Journal of Pioneering Medical Sciences
Received: September 11, 2025 | Accepted: November 07, 2025 | Published: December 05, 2025
Volume 14, Issue 11, Pages 85-91

DOI https://doi.org/10.47310/jpms2025141114

Bariatric Surgery and Glucagon-Like Receptor-1 Agonists' Effects on Weight, HbA1c and Cardiovascular Outcomes: A Meta-Analysis

Salah Alghamdi[1*]
[1]Department of Surgery, Faculty of Medicine, University of Tabuk, Tabuk, Saudi Arabia

Author Designation: [1]Associate Professor

*Corresponding author: Salah Alghamdi (e-mail: s.alghamdi@ut.edu.sa).

Abstract **Introduction:** Obesity is a highly prevalent chronic disease and is associated with high morbidity. Bariatric surgery is an effective, durable management. Glucagon-like receptor-1 agonists (GLP-1 agonists) showed high effectiveness in weight management with cardiac and renal benefits. Studies comparing bariatric surgery and GLP-1 agonists are scarce. This meta-analysis aimed to compare the effects of bariatric surgery and GLP-1 agonists on weight, HbA1c, major adverse cardiovascular events (MACE) and heart failure. **Methods:** We searched PubMed/, Google Scholar, Cochrane Library and Web of Science for relevant articles. We used the keywords bariatric surgery, sleeve gastrectomy, gastric bypass, gastric banding, GLP-1 agonists, twincretins, semaglutide, tirzepatide and liraglutide, MACE, acute coronary syndrome, fatal, myocardial infarction, stroke and non-fatal infarction. Out of the 1142 articles retrieved, 716 remained after duplication removal, 22 full texts were reviewed and 7 full texts were included in the final meta-analysis. **Results:** Bariatric surgery reduced the BMI more than GLP-1 agonists, Standard mean difference (SMD), -8.23, 95% CI, -11.02-5.45, with no differences regarding the HbA1c, MD, 0.08, 95% CI, -0.45-0.6. however, HbA1c was lower in bariatric surgery after eliminating heterogeneity, MD, -0.35, 95% CI, -0.37--0.32. The MACE was lower in bariatric surgery compared to GLP-1 agonists, odds ratio, 1.50, 95% CI, 1.13-1.98 (the result was similar after eliminating heterogeneity, odds ratio, 1.34, 95% CI, 1.15-1.56) and heart failure was lower in bariatric surgery compared to GLP-1 agonists, odds ratio, 1.87, 95% CI, 1.46-2.40. **Conclusion:** Bariatric surgery reduced weight, MACE and heart failure more than GLP-1 agonists, with similar effects on the glycated haemoglobin. Further larger clinical trials investigating the best GLP-1 and bariatric surgery in obesity and its comorbidities management.

Key Words Bariatric Surgery, GLP-1 Agonists, Weight, HbA1c, MACE, Heart Failure

INTRODUCTION

Obesity is on the rise globally and is considered a chronic epidemic; the rising rates of obesity together with its comorbidities significantly impact the patient's quality of life and rising healthcare costs [1]. The aetiology is complex and involves genetic predisposition and unhealthy lifestyles in terms of lack of physical exercise and consumption of high-calorie foods [2]. The prevalence of obesity is 12.5% globally.

In the year 2022, 890 million people were obese and 2.5 billion were overweight (16% and 43% of the adult population, respectively). The projection for the year 2035 is 53% [3]. The obesity-associated mortality is high and obesity caused 3.7 million deaths in the year 2021, mainly due to cardiovascular and neurological disease, diabetes mellitus, chronic respiratory disease and obesity-related cancers [4].

Obesity management is challenging: Lifestyle effects are modest and short-term; in addition, most patients are non-adherent to lifestyle recommendations. Physical exercise, behavioural therapy and reduction of calorie intake are recommended as first line, but the maintenance of weight loss is challenging despite continuous monitoring and counselling [5]. Early drug therapies have low efficacy and safety concerns, including cardiac and psychiatric adverse events [6]. Glucagon-like peptide-1 receptor agonists (GLP-1 agonists) are introduced as antidiabetic medications and have shown high efficacy in weight reduction and glycaemic control. Tirzepatide is a GLP-1agonist and glucose-dependent insulinotropic polypeptide (GIP) with different combination receptor binding affinity and molecular structure [7,8]. These medications were approved for diabetes in 2014 and later approved for weight reduction and showed cardiovascular risk reduction [9].

