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# Robotic Bariatric Surgery: Risks And Benefits

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## 1. Abstract

Obesity is a disease that affects a large part of the world's population. With associated comorbidities, such as cardiorespiratory diseases, diabetes and mobility difficulties, interventions, among which robotic bariatric surgery emerges as promising. The objective of this study is to describe the risks and benefits of robotic bariatric surgery. To this end, a systematic literature review was developed, with searches in the Pubmed, Scielo and Medline databases. Scientific articles, retrospective and prospective studies of clinical cases, published between 2018 and 2024, were selected. As a result, 9 articles were found, which found that performing robotic bariatric surgery requires higher investments and training of the professionals involved. However, its benefits are compensatory, as these are safer, more effective procedures, with shorter hospital stays, faster recovery and greater possibility of more immediate weight loss. It is concluded that it is necessary to expand studies in clinical cases that demonstrate more evidence about these procedures, as well as greater investment by the public health system in robotic CB, in order to expand the supply and meet the population's demand; and thus, contribute to public health, improving the quality of life of people suffering from obesity.

## 2. Introduction

Obesity is a chronic, multifactorial and relapsing disease, with a body mass index (BMI) ≥ 30 kg/m2, which affects a large part of the population. The causes are probably associated with a combination of generic, metabolic, behavioral and hormonal factors, which result in a prolonged imbalance between "energy intake and energy expenditure" [1]. As a consequence of obesity, other chronic diseases may occur, causing a large number of morbidities and mortality. Among the associated comorbidities, the following stand out: diabetes mellitus, gastroesophageal reflux, hypertension, hyperlipidemia, steatotic liver disease, cirrhosis, some types of cancer, osteoarthritis, psychological disorders, such as depression and body dysmorphic disorder, cholelithiasis and reproductive disorders. In people with a BMI ≥ 35 kg/m2, premature death may occur. It is also necessary to consider the socioeconomic consequences, such as absenteeism at work, low productivity and high expenditure on health services, therapies and medications1. Regarding prevalence, in the United States, from 2017 to 2018, 42.4% of adults were obese [1]. In Brazil, between 2006 and 2019, obesity affected 20.3% of the adult population2. According to evidence presented at the International Congress on Obesity (ICO), which took place in São Paulo, between July 26 and 29, 2024, it is estimated that by 2044 46% of Brazilians will be obese [3]. Among the therapeutic interventions and treatments for obesity, diets, physical activities, behavioral therapies, anti-obesity medications and bariatric surgery (BS) for weight loss are highly recommended, as they will affect both the underlying disease itself and the comorbidities [4,5]. BS consists of surgically altering the stomach and/or intestine with the aim of causing weight loss in patients with metabolic disorders associated with obesity and its consequences [6]. BS has shown good results, promoting an improvement in the quality of life of patients and thereby reducing the morbidity and mortality rate and the impact on public health. It is advisable for people with a body mass index greater than 35 kg/m² or greater than 40 kg/m², when associated with type 2 diabetes mellitus, high blood pressure, mobility difficulties, bone and joint diseases, cardiovascular diseases, dyslipidemia, obstructive sleep apnea, asthma, metabolic dysfunction associated with

