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RESEARCH ARTICLE

Can adherence to regular nutrition follow up and intervention lead to reduction in skeletal muscle mass and promote fat loss among individuals with obesity after undergoing bariatric surgery?

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Abstract: This comprehensive literature review seeks to explore the extent to which adherence to regular nutrition follow-up and intervention influences the dynamic changes in skeletal muscle mass and their association with fat loss among individuals with obesity who have undergone bariatric surgery. The review will examine existing studies, clinical trials, and evidence to assess whether consistent nutritional follow-up and interventions contribute to the preservation of skeletal muscle mass while facilitating the reduction of fat mass in the post-bariatric surgery population. By synthesizing relevant findings, this review aims to provide insights into the potential benefits of tailored nutritional strategies for optimizing the health outcomes of post- bariatric surgery patients in terms of body composition. The main objective of this literature review is to systematically analyze and synthesize existing research to determine the impact of adherence to regular nutrition follow-up and interventions on the changes in skeletal muscle mass and their relationship with fat loss among individuals with obesity who have undergone bariatric surgery. This review aims to assess the available evidence, identify trends, and draw conclusions regarding the effects of post-operative nutritional care on body composition outcomes, specifically focusing on the preservation of lean muscle mass and reduction in fat mass. Ultimately, the objective is to provide a comprehensive understanding of the role of nutrition follow-up and interventions in promoting favourable changes in body composition after bariatric surgery.

Keywords: Essential hypertension, Vitamin D deficiency, Left ventricular hypertrophy, LV mass index, Echocardiography.

INTRODUCTION

Obesity is a global public health concern, with its prevalence on the rise over the past few decades. It is characterized by an excessive accumulation of body fat, leading to adverse health effects. According to the World Health Organization (WHO), in 2016, more than 1.9 billion adults were overweight, and out of those, over 650 million were classified as obese, indicating the alarming extent of the issue (World Health Organization, 2021). Obesity is often categorized based on body mass index (BMI), with a BMI greater than or equal to 30 kg/m² considered obese (WHO, 2000).

The prevalence of overweight and obesity has reached epidemic proportions, with devastating consequences. A BMI over 25 is classified as overweight, while a BMI over 30 is considered obese. In 2017, over 4 million people died due to complications of being overweight or obese, as reported by the global burden of disease.

Effective weight management is a critical aspect of obesity treatment, and it necessitates a thorough examination of both surgical and non-surgical approaches.

Bariatric surgery, designed for severe obesity, includes procedures such as Roux-en-Y gastric bypass, sleeve gastrectomy, adjustable gastric banding, and the duodenal switch (Sjöström, 2004).Bariatric surgery achieves significant weight loss and improves obesity-related comorbidities like type 2 diabetes, hypertension, and sleep apnea (Adams, 2007). However, it carries risks, including complications, nutritional deficiencies, and potential psychological effects (Aminian, 2019).

Candidates for bariatric surgery are determined by their BMI, with guidelines typically suggesting surgery for BMI ≥ 40 or BMI ≥ 35 with comorbidities (NIH Guidelines, 1991). It's considered when non-surgical methods fail to achieve weight loss (Courcoulas et al., 2014).
Bariatric surgery is generally safe but not without risks. Complications include infection, leakage, hemorrhage, and nutritional deficiencies (Magro, 2008; Sakran et al., 2016; Dorman et al., 2005). Patients may also experience gastrointestinal issues and psychological effects (Hague, 2005; Sarwer et al., 2008).

Bariatric surgery leads to substantial weight loss and improved comorbidities like type 2 diabetes (Adams et al., 2009; Mingrone et al., 2012). It enhances overall quality of life, reduces cardiovascular risk, and lowers

mortality (Kolotkin et al., 2008; Adams et al., 2007; Sjöström et al., 2007).

Various factors affect post-bariatric weight loss, including the surgical procedure, dietary adherence, physical activity, psychological factors, presence of comorbid conditions, metabolic rate, age, gender, and genetics (Courcoulas et al., 2013; Mechanick et al., 2013; Bond et al., 2017; Sarwer et al., 2008; Hasselbalch et al., 2018).

