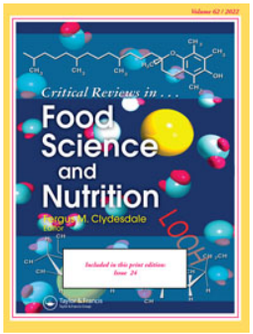

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REVIEW

The relationship between preoperative weight loss and intra and post-bariatric surgery complications: an appraisal of the current preoperative nutritional strategies

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ABSTRACT

Preoperative weight loss before a bariatric surgery reduces long-term complications, but there is no solid evidence for short-term or perioperative complications. This review highlights recent evidence on dietary protocols and the possible correlation between weight loss and surgical complications. Updated evidence was searched in PubMedDirect with the terms "preoperative very low-calorie diet or very-low-calorie ketogenic diet or low-fat diet or intermittent fasting or Mediterranean diet and bariatric surgery or bariatric surgery complications." The main characteristics of each diet, achievements related to weight loss, liver reduction, peri and postoperative outcomes, surgical complications, tolerance, and adherence to the diet are presented from the selected studies. There are few reports about the Mediterranean diet as a strategy to reach these goals. The VLCKD has been associated with better body weight reduction and lesser postoperative complications risk. However, the results in animal models are still controversial. When comparing VLCD with an LCD, there is no apparent superiority between one against the other one. However, LCD has shown better tolerance and adherence than VLCD. There is still a need for more controlled studies to define the best preoperative dietary treatment for weight loss before bariatric surgery since there are controversial positions regarding this issue.

KEYWORDS

Bariatric surgery; LCD; obesity; surgical complications; VLCD; VLCKD

Introduction

Bariatric surgery is the most effective treatment for morbid obesity in terms of long-term weight loss, improved quality of life, and decreased overall mortality (Sherf-Dagan et al. 2021). There have been discussions regarding the necessity of preoperative weight loss before bariatric surgery to decrease the risk of complications in patients (Benotti et al. 2009).

The effect of weight loss before bariatric surgery has become of interest with the widespread of bariatric interventions throughout the world. However, the lack of any clear indications about preoperative weight loss in recent most relevant guidelines (Fried et al. 2014; Mechanick et al. 2013), a beneficial effect of even a modest weight loss (5%–10%) in the immediate preoperative period has been suggested as a mean to facilitate surgery and the risk of peri and postoperative complications in a patient with severe obesity scheduled for bariatric interventions (Bettini et al. 2020). In an analysis of the initial experiences published, Cassie et al. stated that "little evidence was available to support or refute the routine use of preoperative weight reduction in bariatric surgery" (Cassie et al. 2011). More recently, an attempt to review this issue found a low number of reports, many of which did not describe the dietary regimen prescribed or the time interval of administration before surgery (Gerber, Anderin, and Thorell 2015). Even in a manuscript, reporting data of a large cohort of patients was not clearly defined if a standardized dietary protocol was used or not to achieve preoperative weight loss (Anderin et al. 2015). In the review by Gerber et al., weight loss before surgery was beneficial for postoperative complications and weight regain over time but failed to demonstrate any improvement in operative time and intraoperative complications (Gerber, Anderin, and Thorell 2015).

If the value of weight loss before surgery is still not clearly assessed, it is even more challenging to define the best dietary protocol to use and how long to administer it before surgery. Several dietary protocols have been

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introduced over time, along with lifestyle modifications or intragastric balloon insertion (Coffin et al. 2017; Kalarchian et al. 2016). Among them, the very low-calorie diet (VLCD) and the very low-calorie ketogenic diet (VLCKD) are of great interest at the time of this manuscript. Instead, other protocols, such as the Mediterranean diet, have been rarely investigated (Gastaldo, Casas, and Moize 2022).

Based on research, very-low-calorie diets (VLCD) are defined as 800 kcal/day, and low-calorie diets (LCD) are limited to 800–1500 kcal/day with modest weight losses (5%–10% of initial body weight) in the shortest periods (2–5 weeks) are generally associated with reduced liver volume and visceral adiposity prior surgery (Kim 2017). Other recommendations that can accompany the LCDs in pre-surgery are nutritional supplements such as omega-3 fatty acids, antiobesity drugs, and intragastric balloons (Sherf-Dagan et al. 2017).