hepatic steatosis and steatohepatitis, chronic nephropathy, polycystic ovary syndrome, infertility, pseudotumor cerebri and gastric-esophageal reflux disease7. According to data presented by the International Federation of Surgery for Obesity and Metabolic Diseases (IFSO), presented in Madrid, Spain, in 2019, 833,687 bariatric surgery procedures took place in 61 countries [7]. According to the Brazilian Society of Bariatric and Metabolic Surgery (SBCBM), 74,738 BC were performed in 2022, 65,256 of which were performed through health plans. This data shows that although there is a growing consensus on the importance of this surgical procedure for people with severe obesity, there is still little supply by the Unified Health System (SUS) [8]. It also reveals how much the demand for this surgical procedure has grown, increasing both the supply and the development of more effective and safer techniques [9]. BC are classified according to the technique applied and the type. Restrictive techniques stand out, used to impose limits on food intake by reducing gastric volume; and malabsorptive techniques, which aim to reduce the absorption of nutrients by modifying the gastrointestinal tract. Restrictive techniques include adjustable gastric banding, vertical gastrectomy and endoscopic gastroplasty (sleeve). Malabsorptive techniques are those in which a bypass is performed, such as Roux-en-Y bypass surgery (RYGB) and duodenal bypass [10,11]. The techniques used with robotics are highlighted for this study, because with advances in medical technologies, procedures such as robot-assisted gastric bypass (BG) surgery are considered increasingly safer and less invasive, in addition to obtaining results similar to laparoscopic procedures in terms of weight loss [12]. In view of the increasing use of robots to perform BS, the question is: what are the risks and benefits associated with robotic bariatric surgery for people with severe obesity? It is assumed that such procedures performed with the help of robots tend to have a higher cost, as they require investment in specific equipment and training of the professionals involved. However, it is believed that their benefits may be a compensatory factor in relation to the financial costs, as they appear to be safer, presenting a lower risk of complications, reducing the time of hospital discharge and improving the quality of life of patients. It is also believed that it is essential for the government to invest in equipment and training to perform robotic BS and facilitate the population's access to this surgical treatment. In view of the questions and hypotheses presented, as well as the possibilities of BS performed at the present time, the present study is developed with the objective of describing the risks and benefits of robotic bariatric surgery.

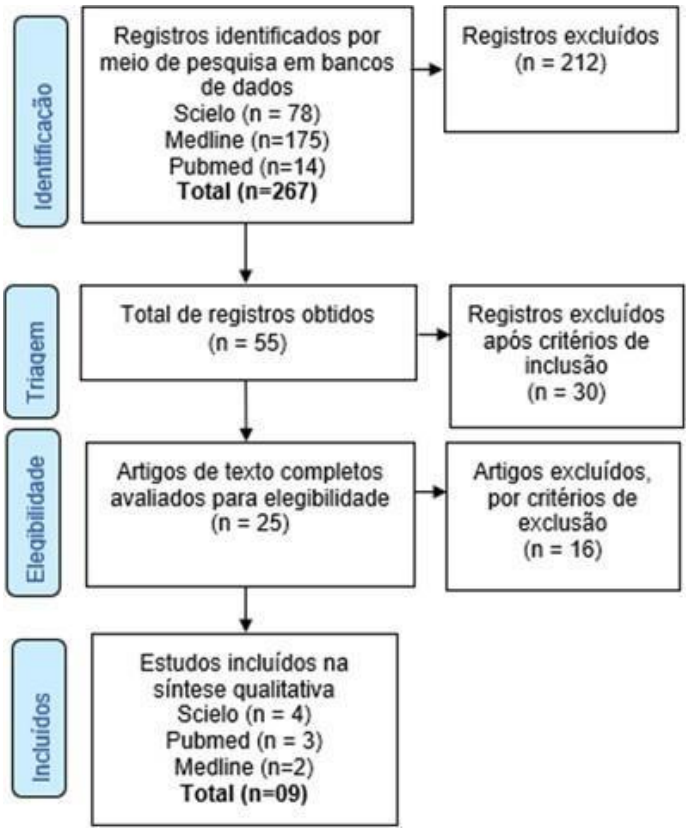
## 3. Methodology

To conduct this research, we chose to conduct a systematic review of scientific articles available in the Pubmed, Scielo and Medline databases. The search was conducted in November and December 2024, using the descriptors (DeCS/MeSH) "Bariatric Surgery"; "Robotic Surgery"; "Patient Safety" and "Obesity". The following inclusion criteria were defined: articles published in English, Portuguese or Spanish and between 2018 and 2024. Regarding the exclusion criteria, review articles, editorials and duplicate articles in more than one database were discarded, in addition to those that do not address the problem of this research, do not present the method and objectives clearly or do not present explicit results. Initially, a selection was made based on the titles; reading of the abstracts; and finally, a new reading, selecting those eligible for this study. The findings were selected, with some discarded, according to the exclusion criteria. The analysis was performed after summarizing the results, highlighting the risks and benefits of robotic CB.