Bariatric surgery has been performed as an effective treatment for obesity and related comorbidities. However, the

uptake is low and amounts to 0.01% of the world's population according to 2013 reports [10]. Bariatric surgery and GLP-1 agonists have the potential to curb obesity with good cardiovascular outcomes. GLP-1 agonists are paradigm shift in obesity trends and shifted the bariatric surgery to the sideway track, Dawwas *et al.* [8] conducted a study in the USA and showed 65% reduction in bariatric surgery following the approval of GLP-1 agonists, a plausible explanation could be the significant surge in GLP-1 agonist surge. The above observations supported Lin *et al.* [11] findings, other contributing factors for bariatric surgery reduction could be limited insurance coverage [12] and referral system [13]. Bariatric surgery might outperform GLP-1s in cardiovascular outcomes beyond weight loss because of high cost and gastrointestinal side effects that can lead to treatment cessation and weight regain [11]. The American Academy of Paediatrics Clinical Practice Guidelines endorsed bariatric surgery as an effective/safe treatment of obesity in adolescents in alignment with a 15% increase in bariatric surgery in this age group [14,15].

GLP-1 agonists are effective in weight reduction after regain following bariatric surgery [16,17]. In addition, GLP-1 agonists were effective adjuvant therapy for preoperative weight loss before bariatric surgery [18]. However, studies comparing bariatric surgery and GLP-1 agonists are limited by a small sample of the included studies and do not include all obesity comorbidities [19-22].

Objectives

We aimed to compare bariatric surgery and GLP-1 agonists in weight reduction, effects on HbA1c and cardiovascular outcomes.

METHODS

We conducted this meta-analysis in August and September 2025 and we strictly followed the PRISMA Guidelines.

Inclusion Criteria

Prospective, retrospective, clinical trials and case-control studies must compare GLP-1 agonists and bariatric surgery outcomes. However, we included only retrospective studies.

Exclusion Criteria

Commentaries, grey literature, opinions, letters to the Editors, case reports and study protocols were excluded.

Population

All patients with obesity/diabetes who received GLP-1 agonists in comparison with bariatric surgery.

Intervention

Different bariatric surgery procedures and GLP-1 agonists.

Outcome Measures

The outcome measures were the effect of bariatric surgery on body mass index, HbA1c, heart failure and major cardiovascular adverse events (MACE). MACE is defined as nonfatal stroke, non-fatal myocardial infarction and cardiovascular death.

Literature Search

We systematically searched PubMed/MEDLINE, Google Scholar, Cochrane Library and Web of Science for relevant articles that assessed the effects of bariatric surgery and GLP-1 agonists on HbA1c, body mass index and MACE. The keywords used were bariatric surgery, sleeve gastrectomy, gastric bypass, gastric banding, GLP-1 agonists, GIP agonists, semaglutide, tirzepatide and liraglutide, MACE, acute coronary syndrome, myocardial infarction and stroke with Boolean "AND" and "OR". Out of the 1142 articles retrieved, 716 remained after duplication removal, of them, 22 full texts were reviewed and 7 full texts were included in the final meta-analysis.

Data Extraction

The first author's name, year of publication, country, study type, study duration, number of participants in bariatric surgery and GLP-1 agonists and body mass index were entered in an Excel sheet. Figure 1 and tables 1 and 2.

Type of Surgery and GLP-1 Agonists

The type of bariatric surgery differs widely and included Sleeve gastrectomy, gastric bypass, banding and the GLP-1 agonists used were Liraglutide, Exenatide, Lixisenatide, dulaglutide and semaglutide.

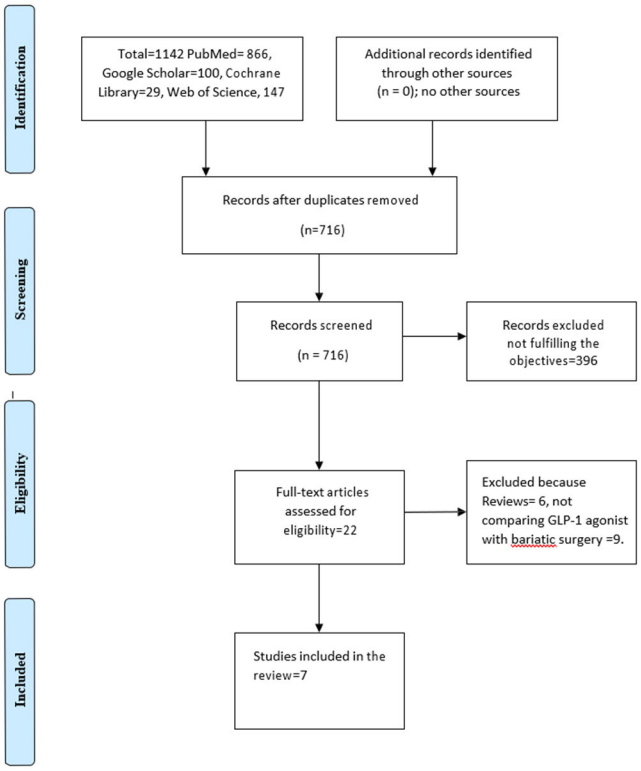

Figure 1: Literature search showing a comparison between bariatric surgery and GLP-1 agonists regarding the effects on HbA1c and cardiovascular outcomes (The PRISMA Chart)

