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The Role of Artificial Intelligence in Bariatric Surgery: Perspectives and Modern Applications

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Abstract: Artificial intelligence (AI) is having a major impact in the field of bariatric surgery (BS) as it helps improve outcomes for patients with severe obesity. This advanced technology optimises clinical decision-making processes and helps reduce the risks associated with surgery. In the context of bariatrics, AI is used to identify suitable patients, and monitor postoperative recovery but also to predict complications that may occur. BS is an effective solution for treating severe obesity, a condition characterised by the excessive accumulation of body fat, which can lead to serious health problems. However, this surgical field faces challenges in terms of patient selection and follow-up. By implementing machine learning (ML) algorithms and advanced imaging technologies, AI offers advantages to surgeons in performing interventions with increased precision and efficiency. The integration of AI into BS brings significant benefits to both patients and healthcare professionals, thereby facilitating the development of a personalised and safe approach to obesity management. Through this review, we aim to explore the potential, benefits, and risks of using AI in the context of BS.

Keywords: bariatric surgery; artificial intelligence; obesity; quality of life; deep learning; machine learning.

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1. Introduction

Artificial Intelligence (AI) is transforming modern medical practice by enabling systems to perform tasks that previously required human intelligence (Chen, & Decary, 2020; Hamet, & Tremblay, 2017; Rashid, & Kausik, 2024; Zhang, & Lu, 2021). In clinical settings, machine learning (ML), a subfield of AI, uses data-driven models to analyse patient-specific features and predict outcomes (Bektaş et al., 2022). These algorithms identify patterns that assist in optimising decision-making processes in areas such as medical imaging, patient selection, and postoperative monitoring (Kaul, Enslin, & Gross, 2020). A subfield of this domain, deep learning (DL), consists of algorithms that utilise multi-layer neural networks to examine data and adjust the weights of various factors, allowing the creation of a trained model applicable to new datasets (Bektaş et al., 2022; Huynh-The et al., 2023; Kaul, Enslin, & Gross, 2020).

The term "artificial intelligence" was introduced in 1956 by John McCarthy at a conference where scientists discussed the idea of creating an "electronic brain" (Mintz, & Brodie, 2019; Vearrier, et al., 2022; Zhang, & Lu, 2021). AI can perform tasks that previously required human skills, such as speech recognition, visual perception, learning, and decision-making (Zhang, & Lu, 2021). As computers have become more powerful, functions once considered manifestations of AI are now commonly used without being perceived as different. For example, language recognition, once an exclusively human ability, is now performed by dictation software, smartphones, and other electronic devices (Vearrier et al., 2022).

The use of AI has grown significantly in recent years (Bellini et al., 2022), demonstrating considerable potential in clinical practice (Bektaş et al., 2022). AI models are widely used in medical imaging analysis, such as X-rays, MRIs, and CT scans, to identify risk factors that may influence treatment outcomes. For example, in colorectal surgery, ML methods have shown up to 96% accuracy in predicting postoperative complications (Bektaş et al., 2022). The ability to predict critical outcomes underlines the importance of integrating AI into medical fields, including BS (bariatric surgery), where technologies can optimise patient selection, post-operative monitoring, and clinical decision-making (Hainer, Toplak, & Mitrakou, 2008). AI is not only transforming medical practice but also improving patient outcomes.

Numerous studies confirm that BS is a popular and effective option for treating obesity, promoting weight loss by altering the digestive system (Aderinto et al., 2023; Hainer, Toplak, & Mitrakou, 2008). This intervention involves a multidisciplinary assessment and diagnosis, including conservative and surgical treatments, followed by lifelong ongoing care (Runkel et al., 2011). Through well-established procedures, BS involves altering the anatomy of the gastrointestinal tract to reduce food intake and nutrient absorption. These procedures may include sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), adjustable gastric banding, Single-anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S), and biliopancreatic diversion with duodenal switch. There are also options under development, such as intragastric balloons and endoscopic sleeve gastroplasty, which, while showing many advantages, require further research (Aderinto et al., 2023; Bektaş et al., 2022; Nguyen, & Varela, 2017).

Recent studies emphasise that the benefits of BS include not only weight loss but also the improvement of comorbidities, thus increasing the quality of life (Aderinto et al., 2023; Li et al., 2015). Through a detailed multidisciplinary evaluation involving careful patient selection and assessment, postoperative care, nutritional support, and psychological counseling, the success of surgical interventions is increased. Furthermore, ongoing monitoring and adherence to recommendations are essential for the long-term maintenance of weight loss (Aderinto et al., 2023).