## 4. Results

As an initial result of the first search, 267 publications were found (Figure 1). Of these, publications that did not correspond to the theme of this study and those whose study did not mention robotics in CB were excluded, totaling 212 initial exclusions. Next, 30 articles were excluded because they were published before 2020. Consequently, the 25 articles were read and analyzed for eligibility, with 16 being excluded due to inadequacy to the theme and for not presenting methods or results clearly. Thus, 09 articles remained, which were analyzed and discussed, with a view to achieving the objective. To obtain a broader perception of the 09 findings, these were summarized (Table 1), in terms of authors, year of publication, objectives, method, sample and results. When analyzing table 1, regarding the year of publication, it is observed that there was a temporal distribution of the 9 selected articles. In 2018, 2 articles13;14 were published, corresponding to 22.2% of the total, indicating a relevant beginning in the registration of studies on CB robotics. In 2020, another 2 articles15;16 were also published, maintaining the same percentage of 22.2% and suggesting the continuity of academic interest in the topic. The year 2021 stood out as the most productive, with three articles17;18;19, representing 33.3% of the total. This increase may be associated with the consolidation of technological advances and the expansion of the use of robotics in CB practice. Finally, in 2023, two articles20;21 were selected, reaching 22.2% and demonstrating that research in the area remains active and relevant. The methods used varied between retrospective and prospective studies and simulation analyses. The retrospective method was predominant, used in 66.7% (6/9) of the articles, while prospective methods appeared in 22.2% (2/9), and simulations in 11.1% (1/9). These methods reflected diverse approaches, from broad population analyses, as in the study that used the Nationwide Readmissions Database (NRD)20, to studies focused on individual cases or specific series [17]. The combined total sample of the 9 articles totals 1,376,277 patients, a significant number that gives high representativeness to the analysis. Some studies stood out for their scope, such as the analysis of 1,371,778 hospitalizations, 7.1% of which were robotic-assisted surgeries (RA)20. Others presented smaller but more detailed samples, such as the study that evaluated 45 patients who underwent robotic gastric bypass [14]. The relevance of robotic surgery was widely highlighted,

especially in studies such as the one that demonstrated significant benefits by reporting the absence of the need for conversion in a series of 329 patients who underwent the robotic Roux-en-Y gastric bypass technique [17]. Regarding the results (Table 1), the benefits of robotic surgery include greater surgical precision15, consistent resolution of symptoms, such as gastroesophageal reflux16, and shorter hospital stay [21]. However, risks and difficulties were also observed, such as a higher rate of complications (13%) and significantly higher hospital costs (31.1%)20. In one of the articles [17], the robotic Roux-en-Y gastric bypass procedure (RYGB) is performed using advanced robotic platforms, such as the Da Vinci Si and the Da Vinci Xi. Before starting the surgery, it is essential to ensure the appropriate configuration of the operating room, allowing free movement between the surgeon's console and the patient's table, in addition to strategically positioning the robotic cart and the vision cart. Under general anesthesia, the patient is placed in the supine position, with specific safety measures for positioning the arms and legs. Abdominal insufflation with carbon dioxide is performed to create the pneumoperitoneum, allowing the necessary space for manipulation of the instruments. The placement of the portals follows a pattern that considers the anatomical characteristics of the patient and the robotic platform used. The robotic portals, measuring 8 to 12 mm, are strategically positioned to minimize collisions and optimize the reach of the robotic arms, which will be responsible for dissection and suturing [17]. During the procedure, advanced instruments, such as the Harmonic ACE curved scissors, the fenestrated bipolar forceps and the megasuturecut needle holder, are used to perform precise dissections and delicate sutures. The creation of the gastric pouch begins with linear stapling, while the gastrojejunal anastomosis is shaped and sutured using precision techniques, with the support of linear staplers and absorbable sutures [17]. In another study, robotic bariatric surgery was performed using the da Vinci Si® platform to create a Roux-en-Y gastric bypass. The procedure involved creating a gastric pouch with a capacity of between 50 and 70 mL using automatic staplers. Both anastomoses (gastric and intestinal) were performed with specific staples and without reinforcement with biological material. The following were used for this procedure: the da Vinci Si® Platform, whose instruments facilitated the precision of the surgeon's movements and ergonomics, who sat on the left side of the patient; the robotic ultrasonic arm, which was used for dissection; Medtronic Signia® automatic staplers for forming the gastric pouch and anastomoses; and suction drains to monitor possible complications in the immediate postoperative period [21]. The ethical and technical challenges of the transition to robotic CB were also addressed, such as the high initial investment in robotic platforms15 and the need for extensive training in simulators [18]. Still, one of the studies reinforces the safety and viability of the technique, with very low rates of complications and readmission [17].




