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REVIEW ARTICLE

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Precise nutrition in the metabolic and nutritional management of bariatric surgery: a systematic review

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Abstract

Introduction: Obesity is a chronic relapsing disease characterized by abnormal or excessive adiposity with health risks. Any nutritional intervention in patients who are candidates for or have already undergone bariatric surgery must be based on a detailed nutritional assessment, including an assessment of personal values, preferences, and social determinants of eating habits. **Objective:** It was to carry out a systematic review to explore and present nutritional importance before, during, and after bariatric surgery. **Methods:** The PRISMA Platform systematic review rules were followed. The research was carried out from September to October 2023 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 122 articles were found. A total of 43 articles were evaluated in full and 34 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 22 studies with a high risk of bias and 26 studies that did not meet GRADE and AMSTAR-2. Most studies showed homogeneity in their results, with X^2=64.5%>50%. It was concluded that enteral nutrition strategies could represent a possible alternative to other methodologies, especially when it is recommended to improve patient adherence to the diet prescribed before bariatric surgery. Weight loss induced by the ketogenic diet before bariatric surgery has beneficial effects in reducing liver volume, metabolic profile, and intra- and postoperative complications. Knowledge of the type of bariatric surgery performed and an understanding of its anatomy and physiology help provide optimal care to patients, especially nutritional complications. Nutritional deficiencies and metabolic disorders result from "malabsorption" procedures, such as RYGB. It is essential to immediately administer thiamine. Dextrose should be avoided in intravenous hydration until thiamine is adequately replaced. For all bariatric patients, a protein intake of 60-70 g/d and multivitamin with iron and vitamin B12 supplementation is recommended. Daily calcium and vitamin D supplementation is also encouraged. Additionally, serum micronutrient levels should be monitored regularly and additional supplemental measures prescribed as indicated.

Keywords: Bariatric surgery. Nutrology. Nutrients. Precise nutrition.

Introduction

Obesity is a chronic relapsing disease characterized by abnormal or excessive adiposity with health risks. Medical nutritional therapy based on the latest scientific evidence should be offered to all patients living with obesity as part of obesity treatment interventions. Obesity affects almost 1 in 4 European adults, increasing the risk of mortality and physical and psychological morbidity. There are more than 2.0 billion overweight and obese people in the world, and Brazil is in fifth place in the world ranking, with an estimate of over 18.0 million people **[1]**.

In this sense, any nutritional intervention in patients who are candidates for or have already undergone bariatric surgery must be based on a detailed dietary assessment, including an evaluation of personal values, preferences, and social determinants of eating habits. Nutritionists are expected to design interventions that are flexible and personcentered. Approaches that avoid calorie restriction or detailed eating plans (non-diet approaches) are also recommended to improve quality of life and body image perception **[2]**.

In this context, it is important to note that most cases of early and late complications of obesity can quickly translate into micronutrient deficiency and malnutrition, especially when administered orally **[2-4]**. Obese patients tend to be predisposed to micronutrient deficiency even before surgery due to the obesogenic diet being calorie-dense but nutrient-deprived **[5-7]**.

Because of this, nutritional support providers must have a better understanding of the complications that necessitate the use of nutritional support, as well as the best technique for providing nutrition, including its effectiveness and associated complications **[8-10]**. There is still a lack of data available on the results of parenteral and enteral administration as nutritional support after bariatric surgery **[11,12]**.

In this scenario, three case-control studies have demonstrated that parenteral nutrition (PN) administration can be used effectively to mitigate nutritional complications arising from bariatric surgery, however, they report significant readmission rates **[13-15]**. With enteral nutrition (EN), a case-control study in patients with leakage after sleeve gastrectomy revealed the benefit of EN administered via nasojejunal (NJ) tube combined with pigtail drainage catheters and stent placement. In this cohort, these surgical procedures were proven to improve obesity-related comorbidities.

