

# THE EFFECTIVENESS OF BARIATRIC SURGERY IN THE CONTROL OF TYPE 2 DIABETES MELLITUS: AN INTEGRATIVE REVIEW

---

***Gleyka de Melo Ribeiro***

Centro Universitário Fipmoc (UNIFIPMOC)  
Montes Claros - MG  
<https://lattes.cnpq.br/1094456211750047>

***Danielle Beltrão Araujo Mendes Amorim***

Centro universitário CESMAC (CESMAC)  
Maceió - AL  
<http://lattes.cnpq.br/0799986886154235>

***Júlia Pereira Santa Bárbara***

Faculdade Ciências Médicas de Minas Gerais  
(FCMMG)  
Belo Horizonte - MG  
<https://orcid.org/0009-0000-7900-5725>

***Gabriel Miranda Morozewsky***

Escola Superior de Ciências da Santa Casa de  
Misericórdia de Vitória (EMESCAM)  
Vitória - ES  
<https://lattes.cnpq.br/2098590786723648>

***Laura Figueiró Euler Vaz de Melo Fernandes***

Faculdade Ciências Médicas de Minas Gerais  
(FCMMG)  
Belo Horizonte - MG  
<https://lattes.cnpq.br/0355628751567077>

***Ketheryn Rocha Fernandes***

Centro Universitário MULTIVIX  
(MULTIVIX)  
Cachoeiro de Itapemirim - ES  
<http://lattes.cnpq.br/9320510512264554>

All content in this magazine is licensed under a Creative Commons Attribution License. Attribution-Non-Commercial-Non-Derivatives 4.0 International (CC BY-NC-ND 4.0).



**Joanna Engert Brito Milward**  
Centro universitário MULTIVIX  
(MULTIVIX)  
Cachoeiro de Itapemirim - ES  
<http://lattes.cnpq.br/7360197726877486>

**Leandro Sampaio Magnago**  
Centro universitário MULTIVIX  
(MULTIVIX)  
Cachoeiro de Itapemirim – ES  
<https://lattes.cnpq.br/4850080695973907>

**Frederico Noboro Figueiredo Nakagawa**  
Instituto Metropolitano de Ensino Superior  
(IMES)  
Ipatinga - MG  
<https://lattes.cnpq.br/2288959885459819>

**Gustavo Lopes de Oliveira**  
Instituto Metropolitano de Ensino Superior  
(IMES)  
Ipatinga - MG  
<https://lattes.cnpq.br/1304432592779888>

**Larissa Lavagnoli Lopes**  
Centro Universitário do Espirito Santo  
(UNESC)  
Colatina - ES  
<http://lattes.cnpq.br/5051898339545205>

**Carolina Brandão Damasceno Góes**  
Faculdade Ciências Médicas de Minas Gerais  
(FCMMG)  
Belo Horizonte - MG  
<http://lattes.cnpq.br/5102471774544083>

**Abstract:** Introduction: Bariatric surgery has shown significant efficacy in controlling Type 2 Diabetes Mellitus, leading to improved glycemic control and even disease remission. Objective: To investigate current studies that discuss the effectiveness of bariatric surgery in the control of Type 2 Diabetes mellitus. Methodology: Research from clinical trials, meta-analyses, controlled and randomized clinical trials, and systematic reviews, selected through the platform of search “PubMed”, using the keywords “*Bariatric surgery*” and “*Diabetes*”. Results: The articles analyzed the effects of different types of bariatric surgery, such as Roux-en-Y gastric bypass, sleeve gastrectomy and adjustable gastric banding, on GLP-1R receptor expression in adipose tissue, on long-term disease outcomes macrovascular and metabolic indicators, as well as HDL (high-density lipoprotein) function in patients with obesity and type 2 diabetes. The results indicate that bariatric surgery presents consistent results that support its efficacy as an effective strategy to optimize the metabolism and induce remission of type 2 diabetes. Conclusion: According to the integrative literature review, the aforementioned examples of bariatric surgery result in significant improvements in glycemia, reduced need for antidiabetic drugs and even remission of the disease. Therefore, bariatric surgery must be considered as an effective and sustainable therapeutic option for patients with DM2 and obesity, with the potential to significantly improve quality of life and reduce the risks associated with the disease.

