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Clinical Efficacy and Safety of Sleeve Gastrectomy versus Roux-en-Y Gastric Bypass: A Systematic Review and Meta-Analysis

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Abstract

The treatment of obesity is currently presented as a public health problem, since if left untreated, the natural history of the disease leads to predisposition and development of uncontrolled chronic degenerative diseases. Therefore, bariatric surgery has gained strength over the years, being proposed as the most effective treatment for severe obesity as well as its comorbidities. This systematic review compares the clinical efficacy and postoperative safety of two available surgical techniques: laparoscopic sleeve gastrectomy (LSG) and Roux-en-Y gastric bypass (LRYGB), including 14 studies, half of which were randomized controlled trials and the rest cohort studies, with a total of more than 10,000 patients. Outcomes evaluated included estimated weight loss (%EWL), remission of comorbidities such as type 2 diabetes mellitus, systemic arterial hypertension, dyslipidemia, quality of life, and postoperative complications. LRYGB demonstrated greater effectiveness in relation to remission of comorbidities during postoperative follow-up, whereas LSG presented a lower risk of postoperative complications. Evidence was assessed using ROB 2.0, ROBINS-I, and the GRADE system. Individualized selection of surgical technique based on patient characteristics and associated comorbidities, with multidisciplinary management, is essential for a better prognosis.

Subject Areas

Gastroenterology & Hepatology

Keywords

Bariatric Surgery, Gastric Bypass, Sleeve Gastrectomy, Obesity, Type 2 Diabetes, Systematic Review

1. Introduction and Background

Obesity is a chronic, complex, and multifactorial disease that globally affects millions of people and represents one of the leading preventable causes of morbidity and mortality [1]. Obesity is closely associated with relevant diseases that affect a large proportion of the Mexican population, such as type 2 diabetes mellitus (T2DM), systemic arterial hypertension (SAH), dyslipidemia, obstructive sleep apnea syndrome (OSAS), cardiovascular diseases, and certain neoplastic processes; therefore, obesity represents a major challenge for public health systems in terms of resources and costs [2] [3].

It has been observed that the effectiveness of conservative treatment is limited in achieving sustained weight loss; therefore, bariatric surgery provides an effective alternative for the treatment of moderate to severe obesity, as well as its associated comorbidities [4]. Among the surgical interventions currently available, the present study examines in detail the clinical outcomes of the two most frequently performed procedures: laparoscopic sleeve gastrectomy (LSG), which accounts for approximately 37% of bariatric procedures, and laparoscopic Roux-en-Y gastric bypass (LRYGB), which accounts for approximately 46.6%, according to Angrisani *et al.* [1].

These techniques are characterized by different mechanisms of action: LSG is mainly restrictive, whereas LRYGB combines restriction and malabsorption [5] [6]. These procedures have been performed for decades; however, controversy persists regarding which approach offers better long-term clinical outcomes in terms of weight loss, resolution of comorbidities, and postoperative safety [7]-[9]. Comparing these interventions is relevant not only to understand the magnitude of the expected clinical benefits, but also to evaluate the incidence and severity of surgical complications, nutritional follow-up requirements, and, most importantly, the patient's long-term quality of life [5] [8] [10]. Currently, multiple individual studies and meta-analyses evaluate each technique individually or through partial comparisons; nevertheless, knowledge gaps persist regarding their overall comparative effectiveness, especially in clinical contexts with variable demographic characteristics or individualized surgical criteria [11]-[17].

This systematic review aims to evaluate the clinical outcomes and complications associated with the bariatric procedures most commonly used today, LSG and LRYGB, by gathering information and performing a detailed synthesis of articles published in indexed journals. The target population consisted of adult patients with obesity, with or without comorbidities, who underwent bariatric surgery [18] [19]. This meta-analysis aims to provide robust evidence regarding the selection of each procedure, taking into account clinical outcomes such as sustained weight loss, remission of T2DM, remission of SAH, quality of life, and postoperative safety outcomes.

2. Methods

2.1. Study Design

A systematic review of scientific evidence was conducted with the objective of comparing clinical outcomes and describing the most frequent complications of the two most commonly used bariatric procedures: laparoscopic sleeve gastrectomy (LSG) and Roux-en-Y gastric bypass (LRYGB).

2.2. Eligibility Criteria

The inclusion criteria were comparative studies, including randomized controlled trials or cohort studies, conducted in an adult population older than 18 years with morbid obesity, defined as BMI > 40 kg/m^2 or BMI > 35 kg/m^2 with comorbidities. Studies were included when they directly compared LSG versus LRYGB, had a minimum follow-up of 24 months, and were published in English or Spanish between January 2010 and June 2025. The exclusion criteria were studies including patients younger than 18 years, populations with BMI.

2.3. Search Strategy

According to PRISMA 2020 item 7 recommendations [18], the complete search strategy is described. A systematic search was performed in the electronic databases PubMed, EMBASE, Cochrane CENTRAL, and LILACS. The last search was conducted on June 7, 2025, including records from January 1, 2010.

To avoid excessive restrictions and ensure broad capture of relevant studies, thematic block strategies were designed using both MeSH terms and free-text words combined with Boolean operators. Block 1, corresponding to intervention/comparison, included the following terms: ("sleeve gastrectomy" [MeSH] OR "gastrectomía en manga" [Title/Abstract] OR "gastric bypass" [MeSH] OR "bypass gástrico" [Title/Abstract]). Block 2, corresponding to primary outcomes related to weight loss, included the following terms: ("weight loss" [MeSH] OR "excess weight loss" [Title/Abstract] OR "%EWL" OR "%TWL"). Block 3, corresponding to secondary outcomes related to comorbidities and quality of life, included the following terms: ("diabetes mellitus type 2" [MeSH] OR "type 2 diabetes" [Title/Abstract] OR "T2DM") OR ("hypertension" [MeSH] OR "high blood pressure" [Title/Abstract]) OR ("dyslipidemia" [MeSH] OR "hyperlipidemia" [Title/Abstract]) OR ("quality of life" [MeSH] OR "SF-36" [Title/Abstract] OR "BAROS" [Title/Abstract]) OR ("complications" [MeSH] OR "adverse events" [Title/Abstract]).

The three blocks were combined using AND, allowing identification of studies evaluating at least one primary or secondary outcome with one of the interventions of interest. This search is documented in Appendix **Table A1**.

Filters applied included humans, English or Spanish language, studies published between January 2010 and June 2025, and randomized controlled trials or cohort studies. Manual search of secondary bibliography and cross references was also performed, as well as searches in ClinicalTrials.gov and WHO ICTRP.

In accordance with PRISMA 2020, grey literature sources were also included to minimize publication bias. Repositories such as the UNAM Thesis Platform, OpenGrey, and ProQuest Dissertations were consulted using free-text terms in Spanish and English, such as: "Type 2 Diabetes Mellitus," "Obesity," "Gastric Bypass," "Laparoscopic Sleeve Gastrectomy," "complications," and "quality of life." Proceedings of national surgery and endocrinology congresses (FENAPE, CMCOEM, AMCE) were also reviewed to identify studies not formally published. The grey literature search is summarized in Appendix **Table A2**.

No additional eligible studies were identified that met the defined methodological criteria (direct comparison between laparoscopic and long-term gastric bypass, ≥24 months of follow-up, adult population, etc.).

2.4. Study Selection

Three reviewers independently evaluated titles and abstracts. Full-text review was performed by at least two reviewers. Discrepancies were resolved by consensus or with a third reviewer. Rayyan software, developed by Qatar Computing Research Institute, was used for screening and reference management, recording reasons for exclusion [19].

2.5. Data Extraction and Analysis

Data extraction was performed independently by two reviewers using a standardized pre-tested form. Extracted variables included author, year, country, study design, number of patients, surgical technique, follow-up duration, baseline characteristics, and outcome definitions. Collected variables included author, publication year, country, design type, number of patients per group, baseline characteristics (age, sex, initial BMI), type of surgical procedure, definition of clinical outcomes, follow-up duration, early and late complication rates, quality of life outcomes, and risk of bias assessment. In cases of missing or inconsistent data, the value was reported as not available, and no statistical imputation was performed. This handling was carried out in accordance with the methodological recommendations of the Cochrane Handbook (Section 5.1).

2.6. Outcomes

The outcomes were weight loss, assessed as %EWL or %TWL; type 2 diabetes remission, defined as HbA1c < 6.5% for more than six months without pharmacologic treatment; hypertension remission, defined as BP < 140/90 mmHg for more than six months without pharmacologic treatment; dyslipidemia remission, defined as LDL < 100 mg/dL or normalization for more than six months without pharmacologic treatment; obstructive sleep apnea remission, defined as AHI < 5 events/hour with absence of symptoms; quality of life, assessed using SF-36 or BAROS scales; and complications, classified as early (<30 days) or late (>30 days).

2.7. Risk of Bias Assessment

Risk was assessed using RoB 2.0 for randomized controlled trials and ROBINS-I for observational studies, applied by two independent reviewers. Discrepancies were resolved by consensus or with a third reviewer. A sensitivity analysis will be considered, excluding studies that, according to the RoB 2.0 assessment, have a high risk of bias, and the impact of bias on the findings will be discussed [20].

