Perioperative and Long-Term Risks in Obese Living Kidney Donors: A Systematic Review and Meta-Analysis

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ABBREVIATIONS

BMI, body mass index; **CKD**, chronic kidney disease; **CI**, confidence interval; **ESKD**, end-stage kidney disease; **IQR**, interquartile range; **OPTN**, Organ Procurement and Transplantation Network; **UNOS**, United Network for Organ Sharing; **U.S.**, United States.

Abstract

Background: Obesity is a globally prevalent condition. Due to the shortage of living kidney donors, transplant centers have increasingly accepted donors with obesity.

Purpose: To synthesize evidence on perioperative and long-term risks of donor nephrectomy for obese versus non-obese donors.

Data Sources: MEDLINE®, Scopus, CINAHL, Web of Science, and the Cochrane Library, with studies published in English from 01/1990-6/2025.

Study Selection: Studies comparing outcomes between adult obese (BMI ≥30 kg/m²) and non-obese donors (<30 kg/m²).

Data Extraction: Three reviewers independently extracted data and assessed study quality; disagreements were resolved by a fourth reviewer.

Data Synthesis: Thirty-three studies were included. Obese donors had a significantly higher risk of surgical complications (odds ratio [OR]=1.43, 95% CI: 1.17–1.74) and conversion to open nephrectomy (OR=1.83, 95% CI: 1.19–2.81). They experienced longer operative times, greater estimated blood loss and hospital stays. Long-term risks were elevated for hypertension (OR=1.28, 95% CI: 1.05–1.57), diabetes (OR=1.72, 95% CI: 1.08- 2.74), proteinuria (OR=1.40, 95% CI: 1.21–1.61). Kidney function using eGFR was lower standardized mean difference [SMD]= -0.19 (95% CI: -0.28–0.11) and risk of end-stage renal disease was higher (OR=1.76, 95% CI: 1.04–3.00). Certainty of evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE).

Limitations: The observational nature of included studies can introduce bias with unmeasured confounding.

Conclusions: Obese donors face higher perioperative and long-term risks. However, the absolute risk increases remain low. These findings highlight the need for individualized shared decision making and long-term monitoring of obese donors.

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INTRODUCTION

Nearly one-fourth of living kidney donors in the United States are obese, defined as a body mass index (BMI) ≥30 kg/m^2.[1] This trend reflects both the prevalence of obesity and the ongoing shortage of donors.[2-7] Clinical practice has broadened donor eligibility criteria to include individuals with higher BMI.[8-10] Beside surgical risks, obesity is associated with glomerulomegaly and lower post-donation kidney reserve capacity.[11,12] The 50% loss of nephron mass associated with donor nephrectomy may predispose obese donors to an increased long-term risk of kidney disease, especially in the event of de novo disease.[13,14] While obese donors are lifesaving for patients with end-stage kidney disease (ESKD),[15] a comprehensive understanding of outcomes among obese donors is critical.

Obesity is a well-established risk factor for increased morbidity and mortality in the general population.[16-23] Elevated BMI is associated with the development of ESKD.[24,25] Remarkably, metabolically healthy obese individuals have an increased risk of death and cardiovascular events,[26] as well as a higher risk of chronic kidney disease (CKD).[27,28] Obese donors are not exempt from these risks.[29-31] The British guidelines allow donation for individuals with a BMI of 30-35 kg/m^2 if they are otherwise healthy, while discouraging donation with a BMI >35 kg/m^2.[32] The Kidney Disease: Improving Global Outcomes (KDIGO) CKD Guideline recommends that decisions concerning donor candidates with BMI >30 kg/m^2 be individualized based on demographic and health profile in relation to the transplant program's acceptable risk threshold.[33,34] A 2013 meta-analysis provided insights into perioperative outcomes among obese donors, reporting no significant differences in perioperative complications; however, it was limited in scope and did not examine the long-term impact of donation in this population, highlighting the need for a more comprehensive synthesis.[35]

This systematic review and meta-analysis aim to synthesize existing evidence on the perioperative and long-term risks associated with obesity among donors. By synthesizing existing and emerging evidence, this study seeks to inform clinical practice, donor counseling, and post-donation care related to obese donors.

METHODS

Data Sources and Searches

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure methodological rigor, transparency, and quality,[36] and prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) (registration number CRD42024499394).[37] A comprehensive database search strategy (Appendix 1) was developed by the research team (AN, AA, AM, SA, FA) and validated by an information specialist (HPG). This search strategy was based on the study aim and utilized the PICO (Population, Intervention, Comparison, Outcome) framework to identify relevant keywords for the literature search.

We identified studies published in English between January 1, 1990, and June 30, 2025, through electronic searches in MEDLINE®, Scopus, CINAHL, Web of Science, and the Cochrane Library. Results were managed in SciWheel,[38] and additional studies were identified through manual citation tracking using forward and backward citation snowballing.

Study Selection

Studies were selected based on predefined inclusion and exclusion criteria. Eligible studies included adult kidney donors (aged ≥18 years) that compared outcomes between obese and non-obese donors. Both randomized controlled trials (RCTs) and observational studies (cohort, case-control, and cross-

sectional designs) were included. Outcome periods were categorized comprehensively based on reported follow-up times as: immediate (perioperative), intermediate (less than five years), and long-term (beyond five years), allowing for evaluation of coherent surgical and medical outcomes. Exclusion criteria included case reports, case series, qualitative reviews, commentaries, letters, and conference proceedings.

All identified studies were imported into Covidence for screening. A pilot test was conducted on 50 randomly selected articles to ensure inter-rater reliability ($\kappa > 0.8$). Three independent reviewers (AN, AA, AM) screened titles and abstracts, followed by full-text reviews for potentially relevant studies. Any disagreements were resolved by a fourth reviewer (FA).

Data Extraction and Quality Assessment

The data elements extracted from each article included the author, country, year of publication, study location, study design, number of patients, age, sex, follow-up time, intervention, and comparators. We categorized outcomes based on reported follow-up times as: immediate (perioperative), intermediate (less than five years), and long-term (beyond five years), allowing for evaluation of coherent surgical and medical outcomes. The primary perioperative outcomes extracted included surgical complications, conversion rate to open surgery, estimated blood loss, operative time, length of hospital stay, infection rate, and warm ischemia time. The primary long-term outcomes extracted included hypertension, diabetes mellitus, proteinuria, estimated glomerular filtration rate (eGFR), and End-stage Kidney Disease (ESKD). Data were inputted into an Excel sheet and categorized by long-term and immediate outcomes (Appendix 6).

The quality of included studies was assessed using Cochrane's Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) tool,[39] which evaluates risk of bias across seven domains: confounding, selection bias, classification of interventions, deviations from intended interventions, missing data, outcome measurement, and reporting bias. Each study was categorized as having low, moderate, serious, or critical risk of bias.

The certainty of the evidence was appraised using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) methodology.[40,41] The GRADE approach evaluates evidence quality by balancing factors that may weaken confidence, such as risk of bias, heterogeneity, indirectness, imprecision, and publication bias, with factors that strengthen confidence like large effect sizes, dose-response relationships, and low confounding. The GRADE evaluation was carried out using the GRADEPro GDT software which also calculates absolute risk differences for binary outcomes by applying pooled relative effect estimates to the baseline risk observed in the non-exposed group and are presented as risk differences per 1,000 individuals.

Data Synthesis and Analysis

A meta-analysis was conducted using Cochrane's RevMan version 5.4 to evaluate the effects of the interventions compared to their comparators.[42] When numerical data were reported as median and interquartile range (IQR), they were approximated to mean and standard deviation (SD) using the method described by Wan et al.[43] Continuous outcomes were analyzed using the inverse variance method, while dichotomous outcomes were assessed using the Mantel-Haenszel approach. The pooled effect sizes were expressed as odds ratios (ORs) and standardized mean differences (SMDs), applying a random-effects meta-analysis model to account for between-study variability.

Heterogeneity across studies was assessed using the τ^2 statistic estimated via the DerSimonian and Laird method and the I^2 statistic.[44,45] The I^2 values describe the percentage of total variation across studies that is due to heterogeneity rather than chance: a value of 0-25% indicates low heterogeneity, between 25-50% is considered moderate, between 50-75% substantial, and above 75% high. Overall effect sizes were tested using Z-statistics, with statistical significance set at $p < 0.05$. All analyses adhered to the statistical algorithms specified in the Cochrane Handbook for Systematic Reviews of Interventions.[46] The results were visually presented using forest plots, displaying pooled estimates and 95% confidence intervals (95% CI).

As we compared obese donors to non-obese donors, if studies provided multiple BMI categories (i.e., normal, overweight, obese and morbidly obese) then a weighted average was done by grouping the normal and overweight categories (i.e., BMI < 30 kg/m²) and grouping obese and severely obese categories (i.e., BMI ≥ 30kg/m²).

In subgroup analyses, we pooled the most extreme BMI comparisons, if reported, i.e., normal (BMI ≤ 25 kg/m²) vs. severely obese (BMI ≥ 35kg/m²) from studies that reported such weight categories. We also pool studies that included participants who underwent laparoscopic donor nephrectomy only. A qualitative synthesis of the included studies was also conducted to synthesize similarities and differences in study characteristics, themes, and interventions.

Role of the Funding Source

The funding source had no role in the study design, data collection, analysis, or interpretation; the writing of the manuscript; or the decision to submit the manuscript for publication.

RESULTS

Study characteristics

A total of 33 unique studies involving 25,994 obese donors and 80,133 non-obese donors met the predefined inclusion and exclusion criteria and were included in the qualitative and quantitative synthesis (Flow Diagram– Figure 1). The majority (59%) were based in the United States. Others include three studies were conducted in Turkey, two in Mexico, and one study each in the Netherlands, United Kingdom, Indonesia, Austria, Denmark, Finland, Saudi Arabia, India, and Iran (Table 1). This geographical distribution underscores the global interest in understanding the implications of obesity among living kidney donors.

The included studies varied in design, with 30 studies (88%) classified as retrospective cohorts and 4 studies (12%) as prospective cohorts, reflecting the predominance of observational data in this field. Retrospective studies ranged widely in sample size—from small, single-center cohorts with fewer than 30 participants to large registry-based analyses with over 78,000 combined donors. In contrast, prospective studies tended to be smaller in scale, typically enrolling fewer than 200 donors each.

The weighted average age among obese donors was 38.75 years, compared to 39.01 years in the non-obese group. The weighted proportion of female donors was 56.76% in the obese group and 59.43% in the non-obese group. Despite variation in design, follow-up duration, and outcome definitions, the included studies consistently aimed to evaluate the perioperative safety and long-term health risks of kidney donation in individuals with obesity. Together, they provide a comprehensive foundation for understanding the evolving risk profile of this growing donor population.