1. Bariatric Surgery and Its Impact on Body Composition

Bariatric surgery proved to be effective in reducing total body mass and body fat at every time interval. However, dietary measures emphasizing adequate protein intake may be implemented in order to reduce loss of LBM and, coupled with frequent physical activity, may help curtail the impact the surgery has on morphological variables.(Gene Carey et al., 2006)

Over 12 months there was significant weight loss for all weight parameters examined ($p< 0.05$). Fat weight loss was most significant; total weight loss and reduction of BMI were significant but less so than fat loss (Wilcoxon's signed ranks test). LBW loss had the smallest contribution to weight loss ($p < 0.0001$). There was a significant loss of LVM and posterior cardiac wall thickness ($p < 0.05$). (Gahtan et al., 1997).

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2. Importance of Protein in Post-Bariatric Surgery

2.1 Protein Requirements and Guidelines

The significance of protein intake in the initial post-bariatric surgery phase is well- established, especially when energy restriction is at its peak. Protein intake should be individualized, considering factors like gender, age, and weight. The AACE/TOS/ASMBS Guidelines (2019) recommend a minimum protein intake of 60 g/day, with an option for up to 1.5 g/kg of ideal body weight per day. In some cases, higher protein amounts (up to 2.1 g/kg) may be considered on an individual basis.

To meet established nutritional targets, modular food supplementation based on whey proteins is recommended in the initial post-bariatric surgery phase. However, the practical application of these guidelines is less clear due to limited real-world studies.

2.2 Protein Sources and Quality

Protein deficiency, as assessed by serum albumin levels, is relatively less common than other nutrient deficiencies post-bariatric surgery. Fish consumption, which is better tolerated than meat, can contribute to sufficient protein intake.

The occurrence of dumping syndrome, a condition triggered by rapid food entry into the small intestine, can be influenced by the intake of simple sugars. To manage this, patients are advised to avoid fruit juices and added sugars, consume small, dry meals, increase dietary fiber, and emphasize dietary protein, especially from fish and chicken (Shah et al., 2006).

This study demonstrates a temporal change in protein requirement after bariatric surgery whatever the type of surgery. Spontaneous protein intakes following bariatric surgery does not cover protein requirements for most patients, suggesting that specific dietary protein recommandations have to be adapted in obese patients with bariatric surgery.(Guillet et al., 2020)

Adequate protein intake plays a crucial role in promoting postoperative recovery and preserving muscle mass. The ASMBS Guidelines recommend a protein intake of 60-80 g/day or

1.5 g per ideal body weight to maintain body protein levels.

2.3 Protein Intake and Surgical Success

Studies have shown that higher protein intake is associated with surgical success, particularly evident in the success group at 12 months post-surgery (Lim et al., 2020).

2.4 Protein Adherence and Compliance

Poor compliance to protein intake can be attributed to factors such as product intolerance, underestimation of nutritional value, and socioeconomic factors. Modular protein supplementation appears effective but requires addressing compliance issues (Bertoni et al., 2021)6.

2.5 Importance of Commercial Protein Supplements

Implementing guidelines for protein intake in the early post-surgery months can be challenging. While natural nutrition alone may not suffice, protein supplementation, especially modular supplements of whey proteins, can positively impact total protein intake. However, compliance remains an ongoing challenge, even in compliant patients (Bertoni et al., 2021).

3. Factors Influencing Changes in Skeletal Muscle Mass, Fat mass and Lean body mass

3.1 Changes in Lean Body Mass

Post-bariatric surgery results in significant transformations in body composition. It involves substantial reductions in body weight and fat mass. These changes also affect skeletal

muscle mass or lean body mass, which is vital for evaluating patients' overall health and surgical outcomes.

Bariatric surgery leads to a rapid reduction in body weight, primarily driven by fat mass loss. However, it's important to note that lean body mass, including skeletal muscle, may also decrease in the early post-operative period. The extent of lean body mass loss depends on factors such as surgery type, nutritional intake, physical activity, and adherence to post-surgery guidelines (Aminian, 2019).