**Keywords:** Bariatric surgery. Glycemic control. Diabetes Mellitus.

## INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disease that has a major impact on public health worldwide. The

number of people affected by this condition has increased significantly in recent decades, which represents a challenge for health systems and the quality of life of affected individuals. Effective control of T2DM is crucial to prevent long-term complications and improve clinical outcomes for patients (HUANG et al., 2021). Obesity is a global epidemic that is associated with a number of health complications, including type 2 diabetes (T2DM), which contributes significantly to morbidity and mortality worldwide. (HUANG et al., 2021).

Bariatric surgery has emerged as a promising therapeutic option for the treatment of T2DM in patients with severe obesity. Studies have shown that bariatric surgery can result in T2DM remission in a significant number of patients. Different surgical procedures have been investigated, including sleeve gastrectomy (SG), gastric bypass of an anastomosis (OAGB) and gastric bypass Roux-en-Y (RYGB) (AFFINATI et al., 2019).

This surgical relationship resulted in higher rates of diabetes remission, improved glycemic control, and reduced need for antidiabetic medications compared with conventional treatment. In addition, patients undergoing bariatric surgery showed significant improvements in cardiovascular risk factors such as blood pressure and lipid profile and in sleep apnea. (ZHOU, X., & ZENG, C., 2023; WANG LORKOWSKI et al., 2020).

However, despite the positive results obtained with bariatric surgery, there are still open questions that need to be addressed, and further research is needed to understand the mechanisms by which bariatric surgery leads to T2DM remission and how these effects can be sustained over time, long term. In addition, it is essential to investigate the comparative effectiveness of different bariatric surgical procedures in DM2 remission and to identify risk factors and patient characteristics that

may influence the results (AFFINATI et al., 2019).

## METHODOLOGY

To carry out this research, a descriptive and exploratory methodology was used, through an integrative review study, with the objective of investigating the effectiveness of bariatric surgery in the control of diabetes mellitus.

The search for articles was carried out in the PubMed database, considered a reliable and comprehensive source in the health area, with the descriptors “*Bariatric surgery*” and “*Diabetes*”, which were chosen according to the topic of interest. Articles published between 2018 and 2023, written in English and with free access to the full text, were selected. In addition, only the following methodologies were considered: clinical trials, meta-analyses, controlled and randomized clinical trials, and systematic reviews. These criteria made it possible to obtain recent, high-quality studies with an adequate methodological approach.

After applying the inclusion criteria, the articles were selected. Initially, a total of 123 relevant articles were identified. Then, an initial reading of the titles and abstracts was carried out to exclude those that did not meet the inclusion criteria or that presented a very broad approach to the subject. After this step, 8 articles remained, which were subjected to a thorough reading and data tabulation in a comparative table subdivided by author and year, research title and conclusions, for further analysis and discussion.

## RESULTS

FIGURE 1 covers the flowchart with the criteria used in the selection of scientific articles for carrying out the integrative review. First, 123 articles were identified following the established methodology. Then, the titles and abstracts of these articles were evaluated, resulting in the selection of 22 articles for a

thorough reading. Finally, 8 articles were chosen for discussion and inclusion in the integrative review.

Consequently, Table 1 presents a comparative dissertation between the authors, separating it into author and year, study title and main conclusions.