Despite these advantages, the prevalence of post-surgical complications can be high, although improving with laparoscopic and advanced techniques. Studies show that complications can occur in up to 15% of patients with prevalence varying widely based on the type of procedure performed **[10,11]**.

Therefore, the present study carried out a systematic review to explore and present nutritional importance before, during, and after bariatric surgery.

Methods

Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. It was accessed on: 09/12/2023. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. It was accessed on: 09/12/2023.

Data Sources and Research Strategy

The literary search process was carried out from August to October 2023 and developed based on Scopus, PubMed, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various eras to the present. The Health Science Descriptors (DeCS/MeSH Terms) were used: "Bariatric surgery. Nutrology. Nutrients. Precise nutrition", and using the Boolean "and" between the MeSH terms and "or" between historical discoveries.

Study Quality and Risk of Bias

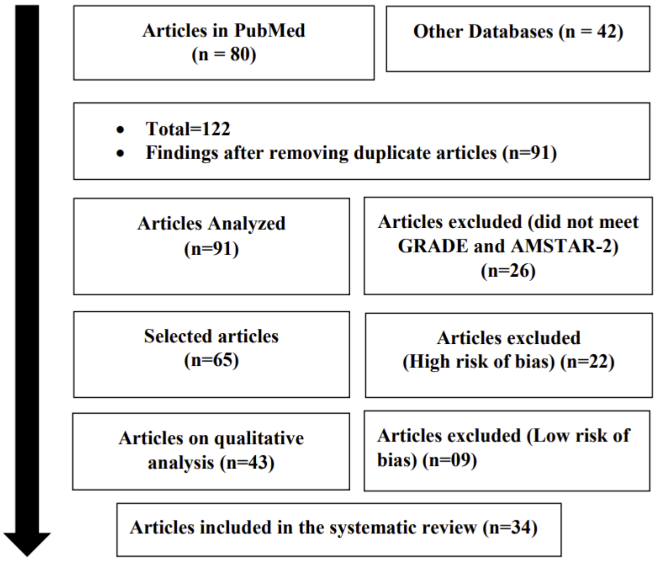
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analysis of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

A total of 122 articles were found that were subjected to eligibility analysis, with 34 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=64.5%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 22 studies with a high risk of bias and 26 studies that did not meet GRADE and AMSTAR-2.

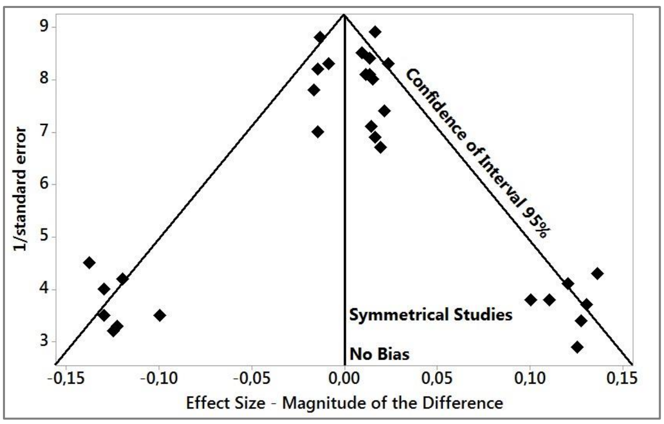
Figure 1. Flowchart showing the article selection process.



Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the bottom of the plot. High confidence and high recommendation studies are shown above the graph (n=34 studies).



Source: Own Authorship.

Nutrology and Bariatric Surgery – Main Clinical Approaches

According to literary findings, nutritional therapy, in patients who are candidates for or have already undergone bariatric surgery, should be administered by trained physicians as part of a multidisciplinary team and should aim to achieve positive health outcomes, and not just changes in weight. A diverse range of nutritional interventions are effective in treating obesity and its comorbidities, and nutritionists should consider all options and provide personalized interventions. While interventions based on calorie restriction are effective in promoting weight reduction, long-term adherence to behavioral changes may be better supported through alternative interventions based on eating patterns, food quality, and mindfulness **[2,3]**.