Table 1: Basic characteristics of the included studies

Author	Study type	Country	Age/ bariatric, GLP-1 agonists	Female	Study duration/ years	Bariatric Surgery	GLP-1 agonists
Cotugno *et al.* 2015 [23]	Retrospective	Italy	47 ±8 vs. 56 ± 9	Not mentioned	1	Roux-en-Y gastric bypass or sleeve gastrectomy	Liraglutide
Dicker *et al.* 2024 [24]	Retrospective	Israel	50.9±9.52 vs. 51.1±9.54	64.9 %vs. 64.9%	1	Sleeve gastrectomy, gastric bypass, banding	Liraglutide, Exenatide, Lixisenatide, dulaglutide
Stenberg *et al.* 2024 [10]	Retrospective	Sweden	52.0±8.76 vs. 51.8±10.9	52.5% vs. 51.7%	7.1	Roux-en-Y gastric bypass or sleeve gastrectomy	Not specified
Wolff Sagy *et al.* 2025 [26]	Retrospective	Israel	52.2 ± 9.26 vs. 52.4 ± 9.30	61.1% vs 61%	12.9	Sleeve gastrectomy, gastric bypass, banding	Liraglutide, Exenatide, Lixisenatide, dulaglutide
Wu *et al.* 2022 [27]	Retrospective	China	48.7±0.6 vs. 52.7±0.2	52.2% vs.42.2%	1	No specified	Not specified
Adekolu *et al.* 2023 [28]	Retrospective	USA	>18	74%	10	Not specified	Not specifies
Stenberg *et al.* 2023 [9]	Retrospective	Sweden	51.1 ± 9.29 vs. 51.5 ± 8.92	64.4% vs. 64.8%	8.92	Sleeve gastrectomy, gastric bypass	Liraglutide, Exenatide, Lixisenatide, dulaglutide, semaglutide

Table 2: Body mass index, HbA1c and major cardiovascular adverse events in patients who received bariatric surgery and glucagon receptor-1 agonists

Author	Heart failure	MACE in bariatric surgery	MACE in GLP-1 agonists	BMI/bariatric, GLP- 1 agonists before	BMI/ bariatric, GLP- 1 agonists after	HbA1c, GLP-1 agonists before	HbA1c, GLP-1 agonists after	Number of patients
Cotugno *et al.* 2015 [23]	Not assessed	Not assessed	Not assessed	44 ± 7 Vs. 40±4	30.1±3.87 Vs. 30.25±0.3 1	Not assessed	Not assessed	25 vs. 25
Dicker *et al.* 2024 [24]	Not assessed	110	167	41.5±5.1 vs. 41.2±5.2	40.7±5 vs 40.7±5.1	7.5±1.5 Vs. 9.1±1.7	7.65±1.55 vs. 9.15±1.65	3035 vs. 3035
Stenberg *et al.* 2024 [10]	Not assessed	191	247	40.2±5.00 vs. 40.2±5.61	30.8±0.76 vs. 38.1±2.13	7.9±3.7 vs. 8.0±3.6	6.7±3.4 vs. 7.7±3.6	2039 vs. 2039
Wolff Sagy *et al.* 2025 [26]	Not assessed	Not assessed	Not assessed	41.7 ± 5.04 vs. 41.4 ± 5.16	28.7 ± 4.85 vs. 35.3 ± 5.87	6.24±1.1 8 vs. 7.69±1.7	5.72±0.85 vs. 6.82±1.17	3,178 vs. 3,178
Wu *et al.* 2022 [27]	Not assessed	Not assessed	Not assessed	37.32±0.1 5 Vs. 34.90±0.2 1	31.86±0.1 6 vs. 34.79±0.2 2	Not assessed	Not assessed	278 vs. 528
Adekolu *et al.* 2023 [28]	1650 vs. 3233	1650	3233	>35	Not assessed	Not assessed	Not assessed	118,828 vs. 118,828
Stenberg *et al.* 2023 [9]	24 vs. 34	113	130	40.8 ± 5.49	Not assessed	Not assessed	Not assessed	2161 vs. 2161

MACE: Major adverse cardiovascular events GLP-1 agonists: Glucagon like receptor-1 agonists BMI: Body mass index

Table 3: The risk of bias of the retrospective studies (Newcastle Ottawa Scale)

Author	Selection	Compatibility	Outcome	Score
Cotugn *et al.* 2015 [23]	4	2	2	8
Dicker *et al.* 2024 [24]	4	2	3	9
Stenberg *et al.* 2024 [10]	4	2	3	9
Wolff Sagy *et al.* 2025 [26]	4	2	2	8
Wu *et al.* 2022 [27]	4	2	2	8
Adekolu *et al.* 2023 [28]	2	1	2	5
Stenberg *et al.* 2023 [9]	3	2	2	7

Table 4: Analysis of the quality of evidence by Grading of Recommendations Assessment, Development and Evaluation (GRADE)