A systematic review conducted by Holderbaum et al., regarding the effects of VLCD with 400–800 kcal/d in 12 weeks found a weight loss of −2.8 to −14.8 kg, liver size reduction of −5% to −20%, and no significant effect on surgical complications during the postoperative period in a total of 9 studies in humans (Holderbaum et al. 2018). They analyzed 3 randomized controlled trials (RCT) and 6 observational studies (n = 849 patients) (Holderbaum et al. 2018). On the contrary, a systematic review that included 282 participants from 11 studies compared the application of different measures from previous bariatric surgery (van Wissen et al. 2016). The review showed a 20%–43% liver volume reduction using pharmacological measures, 32% while introducing an intragastric balloon, and 14% by applying LCD before gastric bypass surgery, showing that other methods can be more effectively applied. Still, LCD is the preferable method to reduce liver volume, considering the level of evidence and practical applicability (van Wissen et al. 2016). Weight reduction has also been linked to a positive factor in improving cardiovascular risk factors in diabetic patients (Ross et al. 2016).

In a wide-ranging retrospective cohort study with 394,016 patients that assessed whether preoperative weight loss is associated with 30-days postoperative complications, they concluded that it was not related to increased readmission, reoperation, mortality, or another complication (Tewksbury et al. 2019). Moreover, according to the Clinical Practice Guidelines for the Perioperative Nutrition, Metabolic, and Nonsurgical Support of Patients Undergoing Bariatric Procedures—2019 Update (Mechanick et al. 2020), weight loss or medical, nutritional therapy before bariatric procedures may be recommended to selected candidates to see improvements in comorbidities such as glycemic targets.

As for other international organizations, the Israel Dietetic Association recognized the need for evidence-based guidelines for pre-and post-surgery to optimize long-term effects and decrease medical complications (Sherf-Dagan et al. 2017).

According to the American Society for Metabolic and Bariatric Surgery (Kim et al. 2016), a one-only dietary focus has not been identified, with an optimal duration or weight loss program that is the only option for individuals with severe obesity. Therefore, bariatric surgery is still a practical approach.

This paper aims to describe the most recent evidence on dietary protocols employed before bariatric interventions, trying to clarify the correlation between weight loss and peri and postoperative complications and eventually if the diet assumed before intervention may have an impact of the surgical outcome.

Methods

In order to find the most up to date evidence on the topic, we conducted a research in PubMed with the terms "preoperative VLCD or VLCKD or Low-fat diet or intermittent fasting or Mediterranean diet and bariatric surgery or bariatric surgery complications" from January 1, 2011, to December 31, 2021. All study designs were evaluated, but those not English language manuscripts, studies on animals or pediatric patients, manuscripts reporting the effects of weight loss on surgical procedures other than bariatric, manuscripts not supporting in the headings the dietary regimen and/or peri or postoperative complications, were excluded. Duplicate articles were eliminated, and further evaluation was carried out according to the content of the abstracts. Manuscripts in which preoperative weight loss was not achieved through a well-described dietary regimen or other strategies such as intragastric balloon insertion and lifestyle modification were also excluded. Each article was evaluated according to the preoperative dietary regimen employed and the results of weight loss. Peri and postoperative outcomes, as well as complications, were evaluated.

Overview of pre bariatric dietary regimens and their impact on preoperative weight loss

Obesity figures are growing steadily worldwide, due to worsening diets and sedentary lifestyles, thus generating obesogenic and toxic environments (Gracia-Arnaiz, Kraemer, and Demonte 2022). Obesity directly contributes to non-communicable diseases such as cardiovascular diseases, diabetes, and cancer (Barrea et al. 2021; Salman et al. 2022). Bariatric surgery appears to be an effective treatment modality for sustainable weight loss in patients with morbid obesity (Salman et al. 2022; Gasmi et al. 2022). According to the Canadian clinical practice guidelines on the management and prevention of obesity in adults and children, bariatric surgery is indicated when the patient has a body mass index (BMI) ≥35 kg/m^2 with risk factors; or when you have a BMI ≥40 kg/m^2, always taking into account if you have had other attempts to lose weight that have failed (Lau et al. 2007).