In this context, telemedicine has been utilised primarily to provide care for patients at home (n = 7), playing a crucial role in supporting patients postoperatively. Additionally, online education modules used to provide support have been applied in five studies and have emerged as the most prominent telemedicine method employed. These tools not only facilitate remote care but also help maintain patient engagement and adherence to postoperative guidelines (Coldebella et al., 2018). On the other hand, after surgery, 10–30% of patients experience insufficient weight loss, and the

associated risk factors are varied and complex. In BS, AI applications have demonstrated the potential to improve patient care by enabling personalised risk assessment and outcome predictions. One of the potential utilities of AI algorithms is their role as predictive tools for postoperative complications, which can significantly contribute to risk management and improve long-term outcomes. Bektaş et al. (2022) demonstrated that ML algorithms show promising capabilities in predicting postoperative complications and weight loss, achieving an accuracy of up to 98%. However, their clinical introduction depends on rigorous external validation to ensure applicability in real-world settings (Bektaş et al., 2022). By integrating these technologies into surgical practice, healthcare providers can enhance clinical decision-making and optimise patient outcomes.

This review aims to evaluate the role of AI in BS, exploring its applications in patient selection, risk prediction, and postoperative monitoring, while identifying limitations and areas for further research. In addition, we will analyse the benefits of AI as well as its limitations to highlight areas where further research is needed.

2. Methodology

Systematic searches were conducted using PubMed, Google Scholar, and Science Direct databases to identify relevant publications in the field of AI and BS. The searches covered the period from inception to October 2024, using keywords 'artificial intelligence', 'bariatric surgery', 'obesity', 'quality of life', 'machine learning', and 'deep learning'. This approach was extended by combining these terms to maximise the relevance of the results obtained. After searching using the combination of “artificial intelligence and bariatric surgery” numerous significant articles were identified in PubMed (n=271), Google Scholar (n=2840) Science Direct (n=651) (Figure 1). This highlights the interest and significant activity of researchers in studying the interaction between AI and BS.

Specific keywords such as 'artificial intelligence' on 'bariatric surgery' were used to identify primary studies focusing on the impact of AI on clinical outcomes. This review aims to synthesise relevant findings to provide a comprehensive perspective on the integration of AI into BS practices.

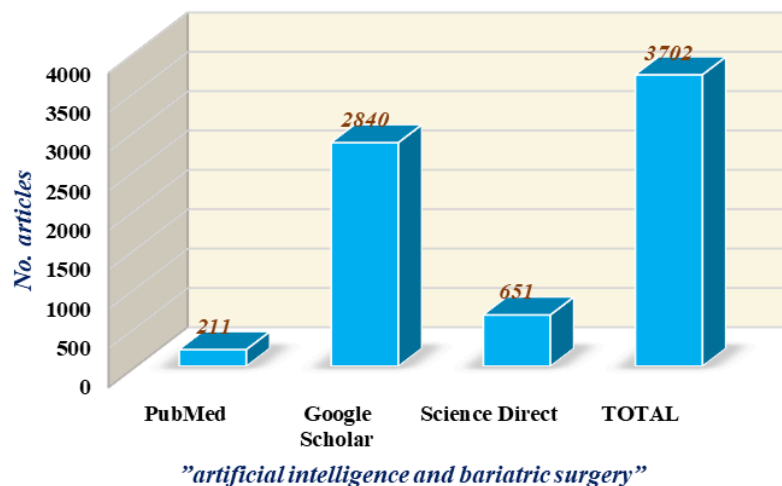


Figure 1. The number of articles in the main search engines.

Finally, 83 articles were included in this study. Inclusion criteria included primary studies focusing on the role of artificial intelligence in bariatric surgery, particularly studies reporting quantitative outcomes or patient quality-of-life assessments. Only peer-reviewed articles written in English were considered. Exclusion criteria included reviews, conference proceedings, case reports, theses, symposia, and posters to ensure a focus on high-quality original research.

Due to the heterogeneity of the studies, narrative synthesis was considered the most appropriate approach. The results are summarised through a multidisciplinary approach that

explores the role of AI in optimising bariatric surgery procedures, besides its impact on the health of people that suffer from morbid obesity. Consequently, this review offers an extensive understanding of the advanced technologies and surgical procedures' alignment. Moreover, there is a focus on the research's importance to be continued.

3. The role of AI in the medical field

Recently, AI has gained greater relevance in medicine (Chang et al., 2019) and it can be referred to as "medical technology," because it helps the medical staff to provide diagnoses accurately and timely, and reduces difficulties and errors (Salomon, & Olivier, 2024). These applications cover the anticipation of some results after surgery, risks evaluation, analysis of the patient's data, and surgical planning. AI can also boost the diagnostic's accuracy, safety of the patients, and disease progression monitoring. Thus, it becomes a key instrument in perioperative medicine and other areas of modern medicine (Bellini et al., 2022; Thomas, 2021).