Outcome	Studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Certainty of evidence
BMI	5	Retro=5	serious	Serious (I^2=100%)	Not serious	Not serious	None	Very low
HbA1c	3	Retro=3	Serious	Serious (I^2=99%)	Not serious	Not serious	None	Very low
MACE	4	Retro=4	Serious	Serious (I^2=90%)	Not serious	Not serious	None	Very low
Heart failure	2	Retro=3	Serious	Not serious (I^2=34%)	Not serious	Not serious	None	Very low

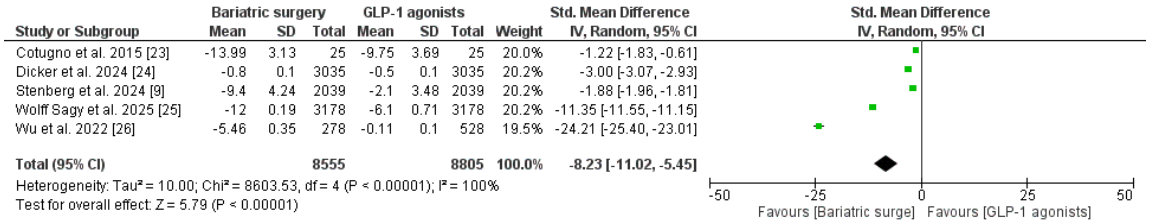

Figure 2: Body mass index in bariatric surgery and GLP-1 agonists

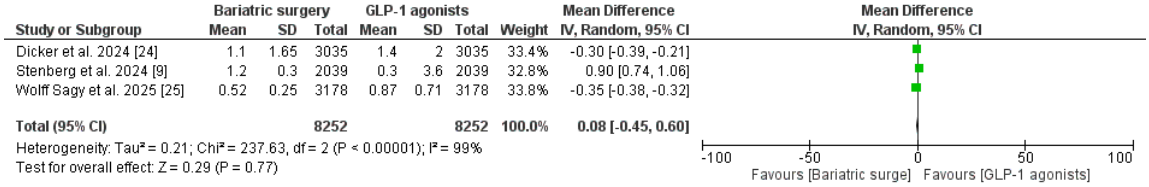

Figure 3: HbA1c in bariatric surgery and GLP-1 agonists

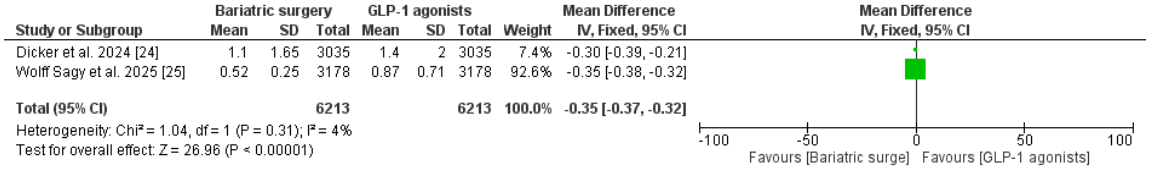

Figure 4: HbA1c in bariatric surgery and GLP-1 agonists

Quality Assessment of the Included Studies

The quality of the included studies was assessed using the Newcastle Ottawa Scale (17, all studies showed good quality except one) (Table 3).

Statistical Analysis

We used the Cochrane tool for meta-analysis (RevMan, version 5.4, Oxford, United Kingdom) for data analysis, the dichotomous and continuous data were entered and the data were analysed, odds ratio and standard differences were estimated at 95% confidence interval, the heterogeneity was assessed and considered significant when I^2 was 50% and the random effect was used, the fixed effect was used for I^2 <25%. Forest plots and funnel plots were generated, the Chi-Square test was assessed with mean differences and Z Scores. A subgroup analysis was conducted to eliminate studies with high contribution to heterogeneity. A p-value <0.05 was considered significant.

The Quality of Evidence

The quality of evidence is very low as shown in table 4.

RESULTS

Characteristics of the Included Studies

We included seven studies [9,10,23-27] (all retrospective) and 259338 patients, three were published Europe, one in the USA and three were conducted in Asia 52.5% to 74% were women and their ages ranged from 47 ±8 to 56 ± 9 years, the duration of the trials ranged from 1 to 12.9 years, the BMI ranged from 34.90±0.21 to 44±7KG/m2 and the HbA1c ranged from 6.24±1.18 to 9.1±1.7. Liraglutide was the most commonly used GLP-1 agonist and Roux-en-Y gastric bypass or sleeve gastrectomy were the most commonly used bariatric surgeries (Tables 1 and 2).

In the present meta-analysis, 5 studies compared the BMI of bariatric surgery and GLP-1 agonists [9, 23-26]; bariatric surgery reduced BMI more than GLP-1 agonists, Z=2.67, Standard mean difference (SMD), -8.23, 95% *CI*, -11.02-5.45 and P-value <0.001 and the standard difference=4. However, a significant heterogeneity was found, Chi-square, 8603.53, *I2* for heterogeneity=100% and P-value for heterogeneity <0.001 (Figure 2).