Bariatric surgery induces 8 kg of LBM loss within 1-year postsurgery. The most optimal time window to intervene are the first weeks postsurgery, since 55% of LBM loss is lost within 3 months. Although adjustable gastric band procedures showed less absolute LBM, FFM, and SMM loss, proportional loss was similar compared with other procedures. Future studies should focus on identifying patients with high risk for excessive loss of muscle tissue and on optimization of protein intake (e.g., protein source, timing, and tolerance) and exercise guidelines (e.g., type, volume, intensity and tolerance) in the first postoperative months. These insights could support the development of evidence-based guidelines to limit postbariatric muscle mass loss, with feasible and effective interventions specifically for the bariatric population.(Nuijten et al.,2022).

3.2 Factors Influencing Changes in Skeletal Muscle Mass

Several factors contribute to the changes in skeletal muscle mass post-bariatric surgery:

Nutritional Intake and Protein Consumption (AACE/TOS/ASMBS Guidelines, 2019): Adequate protein intake is essential for preserving lean body mass. Protein supports muscle maintenance and recovery. Inadequate protein consumption can lead to muscle loss.

3.3 Physical Activity and Resistance Training

Regular physical activity, including resistance training, can help mitigate lean body mass loss. Structured exercise programs aid in preserving muscle mass and overall fitness. (Bond et al., 2017)

Physical activity after MBS can be expected to increase daily energy consumption, maintain muscle mass and function, and improve cardiovascular function. Therefore, 150-300 min of moderate-intensity physical activity, 75-150 min of vigorous-intensity physical activity, or an equivalent combination of weekly moderate-intensity and vigorous-intensity aerobic physical activity and regular muscle-strengthening activity is recommended for health promotion according to the World Health Organization 2020 guidelines.

Oppert et alconducted a 5-year follow-up study after publishing an RCT demonstrating that resistance exercise and protein supplementation after RYGB improved muscle strength in the first 6 postoperative months without significantly affecting WL and body composition

Adherence to Nutritional Guidelines (Miras et al., 2018): Compliance with post-bariatric surgery nutritional guidelines, especially in the early phases, significantly influences lean body mass changes. Proper adherence helps individuals maintain their muscle mass and prevent excessive loss.

3.4 Relevance of Skeletal Muscle Mass Changes after Bariatric surgery

Changes in skeletal muscle mass post-bariatric surgery are relevant for various reasons:

Metabolic Health: Skeletal muscle is metabolically active and contributes to overall metabolic health. Preserving muscle mass supports improved glucose metabolism and insulin sensitivity.

Functional Capacity: Maintaining muscle mass is associated with better physical function and quality of life. Patients who preserve lean body mass may experience enhanced mobility and improved ability to perform daily activities.

Weight Maintenance: Lean body mass contributes to basal metabolic rate, affecting energy expenditure. Preserving muscle mass helps patients maintain their long-term weight loss.

Between 1 and 5 years following common bariatric procedures, FFM and skeletal muscle are maintained or decrease minimally. The changes observed in FFM and muscle during the follow- up phase may be consistent with aging(Davidson et al.,2018)

3.5 Impact on Fat Mass

While bariatric surgery primarily focuses on weight loss, particularly fat loss, it is highly effective in achieving substantial and sustained fat reduction. This leads to improved overall health, including the remission or improvement of obesity-related comorbidities, such as type 2 diabetes, hypertension, and dyslipidemia (Adams, 2007).

The impact of post-bariatric surgery extends beyond fat loss to include changes in lean body mass, especially skeletal muscle. Preserving lean body mass is associated with better metabolic health, functional capacity, and weight maintenance. The extent of skeletal muscle mass preservation depends on factors like nutritional intake, physical activity, and adherence to post-surgery guidelines. Tailored approaches and close monitoring are essential to optimize post- bariatric surgery outcomes and achieve the desired balance between fat loss and the preservation of lean body mass.

4. Nutrition Follow-up and Interventions

4.1 Adherence to Nutritional Follow-up

Bariatric surgery follow-up care often falls short of patient needs, necessitating a flexible and long-term approach involving multidisciplinary healthcare teams. Patient perspectives, including routine and open appointments, moderated peer support groups, and various methods of contact (e.g., telephone, online, and face-to-face), are crucial for designing effective follow-up care, particularly addressing psychological and social well-being (Coulman et al., 2020).