It has been shown that AI utilization is beneficial across various medical fields (Table 1), like cardiology, pulmonology, neurology, nephrology, gastroenterology, endocrinology, oncology, and surgery (Bellini et al., 2022; Delclaux, 2019; Huang, Chan, & Dong, 2017; Mortazavi et al., 2016; Niel, Boussard, & Bastard, 2018; Salomon, & Olivier, 2024; Yang, & Bang, 2019). In order to discover the most relevant issues, so they can be addressed, AI calls for an active collaboration between computer scientists, clinicians, and other healthcare specialists. It has been found that AI is being investigated in various cardiology domains, from clinical decision support systems to imaging interpretation (Koulaouzidis et al., 2022). For example, AliveCor's Kardia app helps patients measure their electrocardiograms by quickly comparing them to a large database to diagnose atrial fibrillation (Salomon, & Olivier, 2024). In the field of endocrinology, continuous glucose monitoring gives diabetes patients the ability to visualize real-time interstitial glucose values, thereby improving their health management (Dixon et al., 2012; Lawton et al., 2018).

Table 1. Applications of artificial intelligence across medical fields.

AI	Medical fields	Aspects	References
Applications of AI	The cardiovascular system	Predicts the risk of cardiovascular conditions, such as heart failure or acute coronary syndrome.	(Huang, Chan, & Dong,, 2017; Mortazavi et al., 2016)
	Pulmonary medicine	Supports decision-making for pulmonary function evaluates and improves interpretation.	(Delclaux, 2019; Salomon, & Olivier, 2024)
	Cardiology	The Kardia app allows easy self-measurement of ECGs, facilitating rapid diagnosis of atrial fibrillation.	(Salomon, & Olivier, 2024)
	Nephrology	Helps predict a reduction in glomerular filtration rate in polycystic kidney disease.	(Geddes et al., 1998; Niel, Boussard, & Bastard, 2018; Salomon, & Olivier, 2024)
	Endocrinology	Enables diabetes patients to track real-time interstitial glucose levels and understand changes in blood glucose trends.	(Dixon et al., 2012; Lawton et al., 2018; Salomon, & Olivier, 2024)

	Gastroenterology	By using convolutional neural networks and other deep learning models, endoscopic and ultrasound images can be analysed, detecting abnormalities such as colorectal polyps.	(Fernández-Esparrach et al., 2016; Salomon, & Olivier, 2024; Yang & Bang, 2019)
	Surgery	Robotic technology enables operations with increased precision.	(Salomon, & Olivier, 2024)
Algorithms used	All medical fields	ML DL CNN	(Bar et al., 2020; Bellini et al., 2022; Chapalain, & Huet, 2019; Hashimoto et al., 2020; Marshall et al., 2017; Zhou et al., 2020)
Benefits	All medical fields	AI optimises treatment plans, improves diagnostic accuracy, and reduces postoperative complications.	(Salomon, & Olivier, 2024; Thomas, 2021; Vearrier et al., 2022)
Risks	All medical fields	In healthcare, AI presents data privacy issues. Thus, it requires validation and standardisation, it raises problems of professional replacement. Involves high costs, requires advanced training, and is limited by insufficient data for continuous learning.	(Salomon, & Olivier, 2024)
Technological tools	All medical fields	Includes portable data collection devices, patient monitoring software, and data analysis platforms.	(Briganti, & Le Moine, 2020; Dixon, et al., 2024; Thomas, 2021; Vearrier, et al., 2022)

AI – artificial intelligence; ECG – electrocardiogram; EM - emergency medicine; ML - machine learning; DL - deep learning; CNN - convolutional neural networks.

In nephrology, AI can be used to improve clinical care, hemodialysis prescriptions, and the monitoring of transplant recipients (Niel, & Bastard, 2019). It has also proven useful for predicting declines in glomerular filtration rate in patients with polycystic kidney disease and for assessing the risks of progressive IgA nephropathy (Geddes et al., 1998; Niel, Boussard, & Bastard, 2018). In gastroenterology, the use of convolutional neural networks for processing endoscopic and ultrasound images allows for the detection of abnormal structures, such as colon polyps, contributing to the early diagnosis of conditions (Fernández-Esparrach et al., 2016; Yang, & Bang, 2019). In modern surgery, robotic technology provides a high level of precision that reduces risks for patients because it facilitates less invasive procedures (Salomon, & Olivier, 2024).