Although there are no clear recommendations as to how much weight loss should be prior to bariatric surgery (Jastrzębska, Boniecka, and Szostak-Węgierek 2021), a fundamental aspect is that the excess body fat itself could complicate the technical aspects of the surgery and increase the risk of complications (Bettini et al. 2020). It is known that excess body fat is a risk factor for developing complications after different surgeries. It is highlighted that due to its cause, there are excessive blood loss, cardiac and pulmonary events, surgical site infection, and more extended hospital

stays (Griffin et al. 2021). It has been documented that those patients with an enlarged liver are more likely to have laparoscopic gastric bypass surgery converted to an open procedure (Salman et al. 2022).

Therefore, assessing previous nutritional status is important; research has suggested that patients with morbid obesity often show micronutrient deficiencies (MD) compared to normal-weight controls (Landais 2014). These deficiencies must be detected and treated prior to surgery (Parrott et al. 2020). A Norwegian publication aimed to compare the serum and blood concentrations of vitamins between 110 patients with morbid obesity and 58 healthy patients who did not take multivitamin supplements; they found that patients with obesity had significantly lower concentrations of vitamins A, B6, C, 25-hydroxyvitamin D, and vitamin E (Aasheim, Hofso, and Sovik 2010). Therefore, preventing nutritional deficiencies before surgery can improve immediate results and thus reduce mortality (Deledda et al. 2021).

Likewise, weight loss must be ensured prior to surgery. Some guidelines recommend a 5%–10% weight loss 6 months prior to surgery (Lau et al. 2007; Naseer et al. 2018). A total weight loss of at least 5% has been shown to achieve overall liver volume reduction by approximately 10% (Naseer et al. 2018). This initial weight loss is essential. There are several components to achieve this goal; one of them is the patient's motivation. Along these lines, it is argued that the diet prior to surgery should not last more than 3 months, precisely so as not to lose motivation and compliance on the part of the patient (Deledda et al. 2021). Additionally, it is critical to provide nutritional education on dietary restrictions after surgery. As a result, the risk of perioperative mortality decreases. Also, there is a decline in liver size; likewise, the intervention time is diminished (Deledda et al. 2021).

The cohort study conducted by Sun et al. with 480,075 patients who underwent bariatric surgery between the years 2015 to 2017 showed that even modest weight loss before the intervention was associated with a lower risk of mortality 30 days after the procedure. Comparing to patients who had no preoperative weight loss, patients with less than 5.0% weight loss, those with a 5.0% to 9.9% decline, and those who achieved a 10% loss, 0%, and more had a 24%, 31%, and 42%, respectively, lower risk of 30-day mortality (Sun et al. 2020).

The Scandinavian Obesity Registry study, conducted with 20,564 patients undergoing Roux-en-Y gastric bypass, showed that preoperative weight loss was positively correlated with sustained weight loss, with the most significant effect being observed with preoperative BMI greater than 45.7 kg/m^2 (Gerber et al. 2016).

LCD, VLCD, and very-low-calorie ketogenic diets (VLCKD) are often indicated at this point in treatment (Bettini et al. 2020). One aspect that must be considered is that there are potential risks in restrictive diets; one of them is turning the body into a catabolic state, leading to the loss of lean body mass, which can impede recovery after bariatric surgery. The other is that the patient may experience symptoms such as fatigue, headache, and nausea, which may compromise adherence to these diets (Romeijn et al. 2021).

LCD implies 800 to 1200 kcal/day, and VLCDs are based on 600 kcal/day. The latter effectively induced rapid weight loss with few adverse effects and no impact on wound healing (Salman et al. 2022). Likewise, VLCD for 2 weeks is associated with better whole-body insulin sensitivity (Stenberg et al. 2022a, 2022b). In this last type of diet, it is indispensable to control protein intake in order to reduce as much as possible the loss of lean body mass (Jastrzębska, Boniecka, and Szostak-Węgierek 2021). It should be noted that the use of this dietary intervention (VLCD) can cause side effects such as headaches, gallstones, electrolyte disturbance, and constipation (Tabesh et al. 2019) (Table 1).