The Mediterranean diet, vegetarian diets, dietary approaches to stop hypertension, the portfolio diet, and Nordic and low-carb diets have been linked to improved metabolic health, with or without changes in body weight. From November 2018 to March 2021, the latest published evidence focused on intermittent fasting and meal replacements as obesity treatment options. Although the role of meal replacements is further strengthened by new evidence, for intermittent fasting no evidence of a significant advantage over continuous energy restriction was found. Legumes, fruits and vegetables, nuts, whole grains, and dairy products are also important elements in the medical nutritional therapy of adult obesity **[2-4]**.

It has been observed that to achieve moderate weight loss and reduction in liver volume and steatosis before bariatric surgery, several dietary protocols have been introduced over time, among them low-calorie diets and ketogenic diets are widely prescribed **[16-20]**. In particular, Schiavo et al. **[21]**, demonstrated that a 4-week preoperative ketogenic diet is safe and effective in reducing body weight (-10.3%, $p < 0.001$, in men; -8.2%, $p < 0.001$, in women) and in the volume of the left hepatic lobe (-19.8%, $p < 0.001$) in patients with obesity scheduled for bariatric surgery.

Furthermore, Albanese et al. **[22]**, to compare surgical results and weight loss in two groups of patients who received two different types of preoperative diet (low-calorie and ketogenic diets), reported that ketogenic diets presented better results than low-calorie diets on surgical results, influencing drainage output, postoperative hemoglobin levels and hospital stay.

Evidence suggests that ketogenic diets can be effective tools for positively managing weight loss, glycemic control, and lipid profile changes **[22,23]**. However, these beneficial effects may be limited by poor adherence to the diet. In particular, cultural, religious, and economic barriers pose unique challenges to achieving nutritional compliance with ketogenic diets [22,24]. A potential solution is represented by enteral nutrition strategies.

In this sense, enteral nutrition strategies based on weight loss have been used in the treatment of obesity, showing promising results. In particular, Sukkar et al. [25], evaluating the feasibility of a modified protein-sparing diet, administered through a nasogastric tube via the enteral route (with continuous feeding) in the treatment of obesity, showed that 10 days of treatment with enteral nutrition followed by 20 days of low nutrition, the calorie diet was safe and effective in reducing total body weight and waist circumference, and improving patients' respiratory capacity without major complications and side effects.

Similarly, Castaldo et al.[26] evaluated the effects of a carbohydrate-free diet delivered via enteral nutrition for two weeks, followed by a nearly equivalent oral diet administered for an additional two weeks in 112 patients, and reported a significant reduction in BMI and waist circumference with improvement in blood pressure values and insulin resistance without major complications.

In this aspect, weight loss induced by the ketogenic diet before bariatric surgery has beneficial effects in reducing liver volume, metabolic profile, and intra- and postoperative complications. However, these beneficial effects may be limited by poor adherence to the diet. A potential solution in patients with poor adherence to the prescribed diet could be represented by enteral nutrition strategies.