Bariatric surgery and GLP-1 achieved similar reduction in the HbA1c [9, 24. 25], Z=0.29, MD, 0.08, 95% *CI*, -0.45-0.6 and P-value, 0.77 and the standard difference=2. However, a significant heterogeneity was found, Chi-square, 237.63, *I2* for heterogeneity=99% and P-value for heterogeneity <0.001 (Figure 3). A subgroup analysis was conducted after removing the study with significant heterogeneity in which the HbA1c reduction was more in bariatric surgery, Z=26.96, MD, -0.35, 95% *CI*, -0.37--0.32 and P-value <0.001 and the standard difference=1. No significant heterogeneity was found, Chi-square, 1.04, *I2* for heterogeneity=4% and P-value for heterogeneity, 0.31. Figure 4.

Bariatric surgery showed less MACE compared to GLP-1 agonists [9,10,24,27], Z=2.83, odds ratio, 1.50, 95% CI, 1.13-1.98 and P-value, 0.005 and the standard difference=3. However, a significant heterogeneity was found, Chi-square,

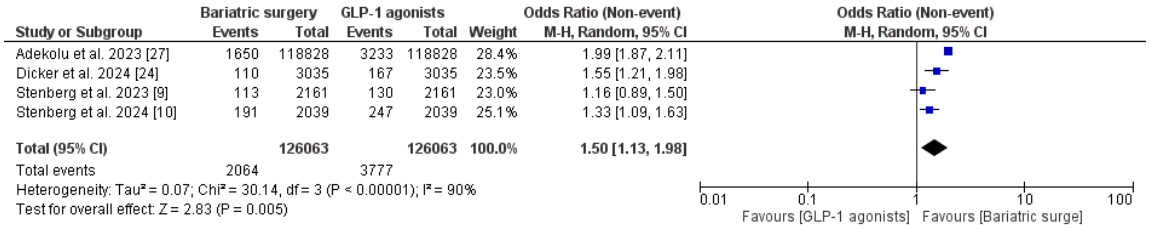

Figure 5: Major adverse cardiovascular events in bariatric surgery and GLP-1 agonists

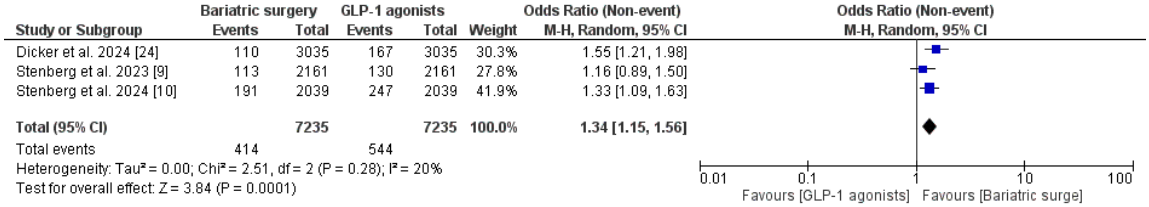

Figure 6: Major adverse cardiovascular events in bariatric surgery and GLP-1 agonists after removing Adekolu *et al.* [27]

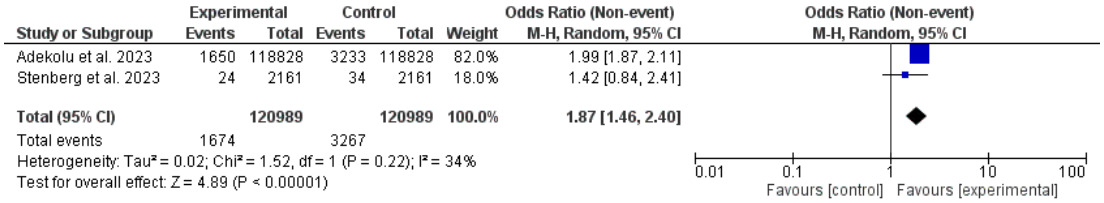

Figure 7: Heart failure in bariatric surgery and GLP-1 agonists

30.14, I2 for heterogeneity=90% and P-value for heterogeneity <0.001, MACE remained lower after removing the study with high contribution to heterogeneity, Z = 3.84, odds ratio, 1.34, 95% CI, 1.15-1.56 and P-value, 0.0001 and the standard difference=2. No significant heterogeneity was found, Chi-square, 2.51, I^2 for heterogeneity =20% and P-value for heterogeneity, 0.28 (Figure 5 and 6).

Similarly, heart failure was lower in bariatric surgery group, Z = 4.89, odds ratio, 1.87, 95 % CI, 1.46-2.40 and P-value <0.001 and the standard difference =1, no significant heterogeneity was found, Chi-square, 1.52, I2 for heterogeneity =34% and P-value for heterogeneity, 0.22 (Figure 7).