For its part, VLCKD consists of a daily intake of about 500–800, with a carbohydrate content of <50 g/day, 1–1.5 g of protein/kg of ideal body weight, 15–30 g of fat/day (Muscogiuri et al. 2021). This low intake of carbohydrates leads to the synthesis of ketones, which are used as fuel by various extrahepatic tissues, such as the central nervous system, skeletal muscle, and the heart (Muscogiuri et al. 2021). The European Association for the Study of Obesity (EASO) suggests VLCKD is a suitable approach before surgery (Muscogiuri et al. 2021). The VLCKD has been reported to result in less blood loss after bariatric surgery, leading to better wound healing and a lower risk of postoperative complications (Albanese et al. 2019). For their part, Leonetti et al. pointed out that short-term VLCKD is safe and effective, with no negative consequences on kidney and liver function (Leonetti et al. 2015). However, it is remarkable to note that a ketogenic diet that provides high amounts of protein in animal models is associated with significant excretion of nitrogenous compounds and may contribute to kidney damage. Excessive dietary protein intake can lead to body acidification and electrolyte imbalance (Jastrzębska, Boniecka, and Szostak-Węgierek 2021).

Albanese et al. compared surgical outcomes and weight loss in two groups of patient candidates for bariatric surgery (laparoscopic sleeve gastrectomy) on different preoperative diets, one group receiving a VLCD and the other a VLCKD. From January to December 2016, 178 patients (139 female and 39 men). The mean pre-diet BMI was 46.3 ± 6.3 kg/m^2 for the VLCKD group and 43.1 ± 6.9 kg/m^2 for the VLCD

Table 1. Daily calorie intake and adverse effects according to type of diet.

Type of diet	kcal/day	Adverse effects
LCD	800–1200	Fatigue, headaches, nausea (Romeijn et al. 2021; PMID: 33140292)
VLCD	600	Headaches dizziness, gallstones, electrolyte imbalance constipation (Tabesh et al. 2019; PMID: 31367987), cholelithiasis, ketosis, increase in serum uric acid concentrations(Joshi 2018; PMID: 30666989)
VLCKD	500–800	Kidney damage, acidification of the body, electrolyte imbalance (Jarestbska 2021; PMID: 33949320)

LCD: low-calorie diet; VLCD: very-low-calorie diet; VLCKD: very-low-calorie ketogenic diet.

group, while the immediate preoperative BMI was 43.9. ± 5.9 kg/m^2 and 41.9 ± 6.8 kg/m^2, respectively. Likewise, the study showed that 2.8% of the patients in the VLCKD group required a hospital stay longer than expected (> 3 days), while in the other group, the percentage was 10.4% ($p = 0.048$), so the researchers conclude that in their study, VLCKD showed better results than VLCD (Albanese et al. 2019).

Another group of investigators conducted a parallel RCT to compare the effect of VLCD versus LCD for 21 days before surgery. Eighty-six morbidly obese participants undergoing bariatric surgery were randomized. They assessed liver volume, anthropometric and biochemical parameters, compliance and tolerance to diets, surgical complications, and length of stay. They concluded that VLCD is more effective for total body weight reduction but not in terms of liver volume reduction. They also found that both diets have similar effects on clinical, biochemical parameters, rate of surgical complications, and length of hospital stay (Gils Contreras et al. 2018).

On the other hand, in the systematic review carried out by Holderbaum et al., whose objective was to evaluate the VLCD effects on liver size, weight loss during the preoperative period, they found that this diet led to significant weight loss and, in turn, in a reduction of hepatic volume in patients in the preoperative period of bariatric surgery (Holderbaum et al. 2018).

Likewise, it would be necessary for the nutritional recommendations at this stage to be quantitative and qualitative, carrying out food nutrition education that includes valuable messages for the post-surgical stage, which has its characteristics. The emphasis on performing all mealtimes, eating in a calm atmosphere, and avoiding eating meals while performing other activities, among many other messages, allows for weight reduction before surgery and preparation for postoperative nutrition (Jastrzębska, Boniecka, and Szostak-Węgierek 2021).

Regardless of the diet selected, controlling protein intake is critical to limit the loss of lean body mass (Jastrzębska, Boniecka, and Szostak-Węgierek 2021) since it could increase the risk of sarcopenia (low muscle mass and impaired muscle function) (Cava, Yeat, and Mittendorfer 2017). It is notable that fat-free mass fulfills critical functions in the body, such as the responsibility of most of resting metabolic rate, preserving skeletal integrity, regulating body temperature, and maintaining an adequate quality of life (Chaston, Dixon, and O'Brien 2007). Loss of lean body mass (LBM) can negatively affect the patient's energy balance, cardiovascular health, and functional capacity, which will affect the correct recovery after bariatric surgery (Romeijn et al. 2021).