Perioperative Outcomes

Surgical Complications

Seventeen studies assessed the odds of surgical complications between obese and non-obese living kidney donors, encompassing a total of 21,784 participants (Figure 2A). The pooled OR was 1.43 (95% CI: 1.17–1.74), significantly favoring non-obese patients (p = 0.0005). This translates to 35 additional complications per 1,000 obese donors compared to non-obese donors. Heterogeneity across the included studies was low (I^2 = 21%).

Conversion rate to open nephrectomy

Eight studies illustrate the odds of conversion from laparoscopic to open nephrectomy between obese and non-obese donors, involving 2,382 obese and 7,675 non-obese individuals (Figure 2B). The pooled OR was 1.83 (95% CI: 1.19–2.81, p = 0.005), indicating that obese donors were three times more likely to require conversion. This corresponds to 7 additional conversion events per 1,000 obese donors. Heterogeneity was low (I^2 = 0%).

Estimated blood loss

Twelve studies examined estimated mean blood loss (mL) across both groups and accounted for a total of 6,153 donors (Figure 2C). The pooled SMD was 0.18 (95% CI: 0.04–0.32, p = 0.01), significantly favoring the non-obese group. This suggests that obese donors experienced higher intraoperative blood loss than non-obese donors. The statistical heterogeneity was substantial (I^2 = 66%).

Operative time

Sixteen studies comparing mean operative times (minutes) between obese and non-obese donors (including 2,437 obese and 7,944 non-obese individuals) demonstrated a pooled SMD of 0.30 (95% CI: 0.19–0.42, $p < 0.00001$), favoring non-obese donors (Figure 2D). This finding suggests that obese patients required significantly longer operative times. The statistical heterogeneity was substantial ($I^2 = 73\%$).

Length of stay

Nineteen studies estimated the mean hospital stay (days) following donor nephrectomy accounting for a total of 17,189 donors (Figure 2E). The overall effect size (SMD = 0.13, 95% CI: 0.04–0.21, $p < 0.005$) indicates that obese donors had a slightly longer hospital stay, though the effect was small. The statistical heterogeneity was substantial ($I^2 = 61\%$).

Wound Infection

Five studies examined the odds of wound infection rate, including 3,642 donors (Figure 2F). The pooled OR was 2.70 (95% CI: 1.52–4.79, $p = 0.0007$), favoring non-obese donors. This corresponds to 14 additional wound infection cases per 1,000 obese donors. The statistical heterogeneity was low ($I^2 = 0\%$).

Warm Ischemia time

Nine studies assessed mean warm ischemia time (minutes) between obese and non-obese donors accounting for a total of 5,130 donors (Figure 2G). The pooled SMD was -0.01 (95% CI: -0.08 to 0.05), indicating no significant difference between obese and non-obese donors. The statistical heterogeneity was low ($I^2 = 0\%$).

In subgroup analyses with extreme BMIs and Laprascopic surgeries only (Appendix 7-8), inferences of perioperative outcomes were directionally consistent but generally larger effect sizes and a dose-response relationship, suggesting that obese participants were strongly associated with higher adverse perioperative outcomes. (Supplementary Table S1: Sub-group analyses)

Long-term Outcomes

Hypertension

Three studies evaluated the risk of post-donation hypertension, including 12,433 donors (Figure 3A). The pooled OR was 1.28 (95% CI: 1.05–1.57, p = 0.02), favoring the non-obese group. This suggests that obese donors had 1.28 times higher odds of developing hypertension, corresponding to 49 additional cases per 1,000 obese donors (95% CI: 9-94). Statistical heterogeneity was moderate (I^2 = 57%).

Diabetes Mellitus

Three studies analyzed the odds of developing diabetes, accounting for 12,433 donors (Figure 3B). The pooled OR was 1.72 (95% CI: 1.08–2.74, p = 0.02), indicating that obese donors had 1.72 times higher odds of developing diabetes. This corresponds to 39 additional cases per 1,000 obese donors (95% CI: 4-88). Statistical heterogeneity was high (I^2 = 77%).

Proteinuria

Two studies assessed the risk of developing proteinuria. The pooled OR was 1.40 (95% CI: 1.21–1.61, p < 0.00001), favoring non-obese donors. This suggests that obese donors had a 40% higher risk of developing proteinuria, corresponding to 34 additional cases per 1,000 obese donors (95% CI: 18-50). Statistical heterogeneity was low (I^2 = 3%).

eGFR

Two studies estimated the kidney function eGFR (mL/min/1.73 m^2) following donor nephrectomy accounting for a total of 3850 donors (Figure 3C). The overall effect size (SMD = -0.19, 95% CI: -0.28, –0.12, $p < 0.00001$) indicates that obese donors had a lower eGFR compared to non-obese donors. The statistical heterogeneity was low ($I^2 = 0\%$).

End-stage Kidney Disease

Three studies evaluated the risk of ESKD, including 90,927 donors (Figure 3D). The pooled OR was 1.76 (95% CI: 1.04–3.00, $p = 0.04$), favoring the non-obese group. This suggests that obese donors had a 76% higher risk of developing ESKD, corresponding to three additional cases per 1,000 obese donors (95% CI: 1-8). Heterogeneity was substantial ($I^2 = 56\%$).

Certainty of evidence

The risk of bias assessment was conducted for all 33 included studies using the ROBINS-I tool (Appendix 2-3). Among these, 6 studies (18%) were classified as having a serious risk of bias, 13 studies (64%) had a moderate risk, and 6 studies (18%) had a low risk. The domains with the highest proportion of serious risk of bias were D1 (bias due to confounding) and D2 (bias due to selection of participants), suggesting that differences in baseline characteristics and selection criteria may have influenced study outcomes. Additionally, D5 (bias due to missing data) had a high proportion of studies with unclear risk, indicating potential concerns regarding incomplete follow-up and unreported data points. (Appendix 3)

To further evaluate the certainty of evidence, we applied the GRADE framework (Appendix 4), which considers multiple domains, including study design, risk of bias, inconsistency, indirectness, imprecision, publication bias, effect magnitude, and dose-response relationships. Based on these criteria, we

determined that six outcomes were rated as high certainty (surgical complications, open conversion rate to open nephrectomy, warm ischemia time, infections, proteinuria, eGFR), five as moderate certainty (length of stay, operative time, blood loss, hypertension, and ESKD), and one as low certainty (diabetes). The variation in certainty ratings reflects differences in study quality, effect consistency, and potential confounding factors. While there is strong (moderate to high) evidence to inform clinical and policy decisions, limitations in study design and risk of bias should be carefully considered when interpreting the individual outcome results (Appendix 4).

DISCUSSION

This systematic review and meta-analysis provide the most comprehensive synthesis to date of a wide range of clinically relevant outcomes associated with obesity in living kidney donors. Drawing from 33 studies across 12 countries, our findings demonstrate that obesity is consistently associated with higher perioperative risk and long-term comorbidities. However, the absolute risk increases were generally small. These findings suggest that obesity should not be treated as an absolute contraindication to living donation, but it warrants individualized risk evaluation, careful selection, and long-term follow-up. Collectively, the results underscore the need for nuanced risk-benefit counseling and shared decision making for donors with obesity.

This meta-analysis affirms that obesity among donors is associated with higher surgical complications, likelihood of conversion to open surgery, higher estimated blood loss, longer operative time, prolonged hospital stay, and wound infections. These findings align with well-established challenges in abdominal surgery in obese individuals, such as technical complexity related to visceral adiposity and impaired wound healing.[26,35] Our results are broadly consistent with the 2013 meta-analysis by Lafranca et al.,[35] which also well-documented higher risk of conversion and longer operative duration in obese donors

undergoing laparoscopic donor nephrectomy. However, our study extends this prior work in several important aspects of perioperative outcomes (Supplementary Table S1). Whereas Lafranca et al. reported no significant differences in surgical complications, estimated blood loss and length of stay, our analysis identified significant increases across these three outcomes. These differences likely reflect our inclusion of more than twice the number of studies (33 vs. 14), providing greater statistical power to detect modest but clinically relevant effects. Importantly, we evaluated outcomes not assessed in the prior meta-analysis, including wound infection rates, which were significantly higher among obese donors, consistent with broader surgical literature linking obesity to impaired wound healing.[47] Remarkably, this meta-analysis and Lafranca et al. found no significant difference in warm ischemia time between obese and non-obese donors, suggesting that critical aspects of graft preservation and intraoperative vascular control remain unaffected despite the technical challenges posed with obesity. Taken together, our findings validate and meaningfully extend prior evidence, by offering novel contributions and more precise estimates of perioperative risk in obese donors. While obesity clearly increases surgical complexity, these risks highlight the importance of transplant surgeon expertise and comprehensive preoperative planning, intraoperative management, and postoperative care for donors with obesity.

This meta-analysis demonstrates that obese donors face elevated risks of developing hypertension and diabetes compared with non-obese donors, which were consistent across studies. A single-center study by Serrano et al. (2018) reported adjusted hazard ratios of 1.75 for hypertension and 3.14 for incident diabetes among obese donors, with these conditions manifesting earlier than in non-obese counterparts.[48] A multi-center study by Ibrahim et al. (2021) emphasized that obesity acts synergistically with hypertension and diabetes to accelerate renal decline following donation.[30] Additionally, our results underscore a significant association between obesity and post-donation proteinuria, an early

marker of kidney injury and a known predictor of progressive kidney disease.[30,34,48-50] In parallel, we observed lower eGFR among obese donors versus non-obese donors. Furthermore, this meta-analysis demonstrated three additional cases of ESKD per 1,000 obese donors (95% CI: 1-8) compared with non-obese donors. Although a registry-based study by Locke et al. (2017) reported a 7% increase in ESKD risk for every 1 kg/m² increase in BMI above 27, indicating a dose-response relationship between adiposity and risk of ESKD, it is worth noting that the estimated absolute risk of ESKD 20 years after donation was 0.9% for obese versus 0.4% for non-obese donors.[29] Our pooled estimate of 1.8-fold higher odds of ESKD among obese donors is also consistent with ESKD risk in prior donor and general population modeling.[29,30,34] Grams et al. (2016) incorporated BMI into a validated risk prediction tool, showing that obese donor candidates have elevated projected lifetime risk of ESKD compared to non-obese peers, particularly when obesity is combined with younger age.[34] While prior observational evidence suggests a trend toward increased late mortality among obese donors,[31] definitive conclusions cannot be drawn without standardized, long-term follow-up. In sum, this meta-analysis synthesizes evidence linking obesity in donors with a measurable increase in long-term metabolic and kidney-related risks. These data emphasize the importance of shared decision making with obese donors, integrating BMI and metabolic optimization predonation, and long-term surveillance after donation, focused on early detection and management of hypertension, diabetes, and proteinuria.