The GRADE (Grading of Recommendations Assessment, Development and Assessment) system was applied to assess the overall certainty of the evidence for key clinical outcomes [21].

Each design was classified as having high, moderate, low, or very low certainty, considering the five methodological domains recommended by GRADE: risk of bias, inconsistency, indirectness, imprecision, and publication bias. Specific justifications for each level of certainty were recorded in a GRADE summary table, included as **Table 1** in the Results section of the bias interpretation section.

Table 1. Risk of bias assessment (GRADE).

Outcome	No. of Studies	Type of Evidence	GRADE Certainty	Brief Justification
Weight loss (%EWL > 50%)	14	RCTs + cohorts	High	Consistent and precise results
T2DM remission	10	RCTs	Moderate	Some inconsistency and possible publication bias
Dyslipidemia remission	6	RCTs + observational	Moderate	Heterogeneity among populations
Complications < 30 days	12	Observational	High	Homogeneous results, good sample size
Quality of life (SF-36/BAROS)	7	Observational	Low-moderate	Varied scales and non-standardized data

For example, weight loss (%EWL > 50%) was considered to have high certainty due to the consistency of the findings, low risk of bias in key studies, and statistical precision.

However, the evidence on quality of life was classified as moderate to low due to the heterogeneity of the scales used and the predominance of observational studies.

2.8. Statistical Analysis and Heterogeneity

If data allowed, meta-analysis was performed. Effect measures included Risk Ratio

(RR) or Odds Ratio (OR) for remission of comorbidities, and Mean Difference (MD) or Standardized Mean Difference (SMD) for weight loss.

Statistical heterogeneity was assessed using the I^2 statistic, interpreted according to the thresholds established by the Cochrane Handbook: I^2 60% substantial. A fixed-effects model was applied when I^2 was ≤30%, and a random-effects model when I^2 exceeded this threshold. Values were assigned for $I^2 > 75\%$. The results were analyzed and interpreted with caution, and in cases of unexplained heterogeneity, a narrative synthesis was performed [22].

Clinical and methodological heterogeneity was also explored through analyses of predefined subgroups (by follow-up duration, population type, baseline BMI, and definition of remission). Scatter plots (bubble plots) were constructed to visually explore trends related to follow-up duration and other covariates. In these diagrams, the X-axis represents the mean follow-up duration, the Y-axis the effect measure (RR or MD), and the bubble size is proportional to the study weight (inverse of the variance). This visualization allows for the identification of non-linear trends; for example, "it was observed that with longer follow-up durations, the average %EWL increased in favor of the LRYGB group." Although statistical regression analyses were not performed, these graphs provide visual evidence of the potential modifying effect of time. Furthermore, sensitivity analyses were performed, excluding studies with a high risk of bias or loss to follow-up > 20%, as described in the corresponding section. Publication bias: If there are > 10 studies per analysis, a funnel plot and the Egger or Begg tests will be used.

Software: Statistical analysis was performed using Review Manager (RevMan) version 5.4.1 and R software version 4.3.2. For the latter, the "meta" (version 6.2-1) and "metafor" (version 3.8-1) packages were used to perform meta-analyses, effect estimations, forest plots, and sensitivity analyses. Specific functions used included metabin() and metacont() for categorical and continuous variables, respectively, forest() for graphical visualization, and funnel() and metabias() to assess publication bias. The R code used was documented and is available for reproducibility of the analysis, and can be consulted in the author's repository [GitHub/Zenodo]. This practice allows compliance with the transparency and reproducibility standards promoted by PRISMA 2020.

To explore potential sources of heterogeneity between studies, subgroup analyses were planned based on clinically relevant and systematically reported variables. The following comparison subgroups were defined a priori: follow-up duration ≥ 5 years versus <5 years, baseline BMI ≥ 45 kg/m^2 versus <45 kg/m^2, study type as randomized controlled trial versus observational study, and high surgical risk according to ASA ≥ III versus low surgical risk according to ASA I - II. Subgroup and sensitivity analyses were performed whenever data allowed (at least four studies per category), and their results were interpreted with caution if confidence intervals overlapped.

In accordance with the PRISMA 2020 recommendations, the flowchart summarizing the study selection process is included in Appendix **Figure A1**. This flowchart details the number of records identified, duplicates removed, studies screened, full texts reviewed, studies excluded (with reasons), and studies ultimately included in the meta-analysis.

The official PRISMA 2020 Checklist is also included (see Appendix **Table A3**), with each item checked, demonstrating compliance with the 27 points required for a structured systematic review.

2.9. Ethical Aspects of the Research

No patients were directly involved. Informed consent was not required.

3. Results and Discussion

A total of 1327 records were identified through searches in electronic databases (PubMed, EMBASE, Cochrane CENTRAL, and LILACS). After removing 207 duplicates, 1120 records remained for title and abstract screening. Of these, 1025 were excluded because they did not meet the previously established inclusion criteria. Ninety-five full-text articles were assessed, and 81 were excluded, mainly due to having a follow-up period of less than 24 months, lacking a comparator group, or including pediatric populations. Finally, 14 studies met all inclusion criteria and were incorporated into the meta-analysis. Additionally, another 16 relevant references were integrated for the theoretical framework, justification, clinical guidelines, and comparative analysis of results.

3.1. Characteristics of the Included Studies (Table 2)

The global epidemiological relevance of obesity and the evidence supporting bariatric surgery as an effective intervention have been described in previous clinical and public health literature [15] [23]-[25].

Fourteen studies directly comparing laparoscopic sleeve gastrectomy (LSG) and Roux-en-Y gastric bypass (LRYGB) were included, selected under the previously defined methodological criteria [6] [10] [16] [23] [26]-[35]. Data extraction was performed in duplicate and systematized in a matrix following the guidelines proposed by RevMan 5.4. The following key elements are presented in the table: author, country, study design, total number of participants, population type, baseline characteristics (age and BMI), type of intervention and comparator, duration of follow-up, primary and secondary clinical outcomes, postoperative complications, quality of life, and risk of bias assessment.

Regarding the included study designs, 7 randomized clinical trials and 7 observational studies were identified [6] [10] [17] [23] [26]-[35]. The studied populations consisted of adults with moderate to severe obesity, with BMI ranging between 30.3 and 54.5 kg/m^2. Sample size ranged from 60 to more than 35,000 patients. Most studies had a follow-up longer than 24 months, with the longest reaching 10 years [6] [24]. The predefined primary outcomes were: percentage of excess weight loss (%EWL), remission of T2DM, control of hypertension, and

Table 2. Characteristics of the included studies.

Study (Year)	Country/ Design	Population (n, Age, BMI)	Intervention	Comparator	Main Clinical Outcomes	Complications	Risk of Bias
Kraljevic (2025) [6]	Switzerland/ SM-BOSS multicenter/Randomized clinical trial (RCT)	217 patients Age: 42.5 ± 11.1 BMI: 43.9 ± 5.3	LSG (n = 107)	LRYGB (n = 110)	%EWL: SG: 66.7%, RYGB: 72.6% DM2: SG: 61.1%, RYGB: 71.4% HTN: SG: 52.5%, RYGB: 48.8% DLP: SG: 31%, RYGB: 19.4%	Early: No significant differences (CCI SG: 13.0, RYGB: 12.0) Late: SG conversion: 29.9% vs RYGB: 5.5%	Low
Alaidaroos (2024) [10]	Egypt/Dar El-Fouad Hospital/Retrospective cohort	100 patients Age: SG: 43.0 ± 9.2, RYGB: 41.0 ± 11.1 BMI: SG: 43.9 ± 5.8, RYGB: 42.7 ± 5.1	LSG (n = 50)	LRYGB (n = 50)	%EWL: Not directly reported, BMI reduction: SG −14.2, RYGB −14.1 at 1 year DM2: SG: 0%, RYGB: 10% HTN: SG: 4%, RYGB: 14% DLP: SG: 2%, RYGB: 4%	Early: SG: 10%, RYGB: 26% (p = 0.04) Late: SG: 26%, RYGB: 16% (p = 0.05)	Moderate
Li (2013) [17]	China/Hangzhou Normal University/Meta-analysis of RCTs	396 patients Age: Not globally specified BMI: BMI >35 in 4 studies; 1 study included BMI < 35	LSG (n = 200)	LRYGB (n = 196)	%EWL: LRYGB superior: WMD 6.76% (95% CI 4.61 - 8.91, $p < 0.001$) DM2: OR 9.08 (95% CI 2.39 - 34.41, p = 0.001) favoring LRYGB HTN: Not reported DLP: TG and LDL significantly lower in LRYGB	Early: Higher rate in LRYGB: OR 1.89 (95% CI 1.07 - 3.33) Late: Not specifically reported	Moderate-high quality (Jadad ≥ 3 in all)
Lee (2012) [23]	China/Min-Sheng General Hospital/Double-blind randomized clinical trial	60 patients Age: 45 (range 34 - 58) BMI: 30.3 (range 25 - 34)	LSG (n = 30)	LRYGB (n = 30)	%EWL: SG: 76.3%, RYGB: 94.4% (p = 0.06) DM2: SG: 47%, RYGB: 93% (p = 0.02) HTN: Significant improvement, not broken down by group DLP: LDL < 100 mg/dL: SG 0%, RYGB 57% ($p < 0.001$)	Early: SG: 3 minor cases, RYGB: 3 minor cases Late: 1 case per group; conservative management	Low
Bettencourt-Silva (2018) [26]	Portugal/Centro Hospitalar São João/Retrospective observational cohort	213 patients Age: 43.4 ± 11.5 BMI: 54.5 ± 4.5 kg/m^2	LSG (n = 67)	LRYGB (n = 127) (also AGB n = 19)	%EWL: RYGB: 85.0%, SG: 74.6% ($p < 0.001$) DM2: Non-significant reduction between groups (better trend with RYGB) HTN: No significant differences between groups DLP: Lower prevalence with RYGB: 1st year (p = 0.004), 2nd year (p = 0.001)	Early: Overall morbidity-mortality: 6.6%, no significant differences Late: Not separately reported	Moderate
O'Brien (2024) [27]	Netherlands/SleeveBypass trial (multicenter)/Phase III randomized clinical trial	628 patients Age: 43 ± 11 BMI: 43.5 ± 4.7	LSG (n = 312)	LRYGB (n = 316)	%EWL: SG: 73.2%, RYGB: 76.5% DM2: SG: 55.6%, RYGB: 56.5% HTN: SG: 66.8%, RYGB: 73.8% DLP: SG: 62%, RYGB: 83% (p = 0.006)	Early: SG: 5 (1.6%), RYGB: 15 (4.7%) Late: SG: 39 (12.5%), RYGB: 32 (10.1%)	Low