DISCUSSION

In this meta-analysis, Bariatric surgery reduced the BMI more than GLP-1 agonists, Standard mean difference (SMD), -8.23, 95% CI, -11.02-5.45, with no differences regarding the HbA1c, MD, 0.08, 95% CI, -0.45-0.6. However, HbA1c was lower in bariatric surgery after eliminating heterogeneity, MD, -0.35, 95% CI, -0.37--0.32. The MACE was lower in bariatric surgery compared to GLP-1 agonists, odds ratio, 1.50, 95% CI, 1.13-1.98 (the result was similar after eliminating heterogeneity, odds ratio, 1.34, 95% CI, 1.15-1.56) and heart failure was lower in bariatric surgery compared to GLP-1 agonists, odds ratio, 1.87, 95% CI, 1.46-2.40. Our findings were similar to those of Sarma *et al.* [19], who conducted a meta-analysis and found higher weight reduction in the bariatric surgery group compared to GLP-1 agonists. Sarma *et al.* [19] found higher HbA1c in bariatric surgery; we found a comparable effect of bariatric surgery and GLP-1 agonists on HbA1c. Importantly, we found lower HbA1c in bariatric surgery after removing studies with significant heterogeneity. The contradiction could be explained by the fact that Sarma and colleagues included studies comparing bariatric surgery and medical therapies, including GLP-1 agonists and used studies published by the same authors. Other limitations of their meta-analysis are the inclusion of studies with very small sample sizes [28]. Another study evaluated the outcomes among patients with diabetic nephropathy [29]. Our study supported the findings of Saeed *et al.* [20], who found lower MACE in patients with bariatric surgery in comparison to GLP-1 agonists. Our findings showed that bariatric surgery achieved higher cardiovascular protection compared to GLP-1 agonists. The reduction of the MACE could be explained by the reduction in the BMI. The effects of GLP-1 agonists on MACE (stroke, myocardial infarction and cardiovascular/all-cause mortality) are well established. Previous studies showed the superiority of GLP-1 agonists on MACE reduction compared to placebo [30,31]. MACE reduction is a priority in patients with obesity and diabetes and the recommendations are the reduction of MACE risk factors, including good glycaemic control, optimal lipid targets and blood pressure control. However, despite the lifestyle

modifications and medication use, many of the patients are not meeting the recommended targets, resulting in high morbidity, mortality and healthcare costs [32,33]. The current findings showed that bariatric surgery lowered BMI and MACE compared to GLP-1 agonists; our results imply that physicians may need to consider bariatric surgery for patients with high BMI and cardiovascular risk factors.

A meta-analysis published by Pipek *et al.* [21] observed the superiority of bariatric surgery compared to drug therapy in line with the current observations, but they compared pharmacological treatment to bariatric surgery and not GLP-1 agonists. In this study, we found lower heart failure in bariatric surgery than in GLP-1 agonists. Our findings were in line with a recent study published in the USA and showed lower rates of heart failure in patients on bariatric surgery compared to semaglutide [34]. Heart failure is common in patients with obesity (852.84 per 10,000), particularly heart failure with preserved ejection fraction and constitutes a clinical and economic burden [35]. Bariatric surgery could be an effective strategy to reduce weight and prevent MACE and heart failure. However, the clinical picture is not complete unless the complications and costs are investigated. Brosnihan *et al.* [36] stated that GLP-1 agonists are inferior to bariatric surgery in weight management due to adverse events necessitating discontinuation, high cost and lack of insurance coverage and Haseeb *et al.* [37] showed that sleeve gastrectomy is cost-saving compared to semaglutide. The current study's strength is that it includes the largest up-to-date studies and assesses many outcomes. Our results showed that bariatric surgery is more effective in BMI, MACE and heart failure reduction, with a similar effect on HbA1c.

CONCLUSIONS

Bariatric surgery showed better effect on body weight, MACE and heart failure reduction, with similar effects on the glycated haemoglobin. A proper randomized controlled trial comparing surgery vs. GLP-1s recommended. Future research should include cost, safety and patient quality-of-life data and avoid grouping all GLP-1s and surgery types together because they differ significantly.

Limitations

This meta-analysis is limited by including only retrospective studies and the high heterogeneity observed. In addition, we pooled different forms of bariatric surgery and GLP-1 agonists and we could not compare bariatric surgery with the most potent long-acting GLP-1 agonists. A major limitation of this study is that it was conducted by a single author increasing the bias, in addition, we could not compare the side effects and the quality of life that significantly impact the patients care.

REFERENCES

[1] Masood, B. and M. Moorthy. "Causes of obesity: a review." *Clinical Medicine*, vol. 23, no. 4, July 2023, pp. 284–291. https://doi.org/10.7861/clinmed.2023-0168.

[2] Prospective Studies Collaboration *et al.* "Body-mass index and cause-specific mortality in 900000 adults: collaborative analyses of 57 prospective studies." *The Lancet*, vol. 373, no. 9669, March 2009, pp. 1083–1096. https://doi.org/10.1016/S0140-6736(09)60318-4.

[3] Alqatari, S.G. *et al.* "Pharmacologic disruption: how emerging weight loss therapies are challenging bariatric surgery guidelines." *Medicina*, vol. 61, no. 7, July 2025, p. 1292. https://doi.org/10.3390/medicina61071292.