The limitations of this meta-analysis should be considered when interpreting the findings. First, the majority of included studies were retrospective cohort designs, which are inherently subject to biases such as unmeasured confounding, e.g., post-donation lifestyle, weight gain and medication use. Second, there was heterogeneity across studies. Although we applied random-effects models to account for between-study variability, moderate to high heterogeneity was observed for several pooled estimates. This may reflect differences in study populations, outcome definitions, study eras span multiple

decades, baseline risk profiles, and reporting standards. Importantly, the direction of effects are consistent and our inferences remain robust in subanalyses. Third, few studies provided stratified analyses by obesity class, sex, or race/ethnicity, thus limiting precision in donor subgroups. Further, although we employed a comprehensive and methodologically rigorous review process—including duplicate screening, data extraction, and risk of bias assessment—our analyses relied on study-level aggregate data. Taken together, these limitations highlight the need for standardized outcome definitions and prospective cohort studies with structured long-term data collection. Nonetheless, the consistency of direction and magnitude of associations across diverse settings enhances the overall credibility and generalizability of our findings making this the most robust evidence available in the absence of a randomized control trial.

This meta-analysis has direct implications for clinical practice. Obesity should be recognized as a clinically meaningful modifier of perioperative risk and long-term metabolic and kidney outcomes among living donors. Evaluation and counseling of donors with obesity should extend beyond BMI alone to incorporate demographic, clinical, and metabolic risk factors, with particular attention to obesity-related comorbidities such as prediabetes, hypertension, and nonalcoholic fatty liver disease. Shared decision-making should explicitly address both relative and absolute risks of perioperative complications and long-term outcomes, including hypertension, diabetes, proteinuria, and kidney disease, while emphasizing the importance of sustained healthy lifestyle behaviors and long-term surveillance. Importantly, current risk assessment tools are limited in young donors, as lifetime risk of CKD or ESKD cannot be reliably predicted decades in advance. Accordingly, otherwise suitable donors with obesity may benefit from structured pre-donation lifestyle interventions to optimize metabolic health, although evidence regarding pharmacologic weight-loss strategies, including GLP-1 receptor agonists, remains limited and warrants further study.

From a policy perspective, current follow-up requirements from the Organ Procurement and Transplantation Network (OPTN), which mandate donor assessments at 6, 12, and 24 months post-donation, may be insufficient for higher-risk subgroups such as donors with obesity. Extended, structured follow-up protocols are warranted, with annual monitoring of blood pressure, glycemic status (fasting glucose or HbA1c), kidney function (eGFR and urine albumin-to-creatinine ratio), and body weight. These efforts could be supported through value-based care models that strengthen coordination between transplant centers and primary care providers. To address persistent barriers to follow-up, particularly in rural or resource-limited settings, telemedicine offers a scalable solution to improve engagement, continuity, and timely risk detection. Finally, rigid BMI-based exclusion policies risk unintended consequences, as obesity disproportionately affects racial and ethnic minority populations and may exacerbate inequities in access to living donation.

This meta-analysis underscores the complex risk-benefit considerations facing clinicians and transplant programs when evaluating and counseling donors with obesity. Although obesity is associated with higher perioperative and long-term risks, absolute risk increases remain small, and should be weighed within the context of individual donor health, values, and preferences. These findings call for the adoption of a personalized approach to donor selection and follow-up that balances safety, equity, and access. Future research should prioritize prospective cohort studies with standardized, long-term follow-up. In parallel, incorporating patient-reported outcomes and qualitative assessments on donor experience will be essential to advancing ethical, person-centered care for donors with obesity.

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DISCLOSURE

None.

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Table 1: Patient characteristics in studies comparing obese vs non-obese kidney donors

First Author	Country	Study design	Time FU	Type	Participants		Age (y)		Sex (Female %)		Lap (%)		Outcomes
					Obese	Non-Obese	Obese	Non-obese	Obese	Non-obese	Obese	Non-Obese	
JacobsJr 2000[55]	USA	Retrospective cohort	Immediate	Perioperative	41	41	36.6 ± 11.4	36.7 ± 11.3	NR	NR	100%	100%	Complications, OT, LOS, EBL, WIT
Kuo 2000[56]	USA	Retrospective cohort	Immediate	Perioperative	12	28	48.5 ± 8.0	39.7 ± 12.1	75%	46%	100%	100%	Complications, OT, LOS, Conversion, EBL
Chow 2002[57]	USA	Retrospective cohort	Immediate	Perioperative	34	75	NR	NR	NR	NR	100%	100%	Complications, OT, Conversion, LOS
Gracida 2003[58]	Mexico	Prospective cohort	Immediate	Perioperative	81	427	37.03	31.4	59%	52%	NR	NR	GFR
Mateo 2003[59]	USA	Retrospective cohort	Immediate	Perioperative	12	35	NR	NR	NR	NR	100%	100%	OT, LOS, EBL, WIT
Leventhal 2004[60]	USA	Retrospective cohort	Immediate	Perioperative	110	390	NR	NR	NR	NR	100%	100%	Complications, LOS, Conversion, EBL
Heimbach 2004[61]	USA	Retrospective cohort	11 months	Perioperative & Intermediate	58	170	41 ± 1	41 ± 1	57%	69%	100%	100%	Complications, OT, LOS, Conversion, WIT, Cr, SBP, DBP, Microalbuminria
Rea 2006[62]	USA	Retrospective cohort	1-3 years	Intermediate	49	41	NR	NR	NR	NR			eGFR
Espinoza 2006[63]	Mexico	Prospective cohort	51-80 months	Long-term	37	37	34.5 ± 11.1	31.4 ± 11.1	65%	54%			GFR
Rook 2008[12]	Netherlands	Retrospective cohort	2 months	Intermediate	21	87	52 ± 8	46 ± 11	67%	66%			eGFR
Reese 2009[64]	USA	Retrospective cohort	6 months	Perioperative & Intermediate	250	2002	37.4 ± 0.6	39.4 ± 0.3	68%	67%	NR	63%	Complications, OT, LOS, Conversion, eGFR, HTN, SBP, DBP
Tavakol 2009[65]	USA	Retrospective cohort	11 years	Long-term	16	82	56 ± 8	56 ± 10	50%	67%	NR	NR	eGFR, HTN, SBP, DBP, DM, Proteinuria, Microalbuminuria
Friedman 2010[66]	USA	Retrospective cohort	Immediate	Perioperative	127	6193	NR	NR	NR	NR	NR	NR	Complications, LOS
Afaneh 2012 (LESS)[67]	USA	Retrospective cohort	Immediate	Perioperative	32	32	48 ± 11.7	47 ± 12.1	56%	56%	100%	100%	Complications, OT, LOS, EBL, WIT,
Afaneh 2012 (LAP)[67]	USA	Retrospective cohort	Immediate	Perioperative	32	32	46 ± 11.8	47 ± 10.7	56%	56%	100%	100%	Complications, OT, LOS, EBL, WIT,
O'Brien 2012[68]	UK	Retrospective cohort	2 year	Perioperative & Intermediate	62	205	43.7 ± 9.0	42.3 ± 10.4	50%	55%	NR	NR	Complications, OT, LOS, EBL, WIT, Mortality, eGFR, SBP, DBP
Hu 2014[69]	USA	Prospective cohort	Immediate	Perioperative	121	494	NR	NR	NR	NR	100%	100%	Complications, OT, LOS, EBL
Chakkera 2015[11]	USA	Retrospective cohort	7 months	Intermediate	93	331	44.3	42.4	69%	73%	NR	NR	eGFR, Microalbuminuria

Taner 2015[70]	USA	Prospective cohort	5.7 years	Long-term	11	16	42.1 ± 10.2	42.4 ± 5.9	64%	69%	NR	NR	eGFR, SBP, DBP, Proteinuria, Microalbuminuria
Uguz 2015[71]	Turkey	Retrospective cohort	Immediate	Perioperative	22	50	52.2 ± 8.4	47.1 ± 12.6	36.00%	54.00%	NR	NR	EBL, LOS, OT
Marcelino 2016[72]	Indonesia	Retrospective cohort	Immediate	Perioperative	20	30	32.63 ± 10.49	35.6 ± 9.8	55%	43%	100%	100%	WIT, OT, EBL, Complications, Conversion, LOS
Locke 2017[29]	USA	Retrospective cohort	20 years	Long-term	20,588	58,004	40.7 ± 10.7	40.8 ± 11.4	57.00%	61.00%	NR	NR	OT, LOS, EBL
Raber 2017[73]	USA	Retrospective cohort	Immediate	Perioperative & Intermediate	160	338	40.1 ± 10.2	41.3 ± 11.0	59%	62%	100%	100%	OT, LOS, Conversion, EBL, WIT
Unger 2017[74]	Austria	Retrospective cohort	Immediate	Perioperative	43	126	47.42 ± 9.89	49.98 ±10.71	63.00%	71%	88.4%	84.9%	Complications, OT, LOS, Conversion, WIT
Wiborg 2017[75]	Denmark	Retrospective cohort	Immediate	Perioperative	21	87	NR	NR	NR	NR	NR	NR	Complications, Mortality
Serrano 2018[48]	USA	Retrospective cohort	>20 years	Perioperative & Long term	656	3,096	40 ± 11	39 ± 12	58%	57%	45%	38%	Complications, OT, LOS, EBL, eGFR, ESKD, HTN, DM, Proteinuria
Barlas 2019[76]	Turkey	Retrospective cohort	Immediate	Perioperative	152	413	48.54 ± 10.46	42.79 ± 12.54	66.00%	53.00%	100%	100%	OT, WIT
Bellini 2019[77]	Finland	Retrospective cohort	5 years	Long-term	231	338	NR	NR	NR	NR			eGFR
Altheaby 2020[78]	Saudi Arabia	Retrospective cohort	Immediate	Perioperative	27	85	NR	NR	NR	NR			eGFR
Rizvi 2020[79]	India	Prospective cohort	Immediate	Perioperative	160	40	46.3 ± 9.41	45.6 ± 9.46	90%	71%	100%	100%	Complications, OT, LOS, WIT
Schussler 2020[80]	USA	Retrospective cohort	2 years	Perioperative & Intermediate	28	46	39 ± 8.88*	40.6 ± 15.55*	54%	54%	100%	100%	eGFR, OT, LOS, EBL
Simforoosh 2020[81]	Iran	Retrospective cohort	Immediate	Perioperative	95	256	28.7 ± 5.5	27.4 ± 4.5	39%	14%	100%	100%	Complications, OT, LOS, WIT
Ibrahim 2021[30]	USA	Retrospective cohort	19 years	Long-term	423	6822	38.7 ± 10.37*	39 ± 13.3*	66%	56.00%	NR	NR	Mortality, ESKD, HTN, DM, Proteinuria
Ozturk 2021[82]	Turkey	Retrospective cohort	Immediate	Perioperative	727	1750	NR	NR	67%	53%	100%	100%	Complications, OT, LOS, Conversion, WIT

*estimated from medians (IQR), LOS= length of stay, WIT= warm ischemia time, OT= operative time, Conversion= conversion from laparoscopic surgery to open, DBP= diastolic blood pressure, SBP= systolic blood pressure, HTN= hypertension, EBL= estimated blood loss, eGFR= estimated glomerular filtration rate.