In healthcare, AI presents data privacy issues. Thus, it requires validation and standardisation, and it raises problems of professional replacement. It involves high costs, requires advanced training, and is limited by insufficient data for continuous learning (Salomon, & Olivier, 2024). One of the key challenges in adopting AI in healthcare is the high cost, which limits access, especially in regions with fewer resources. To make AI more accessible, adopting open-source or cloud-based solutions can reduce infrastructure costs. Additionally, governments and international organisations should provide funding and grants for resource-limited hospitals and clinics. Public-private partnerships could help further reduce costs, ensuring that AI technologies are

available to all, regardless of socioeconomic status. Education and ongoing training programs for healthcare professionals will also be essential to bridge knowledge gaps and ensure equitable adoption of AI.

ML and DL algorithms enable efficient data processing, contributing to the personalisation of patient care and reducing postoperative complications (Thomas, 2021; Vearrier et al., 2022). However, challenges related to data privacy, the need for validation and standardisation of AI tools, as well as the worry that one day AI could take the place of medical professionals, provide a major impediment to adopt the new technology (Salomon. & Olivier, 2024). In spite of these obstacles, future trends recommend that AI be integrated into patient monitoring, which can change how they engage with the healthcare system (Delclaux, 2019; Huang, Chan, & Dong, 2017). In order to guarantee AI's successful integration into medical practice, it is important to adopt a balanced approach that takes into account the benefits but also the concerns of healthcare professionals. In this context, it is necessary to have a thorough analysis of the ethical and legal challenges, including data confidentiality, algorithmic bias, and transparency in decision-making processes. The potential impact on employment in the healthcare sector and the responsibility for decisions assisted by AI have to be carefully taken into consideration. While encouraging the integration of AI effectively and responsibly, it is essential to have a well-defined structure and robust policies to protect the rights of patients and medical professionals.

4. Artificial Intelligence in bariatric surgery

Medical technologies based on AI rapidly evolve into practical solutions for clinical practice (Briganti & Le Moine, 2020), contributing to the improvement of patient selection processes, risk assessment, and personalised treatment recommendations (Figure 2). AI is able to identify the most suitable patients for specific procedures or treatments, in this way reducing risks and maximising the chances of success (Aderinto et al., 2023). It can ensure this by analysing genetic factors, lifestyle, medical history, and other patient data. In terms of risk assessment, AI can calculate personalised probabilities of complications or side effects, allowing doctors to make more informed decisions. In addition, through personalised treatment recommendations, AI supports the adaptation of therapy to each patient's specific needs, thus optimising the dose, type, and duration of treatment based on individual patient characteristics (Dixon et al., 2024).

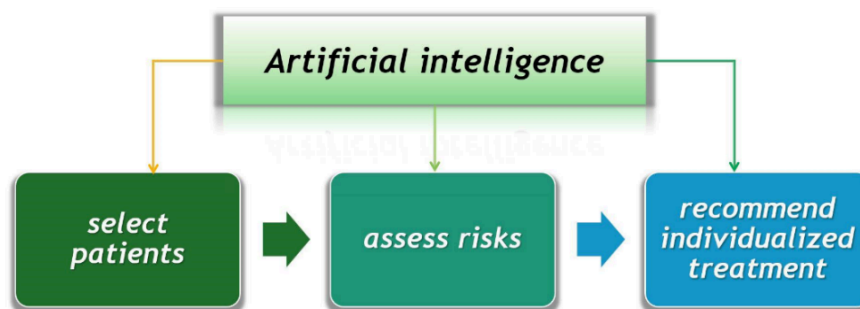


Figure 2. The role of artificial intelligence in personalising and optimising medical treatments.

In surgical applications, augmented reality (AR) is increasingly becoming essential in preoperative planning. By integrating 3D imaging and patient-specific data, AR enables surgeons to simulate the procedure, providing a clearer understanding of the anatomical landscape. Additionally, with the use of three-dimensional (3D) reconstruction and virtual reality (VR), psychological support can be offered to bariatric patients, enhancing body image satisfaction, and improving interventional outcomes (Assaf et al., 2024; Wake et al., 2019). Similarly, Computer Vision, a form of ML, has been successfully applied to evaluate surgical performance. Hashimoto et al. (2019) demonstrated that AI algorithms could identify the operative steps in laparoscopic gastrectomy with

a precision of 85.6%, improving performance assessment and standardising surgical procedures (Hashimoto et al., 2019). In BS, AI algorithms can identify patients at risk of insufficient weight loss, which affects 10% to 30% of cases (Bellini et al., 2022; Dixon et al., 2024). This application supports complex clinical decisions by personalising treatment plans and managing associated comorbidities in real time. Furthermore, Nadal et al. (2024) highlighted AI's ability to predict the success of RYGB surgery in terms of weight loss at one year post-intervention, demonstrating its value in optimising postoperative outcomes.