Although there is general agreement on the benefit of a modest weight loss prior to surgery, the diet to be selected should be analyzed by a suitable professional in each case, assessing treatment adherence, possible adverse effects, and positive aspects for the patient. Parrott et al. argue that a specialized dietitian in bariatric surgery is essential to prepare and support patients to achieve and maintain optimal nutritional status. An expert dietitian should do the follow-up control for these patients. After the first 2 years, it is recommended to carry out pertinent dietary and nutritional reviews and indicate adjustments, if necessary, annually (Parrott et al. 2020).

Nutrition in patients who will undergo bariatric surgery is essential. It is recommended to monitor the state of micronutrients since these patients usually have a deficit of some of them. Also, they need to achieve weight loss prior to the intervention. Although there is no consensus on how much weight they should lose before surgery, its benefits have been widely shown. Different diets have been proposed for this stage; each particular case must be assessed to select the most appropriate for each patient. Furthermore, incorporating nutritional food education during this phase will contribute to reaching the expected results.

The impact of preoperative dietary regimens on intraoperative and postoperative (bariatric) complications

It is crucial to describe what type of complications are reported and observed when patients decide to proceed to surgery as part of obesity treatment to determine or associate the impact of dietary regimens on intraoperative and postoperative complications. Surgical complications are usually rare, but they can develop in any case that undergoes surgery.

One report informed that the most complications of bariatric surgery are anastomotic leakage, bleeding, intestinal occlusion, and stenosis, which are considered early complications within the first 30 days after surgery. The morbidity of bariatric surgery is registered in 13% of the cases, and complication rates vary according to the type of surgery; for example, from 3% to 12.5% for laparoscopic gastric bypass to 8%–13% for the laparoscopic gastric sleeve (Joo et al. 2019).

In a large cohort database obtained from Bariatric Centers in the USA, with 36,254 patients who underwent Y-Roux gastric bypass surgery, the authors documented a 1.38% complication rate. Almost all complicated patients (92%) were from laparoscopic surgery after 30 days post-surgery. They declared that the most common complications were anastomotic leaks, renal and respiratory failures, and death. In Scandinavia, Stenberg et al. notified that after analyzing 25,038 laparoscopic Y-Roux gastric bypass cases in 44 centers, the most common complications were bleeding, leaks and abscesses, and small bowel obstruction. They also enlisted intraoperative adverse events like unintentional small bowel injury, bleeding, and instrumental failure. They even estimated that the relative risks for any postoperative complication were reduced according to initial weight loss, the higher BMI the patients had, the greater reduction in the postoperative complication risk after losing weight preoperatively (Stenberg et al. 2014).

The most critical management of medical treatment in obesity surgery is nutritional management. It is well known that patients with obesity may have nutritional deficiencies before surgery occurs (Thomas-Valdes et al. 2017), so it is vital to determine if a patient has a nutrition deficiency and treat it before surgery.

One of the most common postoperative complications is nutritional deficiencies in macronutrients like proteins and micronutrients like certain vitamins and minerals that must be replaced for months and even years after surgery. There can be significant protein malabsorption after bariatric surgery that we must consider to avoid malnutrition while losing weight (Koch and Finelli 2010). Most of the postoperative protocols for bariatric surgery include maintaining a protein intake between 60 and 70 g daily. Albumin concentrations cannot discriminate between well and undernourished patients because it is fundamental to consider inflammation as one of the reasons for hypoalbuminemia as well. Hair loss is a common early clinical manifestation of postoperative protein malnutrition (caused by zinc deficiency). Long-term manifestations of protein malnutrition often include muscle mass wasting and edema (Gasmi et al. 2022; Koch and Finelli 2010).

As stated in this paper, before bariatric surgery, nutritional status must be checked, and weight loss should be encouraged by managing different types of diets, either VLCD or VLCKD, which are frequently prescribed one month before surgery. After surgery, the patient must have nutritional counseling to help them adapt to the new gastrointestinal anatomy and physiology. Nutritional deficits may arise during the postoperative period, and they should be detected and treated to avoid complications (Bettini et al. 2020).

Is there an effect of the diet prescribed before surgery on the complications?

Gils Contreras et al. performed an RCT evaluating two different preoperative regimens, a VLCD versus an LCD, and their influence on liver volume and surgical complications. They found that in subjects with morbid obesity undergoing bariatric surgery 21 days before surgery, the VLCD was more effective in reducing body weight but not liver volume. Both types of preoperative diets had similar effects on clinical, biochemical parameters, rate of surgical complications, and hospital length stay (Gils Contreras et al. 2018).