Figure 1: The PRISMA flowchart

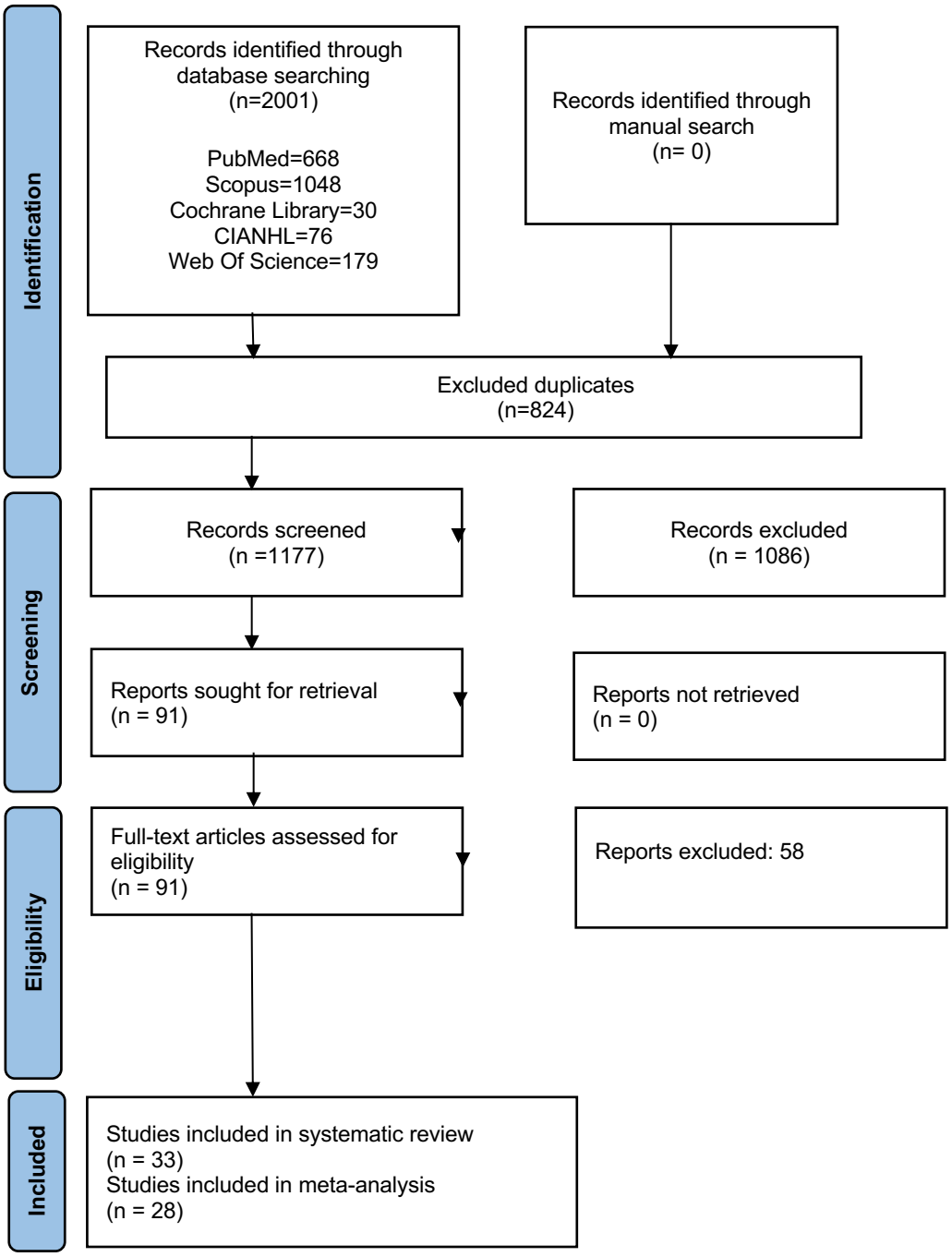
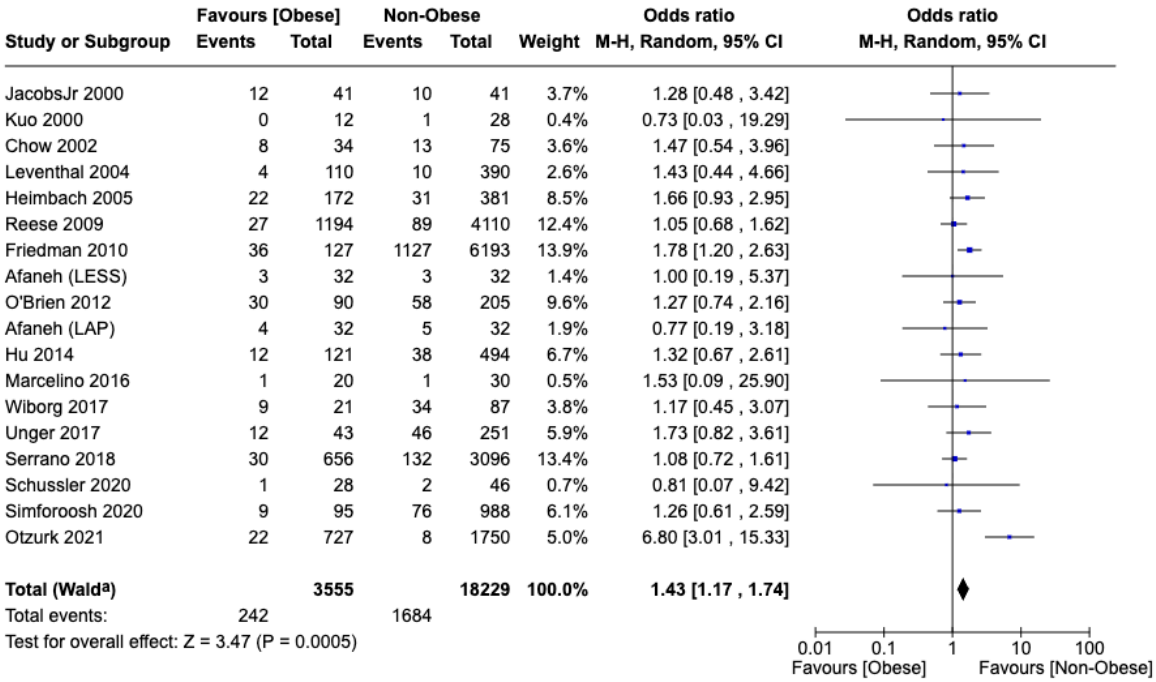


Figure 2: Forest plot comparing perioperative outcomes between obese versus non-obese living kidney donors

2A: Surgical complications



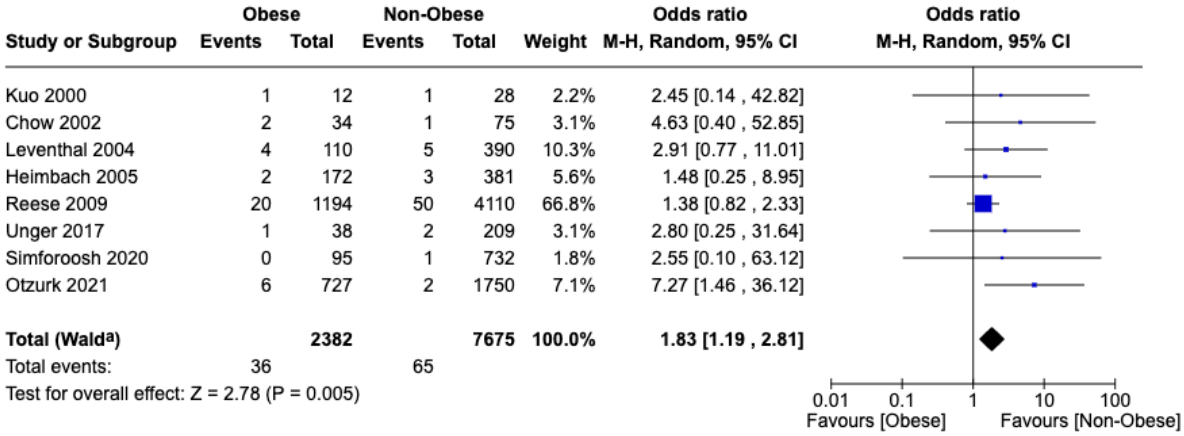
Heterogeneity: Tau² (DL[b]) = 0.04; Chi² = 21.47, df = 17 (P = 0.21); I² = 21%

Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

2B. Conversion rate



Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 5.23, df = 7 (P = 0.63); I² = 0%

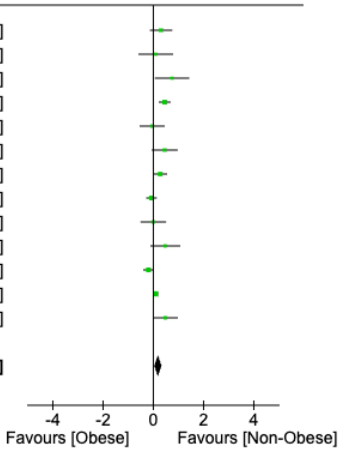
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