[4] World Health Organization. *Obesity and Overweight*. Geneva, World Health Organization, 2025. Accessed August 2025. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

[5] Dale, K.S. *et al.* "Sustainability of lifestyle changes following an intensive lifestyle intervention in insulin resistant adults: follow-up at 2-years." *Asia Pacific Journal of Clinical Nutrition*, vol. 18, no. 1, 2009, pp. 114–120.

[6] Rodgers, R.J. *et al.* "Anti-obesity drugs: past, present and future." *Disease Models & Mechanisms*, vol. 5, no. 5, September 2012, pp. 621–626. https://doi.org/10.1242/dmm.009621.

[7] Jastreboff, A.M. *et al.* "Tirzepatide once weekly for the treatment of obesity." *The New England Journal of Medicine*, vol. 387, no. 3, July 2022, pp. 205–216. https://doi.org/10.1056/NEJMoa2206038.

[8] Dawwas, G.K., J.M. Samuels and C.M. Stein. "Shifting obesity treatment paradigms: trends of glucagon-like peptide-1 receptor agonists and bariatric surgery in the United States." *Diabetes, Obesity and Metabolism*, July 2025. https://doi.org/10.1111/dom.16600.

[9] Stenberg, E. *et al.* "Cardiovascular and diabetes outcomes among patients with obesity and type 2 diabetes after metabolic bariatric surgery or glucagon-like peptide 1 receptor agonist treatment." *British Journal of Surgery*, vol. 111, no. 9, August 2024. https://doi.org/10.1093/bjs/znae221.

[10] Stenberg, E. and E. Näslund. "Major adverse cardiovascular events among patients with type-2 diabetes: a nationwide cohort study comparing primary metabolic and bariatric surgery to GLP-1 receptor agonist treatment." *International Journal of Obesity*, vol. 47, no. 4, April 2023, pp. 251–256. https://doi.org/10.1038/s41366-023-01254-z.

[11] Angrisani, L. *et al.* "Bariatric surgery worldwide 2013." *Obesity Surgery*, vol. 25, no. 10, October 2015, pp. 1822–1832. https://doi.org/10.1007/s11695-015-1657-z.

[12] Lin, K. *et al.* "Metabolic bariatric surgery in the era of GLP-1 receptor agonists for obesity management." *JAMA Network Open*, vol. 7, no. 10, October 2024, p. e2441380. https://doi.org/10.1001/jamanetworkopen.2024.41380.

[13] Mainous, A.G. *et al.* "Inpatient bariatric surgery among eligible black and white men and women in the United States, 1999–2010." *The American Journal of Gastroenterology*, vol. 108, no. 8, August 2013, pp. 1218–1223. https://doi.org/10.1038/ajg.2012.365.

[14] Primomo, J.A. *et al.* "Decreased access to bariatric care: an analysis of referral practices to bariatric specialists." *Surgery for Obesity and Related Diseases*, vol. 12, no. 9, November 2016, pp. 1725–1730. https://doi.org/10.1016/j.soard.2016.08.016.

[15] Messiah, S.E. *et al.* "Metabolic and bariatric surgery utilization in the era of glucagon-like peptide-1 receptor agonists among adolescents versus adults." *The Journal of Pediatrics*, vol. 282, July 2025, p. 114564. https://doi.org/10.1016/j.jpeds.2025.114564.

[16] Hampl, S.E. *et al.* "Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity." *Pediatrics*, vol. 151, no. 2, February 2023, p. e2022060640. https://doi.org/10.1542/peds.2022-060640.

[17] Esparham, A. *et al.* "Safety and efficacy of glucagon-like peptide-1 receptor agonists in patients with weight regain or insufficient weight loss after metabolic bariatric surgery: a systematic review and meta-analysis." *Obesity Reviews*, vol. 25, no. 11, November 2024, p. e13811. https://doi.org/10.1111/obr.13811.

[18] Muñoz, M.P.S. *et al.* "Liraglutide effectiveness in preoperative weight-loss for patients with severe obesity undergoing bariatric-metabolic surgery." *Updates in Surgery*, vol. 76, no. 6, October 2024, pp. 2277–2283. https://doi.org/10.1007/s13304-024-01828-0.

[19] Sarma, S. and P. Palcu. "Weight loss between glucagon-like peptide-1 receptor agonists and bariatric surgery in adults with obesity: a systematic review and meta-analysis." *Obesity*, vol. 30, no. 11, November 2022, pp. 2111–2121. https://doi.org/10.1002/oby.23563.

[20] Saeed, L. *et al.* "Comparative effectiveness of bariatric metabolic surgery versus glucagon-like peptide-1 receptor agonists on cardiovascular outcomes and mortality: a meta-analysis." *Cureus*, vol. 16, no. 10, October 2024, p. e71684. https://doi.org/10.7759/cureus.71684.