Romeijn et al. recently published a systematic review about the effectiveness of an LCD on liver volume reduction before bariatric surgery and found that LCDs showed acceptable patients compliance. The studies they analyzed stated that LCDs after 2 to 4 weeks before surgery were effective in liver volume reduction between 12% and 27%. The weight loss ranged from 5.4 to 23.6 kg, which means a weight loss of 4%–17% in the first weeks. Body composition was reported in four studies analyzed; one measured it by dual-energy X-ray absorptiometry (DEXA) and three by bio-electrical impedance analysis (BIA). They also found that LBM accounted for 22.9%–59.7% of the weight loss. They indicated that 40.3%–77.1% of weight loss was fat mass. In general, LCDs were well tolerated. However, some studies reported side effects like hunger, nausea, the need to chew, headache, diarrhea or constipation, and dizziness. Nevertheless, LCDs have better tolerance and compliance than VLCDs. Therefore, it should be preferred as a preoperative diet (Romeijn et al. 2021; Bakker et al. 2019; Edholm et al. 2015; Schiavo et al. 2015).

In an RCT by Chakravartty et al. evaluating the effect on collagen disposition in wounds in patients following a VLCD (800 kcal diet) for 4 weeks before bariatric surgery compared results with a group that continued with their regular diet, they took skin samples by 4 mm punch biopsies (Chakravartty et al. 2019). They also took samples from the surgical wound and analyzed them to detect collagen, elastin, fibroblasts, myofibroblasts, and new blood vessels. They concluded that short-term VLCD does not result in malnutrition but found that LBM decreases. This fact does not relate to decreasing collagen content in the wound; however, there is a concerning reduction in collagen gene expression, an essential precursor of wound healing. They stated that preoperative VLCD before bariatric surgery has no definite advantage but may have a detrimental effect (Chakravartty et al. 2019).

Schouten et al. performed a randomized non-inferiority trial to compare the effect of VLCDs with protein shake versus a standard diet using ordinary products on preoperative weight loss (Schouten et al. 2016). They assessed parameters like operation time, the difficulty of surgery, complications, compliance, and tolerance to both diets. They acknowledged that both diets were capable of good and similar results in weight loss before surgery, but the standard diet was better accepted, tolerated, and had finer compliance than the protein shakes diet (Schouten et al. 2016).

In another study by van Nieuwenhove et al. with 298 randomized patients with morbid obesity who followed either a VLCD regimen or no preoperative dietary restriction (control group) for 2 weeks, all patients underwent laparoscopic surgery (Van Nieuwenhove et al. 2011). They registered operating time, surgeons' perception of the operation difficulty, 30-day weight loss, morbidity, liver lacerations, intraoperative bleeding, and other complications. There were statistically differences in weight loss between both groups: a weight change of 4.9 kilos on average for the VLCD group versus −0.4 for the control group. Despite surgeons reporting less difficulty for the operation in the control group, the operating time was no different, nor was the estimated blood loss or the intraoperative complications. However, at the 30-day follow-up, the number of complications was greater in the control group compared to the VLCD group (Van Nieuwenhove et al. 2011).

The ERAS Society publication regarding bariatric surgery states that the VLCD for 2 weeks is associated with improved whole-body insulin sensitivity, and perioperative weight loss is associated with reduced postoperative complications and reduced in-hospital length of stay. According to that review, 2 to 4 weeks of either an LCD or a VLCD can contribute to postoperative weight loss with low-quality evidence, decrease postoperative complications with moderate evidence, and achieve a liver volume compaction with a high level of evidence. Preoperative weight loss using either a VLCD or LCD before bariatric surgery is advised to reduce postoperative complications with a level of recommendation

between moderate to strong. They also suggest that patients with diabetes, treated with glucose-lowering drugs, should be closely monitored and be aware of the risk for hypoglycemia. They concluded that a VLCD improves insulin sensitivity in patients with diabetes (Stenberg et al. 2022a, 2022b).