2C. Estimated blood loss

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	170.1	201.6	41	112.9	162.4	41	6.3%	0.31 [-0.13 , 0.75]
Kuo 2000	310	302	12	278	325	28	3.4%	0.10 [-0.58 , 0.78]
Mateo 2003	296	232	12	170	139	35	3.5%	0.74 [0.07 , 1.42]
Leventhal 2004	184	145	110	125	126	390	11.5%	0.45 [0.24 , 0.67]
Afaneh (LAP)	100	99.8	32	104	104	32	5.5%	-0.04 [-0.53 , 0.45]
Afaneh (LESS)	106	90.5	32	73	46.2	32	5.4%	0.45 [-0.04 , 0.95]
O'Brien 2012	149.53	98	90	128.6	62.9	205	10.5%	0.28 [0.03 , 0.53]
Hu 2014	36.4	21.6	121	41	70.9	494	11.9%	-0.07 [-0.27 , 0.13]
Uguz 2015	96.67	133.3	22	96.6	111.1	50	5.3%	0.00 [-0.50 , 0.50]
Marcelino 2016	230	165.75	20	165	106.6	30	4.4%	0.48 [-0.09 , 1.05]
Raber 2017	45.7	45.2	160	59.2	79.3	338	12.2%	-0.19 [-0.38 , -0.00]
Serrano 2018	227	355	656	203	222	3096	14.7%	0.10 [0.01 , 0.18]
Schussler 2020	43.33	14.8	28	35	18.5	46	5.7%	0.48 [0.00 , 0.96]
Total (Wald[a])			**1336**			**4817**	**100.0%**	**0.18 [0.04 , 0.32]**



Test for overall effect: Z = 2.51 (P = 0.01)

Heterogeneity: Tau² (DL[b]) = 0.03; Chi² = 35.23, df = 12 (P = 0.0004); I² = 66%

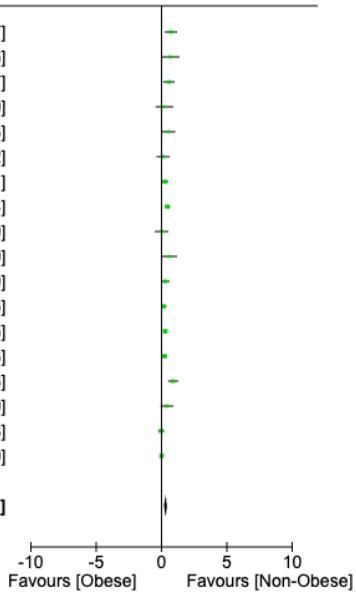
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

2D. Operative time

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	236.5	60.1	41	194.7	54.8	41	4.1%	0.72 [0.27 , 1.17]
Kuo 2000	182	31	12	165	22	28	2.2%	0.67 [-0.03 , 1.36]
Chow 2002	216.6	44.9	34	191.6	44.8	75	4.5%	0.55 [0.14 , 0.97]
Mateo 2003	307	75	12	291	67	35	2.4%	0.23 [-0.43 , 0.89]
Afaneh (LAP)	149	37.9	32	129	36.9	32	3.5%	0.53 [0.03 , 1.03]
Afaneh (LESS)	160	29.9	32	156	29.3	32	3.6%	0.13 [-0.36 , 0.62]
O'Brien 2012	137.8	50.4	90	125.3	47.8	205	7.0%	0.26 [0.01 , 0.51]
Hu 2014	221.3	39.1	121	206.3	32.4	494	7.9%	0.44 [0.24 , 0.64]
Uguz 2015	190	111.1	22	190	111.1	50	3.5%	0.00 [-0.50 , 0.50]
Marcelino 2016	275.75	48.23	20	246.93	45.04	30	2.9%	0.61 [0.03 , 1.19]
Unger 2017	201	54	43	183	65.5	251	5.7%	0.28 [-0.04 , 0.60]
Raber 2017	153.6	32.9	160	147.6	36.2	338	8.1%	0.17 [-0.02 , 0.36]
Serrano 2018	281.4	60	656	264.6	60	3096	9.9%	0.28 [0.20 , 0.36]
Barlas 2019	106.37	34.99	152	99.23	27.49	413	8.2%	0.24 [0.05 , 0.43]
Rizvi 2020	140.6	14.2	160	127.5	17.4	40	5.2%	0.88 [0.52 , 1.23]
Schussler 2020	200.9	44.2	28	182.1	45	46	3.8%	0.42 [-0.06 , 0.89]
Simforoosh 2020	198.6	69.6	95	200.4	59.1	988	7.7%	-0.03 [-0.24 , 0.18]
Otzurk 2021	108	125.9	727	107.3	125.9	1750	9.8%	0.01 [-0.08 , 0.09]
Total (Wald[a])			**2437**			**7944**	**100.0%**	**0.30 [0.19 , 0.42]**



Test for overall effect: Z = 5.18 (P < 0.00001)

Heterogeneity: Tau² (DL[b]) = 0.03; Chi² = 62.43, df = 17 (P < 0.00001); I² = 73%

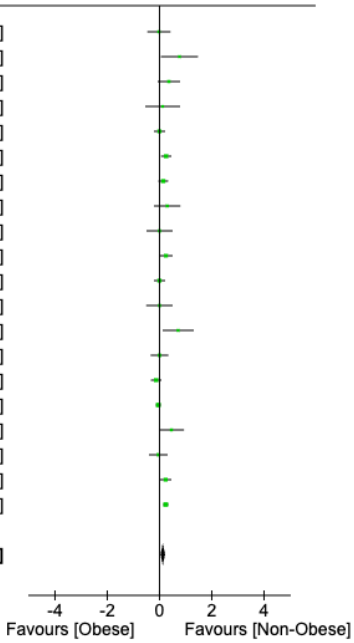
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

2E. Length of stay

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	2.72	0.87	41	2.74	0.88	41	3.0%	-0.02 [-0.46 , 0.41]
Kuo 2000	2.1	0.9	12	1.6	0.5	28	1.4%	0.76 [0.06 , 1.46]
Chow 2002	2.4	0.9	34	2.1	0.8	75	3.3%	0.36 [-0.05 , 0.77]
Mateo 2003	4.17	1.42	12	4	1.38	35	1.6%	0.12 [-0.54 , 0.78]
Leventhal 2004	1.7	0.7	110	1.7	0.7	390	6.8%	0.00 [-0.21 , 0.21]
Heimbach 2005	2.27	0.14	172	2.24	0.11	381	7.7%	0.25 [0.07 , 0.43]
Friedman 2010	3.5	1.39	127	3.3	1.39	6193	7.8%	0.14 [-0.03 , 0.32]
Afaneh (LESS)	2.06	0.49	32	1.92	0.44	32	2.5%	0.30 [-0.20 , 0.79]
Afaneh (LAP)	2.11	0.49	32	2.11	0.51	32	2.5%	0.00 [-0.49 , 0.49]
O'Brien 2012	5.23	1.39	90	4.9	1.3	205	6.0%	0.25 [-0.00 , 0.50]
Hu 2014	1.4	0.6	121	1.4	0.6	494	7.2%	0.00 [-0.20 , 0.20]
Uguz 2015	3.67	1.48	22	3.67	1.48	50	2.4%	0.00 [-0.50 , 0.50]
Marcelino 2016	4.55	1.57	20	3.63	1.04	30	1.9%	0.71 [0.13 , 1.29]
Unger 2017	7	1	43	7	1	251	4.5%	0.00 [-0.32 , 0.32]
Raber 2017	3.1	0.7	160	3.2	0.8	338	7.4%	-0.13 [-0.32 , 0.06]
Serrano 2018	4.14	2	656	4.22	1.7	3096	10.2%	-0.05 [-0.13 , 0.04]
Schussler 2020	2.67	0.74	28	2.33	0.74	46	2.6%	0.45 [-0.02 , 0.93]
Rizvi 2020	2.45	0.78	160	2.48	0.71	40	4.1%	-0.04 [-0.39 , 0.31]
Simforoosh 2020	4.13	1.71	95	3.79	1.4	988	6.9%	0.24 [0.03 , 0.45]
Otzurk 2021	4.67	5.18	727	3.67	3.7	1750	10.1%	0.24 [0.15 , 0.33]
Total (Wald[a])			**2694**			**14495**	**100.0%**	**0.13 [0.04 , 0.21]**



Test for overall effect: Z = 2.80 (P = 0.005)

Heterogeneity: Tau² (DL[b]) = 0.02; Chi² = 48.22, df = 19 (P = 0.0002); I² = 61%

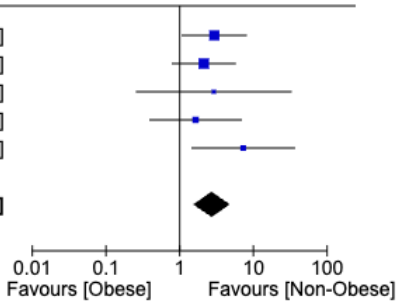
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

2F. Wound infection rate

Study or Subgroup	Obese Events	Obese Total	Non-Obese Events	Non-Obese Total	Weight	Odds ratio M-H, Random, 95% CI
Heimbach 2005	9	172	7	381	32.4%	2.95 [1.08 , 8.06]
O'Brien 2012	8	90	9	205	33.6%	2.12 [0.79 , 5.70]
Unger 2017	1	43	2	246	5.6%	2.90 [0.26 , 32.75]
Barlas 2019	3	152	5	413	15.7%	1.64 [0.39 , 6.96]
Otzurk 2021	6	727	2	1750	12.7%	7.27 [1.46 , 36.12]
Total (Wald[a])		**1184**		**2995**	**100.0%**	**2.70 [1.52 , 4.79]**
Total events:	27		25			



Test for overall effect: Z = 3.41 (P = 0.0007)

Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 2.19, df = 4 (P = 0.70); I² = 0%

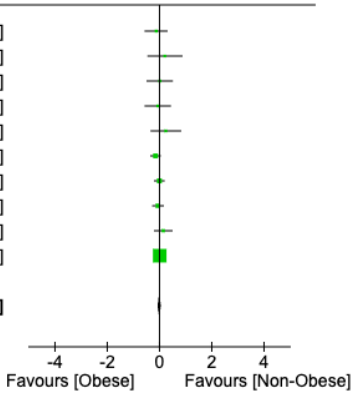
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

2G. Warm ischemia time

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	156.4	46.3	41	167.2	111.5	41	2.2%	-0.13 [-0.56 , 0.31]
Mateo 2003	227	101	12	208	89	35	1.0%	0.20 [-0.45 , 0.86]
Afaneh (LAP)	240.6	33	32	240	49.2	32	1.7%	0.01 [-0.48 , 0.50]
Afaneh (LESS)	228.6	37.8	32	231	31.2	32	1.7%	-0.07 [-0.56 , 0.42]
Marcelino 2016	267.6	174.6	20	223.2	185.4	30	1.3%	0.24 [-0.33 , 0.81]
Raber 2017	112.7	27.6	160	119.4	49.7	338	11.7%	-0.15 [-0.34 , 0.04]
Barlas 2019	81.76	28.04	152	81.88	26.69	413	12.0%	-0.00 [-0.19 , 0.18]
Simforoosh 2020	408	192.6	95	418.9	181.9	988	9.4%	-0.06 [-0.27 , 0.15]
Rizvi 2020	159.1	49.7	160	152.5	20.09	40	3.5%	0.14 [-0.20 , 0.49]
Otzurk 2021	268	275.5	727	265.3	379	1750	55.5%	0.01 [-0.08 , 0.09]
Total (Wald[a])			**1431**			**3699**	**100.0%**	**-0.01 [-0.08 , 0.05]**



Test for overall effect: Z = 0.41 (P = 0.68)

Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 4.82, df = 9 (P = 0.85); I² = 0%

Footnotes

[a]CI calculated by Wald-type method.