[21] Pipek, L.Z. *et al.* "Surgery is associated with better long-term outcomes than pharmacological treatment for obesity: a systematic review and meta-analysis." *Scientific Reports*, vol. 14, no. 1, April 2024, p. 9521. https://doi.org/10.1038/s41598-024-57724-5.

[22] Pereira, M. *et al.* "Role of GLP1-RA in optimizing weight loss post-bariatric surgery: a systematic review and meta-analysis." *Obesity Surgery*, vol. 34, no. 10, October 2024, pp. 3888–3896. https://doi.org/10.1007/s11695-024-07486-w.

[23] Cotugno, M. *et al.* "Clinical efficacy of bariatric surgery versus liraglutide in patients with type 2 diabetes and severe obesity: a 12-month retrospective evaluation." *Acta Diabetologica*, vol. 52, no. 2, April 2015, pp. 331–336. https://doi.org/10.1007/s00592-014-0644-5.

[24] Dicker, D. *et al.* "Bariatric metabolic surgery vs glucagon-like peptide-1 receptor agonists and mortality." *JAMA Network Open*, vol. 7, no. 6, June 2024, p. e2415392. https://doi.org/10.1001/jamanetworkopen.2024.15392.

[25] Wolff Sagy, Y. *et al.* "Glucagon-like peptide-1 receptor agonists compared with bariatric metabolic surgery and the risk of obesity-related cancer." *EClinicalMedicine*, vol. 83, May 2025, p. 103213. https://doi.org/10.1016/j.eclinm.2025.103213.

[26] Wu, T. *et al.* "The comparative effects of metabolic surgery, SGLT2i or GLP-1RA in patients with obesity and type 2 diabetes." *Surgery for Obesity and Related Diseases*, vol. 18, no. 6, June 2022, pp. 762–771. https://doi.org/10.1016/j.soard.2022.02.008.

[27] Adekolu, A.A. *et al.* "Bariatric surgery vs glucagon-like peptide-1 analogues for reducing risk of major cardiovascular events: a multi-center retrospective cohort study." *The American Journal of Gastroenterology*, vol. 118, suppl. 10, October 2023, p. S971. https://doi.org/10.14309/01.ajg.0000954768.41220.8b.

[28] Yong, W., S. Wang and J. Li. "Remission of insulin resistance in type 2 diabetic patients after gastric bypass surgery or exenatide therapy." *Obesity Surgery*, vol. 22, 2012, pp. 1060–1067.

[29] Valderas, J.P. *et al.* "GLP-1 receptor agonist therapy induces a greater reduction in glycaemic variability compared to gastric bypass in type 2 diabetic patients." *Diabetologia*, vol. 59, 2016, p. S331. https://doi.org/10.1007/s00125-016-4046-9.

[30] Husain, M. *et al.* "Semaglutide (SUSTAIN and PIONEER) reduces cardiovascular events in type 2 diabetes across varying cardiovascular risk." *Diabetes, Obesity and Metabolism*, vol. 22, 2020, pp. 442–451.

[31] Kristensen, S.L. *et al.* "Cardiovascular, mortality and kidney outcomes with GLP-1 receptor agonists in patients with type 2 diabetes." *The Lancet Diabetes & Endocrinology*, vol. 7, no. 10, October 2019, pp. 776–785. https://doi.org/10.1016/S2213-8587(19)30249-9.

[32] American Diabetes Association. "10. Cardiovascular disease and risk management: standards of medical care in Diabetes-2020." *Diabetes Care*, vol. 43, suppl. 1, January 2020, pp. S111–S134. https://doi.org/10.2337/dc20-S010.

[33] American Diabetes Association. "16. Diabetes advocacy: standards of medical care in Diabetes-2019." *Diabetes Care*, vol. 43, suppl. 1, January 2020, pp. S203–S204. https://doi.org/10.2337/dc20-S016.

[34] Ascandar, N. *et al.* "Clinical outcomes after hospitalization for acute coronary syndrome in patients treated with semaglutide versus bariatric surgery." *HCA Healthcare Journal of Medicine*, vol. 6, no. 3, June 2025, pp. 249–257. https://doi.org/10.36518/2689-0216.1960.

[35] Zhang, Y. *et al.* "The epidemiology, clinical characteristics and burden of heart failure with or without obesity in US patients." *Current Medical Research and Opinion*, August 2025, pp. 1–15. https://doi.org/10.1080/03007995.2025.2535464.

[36] Brosnihan, P. *et al.* "Great debates: undergoing the knife versus pill-popping — the comparative efficacy and cost-effectiveness of bariatric surgery and GLP-1 receptor agonists in obesity." *The American Surgeon*, April 2025. https://doi.org/10.1177/00031348251337145.

[37] Haseeb, M. *et al.* "Semaglutide vs endoscopic sleeve gastroplasty for weight loss." *JAMA Network Open*, vol. 7, no. 4, April 2024, p. e246221. https://doi.org/10.1001/jamanetworkopen.2024.6221.