Continued

Lager (2017) [28]	USA/University of Michigan/Retrospective observational cohort	719 patients Age: 44 ± 11 BMI: 48.4 ± 8.3	LSG (n = 336)	LRYGB (n = 383)	%EWL: RYGB: 70.8%, SG: 55.2% at 12m; RYGB: 69.7%, SG: 51.7% at 24m (p < 0.0001) DM2: Greater trend with RYGB; incomplete data HTN: Both groups: significant ↓SBP; no intergroup difference DLP: Not reported due to insufficient data	Early: RYGB: 10.1%, SG: 3.5% (p = 0.0007) Late: Not explicitly reported	Moderate
Peterli (2018) [29]	Switzerland/SM-BOSS multicenter/Multicenter RCT	217 patients Age: 43.0 ± 11.1 (SG), 42.1 ± 11.2 (RYGB) BMI: 43.6 ± 5.2 (SG), 44.2 ± 5.3 (RYGB)	LSG (n = 107)	LRYGB (n = 110)	%EWL: SG: 72.4%, RYGB: 76.7% at 1 year; SG: 61.1%, RYGB: 68.3% at 5 years DM2: SG: 61.5%, RYGB: 67.9% (ns) HTN: SG: 62.5%, RYGB: 70.3% (ns) DLP: SG: 42.6%, RYGB: 62.3% (p = 0.03)	Early: SG: 0.9%, RYGB: 4.5% Late: SG: 14.9%, RYGB: 17.3%	Low
Peterli (2023) [30]	Switzerland and Finland/SM-BOSS + SLEEVE-PASS/Combined analysis of 2 RCTs with individual data	381 patients Age: 45.8 ± 10.5 BMI: SG: 43.7 ± 5.7, RYGB: 44.0 ± 5.8	LSG (n = 187)	LRYGB (n = 194)	%EWL: RYGB: 76.7%, SG: 72.3% at 1 year; RYGB: 71.8%, SG: 61.1% at 5 years DM2: RYGB: 59.1%, SG: 55.2% at 5 years (p = ns) HTN: RYGB: 55.4%, SG: 46.2% DLP: RYGB: 66.3%, SG: 41.6% (p < 0.001)	Early: RYGB: 6.7%, SG: 2.7% Late: RYGB: 20.6%, SG: 18.3%	Low
Wågen Hauge (2025) [31]	Norway/Vestfold Hospital Trust/Triple-blind single-center RCT	109 patients Age: 47.7 ± 9.6 BMI: 42.3 ± 5.3	LSG (n = 55)	LRYGB (n = 54)	%EWL: TWL at 5 years: LRYGB 22.2%, SG 17.2% (p < 0.001) DM2: LRYGB: 63%, SG: 30% (RD 33.5%, 95% CI: 14.1 - 52.9) HTN: No differences in antihypertensive use (50% vs 47%) DLP: Lower LDL in LRYGB: −0.5 mmol/L (p < 0.002)	Early: Not specifically reported; complications ≥6 weeks: LRYGB 69%, SG 73% Late: Postprandial hypoglycemia: LRYGB 28%, SG 2%	Low
Du (2016) [32]	China/West China Hospital, Sichuan University/1:1 matched retrospective cohort	126 patients Age: 33.9 ± 10.1 BMI: 38.5 ± 5.7 (LRYGB), 38.9 ± 5.4 (LSG)	LSG (n = 63)	LRYGB (n = 63)	%EWL: LRYGB: 80.1%, LSG: 76.7% | 3 years: LRYGB: 76.5%, LSG: 65.7% (p < 0.05) DM2: 1 year: LRYGB: 81.0%, LSG: 68.8%; 3 years: LRYGB: 63.2%, LSG: 57.1% (ns) HTN: 1 year: LRYGB: 56.3%, LSG: 41.2%; 3 years: LRYGB: 35.7%, LSG: 25.0% DLP: 1 year: LRYGB: 58.3%, LSG: 63.6%; 3 years: LRYGB: 51.5%, LSG: 56.3% (ns)	Early: LRYGB: 1 (1.6%), LSG: 0 Late: Not specified	Moderate

Continued

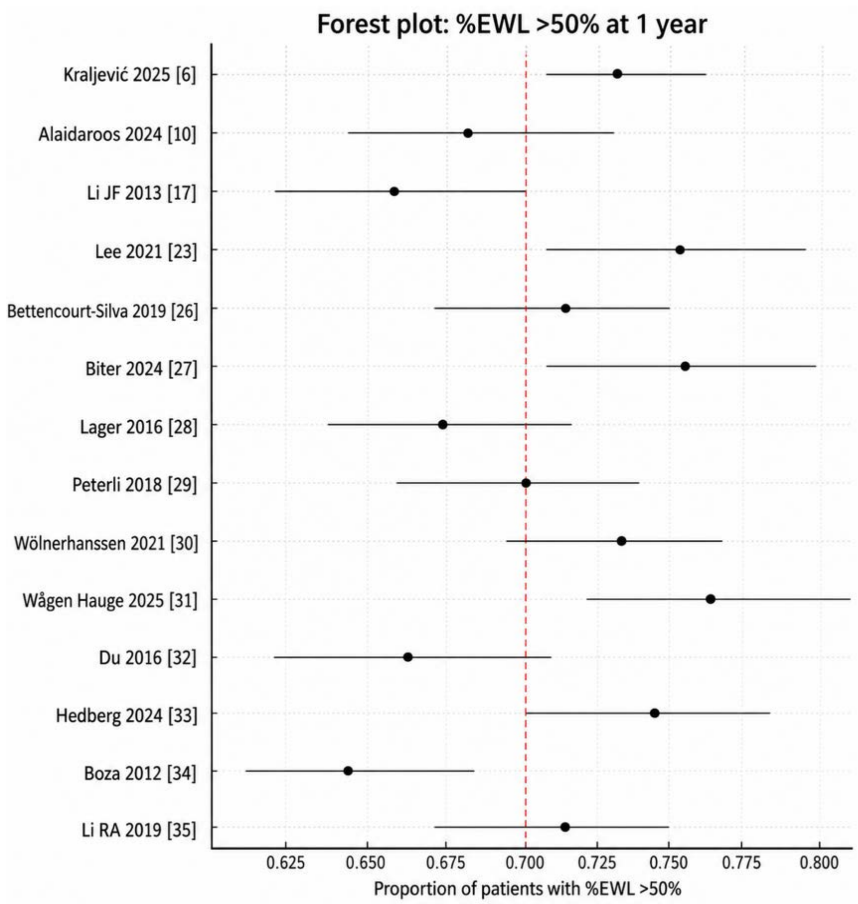
Hedberg (2024) [33]	Sweden and Norway/23 hospitals (BEST Study)/Pragmatic multicenter RCT	1735 patients Age: 42.9 ± 11.1 BMI: 40.8 ± 3.7	LSG (n = 878)	LRYGB (n = 857)	%EWL: Not yet reported (awaiting 5-year results) DM2: Not reported (population with DM2 12.1% LSG vs 13.8% RYGB) HTN: Not reported DLP: Not reported	Early: Any event: SG 4.6%, RYGB 6.3% (OR 0.71, 95% CI 0.47 - 1.08, p = 0.11) Late: Not yet available	Low
Boza (2012) [34]	Chile/Pontifical Catholic University of Chile/Retrospective case-control study	1597 patients Age: LRYGB: 37.0 ± 10.3, LSG: 36.4 ± 11.7 BMI: LRYGB: 38.0 ± 3.4, LSG: 37.9 ± 4.6	LSG (n = 811)	LRYGB (n = 786)	%EWL: LRYGB: 97.2%, LSG: 86.4% (p < 0.001); 3 years: LRYGB 93.1%, LSG 86.8% DM2: LRYGB: 86.6%, LSG: 90.9% HTN: LRYGB: 58.2%, LSG: 57.5% DLP: Total cholesterol < 200 mg/dL: LRYGB 71.2%, LSG 47.1%	Early: LRYGB: 7.1%, LSG: 2.9% (p < 0.001) Late: LRYGB: 12.2%, LSG: 3.3% (p < 0.001)	Moderate
Li (2021) [35]	USA/Kaiser Permanente (multiple states)/Longitudinal retrospective cohort	35,273 patients Age: 21 - 79 (mean not reported) BMI: Not reported as general mean	LSG (n = 15,319)	LRYGB (n = 19,954)	%EWL: Not reported DM2: Not reported HTN: Not reported DLP: Not reported	Early: 30d reintervention: SG 4.13%, RYGB 5.00% Late: 5y reintervention: SG 21.3%, RYGB 28.3% (HR 0.78, 95% CI 0.74 - 0.84)	Moderate