It is necessary to note that some VLCDs can be effective for weight loss, but we must be careful of the body composition changes when a patient loses weight. In a paper by Sivakumar et al., the authors evaluated body composition changes following a VLCD preoperative for 2 weeks in bariatric surgery patients. Body composition was measured using half-body DEXA scans focusing on the upper limbs, lower limbs, trunk, chest, abdomen, and pelvis. The results showed that patients lost an average of 4.5 Kg of body weight but 2.8 kilos of LBM, much greater than the fat mass of only 1.7 kg. After performing a correlation analysis, the authors reported that changes in weight after VLCD are significantly associated with a change in overall LBM ($r = 0.63$), predominantly in the trunk and legs. Therefore, the authors concluded that VLCD is an effective tool for weight loss before bariatric surgery, but the impact of the LBM loss can bring short and long-term consequences that need further assessment (Sivakumar et al. 2020).

In summary, losing weight before bariatric surgery has some advantages in the rate of long-term complications, but it did not show any advantages in the short term or intraoperative complications. There is no clear advantage of a VLCD compared with an LCD for weight loss before bariatric surgery, and LCD is demonstrated to be easier to follow and have more adherence rate than VLCD. Therefore, if patients should lose weight before bariatric surgery, an LCD rather than a VLC should be considered. Both VLCD and LCD should be prescribed and followed up by nutrition professionals to avoid losing LBM and long-term complications (Table 2).

Future perspective and conclusions

The focus on pre-surgery weight loss should be more than just losing specific kilograms but improving eating habits, nutritional status, lifestyle changes, and enhanced literacy. Regarding insurance-mandated preoperative weight-loss

Table 2. Summary of studies comparing preoperative dietary regimens on pre and postoperative complications.

Reference	Population	Design of study/aim	Outcomes
Gils Contreras et al. 2018	86 patients: VLCD (n: 43); LCD (n: 43)	RCT/compliance, tolerance, and nutritional status comparing both LCD and VLCD 21 days before surgery	The biochemical parameters analyzed, number of surgical complications, and LOS showed no differences in both groups. VLCD group had worse tolerance and adherence. VLCD was more effective in reducing TBWt but not liver volume.
Romeijn et al. 2021	8 studies (n: 251 patients)	Systematic review RCTs/effectiveness of LCD on LVR, weight loss and body composition.	LCDs 2–4 weeks after surgery were effective for LVR by 12%–27%, weight loss by 4%–17%, and LBM by 22.9%–59.7%
Chakravartty et al. 2019	Patients undergoing laparoscopic Roux-en-Y gastric bypass: normal diet group (n = 10); VLCD group (n = 10), 800 kcal) for 4 weeks	RCT/effect on collagen disposition in wounds. Secondary outcomes: LVR and fibrosis score, body composition, operating time, blood loss, LOS, and complications	Expression of mature collagen type I was significantly decreased in VLCD patients compared with controls after 4 weeks of diet and 7 days after surgery. VLCD group had a significant decrease in liver volume (23% vs 2%, $p = 0.03$) but no difference in operating time, blood loss, LOS, or complications.
Schouten et al. 2016	212 patients: protein shakes diet (n: 105); standard diet group (n: 107)	RCT/VLCD with protein shakes vs. standard diet. Primary outcome: perioperative weight loss. Secondary outcomes: operation time, surgeons' perception of the operation difficulty, short-term complications, short-term weight loss, compliance, tolerance, and diet acceptance	Operation time, difficulty of surgery, short-term complications, and short-term weight loss were also comparable without significant differences between the groups. Patients' compliance, tolerance, and acceptance of the diet were significantly better in the standard diet group.
Van Nieuwenhove et al. 2011	273 patients: control group (n: 136); VLCD group (n: 137)	Multicenter, double blind RCT/ preoperative VLCD vs no dietary restriction for 14 days before surgery on operating time, surgeons' perception of the operation difficulty, liver lacerations, intraoperative bleeding, other complications, 30-day weight loss, and morbidity.	Mean (SD) preoperative weight change: −4.9 (3.6) kg VLCD group, −0.4 (3.2) kg control group ($p < .001$). surgeons' perception of the operation difficulty was lower in the VLCD group but no differences were found in mean operating time, estimated blood loss or the intraoperative complications. At the 30-day follow-up, the number of complications was greater in the control group compared with the VLCD group (18 vs 8; $p = .04$).
Sivakumar et al. 2020	n: 44 followed a 2-week VLCD	A prospective analysis/pre and postoperative effects of a VLCD including TBW, EBW, BMI, LBM, FM and BMC.	VLCD patients lost a mean of 4.5 kg in TBW and 8.8% of excess BW, mean reduction in BMI 1.6 kg/m^2. Loss of LBM was 2.8 kg and was significantly greater than a loss of FM, 1.7 kg ($p < 0.05$). BMC changes were insignificant

