitamin D: 18 ng/mL (normal: 30–100 ng/mL)
- Alkaline phosphatase: elevated at 190 U/L (normal: 40–130 U/L)

The high serum parathyroid hormone levels and alkaline phosphatase levels suggested secondary hyperparathyroidism with increased bone turnover and the low vitamin D level indicated concurrent vitamin D deficiency. A diagnosis of calcium deficiency with secondary hyperparathyroidism and vitamin D deficiency was made.

Management. .

3.2. Post-operative optimization

3.2.1. Calcium and Vitamin D Supplementation. The patient was started on calcium citrate 1200 mg daily, divided into two doses. Calcium citrate was chosen over calcium carbonate due to its better absorption in the low-acid environment post-RYGB. Vitamin D3 supplementation was initiated at a dose of 50,000 IU weekly for 8 weeks to replenish her stores, followed by a maintenance dose of 3000 IU daily.

3.2.2. Dietary Counseling. The patient was referred to a dietitian for counseling on incorporating calcium-rich foods that are better tolerated post-bariatric surgery, such as fortified plant-based milks, soft tofu, and leafy green vegetables. The dietitian also advised strategies to ensure adequate protein intake, as well as proper timing of calcium and iron supplements to prevent absorption interference.

3.2.3. Long-term monitoring and recommendations. The patient was instructed to return for repeat laboratory testing in 8 weeks to assess serum calcium, vitamin D, and PTH levels. Bone density testing (DEXA scan) was also recommended to evaluate bone health given the prolonged period of calcium deficiency and elevated PTH levels, which indicated potential bone loss.

The patient was encouraged to engage in weight-bearing exercises to promote bone health and prevent further demineralization. A physical therapist was consulted to help design an appropriate exercise regimen that would improve strength while accommodating any postoperative limitations.

After 8 weeks of calcium and high-dose vitamin D supplementation, the patient's serum calcium improved to 8.6 mg/dL, and her vitamin D level increased to 32 ng/mL. PTH levels began to normalize (70 pg/mL), indicating a reduction in secondary hyperparathyroidism. The patient reported significant improvement in muscle cramps and fatigue, with no further episodes of numbness or tingling.

The patient was maintained on daily calcium citrate (1200 mg) and vitamin D (3000 IU), with plans for ongoing monitoring every 6 months. Bone density testing showed early signs of osteopenia, so additional follow-up with an endocrinologist was recommended.

Calcium deficiency is a frequent issue after bariatric surgery, particularly in procedures like RYGB, where calcium absorption is impaired due to bypassing the duodenum and reduced gastric acid production. Secondary hyperparathyroidism occurs as a compensatory response to low calcium levels, leading to increased bone resorption and risk of bone disease. Concurrent vitamin D deficiency exacerbates calcium malabsorption, making supplementation with both calcium and vitamin D essential in post-bariatric patients.

Lifelong supplementation with calcium and vitamin D is necessary after bariatric surgery to prevent deficiencies and maintain bone health. Calcium citrate is the preferred form of calcium in bariatric patients due to its superior absorption in the absence of gastric acid. Regular monitoring of serum calcium, vitamin D, and PTH levels is recommended, along with bone density assessments as clinically indicated. Calcium and vitamin D levels are evaluated at 1, 3, 6, and 12 months post-surgery during the active weight loss phase and yearly thereafter.

3.3. Conclusion

This case underscores the importance of routine monitoring and adequate supplementation of calcium and vitamin D in post-bariatric

surgery patients. Early identification and treatment of these common deficiencies are crucial to prevent complications such as secondary hyperparathyroidism and bone demineralization. Patients must be educated on the importance of consistent supplement use and dietary adjustments to support long-term health after bariatric surgery.

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