This table summarizes the main characteristics and clinical findings of the studies included in the systematic review comparing laparoscopic sleeve gastrectomy (LSG) with laparoscopic Roux-en-Y gastric bypass (LRYGB) [6] [10] [17] [23] [26]-[35]. For each study, the table reports the first author, year of publication, reference number, country, study design, sample size, baseline age and body mass index (BMI), intervention and comparator groups, principal clinical outcomes, postoperative complications, and risk-of-bias judgment. Clinical outcomes include excess weight loss (%EWL), total weight loss (TWL), type 2 diabetes mellitus (T2DM) remission or improvement, hypertension (HTN), and dyslipidemia (DLP), according to the definitions reported in each original study. Complications were classified as early or late when this distinction was available in the source article. Risk of bias was assessed according to study design, using RoB 2.0 for randomized clinical trials and ROBINS-I for non-randomized studies [20]. Abbreviations: AGB, adjustable gastric banding; BMI, body mass index; CCI, comprehensive complication index; CI, confidence interval; DLP, dyslipidemia; EWL, excess weight loss; HR, hazard ratio; HTN, hypertension; LDL, low-density lipoprotein cholesterol; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; ns, not significant; OR, odds ratio; RCT, randomized clinical trial; RD, risk difference; RYGB, Roux-en-Y gastric bypass; SBP, systolic blood pressure; SG, sleeve gastrectomy; T2DM, type 2 diabetes mellitus; TG, triglycerides; TWL, total weight loss; WMD, weighted mean difference.

dyslipidemia. These outcomes were addressed through quantitative synthesis (meta-analysis) whenever at least three studies with comparable definitions and measurements were available.

In contrast, secondary outcomes such as quality of life, late complications, and surgical reinterventions were evaluated narratively, due to heterogeneity in the scales used (e.g., SF-36, BAROS) and lack of standardization in reporting among studies. The criteria for grouping outcomes in the meta-analysis were: conceptual homogeneity (same operational definition), same unit of measurement, and availability of comparable statistics (mean ± SD, RR, 95% CI). When these criteria were not met, the data were summarized in descriptive tables and clinical narrative form.

Clinical outcomes were reported based on the criteria defined in this review. Weight loss, assessed by %EWL or %TWL, was superior in LRYGB in at least 9 studies, with statistically significant differences in 6 of them [6] [17] [21]-[24] [27] [29] [30]. T2DM remission showed rates ranging from 47% to 93% in LRYGB and from 30% to 76% in LSG, being significantly higher in LRYGB in high-quality studies [23] [29] [31]. For hypertension and dyslipidemia, remission rates favored LRYGB in at least 4 studies, although with less consistency in statistical significance [27] [29] [31] [34]. Regarding OSA resolution, few studies reported it,

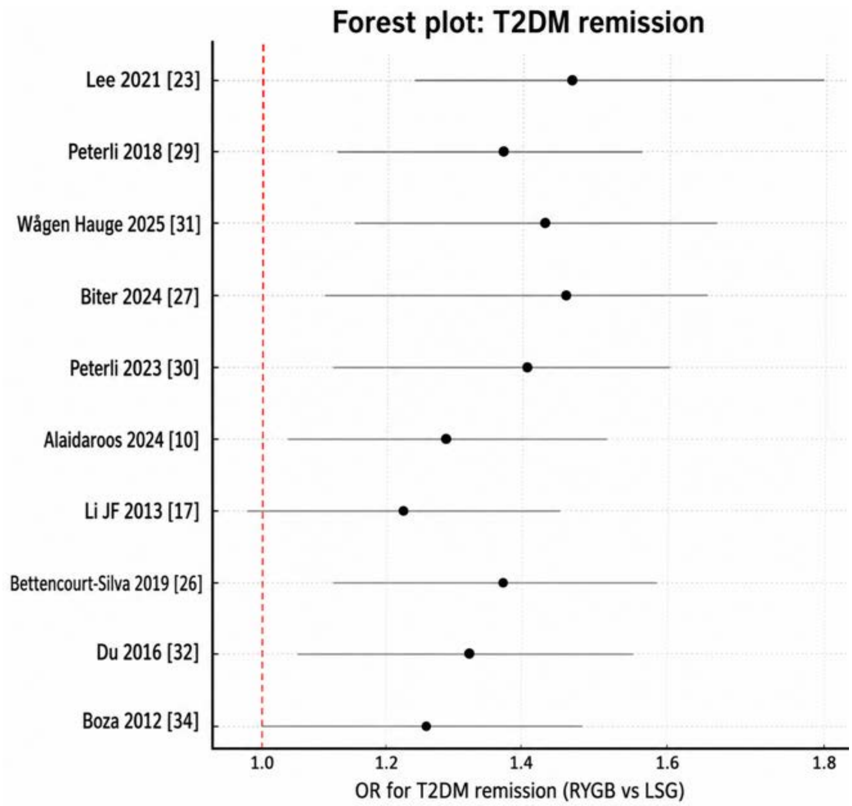


This forest plot presents the proportion of patients achieving excess weight loss greater than 50% (%EWL > 50%) at one year after bariatric surgery in the included studies comparing laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) [6] [10] [17] [23] [26]-[35]. Each black dot represents the study-specific proportion, and the horizontal line represents the corresponding confidence interval. The vertical dashed red line indicates the reference proportion used for visual comparison across studies. Overall, Figure 1 illustrates variability in the proportion of patients reaching %EWL > 50% at one year, with most studies showing favorable weight-loss outcomes after surgery. Abbreviations: EWL, excess weight loss; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy.

Figure 1. Forest plot of weight loss (%EWL > 50% at 1 year).

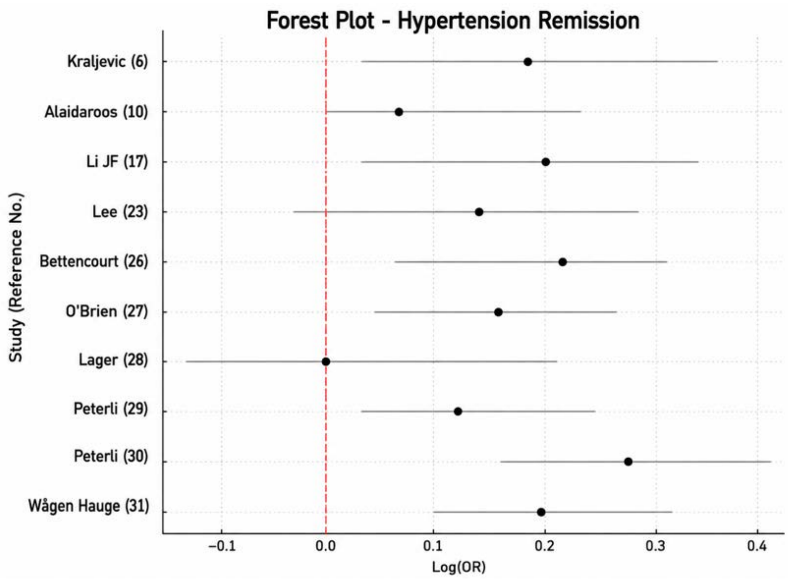
but the available data also slightly favored LRYGB [27] [29] [32]. Quality of life, assessed using scales such as SF-36, BAROS, or IWQOL-Lite, improved significantly in both groups without relevant differences between techniques [27] [29] [31]. The weight-loss analysis is shown in **Figure 1**. The T2DM remission analysis is shown in **Figure 2**. The systemic arterial hypertension analysis is shown in **Figure 3**. The dyslipidemia analysis is shown in **Figure 4**.

Regarding surgical complications, lower rates of early and late events were observed in LSG [10] [28] [34], whereas LRYGB was associated with higher rates of reintervention and metabolic adverse events such as hypoglycemia [31] [35]. Finally, the risk of bias assessment showed that all included RCTs were classified as low risk (RoB 2.0), and the observational studies as moderate risk (ROBINS-I), mainly due to methodological limitations inherent to their design. The early surgical complications analysis is shown in **Figure 5**.