Source: own authorship (2024)

**Figure 1**: Flowchart of results obtained.

**Table 1:** Sumarização dos resultados quanto ao autor, ano, objetivos, método, amostra e resultados.

| Author/Year | Aim | Method | Sample | Results |
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| Hamilton SJ, Onetto CC, Orellana EO, Marín PP.2018 [13]. | To describe the initial experience and short-term outcomes with robotic revision bariatric surgery | Retrospective study of CB performed by a surgeon at the Santa Maria Clinic in Santiago, Chile. | 59 CB, in patients with a mean age of 47.8 years and a mean preoperative BMI of 33.86 kg/m2. | Mean surgical time: 101.63 minutes. Reoperation was required in 2 (3.39%) patients. There were no deaths. Mean length of hospital stay: 3.6 days. Robotic revisional CB is a new technique that appears to be safe and effective. |
| Elias A, Roque-de-Oliveira M, Campos JM, Sasake WT, Bandeira ÁA, Silva LB, et al., 2018 [14]. | To report a series of cases of robotic CB in the treatment of obesity in Brazil. | Patients who underwent robotic CB at the Garrido Institute were evaluated. | 45 patients, with a mean age of 39.44 years, 34 of whom were female, with a mean initial BMI of 41.26 kg/m2. Among the BS performed, 91.11% were Roux-en-Y gastric bypass, and 8.89% were of the vertical gastrectomy type. | The average total surgery time was 158 (±56.54) minutes, with console time 113.0 (±41.4) minutes. The average pain in post-anesthesia recovery was 2.61 (±3.30) points, on a scale of 0 to 10. Robotic CB is a safe procedure, with results comparable to laparoscopic surgery. |
| Acevedo E, Mazzei M, Zhao H, Lu X, Edwards MA., 2020 [15]. | Apresentar uma análise de coorte retrospectiva de CB revisional, comparando técnicas laparoscópicas convencionais (LBS) e assistidas por robótica (RBS). | Retrospective cohort review of the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) Participant User Files (PUF) database. Case-control matching (1:1) was performed. | A total of 1,144 pairs (RBS and LBS) were analyzed, totaling 2,288 paired cases.<br>· Average age: 48 years.<br>· BMI: 40.9 kg/m².<br>· Predominant gender: 85.6% female.<br>· Predominant ethnicity: 67% white. | Greater surgical precision in RBS procedures. The transfusion rate in revision gastric bypass cases was lower in RBS (0.6%) compared to LBS (2.9%). Regarding safety, there was low mortality and infection. RBS requires less physical effort from the surgeon; the initial investment is high; and there is a higher leak rate in some scenarios. |
| Aguilar-Espinosa F, Montoya-Ramírez J, Salinas JG, Blas-Azotla R, Aguilar-Soto AO, Becerra-Gutiérrez LP., 2020 [16]. | To determine the reasons for failure of laparoscopic sleeve gastrectomy (LSGs) and report the results of conversion to gastric bypass surgery, comparing the results with those of primary gastric bypass surgery. | Surgeries using robotic-assisted and laparoscopic (hybrid) techniques were evaluated. | Pacientes totais: 420 submetidos a LSG; 18 (4,28%) realizaram conversão devido à falha.<br>· 13 pacientes (72%) por falha de perda de peso (WLF).<br>· 3 pacientes (17%) por refluxo gastroesofágico refratário (GERD).<br>· 2 pacientes (11%) por estenose gástrica. | After 36 months, patients with WLF who underwent conversion had a %EWL[1] of 54.17 ± 12.48, lower than primary gastric bypass (%EWL of 69.17 ± 23.73). All patients had symptom resolution. Hybrid robotic surgery had a longer duration (200.62 ± 69 minutes) compared to primary gastric bypass (168.46 ± 38 minutes). Two patients required reintervention due to internal hernias (Clavien-Dindo classification IIIb). |
| Morrell ALG, Morrell-Junior AC, Morrell AG, Mendes JMF, Morrell AC., 2021 [17]. | To present a series of cases operated with a standardized robotic Roux-en-Y gastric bypass (rRYGB) technique, and their results. | Prospective review of a case series of patients undergoing robotic Roux-en-Y gastric bypass surgery between April 2015 and July 2019 | 329 patients undergoing robotic Roux-en-Y gastric bypass. Both Da Vinci, Si and Xi platforms were used. The average age was 34.4 years, with a median BMI of 44.2 kg/m2. | The average console time was 102 min and there was no conversion. No surgical hospital readmission rate was observed in the first 30 days. The technique is feasible, safe, and potentially beneficial to the patient, showing good results and minimal complications. |