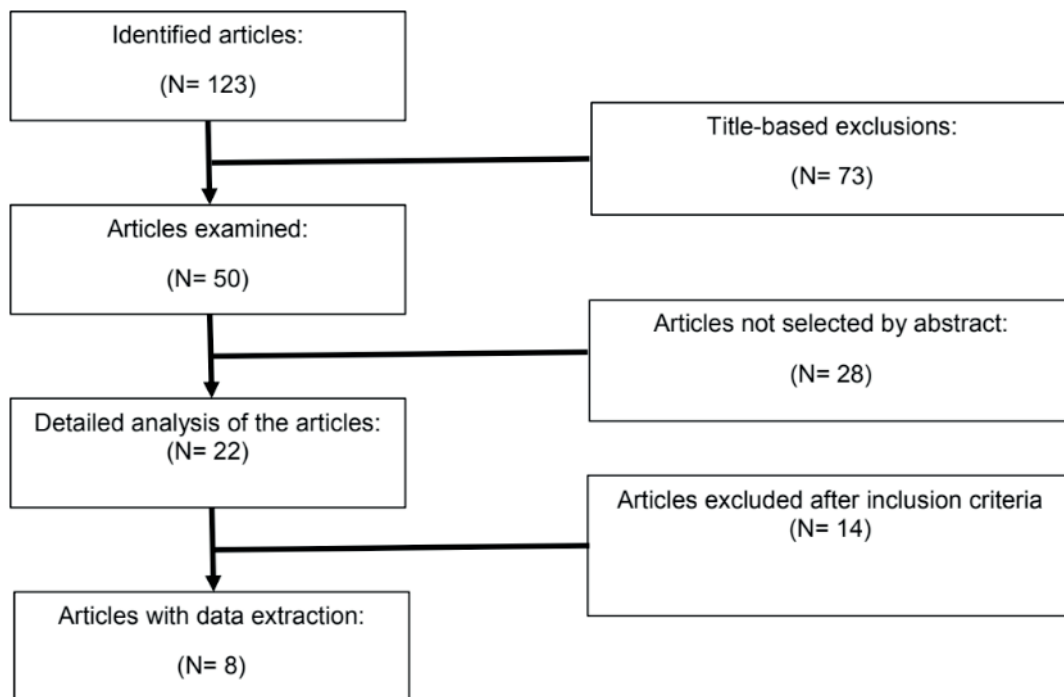
## DISCUSSION

The study carried out by Ejarque et al. (2019), through a retrospective analysis, compared the expression of GLP-1R in the subcutaneous adipose tissue of patients with type 2 diabetes before and after bariatric surgery. They also looked at blood sugar levels, lipid profiles, inflammation and pancreatic beta cell function before and after surgery. Results showed that GLP-1R expression in subcutaneous adipose tissue increased significantly after bariatric surgery. This finding suggests that surgery can modulate GLP-1R expression in adipose tissue, possibly as an adaptive response to the metabolic effects of surgery. In addition, patients showed significant improvement in blood sugar levels and lipid profile after surgery. These improvements were accompanied by a reduction in markers of inflammation in adipose tissue, suggesting that the reduction in inflammation may be related to the beneficial effects of bariatric surgery. The researchers also observed improvements in the function of pancreatic beta cells, which are responsible for producing insulin. This suggests that increased GLP-1R expression in adipose tissue may be associated with regulation of glucose metabolism and improved beta cell function.

For Yan et al. (2019), bariatric surgery is associated with a significant reduction in the risk of macrovascular diseases in patients with severe obesity and type 2 diabetes. The results of the meta-analysis performed indicated a reduction in the incidence of cardiovascular events, such as myocardial infarction and

accident stroke compared to patients who did not undergo surgery. In addition, the authors examined metabolic indicators such as glycemic control and lipid profile after bariatric surgery. A significant improvement in blood glucose levels and glycated hemoglobin (HbA1c) was observed in patients undergoing surgery. This indicates better glycemic control and a reduced risk of complications associated with type 2 diabetes. Regarding blood lipids, patients undergoing bariatric surgery showed a decrease in triglyceride levels and an increase in HDL cholesterol levels, known as “good” cholesterol. These changes are favorable to cardiovascular health and are associated with a lower risk of cardiovascular disease. However, the authors also observed the occurrence of nutritional deficiencies in patients undergoing bariatric surgery, such as vitamin B12 and iron deficiency, noting that these deficiencies may result from reduced food intake and inadequate absorption of nutrients after surgery.

Authors Wang Lorkowski et al. (2020), followed 90 patients, through an observational study, with obesity and type 2 diabetes who underwent bariatric surgery. Before and after surgery, they assessed HDL function using the Alipoprotein A1 (ApoA1) exchange rate and cholesterol efflux capacity. These parameters were measured to determine HDL's ability to remove cholesterol from cells and transport it back to the liver. Results showed that bariatric surgery resulted in significant improvements in HDL function. The rate of ApoA1 exchange increased after surgery, which indicates an increase in the ability of HDL to remove cholesterol from cells. This is important because efficient removal of cholesterol from cells can prevent the formation of plaque in the arteries and reduce the risk of cardiovascular disease. Furthermore, cholesterol efflux capacity also improved after bariatric surgery. This means that HDL has become more