A recent study carried out by authors Castaldo et al. (2023) [27] evaluated the clinical impact, efficacy, and safety of ketogenic enteral nutrition protein (KEN) versus hypocaloric enteral nutrition (HEN) protocols in patients with obesity who were candidates for bariatric surgery. 31 patients with KEN were compared to 29 patients with HEN through a 1:1 randomization. No significant difference was found between the KEN and HEN groups in terms of weight loss ($p = 0.559$), BMI ($p = 0.383$), WC ($p = 0.779$), and WC ($p = 0.559$), while it was found a statistically significant difference in terms of NC (KEN, -7.1% vs. HEN, -4%, $p = 0.011$). A significant improvement in the general clinical status was observed in both groups. However, a statistically significant difference was found in terms of blood glucose (KEN, -16% vs. HEN, -8.5%, $p < 0.001$), insulin (KEN, -49.6% vs. HEN, -17.8 %, $p < 0.0028$), HOMA index (KEN, -57.7% vs. HEN, -24.9%, $p < 0.001$), total cholesterol (KEN, -24.3% vs. HEN, -2 .8%, $p < 0.001$), low-density lipoprotein (KEN, -30.9% vs. HEN, 1.96%, $p < 0.001$), apolipoprotein A1 (KEN, -24.2% vs. HEN, - 7%, $p < 0.001$) and apolipoprotein B (KEN, -23.1% vs. HEN, - 2.3%, $p < 0.001$), while no significant difference was noted between the KEN and HEN groups in terms of thickness of aortomesenteric fat ($p = 0.332$), triglyceride levels ($p = 0.534$), degree of steatosis ($p = 0.616$) and volume of the left hepatic lobe ($p = 0.264$). Furthermore, KEN and HEN treatments were well tolerated and no major side effects were recorded.

Early oral feeding is the preferred mode of nutrition for surgical patients. Avoiding any nutritional therapy carries the risk of malnutrition during the postoperative period of major surgery. Considering that malnutrition and undernutrition are risk factors for postoperative complications, early enteral feeding is especially relevant for any surgical patient at nutritional risk, especially for those undergoing upper gastrointestinal surgery [28,29].

The authors Weimann et al. (2021) [30] wrote the ESPEN guideline that discussed both the nutritional aspects of the concept of Enhanced Recovery After Surgery (ERAS) and the special nutritional needs of patients undergoing major surgeries such as cancer and those who develop serious complications despite better perioperative care. From a metabolic and nutritional perspective, key aspects of perioperative care include the integration of nutrition into the patient's overall care, avoidance of long periods of preoperative fasting, reestablishment of oral nutrition as early as possible after surgery, initiation of nutritional therapy immediately if a nutritional risk becomes apparent, metabolic control such as blood glucose, reduction of factors that exacerbate stress-related catabolism or impaired gastrointestinal function, minimized time of paralytic agents for ventilatory management in the postoperative period, and early mobilization for facilitate protein synthesis and muscle function.

In this sense, bariatric surgery is by far the most effective treatment option available to successfully achieve and maintain weight loss in the obese population, but it can also be associated with complications that lead to malnutrition. There is limited data on how enteral nutrition can be used to provide nutritional support in these cases. During the study period, 72 patients (86% women; mean age 50.3 ± 11.6) were started on home enteral nutrition (NED) due to complications of bariatric surgery. The most common bariatric surgery was Roux-en-Y (74%) and the most common indication for NED was malnutrition/failure to thrive (33%). NED was most commonly provided via nasojejunal feeding and resulted in a mean increase in patients' body weight and BMI of 74.8kg and 26.5kg/m^2, respectively, before NED to 76.9kg and 27.2kg/m^2 respectively at the end of the NED period. Through NED, patients received 22.2 ± 7.9 kcal/kg/day and 1.0 ± 0.3

g/kg/day of protein, reaching 94% ± 17% of their calories and 95% ± 29 % of their protein goals. Vitamin deficiencies were observed in 69% of patients at the time of NED onset, which improved to 10% after enteral feeding and adequate vitamin supplementation. Therefore, NED is safe and effective in treating malnutrition and vitamin deficiencies that can occur as a complication of bariatric surgery, leading to the avoidance of parenteral nutritional support in most cases **[31]**.

In particular, iron and vitamin D deficiencies are the most common. The importance of preoperative correction cannot be underestimated, as the absorption of iron, calcium, and vitamin D is reduced after bariatric procedures **[2]**. Other common preoperative micronutrient deficiencies include vitamin B12, folic acid, and thiamine **[10-13]**.