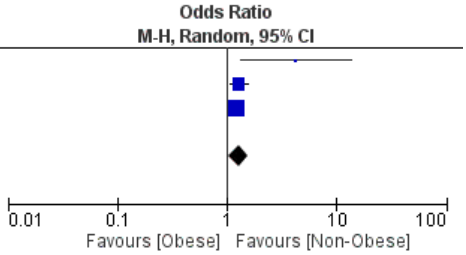
[b]Tau² calculated by DerSimonian and Laird method.

Figure 3: Forest plot comparing Forest plots comparing long-term risks in obese and non-obese donors

3A. Hypertension

Study or Subgroup	Obese Events	Obese Total	Non-Obese Events	Non-Obese Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Tavakol 2009	11	16	28	82	3.0%	4.24 [1.34, 13.42]	2009
Serrano 2018	186	656	734	3096	42.3%	1.27 [1.05, 1.54]	2018
Ibrahim 2021	525	1761	1773	6822	54.7%	1.21 [1.08, 1.36]	2021
Total (95% CI)		**2433**		**10000**	**100.0%**	**1.28 [1.05, 1.57]**	
Total events	722		2535				

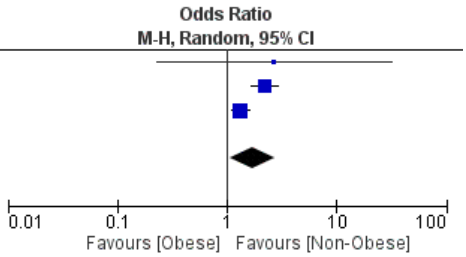
Heterogeneity: Tau² = 0.02; Chi² = 4.64, df = 2 (P = 0.10); I² = 57%
Test for overall effect: Z = 2.40 (P = 0.02)



3B. Diabetes Mellitus

Study or Subgroup	Obese Events	Obese Total	Non-Obese Events	Non-Obese Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Tavakol 2009	1	16	2	82	3.4%	2.67 [0.23, 31.31]	2009
Serrano 2018	74	656	168	3096	46.0%	2.22 [1.66, 2.95]	2018
Ibrahim 2021	142	1761	424	6822	50.6%	1.32 [1.09, 1.61]	2021
Total (95% CI)		**2433**		**10000**	**100.0%**	**1.72 [1.08, 2.74]**	
Total events	217		594				

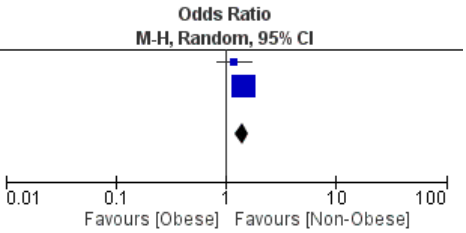
Heterogeneity: Tau² = 0.10; Chi² = 8.58, df = 2 (P = 0.01); I² = 77%
Test for overall effect: Z = 2.26 (P = 0.02)



3C. Proteinuria

Study or Subgroup	Obese Events	Obese Total	Non-Obese Events	Non-Obese Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Serrano 2018	41	656	165	3096	15.9%	1.18 [0.83, 1.69]	2018
Ibrahim 2021	280	1761	790	6822	84.1%	1.44 [1.25, 1.67]	2021
Total (95% CI)		**2417**		**9918**	**100.0%**	**1.40 [1.21, 1.61]**	
Total events	321		955				

Heterogeneity: Tau² = 0.00; Chi² = 1.03, df = 1 (P = 0.31); I² = 3%
Test for overall effect: Z = 4.63 (P < 0.00001)

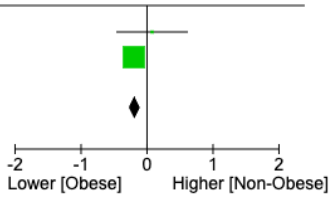


3D. eGFR

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
Tavakol 2009	64	13	16	63	13	82	2.4%	0.08 [-0.46 , 0.61]
Serrano 2018	61	20	656	65	20	3096	97.6%	-0.20 [-0.28 , -0.12]
Total (Wald[a])			**672**			**3178**	**100.0%**	**-0.19 [-0.28 , -0.11]**

Test for overall effect: Z = 4.55 (P < 0.00001)

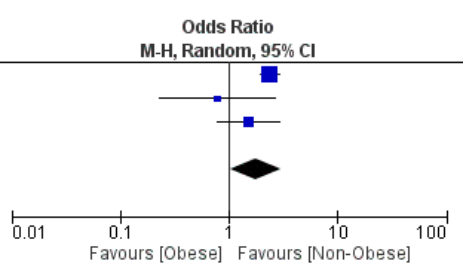
Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 1.00, df = 1 (P = 0.32); I² = 0%



3E. End-stage kidney disease

Study or Subgroup	Obese Events	Obese Total	Non-Obese Events	Non-Obese Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Locke 2017	193	20588	230	58004	55.1%	2.38 [1.96, 2.88]	2017
Serrano 2018	3	656	18	3096	14.3%	0.79 [0.23, 2.67]	2018
Ibrahim 2021	12	1761	31	6822	30.6%	1.50 [0.77, 2.93]	2021
Total (95% CI)		**23005**		**67922**	**100.0%**	**1.76 [1.04, 3.00]**	
Total events	208		279				

Heterogeneity: Tau² = 0.12; Chi² = 4.55, df = 2 (P = 0.10); I² = 56%
Test for overall effect: Z = 2.09 (P = 0.04)

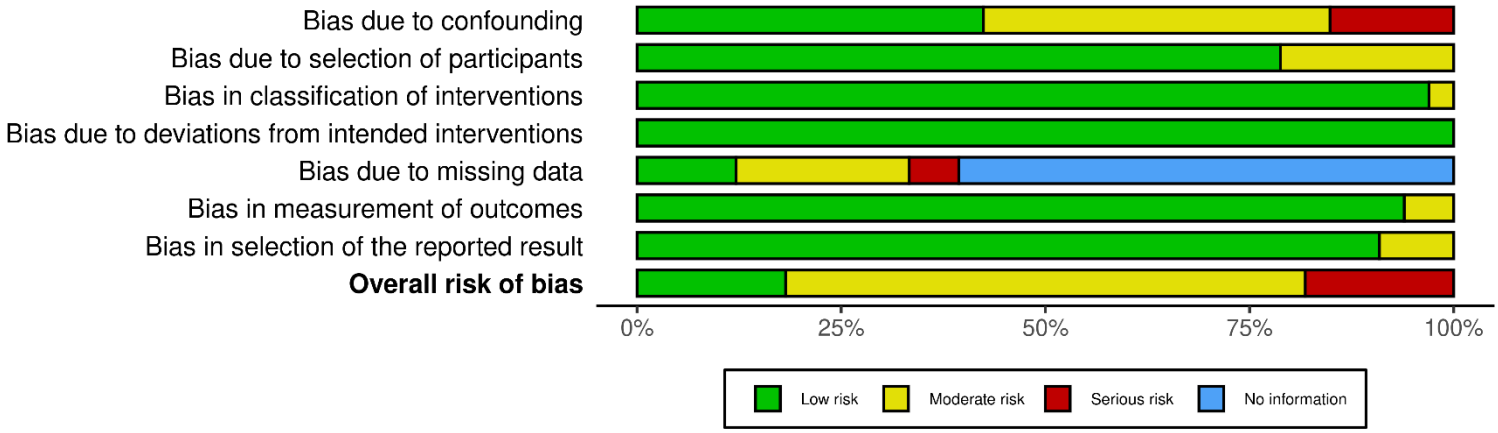


Appendix 1: The search strategy (PubMed)

("Obesity"[MeSH] OR "obesity, morbid"[MeSH] OR "Body Mass Index"[MeSH] OR "Body Weight"[MeSH] OR "Obesity"[Text Word] OR "Overweight"[Text Word] OR "Body Mass Index"[Text Word] OR "Body Weight"[Text Word]) AND ("Living Donors"[MeSH] OR "Living Donor"[Text Word]) AND ("Adult"[MeSH] OR "Male"[MeSH] OR "Female"[MeSH] OR "Adults"[Text Word] OR "Male"[Text Word] OR "Female"[Text Word]) AND ("Kidney"[Text Word] OR "Kidney"[MeSH] OR "Nephrectomy"[Mesh] OR “Nephrectomy”[Text Word])

Appendix 2: The risk of bias assessment of each included study

Appendix 3: The risk of bias summary



Appendix 4: The GRADE analysis

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Obese donors	Non-obese donors	Relative (95% CI)	Absolute (95% CI)		
Surgical Complications												
19	non-randomised studies	not serious	not serious	not serious	not serious	dose response gradient	242/3555 (6.8%)	1684/18229 (9.2%)	**OR 1.43** (1.17 to 1.74)	**35 more per 1,000** (from 14 more to 58 more)	⊕⊕⊕⊕ High	CRITICAL
Conversion rate												
8	non-randomised studies	not serious	not serious	not serious	not serious	strong association	20/1324 (1.5%)	32/5256 (0.6%)	**OR 3.01** (1.59 to 5.68)	**12 more per 1,000** (from 4 more to 28 more)	⊕⊕⊕⊕ High	CRITICAL
Estimated Blood loss												
13	non-randomised studies	not serious	serious	not serious	not serious	none	1336	4817	-	SMD **0.18 SD higher** (0.04 higher to 0.32 higher)	⊕⊕⊕◯ Moderate	CRITICAL
Operative Time												
17	non-randomised studies	not serious	serious	not serious	not serious	none	2437	7944	-	SMD **0.3 SD higher** (0.19 higher to 0.42 higher)	⊕⊕⊕◯ Moderate	IMPORTANT
Length of Stay												
21	non-randomised studies	not serious	serious	not serious	not serious	none	2694	14495	-	SMD **0.13 SD higher** (0.04 higher to 0.21 higher)	⊕⊕⊕◯ Moderate	IMPORTANT
Wound infection rate												