AI-based predictive analysis uses advanced algorithms and ML techniques to examine large volumes of patient data, including medical history, demographic information, and treatment outcomes. These algorithms can identify patterns and correlations, providing accurate forecasts about patient trajectories, often more effectively than traditional methods. However, the literature presents a lack of direct evidence regarding the impact of these modern techniques on patient outcomes, with most studies focusing on the technical aspects of the algorithms (Dixon et al., 2024; Shan, 2024; Thomas, 2021).

AI algorithms also improve the safety and accuracy of BS procedures by identifying patients at risk of insufficient weight loss, which affects up to 30% of patients. This identification facilitates complex decision-making, enabling appropriate dosing based on each patient's specific parameters, and aiding real-time management of associated comorbidities (Bellini et al., 2022; D. Dixon et al., 2024). AI can optimise clinical decision-making processes and help reduce the risks associated with surgical interventions. However, its measurable impact on surgical outcomes needs to be supported by concrete evidence and case studies. In a recent study, Fuentes et al. (2024) stated that AI significantly improved the accuracy of complication prediction with a 25% improvement over traditional methods and reduced intraoperative errors by 18%. Another example comes from the study by Dixon et al. (2024), which demonstrates improved surgical precision through AI-guided imaging, significantly reducing operational time and the risk of error.

Moreover, quantitative data, such as the findings from Bellini et al. (2022), suggest that AI can reduce postoperative recovery time by up to 30%, thanks to precise monitoring and personalised treatment adjustments. Risk factors vary and include socio-economic aspects and characteristics of the microbiome. Creating an algorithm capable of assessing individual risks would contribute to more informed decision-making for both patients and surgeons (Bektaş et al., 2022). AI and robotic systems improve the overall quality of interventions, reducing the risks of surgical errors by performing complex tasks with greater accuracy and consistency compared to humans (Shan, 2024).

By improving preoperative planning, increasing precision during procedures, and optimising postoperative care, AI can yield better outcomes for patients, such as higher success rates, fewer complications, and faster recoveries (Abdulabbas, 2024; Aderinto et al., 2023; Shan, 2024). While AI and robotic systems can improve surgical outcomes, high costs can limit their affordability. It is also necessary that these technologies are available to all patients, regardless of socioeconomic status (Shan, 2024). These technologies must be accessible to all patients, irrespective of socioeconomic status. Governments and international organisations must step in to ensure equitable distribution. Furthermore, advanced technologies have proven promising in supporting the diagnosis and prognosis of cancer by clinicians (Kumar et al., 2023). Mathematical algorithms allow computers to perform tasks that require human intelligence, with varied applications ranging from natural language processing to image recognition (Bignami et al., 2021; Yoon et al., 2022). In bariatrics, AI and ML play an increasingly significant role in modern medicine, including in perioperative management, contributing to the optimisation of patient care at every stage, from preoperative assessment and health optimisation to intraoperative monitoring and precise drug dosing (Bignami et al., 2021). Therefore, these technologies contribute to reducing risks and improving postoperative outcomes, facilitating precision medicine tailored to the individual needs of patients (An, Shen, & Xiao, 2022; Bektaş et al., 2022; Bellini et al., 2022; Dixon et al., 2024; Jaki et al., 2024). Recent studies demonstrate that ML algorithms outperform traditional statistical

methods and are effective at all stages of bariatric patient care, from preoperative assessment to intraoperative monitoring and prediction of postoperative outcomes (Bellini et al., 2022; Dixon et al., 2024).

5. The role of bariatric surgery in the treatment of severe obesity

BS plays a crucial role in combating morbid obesity, facilitating significant weight loss, and addressing associated comorbidities (Adams et al., 2007; Buchwald et al., 2004; Chang et al., 2014; Schauer et al., 2017; Syn et al., 2021), which reduces mortality, decreases the risk of cardiovascular diseases, corrects metabolic disorders, and improves the patient's quality of life (Bektaş et al., 2022; Dhahri et al., 2009). Obesity is a major public health problem globally, which in 2014 had an estimated prevalence of 13% among adults (Nguyen, & Varela, 2017) being recognised as a leading cause of death worldwide (An, Shen, & Xiao, 2022). This is a multifactorial condition that has steadily increased over the past two decades (Wimalawansa, 2014), with a prevalence of approximately 36% among adults over 20 years old in the United States (Figure 3). Thus, obesity represents a significant challenge globally, with serious implications for the physical and mental well-being of the population (Arroyo-Johnson, & Mincey, 2016).