**FIGURE 1:** Flowchart with the analyzes used for inclusion and exclusion of scientific articles used in the research

**Source:** Ribeiro, et al. (2023).

Author and Year	Title of job	Conclusions
Ejarque et al. (2019)	Role of adipose tissue GLP-1R expression in metabolic improvement after bariatric surgery in patients with type 2 diabetes	Increased expression of GLP-1R in adipose tissue is associated with metabolic improvement after bariatric surgery in patients with type 2 diabetes, including reduction in blood sugar levels, improved lipid profile, reduction of inflammation in adipose tissue and improvement in pancreatic beta cell function.
Yan et al. (2019)	Long-term outcomes of macrovascular diseases and metabolic indicators of bariatric surgery for severe obesity type 2 diabetes patients with a meta-analysis	Bariatric surgery has long-term benefits in controlling type 2 diabetes and reducing the risk of macrovascular disease. Patients undergoing surgery showed improvements in metabolic markers, including reduction in body weight, blood glucose levels and glycated hemoglobin.
Wang Lorkowski et al. (2020)	Bariatric Surgery Improves HDL Function Examined by ApoA1 Exchange Rate and Cholesterol Efflux Capacity in Patients with Obesity and Type 2 Diabetes	Bariatric surgery improves high-density lipoprotein (HDL) function in patients with obesity and type 2 diabetes, as demonstrated by increased ApoA1 exchange rate and cholesterol efflux capacity. These improvements in HDL function may contribute to reduced cardiovascular risk in these patients.
Ilyas et al. (2020)	Bariatric Surgery and Type 2 Diabetes Mellitus: Assessing Factors Leading to Remission. A Systematic Review	Bariatric surgery is effective in inducing remission of type 2 diabetes in obese patients. Several factors, including weight loss, improved insulin sensitivity, and changes in gut hormones, may contribute to diabetes remission after surgery.

Courcoulas et al. (2020)	Bariatric Surgery vs Lifestyle Intervention for Diabetes Treatment: 5-Year Outcomes from a Randomized Trial	Bariatric surgery is more effective than lifestyle intervention in treating type 2 diabetes in the long term. The surgery results in greater diabetes remission, sustained weight loss, improvement in glycemic control, and reduced use of antidiabetic medications compared with the lifestyle intervention.
Ding et al. (2020)	Comparative effectiveness of bariatric surgeries in patients with obesity and type 2 diabetes mellitus: A network meta-analysis of randomized controlled trials	Bariatric surgery, including sleeve gastrectomy and Roux-en-Y gastric bypass, is effective in controlling type 2 diabetes in patients with obesity. Both surgeries result in reduced body weight, improved glycemic control, and diabetes remission compared to other interventions and conservative treatments.
Liao et al. (2022)	Bariatric surgery and health outcomes: An umbrella analysis	Bariatric surgery results in significant improvements in health outcomes in patients with obesity and type 2 diabetes. These include reduced body weight, improved glycemic control, diabetes remission, reduced cardiovascular risk and improved quality of life.
Balasubramaniam, V. e Pouwels, S. (2023)	Remission of Type 2 Diabetes Mellitus (T2DM) after Sleeve Gastrectomy (SG), One-Anastomosis Gastric Bypass (OAGB), and Roux-en-Y Gastric Bypass (RYGB): A Systematic Review	Bariatric surgery, including sleeve gastrectomy (SG), gastric bypass of an anastomosis (OAGB) and gastric bypass Roux-en-Y (RYGB), can lead to remission of type 2 diabetes (T2DM), being more prevalent in patients undergoing OS and OAGB compared to RYGB.

**TABLE 1:** Comparative dissertation on the effectiveness of bariatric surgery on the intestinal microbiota in cardiovascular health

**Source:** Ribeiro, et al. (2023)



effective at transporting cholesterol back to the liver for disposal. This improvement in the ability to efflux cholesterol is beneficial, as it helps maintain a healthy balance of lipids in the body and contributes to the reduction of cardiovascular risk in patients undergoing bariatric surgery.

The systematic review carried out by Ilyas et al. (2020) highlighted the effectiveness of bariatric surgery in achieving DM2 remission in a significant proportion of patients. Substantial weight loss has been identified as one of the main contributing factors to improved blood glucose levels and remission of T2DM after surgery. Research has correlated body weight reduction with improved insulin sensitivity and pancreatic beta cell function, resulting in better glycemic control. In addition to weight loss, the authors discussed other factors that play an important role in DM2 remission after bariatric surgery. This includes changes in hormone profiles, such as increased production of incretins and reduced levels of ghrelin, which are associated with better glycemic regulation. Modification of the intestinal microbiota was also identified as a relevant factor, since bariatric surgery can lead to changes in the bacterial composition of the intestine, which can positively affect glucose metabolism. Another aspect discussed in the article is the importance of adequate selection of patients for bariatric surgery, emphasizing that the duration and severity of DM2, the presence of comorbidities and adherence to preoperative treatment are factors that must be considered when determining eligibility of a patient for surgery.