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Obese donors	Non-obese donors	Relative (95% CI)	Absolute (95% CI)		
5	non-randomised studies	not serious	not serious	not serious	not serious	strong association	14/978 (1.4%)	20/2664 (0.8%)	**OR 2.96** (1.15 to 7.58)	**14 more per 1,000** (from 1 more to 47 more)	⊕⊕⊕⊕ High	CRITICAL

Warm ischemia

10	non-randomised studies	not serious	not serious	not serious	not serious	none	1431	3443	-	SMD **0.01 lower** (0.08 lower to 0.05 higher)	⊕⊕⊕⊕ High	IMPORTANT

Hypertension

3	non-randomised studies	not serious	serious	not serious	not serious	none	722/2433 (29.7%)	2535/10000 (25.4%)	**OR 1.28** (1.05 to 1.57)	**49 more per 1,000** (from 9 more to 94 more)	⊕⊕⊕◯ Moderate	CRITICAL

Diabetes Mellitus

3	non-randomised studies	not serious	very serious	not serious	not serious	none	217/2433 (8.9%)	594/10000 (5.9%)	**OR 1.72** (1.08 to 2.74)	**39 more per 1,000** (from 4 more to 88 more)	⊕⊕◯◯ Low	CRITICAL

Proteinuria

2	non-randomised studies	not serious	not serious	not serious	not serious	none	321/2417 (13.3%)	955/9918 (9.6%)	**OR 1.40** (1.21 to 1.61)	**34 more per 1,000** (from 18 more to 50 more)	⊕⊕⊕⊕ High	CRITICAL

eGFR

4	non-randomised studies	not serious	not serious	not serious	not serious	none	672	3178	-	SMD **0.19 SD lower** (0.28 lower to 0.11 lower)	⊕⊕⊕⊕ High	CRITICAL

End-stage Kidney Disease

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Obese donors	Non-obese donors	Relative (95% CI)	Absolute (95% CI)		
3	non-randomised studies	not serious	serious	not serious	not serious	none	208/23005 (0.9%)	279/67922 (0.4%)	**OR 1.76** (1.04 to 3.00)	**3 more per 1,000** (from1 more to 8 more)	⨁⨁⨁◯ Moderate	CRITICAL

CI: confidence interval; **OR:** odds ratio; **SMD:** standardised mean difference

Appendix 5: The PRIMSA checklist

Section and Topic	Item #	Checklist item	Page #
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	7
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	8
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.	8
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	7, 8
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.	8
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.	8, 9
Data items	10a	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.	9
	10b	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.	8, 9
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.	9
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.	9
Synthesis methods	13a	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)).	9
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	9
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	8, 9
	13d	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.	8, 9
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	9
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	9
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	9
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	9
RESULTS			
Study selection	16a	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.	10
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and	10

Section and Topic	Item #	Checklist item	Page #
		explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	10
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	14
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.	11-14
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	14
	20b	Present 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.	11-14
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	11-14
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	14
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	14
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	14
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	15
	23b	Discuss any limitations of the evidence included in the review.	18
	23c	Discuss any limitations of the review processes used.	18
	23d	Discuss implications of the results for practice, policy, and future research.	15-18
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	7
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	7
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	1
Competing interests	26	Declare any competing interests of review authors.	1
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.	1

Supplementary Table S1: Sub -group analyses of short-term outcomes Comparing Obese vs Non-Obese Living Kidney Donors

Outcome	Weighted average effect (Primary Analysis)	Extreme BMI categories effect (Sub-group analysis 1)	Laparoscopic-only pooled effect (Sub-group analysis 2)
Surgical complications	OR 1.43 (1.17, 1.74)	OR 1.54 (1.21, 1.96)	OR 1.69 (1.12, 2.55)
Conversion rate	OR 1.83 (1.19, 2.81)	OR 3.01 (1.59, 5.68)	OR 4.20 (1.86, 9.47)
Estimated blood loss	SMD 0.18 (0.04, 0.32)	SMD 0.20 (0.05, 0.36)	SMD 0.23 (0.01, 0.45)
Operative time	SMD 0.30 (0.19, 0.42)	SMD 0.34 (0.22, 0.47)	SMD 0.39 (0.22, 0.56)
Length of stay	SMD 0.13 (0.04, 0.21)	SMD 0.17 (0.06, 0.29)	SMD 0.22 (0.08, 0.37)
Infection rate	OR 2.70 (1.52, 4.79)	OR 2.96 (1.15, 7.58)	OR 4.49 (1.44, 13.93)
Warm ischemia time	SMD −0.01 (−0.08, 0.05)	SMD −0.01 (−0.08, 0.05)	SMD −0.01 (−0.08, 0.05)

Supplementary Table S2: Comparison of perioperative outcomes

Outcome	Lafranca et al Meta-analysis (2013)	This Meta-analysis	Novel Contributions
Surgical complications	No significant difference	Significantly increased	Previously non-significant; now significant due to increased power
Conversion to Open Surgery	OR = 1.69 (significantly increased)	significantly increased	Higher magnitude of risk; updated estimate from more recent studies
Estimated Blood Loss	No significant difference	Significantly increased	New significant finding with more studies included
Operative Time	Significantly increased in obese donors	Significantly increased in obese donors	Confirmed and updated with larger sample
Length of Stay	No significant difference	Significantly increased	New significant finding; not observed previously
Wound Infection rate	Not reported	Significantly increased	New outcome analyzed; not previously reported
Warm Ischemia Time	No significant difference	No significant difference	Confirmed no difference

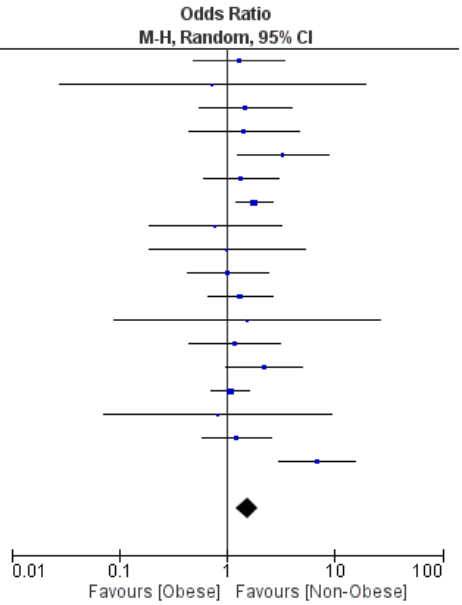
Appendix 6: The Data Extraction Sheet (Excel)

Appendix 7: Sub-group Analysis 1 - Extremes of BMI (when reported)

A. Surgical complications

Study or Subgroup	Favours [Obese] Events	Total	Non-Obese Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
JacobsJr 2000	12	41	10	41	4.9%	1.28 [0.48, 3.42]	2000
Kuo 2000	0	12	1	28	0.5%	0.73 [0.03, 19.29]	2000
Chow 2002	8	34	13	75	4.8%	1.47 [0.54, 3.96]	2002
Leventhal 2004	4	110	10	390	3.6%	1.43 [0.44, 4.66]	2004
Heimbach 2005	9	58	9	170	4.9%	3.29 [1.24, 8.73]	2005
Reese 2009	7	250	42	2002	6.5%	1.34 [0.60, 3.03]	2009
Friedman 2010	36	127	1127	6193	14.9%	1.78 [1.20, 2.63]	2010
Afaneh (LAP)	4	32	5	32	2.6%	0.77 [0.19, 3.18]	2012
Afaneh (LESS)	3	32	3	32	1.9%	1.00 [0.19, 5.37]	2012
O'Brien 2012	8	28	58	205	5.8%	1.01 [0.42, 2.43]	2012
Hu 2014	12	121	38	494	8.3%	1.32 [0.67, 2.61]	2014
Marcelino 2016	1	20	1	30	0.7%	1.53 [0.09, 25.90]	2016
Wiborg 2017	9	21	34	87	5.0%	1.17 [0.45, 3.07]	2017
Unger 2017	12	43	19	126	6.3%	2.18 [0.95, 4.98]	2017
Serrano 2018	30	656	132	3096	14.5%	1.08 [0.72, 1.61]	2018
Schussler 2020	1	28	2	46	0.9%	0.81 [0.07, 9.42]	2020
Simforoosh 2020	9	95	58	732	7.5%	1.22 [0.58, 2.54]	2020
Otzurk 2021	22	727	8	1750	6.5%	6.80 [3.01, 15.33]	2021
Total (95% CI)		**2435**		**15529**	**100.0%**	**1.54 [1.21, 1.96]**	
Total events	187		1570				

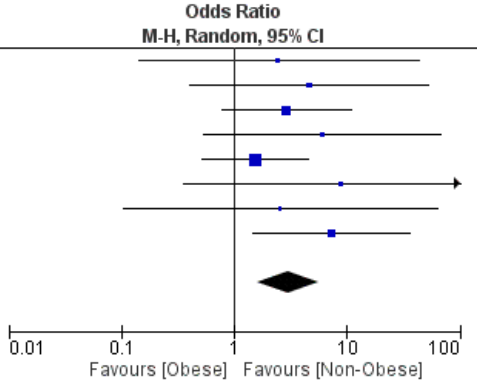
Heterogeneity: Tau² = 0.06; Chi² = 22.92, df = 17 (P = 0.15); I² = 26%
Test for overall effect: Z = 3.49 (P = 0.0005)



B. Conversion rate

Study or Subgroup	Obese Events	Total	Non-Obese Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Kuo 2000	1	12	1	28	5.0%	2.45 [0.14, 42.82]	2000
Chow 2002	2	34	1	75	6.8%	4.63 [0.40, 52.85]	2002
Leventhal 2004	4	110	5	390	22.8%	2.91 [0.77, 11.01]	2004
Heimbach 2005	2	58	1	170	6.9%	6.04 [0.54, 67.84]	2005
Reese 2009	4	250	21	2002	34.9%	1.53 [0.52, 4.51]	2009
Unger 2017	1	38	0	109	3.9%	8.76 [0.35, 219.69]	2017
Simforoosh 2020	0	95	1	732	3.9%	2.55 [0.10, 63.12]	2020
Otzurk 2021	6	727	2	1750	15.8%	7.27 [1.46, 36.12]	2021
Total (95% CI)		**1324**		**5256**	**100.0%**	**3.01 [1.59, 5.68]**	
Total events	20		32				