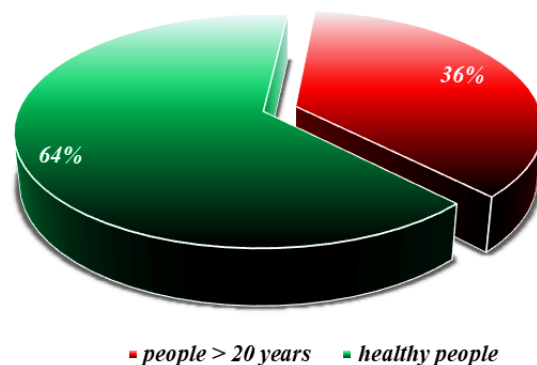


Figure 3. Obesity prevalence among US adults in 2016 (according to the data suggested by Arroyo-Johnson & Mincey, 2016).

Although obesity is prevalent in developed countries due to favourable social and economic conditions, in recent decades, developing countries have seen an increase in its prevalence, influenced by the adoption of the Western lifestyle (Nopour, 2024). In this context, BS proves to be the most effective obesity treatment, preferred over non-invasive options because visible results are obtained in a shorter time (Angrisani et al., 2015). It has been found that there are various bariatric surgeries to treat severe obesity. SG involves reshaping the stomach into a tubular form through laparoscopy, reducing gastric volume (Aderinto et al., 2023). This procedure limits food intake and appetite-stimulating hormones, therefore facilitating significant short-term weight loss (Brethauer, 2011). Studies show a considerable reduction in weight and BMI in patients six, twelve, and twenty-four months after surgery (Melissas et al., 2008). Although there is a risk of weight regain, most patients manage to maintain their weight loss after the procedure (Brajcich, & Hungness, 2020).

Gastric bypass is a multi-stage procedure that creates a small pouch at the top of the stomach, directly connected to the small intestine. This limits the amount of food eaten and reduces calorie intake, achieving high success rates in improving comorbidities and weight loss (Adams et al., 2012; Aderinto et al., 2023). The Lap-Band procedure involves placing an adjustable band around the stomach, helping to reduce appetite. Biliopancreatic diversion with duodenal switch combines SG and biliopancreatic diversion, limiting food intake and nutrient absorption, and is remarkably effective for weight loss. All the same, by using it there is a greater risk of malnutrition. Therefore, each procedure requires consultation with a specialist to determine the most suitable option. In this context, the characteristics, success rates, and complications specific to each

intervention are considered, as a result providing valuable solutions for patients with severe obesity (Aderinto et al., 2023; Perrotta et al., 2024).

Because of the complexity of BS procedures, it requires thorough preoperative planning, precise execution during the procedure, and adequate postoperative care. AI technologies, including ML and DL, as well as robotic systems, have shown significant potential in optimising these processes in BS (Dixon et al., 2024; Shan, 2024). AI can improve preoperative assessments, provide real-time support during surgical interventions, and contribute to more efficient postoperative care. This leads to a reduction in complications and more favorable patient outcomes (Shan, 2024). AI combined with advanced imaging techniques provides a detailed understanding of patient anatomy and the identification of anatomical variations, improving the interpretation of imaging results. These technologies facilitate surgical planning by creating accurate and personalised models of the gastrointestinal system. By using AI-based predictive models and patient data, surgeons can develop individualised surgical plans, optimising interventions for each patient (Shan, 2024).

Although patients' quality of life improves, approximately 20% of those who undergo surgery experience various long- or short-term complications (Coblijn et al., 2014). These complications can include metabolic and nutritional conditions (Malinowski, 2006), as well as issues such as fistula, stenosis, ulcer, intestinal obstruction (Kim et al., 2023), bleeding (Kollmann et al., 2024), tachycardia, peritonitis, hernia, gastric erosion, deep vein thrombosis, pneumonia, malnutrition, liver and bile disorders, and in rare cases, mortality (Gagnon, & Sheff, 2012; Nopour, 2024). In 2019, Fritz et al. developed a convolutional neural network model to predict 30-day mortality after surgery. The model integrated 54 preoperative parameters, including laboratory test results and patient characteristics, as well as 28 intraoperative variables. Compared to other algorithms, such as DL, random forest, and logistic regression, the convolutional neural network model demonstrated the best performance, especially when fed with time-series data (Fritz et al., 2019).