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| Belotto M, Coutinho L, Pacheco-JR A M, Mitre A I, Fonseca E A da. 2021 [18]. | To evaluate the performance and learning of tasks on a simulated robotic platform in individuals with different surgical knowledge. | Performance analysis from simulations, with the realistic robotic platform (Mimic, Intuitive Surgery, Sunnyvale), with two manual controls and seven pedals. | Total: 16 individuals, aged between 40-50 years. Male predominance (13/16 participants). Distributed into 3 groups: a) 6 specialists in laparoscopic surgery; b) 6 specialists in conventional surgery; and c) 4 non-medical individuals. | Laparoscopic surgery specialists performed similarly to nonphysician subjects and better than conventional surgery specialists. Conventional surgery specialists performed worse. All groups improved their performance with repetition. Robotic surgery demonstrated a shorter learning curve compared with laparoscopy. |
| King K, Galvez A, Stoltzfus J, Claros L, Chaar ME. 2021 [19]. | To compare the safety and outcome of laparoscopic and robotic Revisional Bariatric Surgery (RBS) in a single accredited center. | Retrospective analysis of prospectively collected data on patients undergoing laparoscopic (L-CBR) or robotic (R-CBR) CBR between January 1, 2017, and December 31, 2019. | Total of 167 patients: 52 patients underwent R-CBR (31%) and 115 underwent L-CBR (69%) | The 30-day major and minor complication rates for R-CBR and L-CBR were 1.9% and 5.8% vs 5.2% and 5.2%, respectively ($p > 0.05$). There was no difference in readmission rates (3.8% vs 8.7%, $p > 0.05$) or intraoperative blood loss (35.5 mL vs 37.4 mL, $p > 0.05$) between R-CBR and L-CBR. R-CBR resulted in a shorter length of stay when compared with L-CBR (40.2 h vs 62.6 h, $p < 0.05$). |
| Klock JA, Bremer K, Niu F, Walters RW, Nandipati KC, 2023 [20]. | To evaluate and compare intra- and postoperative complications, hospital readmissions at 30 and 90 days between robotic-assisted (RA) and laparoscopic (LA) BS. | Retrospective analysis of population-based data on adult patients undergoing CB (RA or LA), using data from the Nationwide Readmissions Database (NRD) from 2010 to 2019. | Sample of 1,371,778 hospitalizations, of which: 7.1% were due to RA. | The probability of adjustments due to complications was 13% in procedures performed by robotics; regarding readmission, in this group, it was 10% after 30 days and 10% after 90 days. Regarding hospital costs, they were 31.1% higher than in LA. |
| Barros F de, Fonseca ABM, Kiss ASB, Braga CF, da-Silva FR, Regonati YH. 2023 [21]. | To compare patients undergoing robotic versus laparoscopic gastric bypass in a single center by a single surgeon. | Retrospective study with data collection from medical records. | 221 patients (121 laparoscopic procedures vs 100 with daVinci platform). | The group submitted to the robotic method had a shorter surgical time and shorter hospital stay. No difference was found in the sample in relation to stenosis, bleeding or leakage. |