LCD: low-calorie diet; VLCD: very-low-calorie diet; RCT: randomized clinical trial; LOS: length of stay; LVR: liver volume reduction; LBM: lean body mass; BMI: body mass index; LBM: lean body mass; FM: fat mass; BMC: bone mineral; TBW: total body weight; EBW: excess body weight.

requirements as the American Society for Metabolic and Bariatric Surgery, obligatory preoperative weight loss is not well supported (Kim et al. 2016). Consequently, there is a need for long-term clinical trials to sustain the practice of weight-loss previous surgery.

Different multidisciplinary bariatric surgery teams recommend a preoperative weight-loss program according to the specific needs and circumstances of the patients (Tewksbury et al. 2019). Nevertheless, there is a lack of standardized consensus on whether this procedure is optimal for patients. Additional research will establish specific standards of care regarding post-bariatric surgery complications and for people with special needs within the reproductive age range, pregnancy, and lactation status to ensure the proper development of the fetus (Sherf-Dagan et al. 2021). Therefore, postoperative outcomes of presurgical nutritional intervention programs should be further studied so evidence-based nutritional guidelines for bariatric patients guarantee long-term success and prevent complications (Sherf-Dagan et al. 2017). Likewise, revisional bariatric surgery must be considered in the formula, specifically looking at adaptation to the initial procedure through nutritional and behavioral evaluation (Kalarchian et al. 2014).

Future perspectives that should also be considered include preoperative conditioning, which entails physical conditioning and inspiratory muscle training (prehabilitation) in people awaiting surgery. A recent study protocol and a pilot study with 5 patients that were added to a standard 8-week group intervention showed weight loss, an average of 0.54 ± 5.2 kg, and a final BMI was 48.1 ± 7.6 kg/m^2, leading to a shift in the preoperative management of these bariatric surgery patients (García-Delgado et al. 2021).

Moreover, future metabolic and bariatric surgery will continue to nurture a safety culture while maintaining the efficacy of the surgery. There might also be related to new mechanisms for procedures with less alteration of gastrointestinal tract anatomy and function that may be more beneficial for patients, diminishing complications (Phillips and Shikora 2018).

As evidence-based guidelines continue to be revised and updated recommendations are established in perioperative medical care, it will be essential to investigate new potential mechanisms explaining changes in nutrient status, such as micronutrients (Parrott et al. 2017). There is a demand to look for micronutrient deficiency in preoperative screening. It is common to find candidates presenting at least one vitamin or mineral deficiency prior to surgery, increasing complications and long-term effects post-surgery (Gehrer et al. 2010; Peterson et al. 2016).

It is important to consider human eating behavior; therefore, culture, foodscapes, social environments, tastes, and even nutritional information have generated that patients can make an uninformed choice that can alter their initial goal for surgery (Enriquez and Archila-Godinez 2022). It is primordial to propose action policies that seek the health and well-being of the candidates further than just 3 to 6 months after surgery. Education is a strategy to promote and improve better food choices (Enriquez and Archila-Godinez 2022). Restricting food accessibility generates a reactive action, so it is necessary to create a supportable food environment that allows people to take advantage of educational and marketing strategies to generate a behavior change to lead to diets that can be sustainable in time (Enriquez and Archila-Godinez 2022).

Finally, seeing how COVID-19 could influence the delay of bariatric surgery may have caused an increase in chronic diseases among surgical candidates. However, the likelihood of hyperglycemia reduction after bariatric surgery depends upon the timing of the surgery during the natural history of diabetes. Also, patients that suffer from respiratory complications such as obesity hypoventilation syndrome and cardiac or renal complications are crucial to act in a time-sensitive matter with lifesaving treatments (such as organ transplants) to prevent complications (Rubino et al. 2020).

In conclusion, the lack of clear indications for preoperative weight loss before bariatric intervention still does not allow for a definitive preoperative dietary treatment since low evidence specifically addressing this issue is available. In this view, future studies with a large cohort of patients need to address this issue.

Authors' contributions

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