6. Assessment and eligibility criteria for surgical interventions

To prevent adverse events after surgery and to facilitate comparisons between therapies, the development of standardised tools for outcome assessment is necessary (Domenghino et al., 2023). The choice of weight loss procedure depends on factors such as age, medical history, technique chosen, associated health conditions, and body mass index (BMI). The identification of a higher BMI often indicates the need for more complex interventions, such as gastric bypass. However, commitment to lifestyle changes, surgical risks, and patient preferences for permanent or reversible solutions are also important (Aderinto et al., 2023). These tools need to be accepted across different healthcare systems and be relevant to both providers and patients (Domenghino et al., 2023). It was found that BS is not recommended for people with a BMI below 35 kg/m² without other comorbidities (Aderinto et al., 2023; Cummings, & Cohen, 2014). Moreover, each weight loss procedure is adapted to different patient profiles. SG offers a less complex option with lower risk and quick recovery, making it ideal for resource-constrained settings. Instead, gastric bypass is indicated for patients with a higher BMI or people who have failed to lose weight with less invasive methods. All the same, it carries risks such as marginal ulcers and dumping syndrome. Patients taking NSAIDs for arthritis may benefit more from this procedure but must take daily multivitamin supplements. Therefore, in the patient selection process, it is essential to consider perioperative risks such as nutritional deficiencies and anastomotic leaks (Aderinto et al., 2023).

A crucial role in ensuring patient safety in BS is played by the multidisciplinary team, starting with counseling and education about the options and risks of the intervention. Informed consent is obtained, and the medical history is updated before the procedure. Cancellations are possible for various reasons, such as unstable conditions or pregnancy. During the operation, the team is prepared for potential challenges, and postoperatively, the patient receives continuous monitoring and follows a well-established nutritional plan (Aderinto et al., 2023). Postoperative follow-up also involves a multidisciplinary approach, involving clinicians as well as psychologists

and nutritionists who assess progress and support lifestyle changes, focusing on nutritional and psychosocial support, which is essential for long-term success (Aderinto et al., 2023; Bettini et al., 2020). In this context, the experience of the bariatric surgeon is critical to minimise complications and achieve optimal results. A careful evaluation of these aspects is fundamental for personalising the weight loss procedure (Aderinto et al., 2023).

7. Innovative and research-based bariatric procedures

In addition to established interventions, emerging procedures in BS are introducing significant innovations. Recent methods, such as different types of intragastric balloons, offer significant solutions for patients, especially those looking for alternatives to traditional treatments. Among these emerging interventions are the intragastric balloon, the heliosphere balloon, and the Spatz gadget (Aderinto et al., 2023), all used to bridge the gap in obesity treatment and facilitate preoperative weight loss and largely replace invasive procedures (Al-Momen, & El-Mogy, 2005; Vantanisiri et al., 2020). The intragastric balloon is a minimally invasive device filled with saline. Although associated with some gastrointestinal adverse effects, it has shown significant results in weight loss in patients with a BMI between 30 and 40 kg/m² (Aderinto et al., 2023). It acts as a temporary aid in treating obesity by helping to reduce food intake and appetite (Fernandes et al., 2007; Silva, & Neto, 2022).

Moreover, the air-filled heliosphere balloon commonly used as a preoperative treatment has been found to be better tolerated, resulting in an average weight loss of 12.66 kg over 6 months. The Spatz Gadget, an adjustable intragastric balloon, produces an average loss of 15% of total body weight, yielding the best results when combined with behavioural and dietary changes (Aderinto et al., 2023). Another device, AspireAssist, allows patients to aspirate gastric contents 20 minutes after a meal (Norén, & Forssell, 2016), resulting in a significant weight loss of 12.1%. Even so, further research is needed to assess its long-term effects. Finally, endoscopic SG presents itself as a minimally invasive solution with promising results in improving comorbidity and weight reduction, demonstrating a favorable safety profile. These interventions offer valuable options for obesity management, but further research is critical to assess their long-term efficacy and safety (Aderinto et al., 2023). Furthermore, we believe that integrating AI into bariatric surgery can revolutionise how these interventions are managed. By using AI to analyse surgical workflows and optimise procedures, long-term success rates for patients can be improved. AI can play a crucial role in preoperative assessment, risk prediction, and postoperative monitoring, enabling greater personalisation of treatment and improved outcomes. For example, recently, AI methods such as convolutional neural networks have shown promise in predicting postoperative complications and assessing short- and long-term outcomes (Fritz et al., 2019). By integrating these technologies into surgical practice, healthcare providers can enhance clinical decision-making, thereby advancing our contribution to bariatric surgery and obesity management.