The acronym EWL stands for Excess Weight Loss.

Source: Own authorship (2024)

## 5. Discussion

BC has been an effective treatment, compared to other long-term treatments, for weight loss [13]. Overweight people are often targets of discrimination and prejudice, because they do not fit into the beauty standards imposed mainly by the media. This can negatively affect the perception of these individuals' body image. In addition to the psychological problems resulting from high levels of overweight, such as depression and anxiety. Therefore, many see BC as the solution to their dissatisfaction with their bodies and a reduction in comorbidities associated with obesity, improving their quality of life. In the context of the various BC techniques, those performed with robotic assistance stand out as a promising innovation, expanding the perception of the importance of technologies for the medical field. Conventional laparoscopy techniques for performing gastric bypass continue to be well accepted. However, robotics can be applied in several procedures, such as: vertical gastric bypass remodeling, Roux-en-Y gastric bypass, laparoscopic adjustable gastric banding extractions, Roux-en-Y gastric bypass pouch remodeling, laparoscopic adjustable gastric banding for patients with previous Roux-en-Y gastric bypass, total gastrectomies, gastrogastric fistula resection and gastroenteral anastomosis [13]. All of these procedures can be performed with robotics, although in some cases, such as adjustable gastric banding extractions or gastric banding placement, traditional laparoscopy is more common due to the simplicity of the procedure and the cost of robotics. Laparoscopic adjustable gastric banding for patients with previous Roux-en-Y gastric bypass is generally performed by laparoscopic approach, with robotics being used for more complex cases. However, there is a growing trend to perform these procedures robotically, in line with hospitals' investments in this equipment and the training of professionals. Other