Courcoulas et al. (2020), performed a randomized clinical trial including patients with type 2 diabetes who were randomly assigned to receive bariatric surgery or an intensive lifestyle intervention. The duration of follow-up was 5 years, allowing the assessment

of long-term outcomes. The authors demonstrated that both bariatric surgery and lifestyle intervention were effective in reducing hemoglobin A1c (HbA1c) and improving glycemic control. These findings are relevant, since lowering HbA1c is associated with a lower risk of diabetes-related complications, such as cardiovascular disease, retinopathy, and neuropathy. Furthermore, the study showed that bariatric surgery resulted in greater weight loss compared to the lifestyle intervention. The significant weight loss observed after bariatric surgery is related to the improvement of cardiometabolic risk factors, such as blood pressure, lipid profile and insulin resistance. These findings reinforce the importance of weight loss in controlling diabetes and preventing related complications. However, it is important to emphasize that bariatric surgery has risks and potential complications. Complications can include nutritional deficiencies, surgical complications, gastrointestinal problems, and changes in nutrient absorption.

Through the meta-analysis carried out by Ding et al. (2020) found that Roux-en-Y gastric bypass was consistently associated with greater weight loss and higher rates of type 2 diabetes remission compared with sleeve gastrectomy and adjustable gastric banding. In addition, the research also concludes that all three interventions are considered safe, and it is important to highlight that the rate of complications can vary between procedures. Roux-en-Y gastric bypass, for example, may be associated with a slightly higher risk of complications due to its more invasive nature and the anatomical reconfiguration involved. Another relevant aspect covered is the importance of individualizing treatment, as each patient has unique characteristics and needs, and the choice of bariatric surgery must take into consideration, factors such as the profile of comorbidities, surgical risk,

patient preferences and patient experience. surgeon. Therefore, according to the authors, it is essential that a multidisciplinary team, including physicians, surgeons, nutritionists and psychologists, is involved in the decision and in the postoperative follow-up.

The study conducted by Liao et al. (2022) included randomized controlled trials and cohort studies, aiming to obtain an overview of the results obtained after bariatric surgery in patients with diabetes mellitus. With regard to weight loss, bariatric surgery proved to be highly effective, demonstrating a significant reduction in body mass index (BMI) after surgery and a reduction in absolute body weight in patients. With regard to glycemic control, bariatric surgery has also shown important benefits, with an improvement in blood glucose levels and even remission of diabetes after surgery. Accordingly, bariatric surgery had a positive impact on reducing blood pressure in patients with hypertension, with a significant decrease in blood pressure after surgery, in addition to a reduction in total cholesterol and triglyceride levels being observed in many of the included studies, in addition to of an increase in HDL cholesterol levels, considered the “good cholesterol”.

In line with Ding et al. (2020), the authors Balasubramaniam and Pouwels, (2023) mention that bariatric surgery has the potential to promote type 2 diabetes remission in obese patients. Through a systematic review, the authors evaluated the effects of sleeve gastrectomy (SG), single-anastomosis gastric bypass (OAGB) and Roux-en-Y gastric bypass (RYGB) on type 2 diabetes remission. sleeve gastrectomy (SG) and gastric bypass of an anastomosis were particularly effective in inducing diabetes remission. These procedures resulted in significant improvements in blood glucose levels and reduced need for antidiabetic medications. Furthermore, Roux-en-Y gastric

bypass has also been shown to be effective in type 2 diabetes remission, although to a lesser extent compared to sleeve gastrectomy and gastric bypass of an anastomosis. However, it's important to point out that RYGB may offer other benefits related to weight loss and overall health improvement.

## CONCLUSION

Bariatric surgery has been widely studied as a treatment option for patients with type 2 diabetes. It has been found that bariatric surgery demonstrates high effectiveness in controlling diabetes, resulting in significant rates of disease remission, in addition to extensive benefits such as loss sustained weight loss, improved insulin sensitivity, and reduced insulin resistance, all of which contribute to long-term glycemic control.

A systematic review of trial results revealed that bariatric surgery is superior to non-surgical interventions in controlling diabetes. Patients undergoing bariatric surgery showed a significant reduction in glycated hemoglobin (HbA1c) levels, improvements in insulin sensitivity and a greater likelihood of achieving remission of diabetes. These results demonstrate that bariatric surgery is a promising approach in the treatment of type 2 diabetes, especially in patients with severe obesity and associated comorbidities.