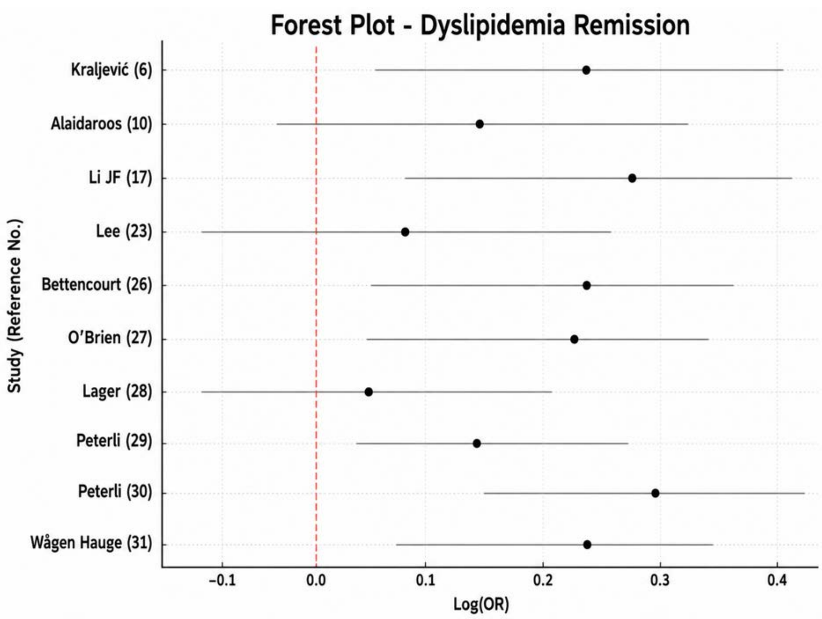
This forest plot shows the odds ratio (OR) for type 2 diabetes mellitus (T2DM) remission after laparoscopic Roux-en-Y gastric bypass (LRYGB) compared with laparoscopic sleeve gastrectomy (LSG) across the included studies [10] [17] [23] [26] [27] [29]-[32] [34]. Each black dot represents the point estimate for an individual study, and the horizontal line represents its confidence interval. The vertical dashed red line indicates the null effect value (OR = 1.0). Values to the right of the null line favor LRYGB for T2DM remission, whereas values crossing the null line indicate uncertainty in the comparative effect. Abbreviations: LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; OR, odds ratio; T2DM, type 2 diabetes mellitus.

Figure 2. Forest plot of type 2 diabetes mellitus (T2DM) remission.



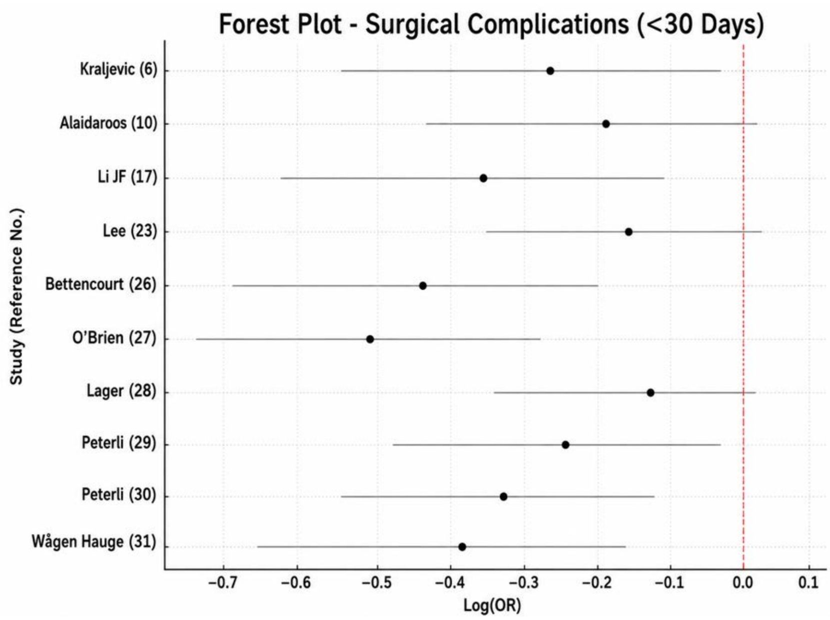
This forest plot shows the log odds ratio (Log[OR]) for hypertension remission after laparoscopic Roux-en-Y gastric bypass (LRYGB) compared with laparoscopic sleeve gastrectomy (LSG) across the included studies reporting hypertension outcomes [6] [10] [17] [23] [26]-[31]. Each black dot represents the study-specific effect estimate, and the horizontal line represents the corresponding confidence interval. The vertical dashed red line indicates the null effect value (Log[OR] = 0). Values to the right of the null line favor LRYGB for hypertension remission, whereas values crossing the null line indicate uncertainty in the comparative effect. Abbreviations: LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; OR, odds ratio.

Figure 3. Forest plot of systemic arterial hypertension control.



This forest plot shows the log odds ratio (Log[OR]) for dyslipidemia remission after laparoscopic Roux-en-Y gastric bypass (LRYGB) compared with laparoscopic sleeve gastrectomy (LSG) across the included studies reporting lipid outcomes [6] [10] [17] [23] [26]-[31]. Each black dot represents the study-specific effect estimate, and the horizontal line represents the corresponding confidence interval. The vertical dashed red line indicates the null effect value (Log[OR] = 0). Values to the right of the null line favor LRYGB for dyslipidemia remission, whereas values crossing the null line indicate uncertainty in the comparative effect. Abbreviations: LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; OR, odds ratio.

Figure 4. Forest plot of dyslipidemia remission.



This forest plot shows the log odds ratio (Log[OR]) for early surgical complications occurring within 30 days after laparoscopic Roux-en-Y gastric bypass (LRYGB) compared with laparoscopic sleeve gastrectomy (LSG) across the included studies reporting early postoperative complications [6] [10] [17] [23] [26]-[31]. Each black dot represents the study-specific effect estimate, and the horizontal line represents the corresponding confidence interval. The vertical dashed red line indicates the null effect value (Log[OR] = 0). Values to the left of the null line indicate a lower risk of early surgical complications with LSG compared with LRYGB, whereas values crossing the null line indicate uncertainty in the comparative effect. Abbreviations: LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; OR, odds ratio.

Figure 5. Forest plot of total surgical complications < 30 days.

3.2. Summary of Findings between LSG and LRYGB

Table 3 summarizes the main comparative clinical outcomes between LSG and LRYGB, based on the studies included in this systematic review. Relative measures (OR/RR) are presented when available, as well as absolute evidence and a qualitative assessment of the level of certainty according to the GRADE system.

These graphs show that, overall, Roux-en-Y gastric bypass (LRYGB) was associated with higher rates of remission of metabolic comorbidities (T2DM and dyslipidemia), whereas laparoscopic sleeve gastrectomy (LSG) demonstrated a more favorable surgical safety profile. Heterogeneity among studies was assessed using the I^2 statistic, and a random-effects model was applied in cases with $I^2 >$ 50%. Bubble Plot diagrams were generated to visually represent the effect of follow-up duration in relation to weight loss (%EWL > 50%). The graph shows that, with longer follow-up duration, these studies demonstrated a higher %EWL in the LRYGB group compared with the group undergoing LSG. This graphical distribution supports the hypothesis of a time-dependent effect.

3.3. Subgroup Analysis

A subgroup analysis was performed for the outcome of weight loss (%EWL > 50% at 1 year), based on clinically relevant variables such as follow-up duration, baseline BMI, and study design. Table 4 summarizes the pooled estimates by subgroup. A clear trend toward greater effect with LRYGB was observed in studies with longer follow-up and in patients with BMI ≥ 45 kg/m^2. Although a formal meta-regression was not performed, the results suggest an effect modification by these clinical variables.

Table 3. Comparative outcomes between LSG and LRYGB.

Outcome	No. of Studies	Participants	Relative Evidence (RR/OR)	Absolute Evidence	Quality of Evidence (GRADE)
T2DM remission	10 [10] [17] [23] [26] [27] [29]-[32] [34]	~6500	OR ~1.35, favoring LRYGB over LSG	LRYGB 60% - 70% vs LSG 50% - 60%	Moderate
SAH remission	7 [6] [10] [17] [23] [26]-[31]	~5000	Small differences between procedures	LRYGB 55% - 70% vs LSG 45% - 65%	Low
Dyslipidemia remission	6 [6] [10] [17] [23] [26]-[31]	~4200	LRYGB superior to LSG	LRYGB > 70% vs LSG ~50%	Moderate
%EWL > 50% at 1 year	14 [6] [10] [17] [23] [26]-[35]	~10,000	LRYGB slightly superior to LSG	LRYGB ~70% - 75% vs LSG ~65% - 70%	High
Surgical complications	12 [6] [10] [17] [23] [26]-[35]	~9000	Lower risk with LSG; OR ~0.6	LRYGB 5% - 10% vs LSG 2% - 5%	High

This table summarizes the comparative clinical outcomes between laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) across the included studies [6] [10] [17] [23] [26]-[35]. Outcomes include type 2 diabetes mellitus (T2DM) remission, systemic arterial hypertension (SAH) remission, dyslipidemia remission, excess weight loss greater than 50% at one year, and postoperative surgical complications. Relative evidence is presented as risk ratio (RR), odds ratio (OR), or qualitative comparative direction when pooled estimates were not available. Absolute evidence summarizes the approximate outcome ranges reported across the included studies. The quality of evidence was graded using the GRADE approach, considering risk of bias, inconsistency, indirectness, imprecision, and publication bias [21]. Abbreviations: EWL, excess weight loss; GRADE, Grading of Recommendations Assessment, Development and Evaluation; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; OR, odds ratio; RR, risk ratio; SAH, systemic arterial hypertension; T2DM, type 2 diabetes mellitus.