4.2 Compliance Rates

Maintaining good compliance with diet and exercise post-bariatric surgery is essential for stimulating weight loss, preventing weight regain, averting malnutrition, and enhancing quality of life. Sarwer et al. discovered that patients with good dietary adherence achieved 28% more weight loss than those who did not adhere properly. However, a multicenter study of young adults who underwent bariatric surgery noted a decline in dietary adherence over time, potentially affecting outcomes (Assakran et al., 2020).

This study suggests that patients who have bariatric surgery are not receiving the recommended nutritional monitoring after discharge from specialist care. GPs and patients should be supported to engage with follow-up care. Future research should aim to understand the reasons underpinning these findings. Results indicated that the most common deficiency was anaemia. Annual proportions of patients with prescriptions for recommended nutritional supplements were low.(Parretti et al.,2021)

4.3 Barriers to Adherence

Patients post-bariatric surgery commonly face challenges in adhering to dietary and exercise recommendations. Reasons for non-adherence include low self-discipline, a lack of motivation, and other factors like lack of time and unfavorable weather for physical activity. To address these challenges and reduce obesity worldwide, there is a need for targeted interventions and technological support, including video appointments, group therapy, and smartphone applications (Assakran et al., 2020).

4.4 Impact of Nutrition Follow-up

Nutrition follow-up plays a significant role in the success of bariatric surgery. Dietary counseling and personalized nutrition plans can improve weight loss and long-term weight maintenance, enhancing patient outcomes and quality of life (David et al., 2012).

Calorie prescription is a key component of nutritional interventions for weight management post-bariatric surgery. Energy intake trends show an increase over time, emphasizing the need for a balanced diet to achieve optimal and sustainable weight loss without compromising nutrition (Nawfal et al., 2020). Patients with severe obesity can benefit from a medically supervised weight management program alongside surgery to prevent weight regain (Geetanjali et al., 2018).

4.5 Physical inactivity and Weight Regain

The results of this research showed that a higher level of physical activity was associated with lower weight regain. This effect was also noticed in the dimensions of quality of life, which were consistently higher in participants who were active and kept their weight regain below 5% after surgery Maintaining the BMI below 30 kg/m2 was associated with better sleep quality Metabolic risk factors' evolution was similar across all patients who underwent bariatric surgery However, there were significant differences in the evolution of glycaemia, cholesterol and mean blood pressure across the weight regain groups. Only the mean blood pressure improvement was maintained in both weight regain groups five years after the surgery.(Santos et al.,2022)

4.6 Personalized Nutrition Plan

With the increase in bariatric surgery procedures, WR is now recognized as a clinical problem. Defining "significant" and "rapid" weight regain is critical to help clinicians to recognize and implement the treatment for an improved outcome in a timely fashion. We have identified herein an algorithm to define and track significant WR after bariatric surgery as well as to offer treatment strategies to mitigate WR early in its course. This requires a multidisciplinary approach for diagnosis of the etiology of WR as well as its treatment with input from bariatric surgeons, obesity medicine specialists, dietitians, exercise specialists, and mental

health providers. This method of approach to the patient with WR after bariatric surgery can significantly extend the benefits of the surgery with the use of AOMs combined with behavioral methods. Although we focused primarily on WR following RYGB, we believe this approach may also be applied to patients who regain weight following other surgical procedures. The case presented illustrates that even when bariatric surgery produces early and robust weight loss, a follow-up plan to monitor eating behaviors, diet, and exercise is necessary to ensure long-term weight maintenance.(Istafan et al., 2021)

4.7 Non-compliance and weight regain

Owing to anatomical and hormonal changes, calorie intake, a major factor in WL, decreases immediately after MBS. However, reduced appetite hormone levels and recurrence of problematic eating habits often cause progressive weight gain in patients. Adherence to a postoperative diet is associated with greater postoperative WL, whereas poor diet quality, characterized by excessive intake of calories, snacks, sweets, and fatty foods, is associated with WR(Mitchell et al.,2016)