8. The role of diet after bariatric surgery

Assessing the nutritional status of candidates for BS before surgery is crucial for postoperative management (Bettini et al., 2020). Patients with severe obesity often suffer from micronutrient deficiencies. A study conducted in 2008 by Aasheim et al. compared 110 obese patients with 58 normal-weight subjects, concluding that obese individuals had significantly lower levels of vitamins A, B6, C, 25-hydroxyvitamin D, and E (Aasheim et al., 2008). After surgery, patients need to receive periodic counseling from a registered dietitian to maximise the outcomes of the bariatric procedure and minimise the risk of regaining weight (Bettini et al., 2020). Detailed preprocedural nutritional education, appropriate patient selection, and postoperative nutritional monitoring, along with patient adherence to guidelines (Elliot, 2003), can prevent the risk of malnutrition, one that is associated with all BS. It remains the most effective solution (Panteliou, & Miras, 2017; Wilson, 2020), even though there are many options for losing weight, including most moderate diets with calorie restriction, cognitive-behavioural therapies, pharmacotherapy, and

increased physical activity. The awareness of this intervention's systemic benefits has grown over the past two decades. Improvements in the safety and expansion of laparoscopic techniques had a great contribution to the popularity of systemic benefits. Mortality and coexisting diseases correlated with obesity, such as type 2 diabetes, hypertension, osteoarthritis, coronary artery disease (Liu et al., 2021), and obstructive sleep apnea (Jehan et al., 2017), are considerably better after the intervention. Weight loss mechanisms go beyond food restriction and nutrient absorption, encompassing changes in hunger levels and food preferences. Despite that, less than 1% of adults with obesity benefit from BS (Panteliou, & Miras, 2017). It is essential to improve BS access and develop safer treatments as obesity rates rise globally. The future of BS is shaped by advances in AI, with possible applications in personalised care and nutritional management (Lee et al., 2024).

Continued advances in AI and further studies will shape the role of these tools in research as well as applications in BS, particularly in the development of domain-specific models (Lee et al., 2024). AI holds significant promise for improving the precision of bariatric surgery and post-surgical care. It can support preoperative assessments, refine intraoperative decision-making, and personalize postoperative care (Dixon et al., 2024). However, ethical concerns, transparency, and cost remain challenges for widespread adoption. AI algorithms must be transparent, ensuring accountability for outcomes and maintaining trust (Shan, 2024).

Although these challenges, AI's potential to improve outcomes is undeniable. It can reduce surgical risks, optimize perioperative management, and offer personalised nutritional plans (Aderinto et al., 2023). AI can also predict postoperative complications like malnutrition, enabling tailored interventions to enhance recovery. As AI evolves, it has the potential to transform bariatric surgery into a more personalised, effective treatment for obesity.

Looking ahead, AI research continues to advance rapidly, and its applications in BS are likely to become even more sophisticated. As technologies such as DL and natural language processing develop, algorithms are expected to analyse patient data more efficiently and predict complications with much greater accuracy. Moreover, the integration of AI with robotics will allow surgeons to perform bariatric interventions with exceptional precision, thereby reducing the risks associated with traditional surgeries and accelerating patient recovery. Through better postoperative monitoring and dynamic adjustment of treatments, AI could further improve the long-term quality of life of patients, decreasing complications. Another important aspect of the future of AI in bariatric surgery is improving the accessibility and scalability of these technologies, allowing their use in resource-limited countries. These advances will have a significant impact on the management of obesity worldwide, a major public health problem affecting millions of people.

9. Limitations

High costs and the need for specific training for healthcare professionals are major barriers. In addition, professional acceptance can be difficult, with some doctors reluctant due to a lack of familiarity with advanced technology. Legal and regulatory challenges also arise, especially regarding data privacy, the responsibility for AI-assisted decisions, and ensuring transparency in algorithmic processes. These limitations highlight the need for ethical and sustainable solutions for integrating AI into medicine.

10. Conclusion

In conclusion, AI has a significant role in BS as it improves diagnostic accuracy, enables faster patient monitoring, and improves treatment outcomes. By integrating interdisciplinary technologies, AI contributes to safer and more personalised patient care. ML can help reduce morbid obesity and predict postoperative complications. However, the use of AI in BS faces critical challenges. Current models are limited by data variability, integration issues, and the need for validation in clinical settings. Additional research is needed to ensure the robustness and generalisability of these technologies. Practical recommendations for optimising AI in BS include

conducting further research to refine and validate AI algorithms, training clinicians to interpret and apply AI insights, and developing standardised protocols.

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