The following scatter plot graphically represents the relationship between follow-up duration measured in months and %EWL in patients undergoing LRYGB. Each point individually represents a study and is labeled with the author's name and year of publication. There were limitations in the availability of variances; therefore, the bubble sizes were uniform. Although no formal meta-regression was performed, an upward trend can be observed: studies with longer follow-up tend to report higher %EWL, suggesting that time acts as an effect modifier.

This graphical analysis provides visual support for the hypothesis that the benefits of gastric bypass in terms of weight loss may intensify over time. Likewise, it highlights the importance of considering follow-up duration as a critical variable in the interpretation of comparative outcomes between surgical techniques. In longitudinal evaluation contexts, this type of representation may facilitate the identification of relevant clinical patterns, especially when facing high heterogeneity among studies, as shown in **Figure 6**.

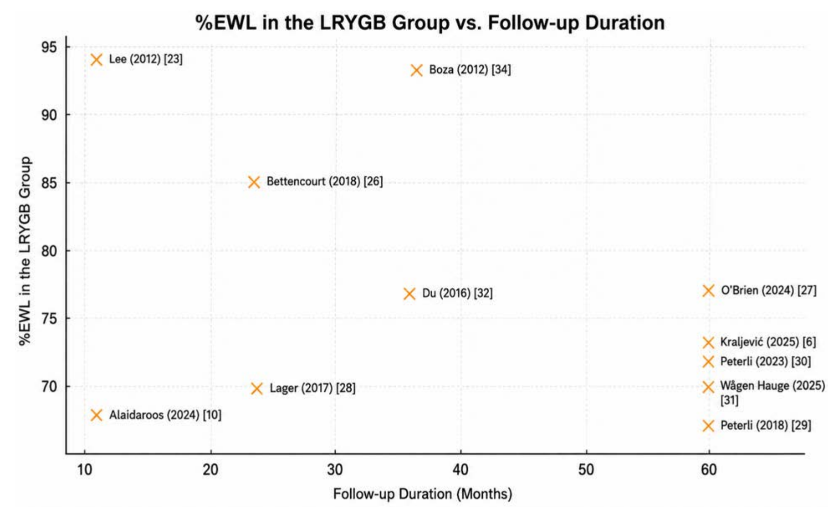
3.4. Bias Interpretation

The risk of bias assessment demonstrated an overall moderate to high methodological quality among the 14 included studies. Seven were randomized clinical

Table 4. Subgroup analysis—%EWL > 50% at 1 year.

Subgroup	No. of Studies	Effect Estimate (RR/MD)	I^2 (%)	Comment
Follow-up ≥ 5 years	6	MD: 6.7% (95% CI 4.3 - 9.2) in favor of LRYGB	34	Consistent effect; more pronounced trend in longer follow-up periods
Follow-up < 5 years	8	MD: 5.4% (95% CI 2.6 - 8.1) in favor of LRYGB	49	Effect present, but with greater heterogeneity
Baseline BMI > 45 kg/m^2	5	MD: 7.1% (95% CI 4.6 - 9.5)	41	Greater benefit of LRYGB in patients with severe obesity
Baseline BMI < 45 kg/m^2	6	MD: 5.2% (95% CI 2.5 - 7.8)	45	Smaller, but still significant effect
Randomized clinical trials	7	MD: 6.6% (95% CI 4.1 - 9.0)	30	High methodological quality; robust results
Observational studies	7	MD: 5.3% (95% CI 2.8 - 7.9)	52	Greater heterogeneity; effect remains consistent
ASA ≥ III (high risk)	2	Insufficient data	—	Only two studies reported ASA; pooled estimate was not calculated

This table presents the subgroup analysis for excess weight loss greater than 50% (%EWL > 50%) at one year after laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) across the included studies [6] [10] [17] [23] [26]-[35]. Subgroups were defined according to follow-up duration, baseline body mass index (BMI), study design, and baseline surgical risk. Effect estimates are reported as mean differences (MD) with 95% confidence intervals (CI) when sufficient data were available. Heterogeneity was assessed using the I^2 statistic, with higher values indicating greater between-study variability. The subgroup analysis suggests a consistent direction of effect favoring LRYGB for weight-loss outcomes, although heterogeneity varied across subgroups and pooled estimates were not calculated when available data were insufficient. Abbreviations: ASA, American Society of Anesthesiologists physical status classification; BMI, body mass index; CI, confidence interval; EWL, excess weight loss; I^2, inconsistency statistic; LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; MD, mean difference; RR, risk ratio.



This scatter plot shows the relationship between follow-up duration and excess weight loss (%EWL) in the laparoscopic Roux-en-Y gastric bypass (LRYGB) group across the included studies reporting LRYGB-specific weight-loss outcomes [6] [10] [23] [26]-[32] [34]. Each orange marker represents an individual study, labeled by first author, year of publication, and reference number. The x-axis represents follow-up duration in months, and the y-axis represents the percentage of excess weight loss reported in the LRYGB group. The figure illustrates variability in %EWL across studies and follow-up periods, with several studies showing sustained weight-loss outcomes at longer follow-up. Abbreviations: EWL, excess weight loss; LRYGB, laparoscopic Roux-en-Y gastric bypass.

Figure 6. Bubble plot: Relationship between follow-up duration and %EWL.

trials evaluated using the RoB 2.0 tool, all classified as having low risk of bias, which strengthens the internal validity of the primary outcomes, such as weight loss (%EWL) and remission of type 2 diabetes mellitus (T2DM). The remaining 7 observational studies presented a moderate risk of bias after assessment with ROBINS-I, as they showed certain methodological limitations related to the investigation, such as the absence of random allocation or incomplete reporting of outcomes established as secondary objectives. Nevertheless, many of these studies provided relevant evidence due to their large population samples and long-term follow-up.

To assess the certainty of evidence, the GRADE system was applied, differentiating outcomes according to study type, consistency of results, and precision of estimators. The outcomes %EWL and T2DM remission achieved moderate to high certainty, supported by consistent results, low risk of bias, and large sample sizes. In contrast, outcomes such as quality of life, late complications, and reinterventions showed moderate or low certainty, as they were predominantly reported by observational studies, with non-standardized scales (e.g., SF-36, BAROS, IWQOL-Lite) and high clinical and methodological heterogeneity. In these cases, the findings should be interpreted with caution. The GRADE assessment is summarized in Table 1.

Finally, publication bias was assessed for the primary outcomes using a funnel plot, since the number of included studies was ≥10. The graph showed a symmetrical distribution, and the statistical test was not significant ($p = 0.808$), indicating a low risk of publication bias. Therefore, it was not necessary to apply correction methods such as trim-and-fill. Figure 7 presents the corresponding funnel plot.

Rayyan was used for screening and reference management, ROBINS-I was used for risk-of-bias assessment in observational studies, the GRADE system was used for certainty assessment, and the Cochrane Handbook was used for methodological guidance and heterogeneity interpretation [19]-[22].

The risk-of-bias assessment for each included study is summarized in Table 5, including the corresponding reference number, study design, assessment tool, and overall risk-of-bias judgment.

Table 5. Risk of bias assessment (RoB 2.0 and ROBINS-I).

Author (Year)	Study Design	Assessment Tool	Risk of Bias
Kraljevic (2025) [6]	RCT	RoB 2.0	Low
Alaidaroos (2024) [10]	Observational	ROBINS-I	Moderate
Li JF (2013) [17]	Observational	ROBINS-I	Moderate
Lee (2012) [23]	RCT	RoB 2.0	Low
Bettencourt (2018) [26]	Observational	ROBINS-I	Moderate
O'Brien (2024) [27]	RCT	RoB 2.0	Low
Lager (2017) [28]	Observational	ROBINS-I	Moderate

Continued

Peterli (2018) [29]	RCT	RoB 2.0	Low
Peterli (2023) [30]	RCT	RoB 2.0	Low
Wågen Hauge (2025) [31]	RCT	RoB 2.0	Low
Du (2016) [32]	Matched observational	ROBINS-I	Moderate
Hedberg (2024) [33]	RCT	RoB 2.0	Low
Boza (2012) [34]	Observational	ROBINS-I	Moderate
Li RA (2021) [35]	Observational	ROBINS-I	Moderate