procedures, such as laparoscopic adjustable gastric band extractions, which can also be performed robotically, may change from conventional surgery due to some adhesions (internal hernias)16, which may require more precise maneuvers performed by hand. The choice will depend on factors such as the complexity of the case, the equipment available, and the experience of the surgical team. As new robotic equipment is developed, such risk situations or complexities tend to be resolved, expanding the use of robotics. Equipment such as the Da Vinci Surgical System, from the Si (Intuitive Surgical Inc. Sunnyvale, CA, USA) or Xi platforms, are used to perform procedures such as gastric bypass, sleeve gastrectomy, and revisions. The Da Vinci Si equipment requires cephalic coupling, with the robotic cart close to the patient's head; The Da Vinci Xi, on the other hand, consists of a more flexible exoskeleton, with a versatility that allows left-side coupling, so that there is complete exposure of the patient's head, facilitating the anesthesiologist's work at the bedside. However, with both instruments, the assistant surgeon is positioned to the right of the patient [17]. The platforms allow precise movements and articulation of the instruments. The Da Vinci portal belongs to the North American company Intuitive, responsible for manufacturing the Da Vinci robotic system [22]. Robotic technology allows the simultaneous manipulation of multiple instruments and the performance of complex sutures in narrow anatomical spaces. The Xi platform, for example, offers greater flexibility in the coupling and positioning of the robotic arms, while the high-definition three-dimensional camera provides a clear and detailed view of the structures. To ensure the safety of the anastomosis, integrity tests, such as the use of methylene blue or indocyanine green, are performed at the end of the procedure [17]. Robotic BS entails some risks, which are associated with factors inherent to surgical procedures in general, such as those associated with anesthesia and previous diseases [22]. However, it is also important to highlight the risks inherent to this type of procedure, especially the incidence of some comorbidities before and after surgery. Hiatal hernia, hepatic steatosis and arterial hypertension, pre-existing diseases in obese patients, may be remitted after robotic BS, but they may still occur in the postoperative period in a higher rate compared to laparoscopic procedures [14]. Another factor to be considered is the high investment. Hospital costs can be 31.1% higher than in laparoscopic procedures15;20. Regarding the technical capacity of professionals, during training, "with five repetitions of four simulated taskss were performed: spatial vision, bimanual coordination, hand-foot-eye coordination and manual dexterity"18:1. Four actions were performed: aiming the camera, passing the ring, changing power and picking up and placing. These tasks were trained on a Mimic simulator, Intuitive Surgery, Sunnyvale with two manual controls and seven pedals. It was observed that although specialists in conventional surgeries presented worse results in handling the equipment, all achieved a short learning curve, mastering the techniques in less time, compared to traditional handling [18]. As for the benefits, there are several listed by the authors surveyed (Table 1), such as: (i) reduced need for reoperation [17] – only 3.39% of 59 patients13; (ii) low mortality or no deaths13; (iii) reduction in hospital stay14;19;21 – only 1 patient required ICU admission for a period of 2 days after surgery due to previous heart disease14; (iv) reduction in post-anesthetic pain - 2.61 (±3.30) points on a scale of 0 to 1014; (v) greater safety and reduction in surgical complications15;20 – lower rate of need for transfusion (0.6%) compared to laparoscopic procedures (2.9%)15; (vi) greater precision in performing procedures15; (vii) shorter learning curve for professionals compared to laparoscopy18; (viii) shorter surgical time.

## 6. Final Considerations

When analyzing the risk-benefit ratio, it is understood that robotic CB is quite promising, and it is essential to invest in the installation of consoles, in the acquisition of platforms, such as the Da Vinci, and in the training of surgeons. In this way, there will be greater chances of expanding this type of procedure, increasing the possibilities of promoting safer and more effective surgery for all patients. The study reinforces that the use of robotics in CB not only offers greater precision and ergonomics, but also reduces the physical effort of the surgeon and improves operative results, with minimal reported complications. This standardized approach, using cutting-edge technologies, demonstrates the viability and benefits of robotic surgery compared to traditional laparoscopic techniques. Given that BS is offered in greater numbers by health plans and in lesser numbers by free health services, there is an inequality of access, a factor that has serious consequences, keeping obesity at the level of a global pandemic. By recognizing that it is everyone's right to have access to free and quality public health services, without any distinction or discrimination23, there is a growing need to expand the supply of robotic BS throughout the country. BS is still the safest and most effective procedure for solving health problems associated with obesity. Since obesity is a public health problem, it is essential that the SUS invest in expanding the effectiveness of this procedure, investing in resources and training, so that hospital units can expand the supply. There is a need for more effective and multidisciplinary health care for people suffering from obesity and its comorbidities, taking into account their lifestyle, socioeconomic conditions, cultural and physical-biological aspects. In this process, it is important to have the ability to offer robotic CB as a safer treatment with better results. However, it is important to publish research with clearer and more detailed evidence to elucidate the discoveries and updates on robotic CB. In this context, this research is recommended as an instrument to encourage new studies to be carried out, in order to encourage surgeons and other professionals, as well as health institutions, to invest more and more in robotic CB and contribute to public health by improving the quality of life of people suffering from obesity.

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