The study emphasizes the importance of a personalized approach when choosing the most appropriate surgical procedure for each patient. The effectiveness of each type of surgery may vary according to the individual characteristics of the patient, such as the degree of obesity, comorbidities, preferences and risk profile, and it was observed that the Roux-en-Y gastric bypass demonstrated a better clinical result related to loss weight loss and higher rates of type 2 diabetes remission when compared with sleeve gastrectomy and adjustable gastric banding.



Another important detail is the relationship between bariatric surgery and improvement in HDL function, increasing the ApoA1 exchange rate and cholesterol removal capacity. These improvements are significant, as HDL function plays a crucial role in cardiovascular health. These findings further reinforce the role of bariatric surgery as an effective intervention for metabolic disorders and underscore the importance of considering the role of HDL in assessing the impact of bariatric procedures on cardiometabolic outcomes in patients with obesity and type 2 diabetes.

In summary, the results of the reviewed studies provide robust evidence that bariatric surgery is an effective and safe approach to treating type 2 diabetes in obese patients. Understanding the physiological and metabolic mechanisms involved in these benefits can contribute to the development of more targeted therapeutic strategies. However, it is important to consider each patient's individuality and carefully evaluate the benefits and risks associated with each surgical procedure before making a clinical and surgical decision.

## REFERENCES

- AFFINATI, Alison H. et al. Bariatric Surgery in the Treatment of Type 2 Diabetes. **Current Diabetes Reports**, v. 19, n. 12, p. 156, dez. 2019.
- BALASUBARAMANIAM, Vignesh; POUWELS, Sjaak. Remission of Type 2 Diabetes Mellitus (T2DM) after Sleeve Gastrectomy (SG), One-Anastomosis Gastric Bypass (OAGB), and Roux-en-Y Gastric Bypass (RYGB): A Systematic Review. **Medicina (Kaunas)**, v. 59, n. 5, p. 985, maio 2023.
- COURCOULAS, Anita P et al. Bariatric Surgery vs Lifestyle Intervention for Diabetes Treatment: 5-Year Outcomes From a Randomized Trial. **Journal of Clinical Endocrinology & Metabolism**, v. 105, n. 3, p. 866-876, mar. 2020.
- DING, Li et al. Comparative effectiveness of bariatric surgeries in patients with obesity and type 2 diabetes mellitus: A network meta-analysis of randomized controlled trials. **Obesity Reviews**, v. 21, n. 8, p. e13030, ago. 2020.
- EJARQUE, Miriam et al. Role of adipose tissue GLP-1R expression in metabolic improvement after bariatric surgery in patients with type 2 diabetes. **Scientific Reports**, v. 9, n. 1, p. 6274, abr. 2019.
- HUANG, Tzu-Wen et al. Alterations of bone markers in obese patients with type 2 diabetes after bariatric surgery: A meta-analysis and systematic review of randomized controlled trials and cohorts. **Medicine**, v. 100, n. 20, p. e26061, maio 2021.
- ILYAS, Shahbakht et al. Bariatric Surgery and Type 2 Diabetes Mellitus: Assessing Factors Leading to Remission. A Systematic Review. **Cureus**, v. 12, n. 8, p. e9973, ago. 2020.
- LIAO, Jing et al. Bariatric surgery and health outcomes: An umbrella analysis. **Frontiers in Endocrinology**, v. 13, p. 1016613, out. 2022.
- WANG LORKOWSKI, Shuhui et al. Bariatric Surgery Improves HDL Function Examined by ApoA1 Exchange Rate and Cholesterol Efflux Capacity in Patients with Obesity and Type 2 Diabetes. **Biomolecules**, v. 10, n. 4, p. 551, abr. 2020.
- YAN, Guoli et al. Long-term outcomes of macrovascular diseases and metabolic indicators of bariatric surgery for severe obesity type 2 diabetes patients with a meta-analysis. **PLoS One**, v. 14, n. 12, p. e0224828, dez. 2019.
- ZHOU, Xiaoying; ZENG, Chunping. Diabetes remission of bariatric surgery and nonsurgical treatments in type 2 diabetes patients who failure to meet the criteria for surgery: a systematic review and meta-analysis. **BMC Endocrine Disorders**, v. 23, p. 46, fev. 2023.