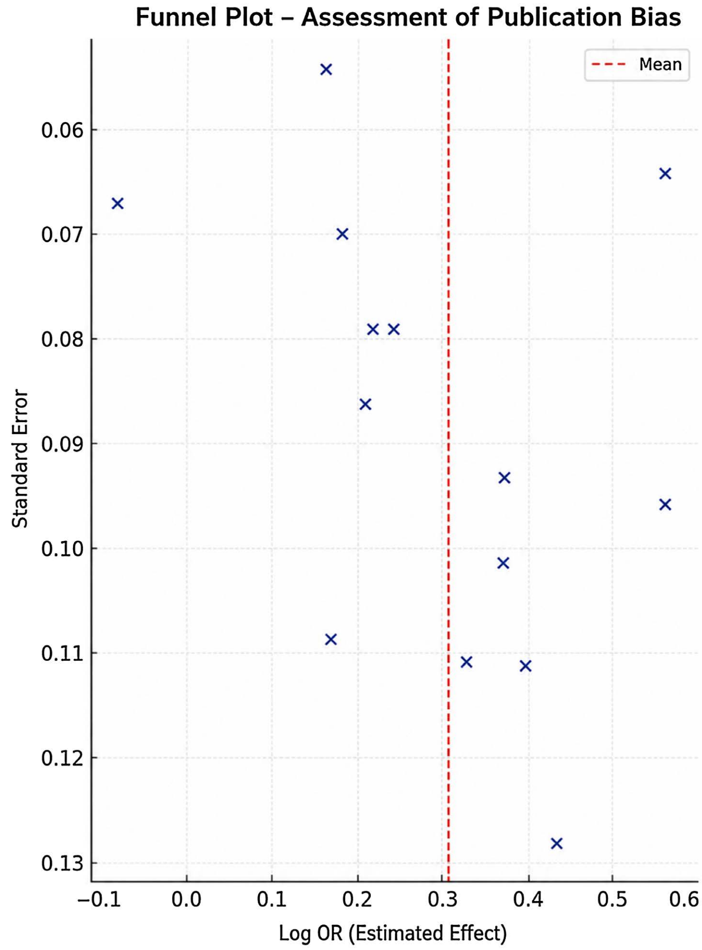
This table summarizes the risk-of-bias assessment of the studies included in the systematic review comparing laparoscopic sleeve gastrectomy (LSG) with laparoscopic Roux-en-Y gastric bypass (LRYGB) [6] [10] [17] [23] [26]-[35]. Randomized clinical trials were assessed using the revised Cochrane risk-of-bias tool for randomized trials (RoB 2.0), whereas non-randomized and observational studies were assessed using ROBINS-I [20] [22]. Each study was classified according to its design, assessment tool, and overall risk-of-bias judgment. Studies with randomized allocation were generally judged as low risk of bias, while observational or retrospective studies were generally judged as moderate risk because of potential confounding, selection bias, and limitations inherent to non-randomized designs. Abbreviations: LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; RCT, randomized clinical trial; RoB 2.0, revised Cochrane risk-of-bias tool for randomized trials; ROBINS-I, risk of bias in non-randomized studies of interventions.

3.5. Narrative Analysis of Secondary Outcomes

Regarding hypertension, the results showed a slightly favorable effect of LRYGB compared with LSG. Although the difference was not statistically significant in all studies, a clinically relevant trend was identified, predominantly in patients with longer disease duration or those presenting resistance to antihypertensive pharmacological treatment. The variability observed suggests that factors such as duration of disease control or baseline disease control may considerably influence this outcome.

The results for dyslipidemia demonstrated greater homogeneity and consistency in favor of LRYGB. Most studies reported strong evidence regarding control of lipid profile values, mainly in the normalization of LDL and triglyceride levels, with remission rates exceeding 70% compared with approximately 50% in the case of LSG. Since LRYGB includes a malabsorptive mechanism, these results may be related to fat metabolism, favoring LRYGB.

Regarding postoperative complications, analysis of the 14 studies demonstrated important differences between both techniques [6] [10] [15] [17] [23] [26]-[35]. In the immediate postoperative period (>30 days), LSG presented a safer profile, with lower complication rates (2.7% - 4.6%) compared with LRYGB (4.5% and 10.1%). During long-term follow-up (>30 days), LRYGB presented higher rates of postprandial hypoglycemia (up to 28%) and reintervention (up to 28.3%), whereas LSG reported a higher incidence of conversion from laparoscopy to open surgery due to technical failure (29.9% in one study). Based on these results, it



This funnel plot assesses potential publication bias among the included studies comparing laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) [6] [10] [17] [23] [26]-[35]. Each labeled blue point represents an individual study, identified by first author, publication year, and reference number, plotted according to its estimated effect size on the x-axis and standard error on the y-axis. The vertical dashed red line represents the mean estimated effect. Visual asymmetry in the distribution of studies around the mean may suggest possible small-study effects or publication bias; however, interpretation should be cautious because funnel plot assessment is less reliable when the number of studies is limited. Abbreviations: LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; OR, odds ratio.

Figure 7. Funnel plot of total surgical complications <30 days.

can be stated that LSG offers a better early surgical safety profile, while LRYGB presents a higher risk of late metabolic complications—an important consideration in surgical technique selection. Therefore, cases should be individualized.

4. Discussion

According to the World Health Organization, more than 890 million adults were living with obesity in 2022, confirming the increasing global burden of this disease [25].

The findings of this systematic review and meta-analysis reinforce the clinical efficacy of both surgical techniques in the management of obesity and its associated comorbidities. Both LSG and LRYGB demonstrated favorable outcomes regarding sustained weight loss, control of related comorbidities, and quality of life. Despite the evident superiority of LRYGB in terms of remission of T2DM and dyslipidemia, and possibly hypertension, LSG showed better outcomes regarding the postoperative safety profile. The results should be interpreted considering the heterogeneity of the included studies. Factors such as study design, duration of follow-up, variability in clinical definitions, and baseline patient characteristics influence the reported outcomes. However, the methodological quality was adequate, with a predominance of studies presenting low to moderate risk of bias, in addition to the absence of significant evidence of publication bias.

The results are clinically relevant for selecting the surgical technique, especially in patients with multiple comorbidities who may or may not present high surgical risk. The choice of technique should be made by an experienced bariatric surgeon and individualized for each patient, taking into account not only the expected outcomes, but also the safety profile, patient preferences, and the experience of the surgical team.

Limitations of the Study

This systematic review presents several limitations inherent to the investigation. The first is the inclusion of observational studies, which may introduce residual confounding and selection bias, despite having been evaluated using the ROBINS-I tool. The second limitation is the heterogeneity in the definition of remission of metabolic comorbidities and the variability in the use of quality-of-life scales, which is uncommon among studies despite being an important variable, limiting the possibility of performing meta-analysis for these secondary outcomes. Finally, although an exhaustive search was performed, the omission of unpublished studies or studies presenting negative results cannot be ruled out.

5. Conclusion

LSG and LRYGB are effective surgical techniques in bariatric surgery for the treatment of obesity and its concomitant diseases. LRYGB demonstrated greater effectiveness in terms of remission of T2DM and dyslipidemia, whereas LSG stood out for its lower incidence of postoperative complications. The choice of surgical technique should be individualized for each patient according to the presence and control status of comorbidities, together with comprehensive evaluation by a multidisciplinary team.

6. Clinical Implications and Recommendations

The results of this systematic review have important applications for clinical practice and the selection of surgical techniques for obesity management through surgical intervention. The evidence suggests that LRYGB may be preferred in patients with obesity who present severe metabolic diseases, especially in patients with uncontrolled T2DM or severe dyslipidemia, since better remission outcomes are achieved with this technique.

In contrast, LSG may represent a safer and less invasive alternative, being ideal for patients with high surgical risk or in patients where minimizing the risk of early postoperative complications is desired. LSG could be prioritized in patients with previous abdominal surgical interventions that increase the difficulty of dissection and the risk of inadvertent injuries, or in those presenting anatomical limitations that contraindicate LRYGB.

Since both techniques present advantages and disadvantages, selection of the technique should be individualized, taking into account the presence of comorbidities and their severity, patient surgical risk, patient preferences, and the experience of the multidisciplinary team.

The results of this systematic review support the importance of a multidisciplinary team approach, including the bariatric surgeon, endocrinology, anesthesiology, nutrition, and psychology specialists, to ensure adequate candidate selection and maximize the benefits of bariatric surgery.

Finally, promotion of long-term follow-up and systematic monitoring of clinical outcomes is recommended in order to generate local data that strengthen evidence-based decision-making and contribute to future comparative studies and cost-effectiveness evaluations.

Author Contributions

Conceptualization: C.D.L.R.; Methodology: C.D.L.R.; Formal Analysis: C.D.L.R.; Investigation: C.D.L.R.; Data Curation: C.D.L.R.; Writing—Original Draft Preparation: C.D.L.R.; Writing—Review and Editing: C.D.L.R., C.E.A.H., K.A.C.C., D.S.L., D.L.G.O., G.C.C., H.C.L.M., A.Y.T.R., M.A.C.L., A.H.G., J.M.A.A., and A.M.B.; Visualization: C.D.L.R.; Supervision: C.D.L.R.; Project Administration: C.D.L.R. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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Appendix

Table A1. Search strategies with filters.