A cross-sectional study reported that poor WL outcomes in patients 10 to 15 years after RYGB were associated with an intake of high energy and energy-dense foods and low physical activity(Nymo et al.,2022)

4.8 Nutritional Deficiencies and Long-term Health Implications

Sustained nutritional follow-up is critical for post-bariatric surgery patients to avoid long-term nutritional deficiencies and their health implications. Iron, vitamin B12, folate, calcium, and vitamin D deficiencies are common concerns. Deficiencies can lead to complications such as anaemia, fatigue, neuropathy, hypertension, and bone mineral loss. Appropriate supplementation and monitoring are necessary to address these concerns and ensure patient well-being (Mehaffy et al., 2017).

Nutritional deficiencies represent a relevant long-term clinical problem in patients who underwent bariatric surgery as a result of modifications to the gastrointestinal anatomy and physiology, which could impact macro- and micro-nutrient absorption.

Therefore, the best practice guidelines highly recommend regular metabolic and nutritional monitoring after bariatric surgery, which frequency varies according to the type of procedure. In light of the high prevalence of nutrient deficiencies even prior to surgery, the current Guidelines also underscore the need for a complete pre-surgery nutritional assessment in all candidates for bariatric surgery.. Although there are few studies with long-term nutritional follow-up, there is general agreement that nutritional assessments should be performed throughout life; furthermore, multivitamin and calcium supplementation with added vitamin D is recommended for all weight-loss surgery patients. In conclusion, nutritional surveillance is an essential component of the management of bariatric patients for the following reasons: (1) increases the patients' adherence to healthy dietary habits and appropriate supplementation regimens; (2) prevents the risk of weight regain;
(3) facilitates the detection of possible nutritional deficiencies that could develop despite medical therapy; and (4) contributes to maintaining a good quality of life.(Lupoli et al., 2017)

CONCLUSION

The review of existing literature suggests that adherence to regular nutrition follow- up and interventions plays a crucial role in the outcomes of individuals with obesity after bariatric surgery. While the primary goal of bariatric surgery is weight loss, preserving skeletal

muscle mass is equally important to achieve a balanced and sustainable body composition. Research indicates that nutritional follow-up and interventions, which encompass dietary counselling, personalized nutrition plans, and dietary adherence, significantly impact body composition changes.

Adherence to post-surgery nutritional guidelines, including protein intake, calorie prescription, and nutrient control, are essential for preserving lean muscle mass. This not only contributes to favourable metabolic health but also supports functional capacity and weight maintenance. Moreover, the literature emphasizes the importance of a multidisciplinary healthcare approach, involving healthcare professionals, peer support groups, and various methods of contact, to provide comprehensive and long-term follow-up care tailored to the specific needs of post-bariatric surgery patients.

In conclusion, adherence to regular nutrition follow-up and interventions can promote reductions in fat mass and help preserve skeletal muscle mass among individuals with obesity after bariatric surgery. The findings underscore the significance of a holistic approach to post- operative care that includes personalized nutrition plans, dietary counselling, and ongoing monitoring to optimize body composition outcomes, enhance overall health, and improve the quality of life for these patients.

Gaps

Several potential gaps in the existing literature have been identified. Firstly, a need for long-term follow-up studies beyond the initial postoperative period to assess the sustained impact of adherence to nutritional follow-up and interventions on skeletal muscle mass and fat loss. Secondly, the inclusion of more diverse patient populations in research to improve the generalizability of findings. Thirdly, a gap in understanding the psychological and social well- being aspects influenced by adherence, calling for more investigation in these areas. Additionally, there's a need for specific guidelines for optimal and tailored nutrition interventions. Managing and preventing nutrient deficiencies among post-bariatric surgery patients requires further exploration. Furthermore, the collective impact of adherence to both nutritional and exercise recommendations on skeletal muscle mass and fat loss should be investigated. Finally, research into the cost-effectiveness of long-term nutritional follow-up and interventions could guide healthcare policies and practices in the future. Addressing these gaps will contribute to a more comprehensive understanding of the topic and improve post-operative care strategies.

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