In this context, approximately 30% of patients undergoing bariatric surgery develop a nutrition-related complication, usually a macronutrient or micronutrient deficiency or both, at some point after the operation **[15]**. Specific nutrition-related complications include iron anemia, folate, vitamins B12, A, and E, copper; zinc, metabolic bone disease, calcium, vitamin D, protein-energy malnutrition, steatorrhea, Wernicke's encephalopathy (thiamine), polyneuropathy and myopathy (thiamine, copper, vitamins B12 and E), visual disturbances (vitamins A and E, thiamine), rash (zinc, essential fatty acids, vitamin A) **[3,4]**.

The etiology of most nutritional deficiencies after bariatric surgery

Surgery is multifactorial, with contributions from reduced dietary intake, altered dietary choices, and malabsorption. The number and severity of deficiencies are determined by the type of bariatric surgery performed, the patient's eating habits, and the presence of other gastrointestinal complications related to the surgery, such as nausea, vomiting, or diarrhea. For example, operations that result in the flow of nutrients bypassing the distal stomach, duodenum, and proximal jejunum can cause malabsorption of iron, calcium, folate, and vitamin B12 **[2,3]**.

Procedures such as Roux-en-Y gastric bypass (RYGB) can put patients at greater risk of deficiencies in fat-soluble vitamins, calcium, essential fatty acids, copper, and zinc. Although some deficiencies can develop quickly, most are insidious at first and may not be apparent clinically. Therefore, all bariatric surgery patients should adhere to lifelong vitamin and mineral supplementation and monitoring for deficiencies **[28,32,33]**.

It is important to recognize that anemia can also occur as a result of other micronutrient deficiencies or a combination of deficiencies. Vitamin B12 and folate deficiencies can result in the development of macrocytic anemia. Deficiencies of copper and zinc and vitamins A and E are other potential causes of anemia in bariatric surgery patients. A vitamin B12 deficiency can also result in a folate deficiency. Significant vitamin B12 and folate deficiencies can cause macrocytic anemia, pancytopenia, and glossitis **[34]**.

In addition, neurological sequelae, including subacute combined degeneration of the dorsal and lateral spine, a rare complication of vitamin B12 deficiency, may also occur. Also, the most potentially devastating micronutrient deficiency that occurs in hospitalized post-bariatric surgery patients is thiamine (vitamin B1) deficiency **[12]**.

Lastly, humans cannot synthesize thiamine, which is mainly absorbed in the proximal small intestine, and thiamine reserves in the body are low, making adequate dietary intake essential. Thiamine deficiencies after bariatric surgery can manifest clinically as Wernicke-Korsakoff syndrome and beriberi **[12]**. Protein-energy malnutrition is one of the most serious nutritional complications of bariatric surgery. This complication may be a consequence of reduced intake of proteins such as red meat, which is poorly tolerated after bariatric surgery, or the development of other gastrointestinal diseases that result in poor oral intake and excess weight loss **[2]**.

Conclusion

It was concluded that enteral nutrition strategies could represent a possible alternative to other methodologies, especially when it is recommended to improve patient adherence to the diet prescribed before bariatric surgery. Weight loss induced by the ketogenic diet before bariatric surgery has beneficial effects in reducing liver volume, metabolic profile, and intra- and postoperative complications. Knowledge of the type of bariatric surgery performed and an understanding of its anatomy and physiology help provide optimal care to patients, especially nutritional complications. Nutritional deficiencies and metabolic disorders result from "malabsorption" procedures, such as RYGB. It is essential to administer thiamine immediately. Dextrose should be avoided in intravenous hydration until thiamine is adequately replaced. For all bariatric patients, a protein intake of 60-70 g/d and multivitamins with iron and vitamin B12 supplementation is recommended. Daily calcium and vitamin D supplementation is also encouraged. Additionally, serum micronutrient levels should be monitored regularly and additional supplemental measures prescribed as indicated.

CRediT

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The authors declare no conflict of interest.

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