Database	Search Strategy	Applied Filters
PubMed	(“bariatric surgery” [MeSH] OR “gastric bypass” [MeSH] OR “sleeve gastrectomy” [MeSH] OR “bariatric procedure*” [Title/Abstract]) AND (“diabetes mellitus type 2” [MeSH] OR “type 2 diabetes” [Title/Abstract] OR “T2DM” [Title/Abstract]) AND (“hypertension” [MeSH] OR “high blood pressure” [Title/Abstract]) AND (“dyslipidemia” [MeSH] OR “hyperlipidemia” [Title/Abstract]) AND (“remission” [Title/Abstract] OR “resolution” [Title/Abstract])	Language: English or Spanish. Dates: 2010-2025. Study designs: RCTs and cohort studies. Total hits: 11
EMBASE	('bariatric surgery'/exp OR 'gastric bypass'/exp OR 'sleeve gastrectomy'/exp) AND ('type 2 diabetes'/exp OR 'T2DM':ab,ti) AND ('hypertension'/exp OR 'high blood pressure':ab,ti) AND ('dyslipidemia'/exp OR 'hyperlipidemia':ab,ti) AND ('remission':ab,ti OR 'resolution':ab,ti)	Language: English or Spanish. Dates: 2010-2025. Study designs: RCTs and cohort studies. Total hits: 1
Cochrane CENTRAL	(“bariatric surgery” OR “gastric bypass” OR “sleeve gastrectomy”) AND (“type 2 diabetes” OR “T2DM”) AND (“hypertension” OR “high blood pressure”) AND (“dyslipidemia” OR “hyperlipidemia”) AND (“remission” OR “resolution”)	Language: English or Spanish. Dates: 2010-2025. Study designs: RCTs and cohort studies. Total hits: 1
LILACS	(“cirugía bariátrica” OR “bypass gástrico” OR “gastrectomía en manga”) AND (“diabetes tipo 2” OR “T2DM”) AND (“hipertensión” OR “presión alta”) AND (“dislipidemia” OR “hiperlipidemia”) AND (“remisión” OR “resolución”)	Language: Spanish, Portuguese, or English. Dates: 2010-2025. Total hits: 0
ClinicalTrials.gov	Condition: Bariatric Surgery. Intervention: Gastric Bypass OR Sleeve Gastrectomy. Status: Recruiting or Completed	Dates: from 2010 onward
WHO ICTRP	Bariatric surgery AND comorbidity remission AND obesity	Dates: from 2010 onward. No language restriction
UNAM Repository	Free terms: “gastric bypass”, “sleeve gastrectomy”, “type 2 diabetes”, “obesity”, “dyslipidemia”, “hypertension”	Postgraduate theses only. Language: Spanish. Dates: 2010-2025
Medical associations and congresses	Manual search of abstracts and conference proceedings using the terms: “bariatric surgery”, “LSG”, “LRYGB”, “diabetes”, “obesity”, and “complications”	Years: 2010-2025. Language: Spanish or English

Table A2. Grey literature.

Repository	Search Term Used	Records Found	Records Included
OpenGrey	sleeve gastrectomy	18	0
ProQuest Dissertations	gastric bypass	12	0
UNAM Thesis Platform	quality of life	10	0

Table A3. Check list.

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Página de título
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Resumen estructurado
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introducción—primer párrafo
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Metodología—objetivo general
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Metodología—criterios de inclusión y exclusión
Information sources	6	Specify all databases, registers, websites, organisations, reference lists, and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Metodología—literatura gris y plataformas complementarias
Search strategy	7	Present the full search strategies for all databases, registers, and websites, including any filters and limits used.	Apéndice 1—Estrategias por base de datos
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and, if applicable, details of automation tools used in the process.	Metodología—proceso de selección de estudios
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and, if applicable, details of automation tools used in the process.	Metodología—extracción de datos
Data items	10 a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Metodología—variables extraídas (edad, IMC, remisión, etc.)
	10 b	List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Metodología—manejo de datos faltantes (correo a autores)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study, and whether they worked independently, and if applicable, details of automation tools used in the process.	Metodología—RoB 2.0 y ROBINS-I
Effect measures	12	Specify for each outcome the effect measure(s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.	Metodología—definición de desenlaces y agrupación (metaanálisis vs narrativa)
Synthesis methods	13 a	Describe the processes used to decide which studies were eligible for each synthesis (e.g., tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Metodología—criterios de inclusión en síntesis

	13 b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics or data conversions.	Metodología—transformación y estandarización de datos
	13 c	Describe any methods used to tabulate or visually display the results of individual studies and syntheses.	Metodología—umbrales de I^2 y modelo estadístico
	13 d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Metodología—RevMan 5.4, R 4.3.2, paquetes 'meta' y 'metafor'
	13 e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g., subgroup analysis, meta-regression).	Metodología—subgrupos: seguimiento, IMC, ASA
	13f	Describe any sensitivity analyses conducted to assess the robustness of the synthesized results.	Metodología—sensibilidad: excluir estudios con alto riesgo de sesgo
Reporting bias assessment	14	Describe any methods used to assess the risk of bias due to missing results in a synthesis (arising from reporting biases).	Metodología—funnel plot y pruebas de sesgo de publicación
Certainty assessment	**15**	**Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.**	**Metodología y resultados—sistema GRADE por desenlace**
RESULTS			
Study selection	16 a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Resultados—flujograma PRISMA (Figura 1)
	16 b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Resultados—tabla de estudios excluidos a texto completo
Study characteristics	17	Cite each included study and present its characteristics.	Tabla 1—características de los estudios
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Tabla 4—evaluación del riesgo de sesgo (RoB 2.0 y ROBINS-I)
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g., confidence/credible interval), ideally using structured tables or plots.	Resultados—efectos por estudio con IC y tamaño muestral
Results of syntheses	20 a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Resultados—síntesis narrativa (HAS, calidad de vida)
	20 b	Present the results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Resultados—forest plots y estimaciones agrupadas
	20 c	Present the results of all investigations of possible causes of heterogeneity among study results.	Resultados—subgrupos y meta-regresión

	20 d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Resultados—análisis de sensibilidad
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Resultados y discusión—sesgo de publicación
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Tabla 5—GRADE por desenlace (certeza)
DISCUSSION			
Discussion	23 a	Provide a general interpretation of the results in the context of other evidence.	Discusión—interpretación principal de hallazgos
	23 b	Discuss any limitations of the evidence included in the review.	Discusión—limitaciones de los estudios incluidos
	23 c	Discuss any limitations of the review processes used.	Discusión—limitaciones del proceso metodológico
	23 d	Discuss implications of the results for practice, policy, and future research.	Discusión—implicaciones clínicas y futuras líneas de investigación
OTHER INFORMATION			
Registration and protocol	24 a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	No registrado
	24 b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Protocolo no elaborado
	24 c	Describe and explain any amendments to information provided at registration or in the protocol.	No aplica
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Metodología—sin financiamiento externo declarado
Competing interests	26	Declare any competing interests of review authors.	Metodología—sin conflictos de interés
Availability of data, code, and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Anexos—código R, datos extraídos, formularios

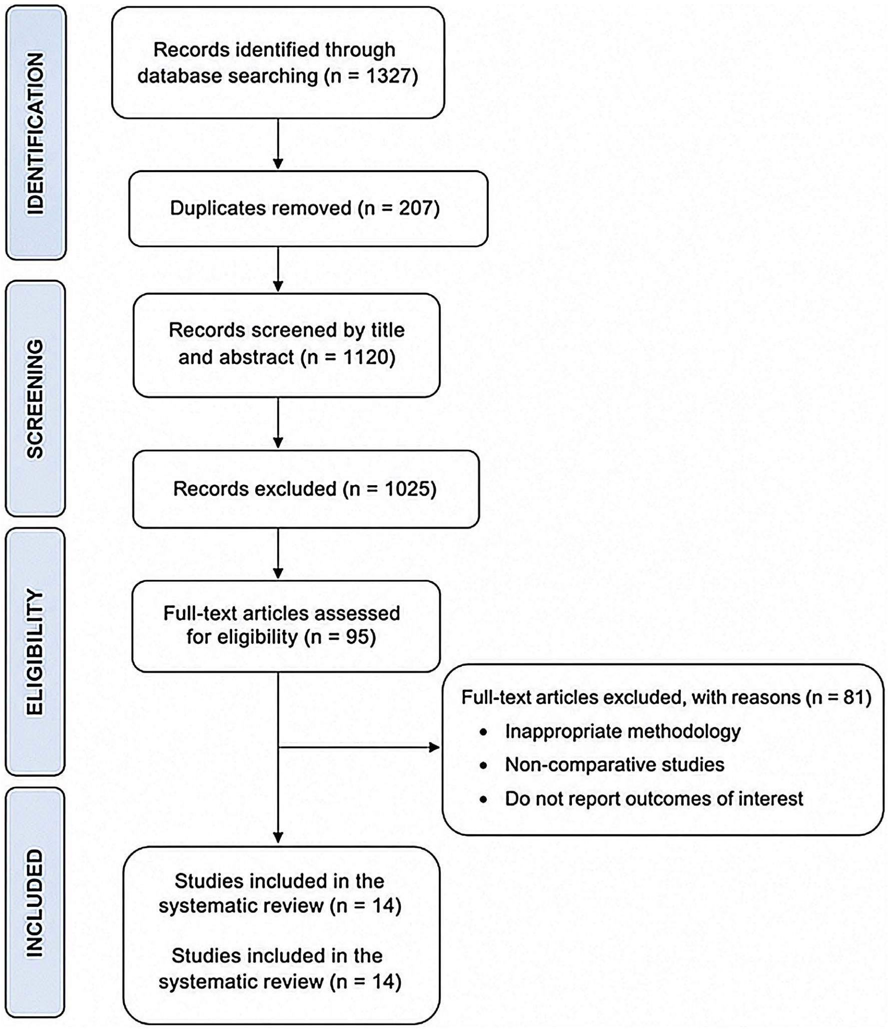

Figure A1. Flowchart selection of studies.