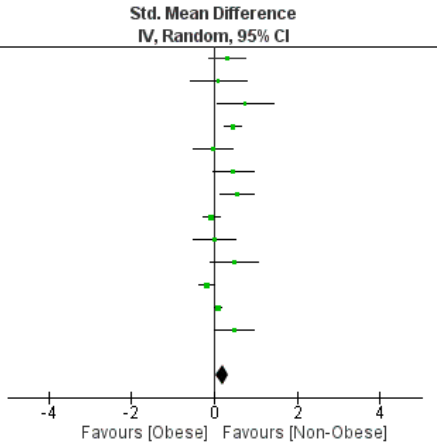
Heterogeneity: Tau² = 0.00; Chi² = 3.58, df = 7 (P = 0.83); I² = 0%
Test for overall effect: Z = 3.39 (P = 0.0007)



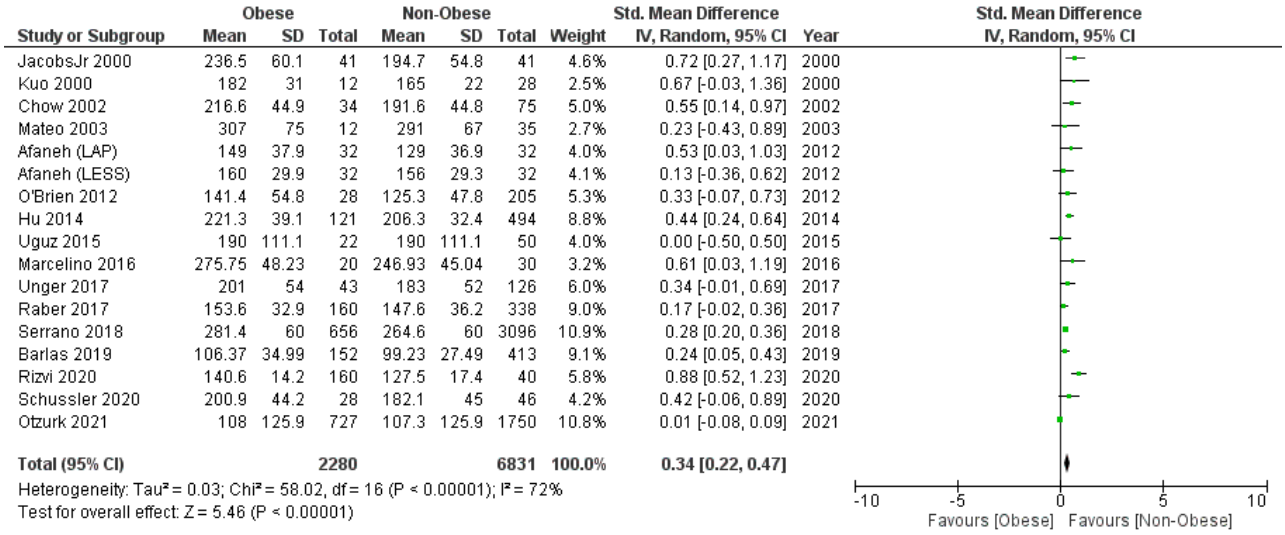
C. Estimated blood loss

Study or Subgroup	Obese Mean	SD	Total	Non-Obese Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI	Year
JacobsJr 2000	170.1	201.6	41	112.9	162.4	41	6.8%	0.31 [-0.13, 0.75]	2000
Kuo 2000	310	302	12	278	325	28	3.8%	0.10 [-0.58, 0.78]	2000
Mateo 2003	296	232	12	170	139	35	3.8%	0.74 [0.07, 1.42]	2003
Leventhal 2004	184	145	110	125	126	390	11.5%	0.45 [0.24, 0.67]	2004
Afaneh (LAP)	100	99.8	32	104	104	32	5.9%	-0.04 [-0.53, 0.45]	2012
Afaneh (LESS)	106	90.5	32	73	46.2	32	5.8%	0.45 [-0.04, 0.95]	2012
O'Brien 2012	166.6	106.1	28	128.6	62.9	205	7.4%	0.55 [0.15, 0.94]	2012
Hu 2014	36.4	21.6	121	41	70.9	494	11.9%	-0.07 [-0.27, 0.13]	2014
Uguz 2015	96.67	133.3	22	96.6	111.1	50	5.7%	0.00 [-0.50, 0.50]	2015
Marcelino 2016	230	165.75	20	165	106.6	30	4.8%	0.48 [-0.09, 1.05]	2016
Raber 2017	45.7	45.2	160	59.2	79.3	338	12.1%	-0.19 [-0.38, -0.00]	2017
Serrano 2018	227	355	656	203	222	3096	14.2%	0.10 [0.01, 0.18]	2018
Schussler 2020	43.33	14.8	28	35	18.5	46	6.1%	0.48 [0.00, 0.96]	2020
Total (95% CI)			**1274**			**4817**	**100.0%**	**0.20 [0.05, 0.36]**	

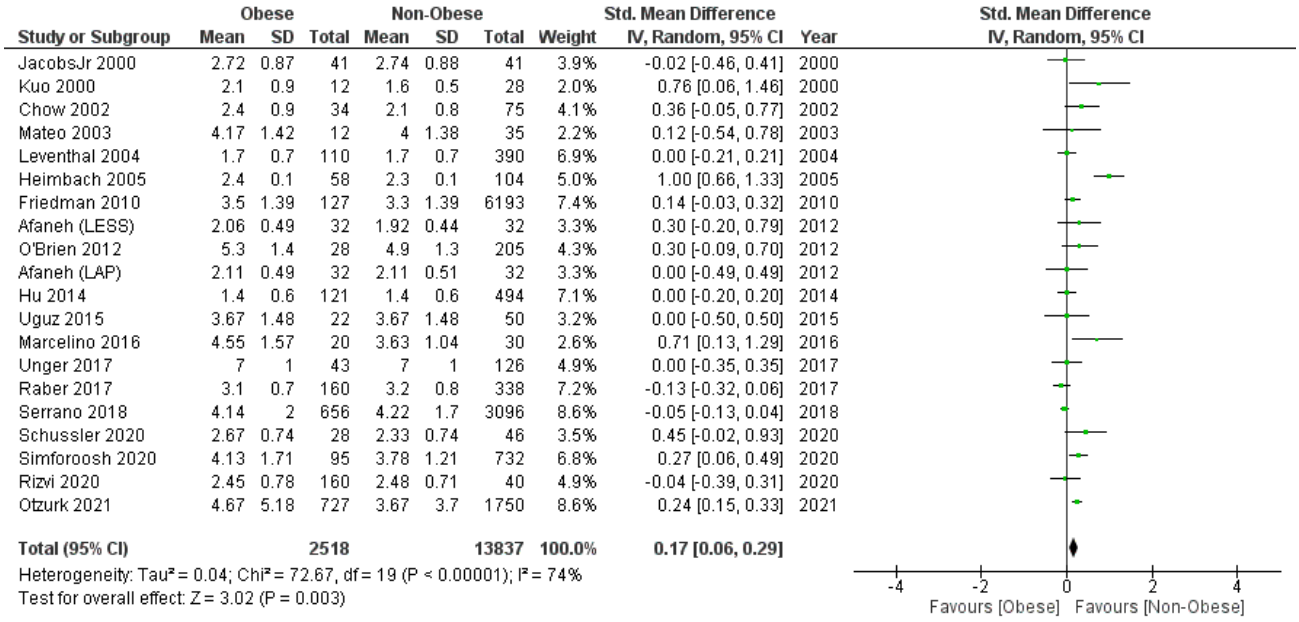
Heterogeneity: Tau² = 0.04; Chi² = 38.11, df = 12 (P = 0.0001); I² = 69%
Test for overall effect: Z = 2.61 (P = 0.009)



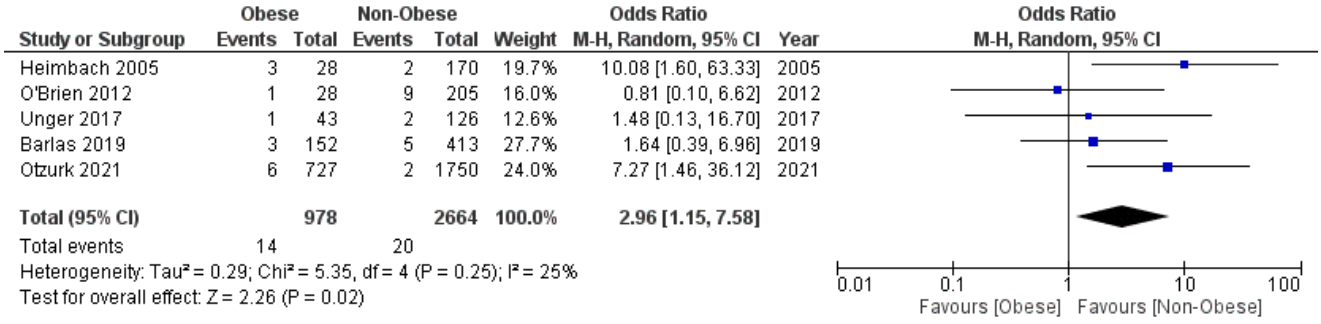
D. Operative time



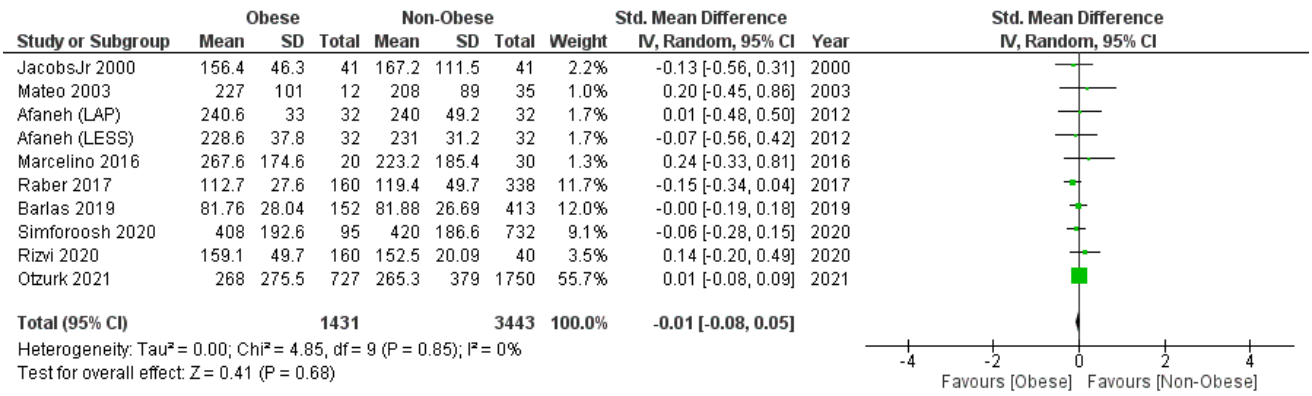
E. Length of stay



F. Infection rate

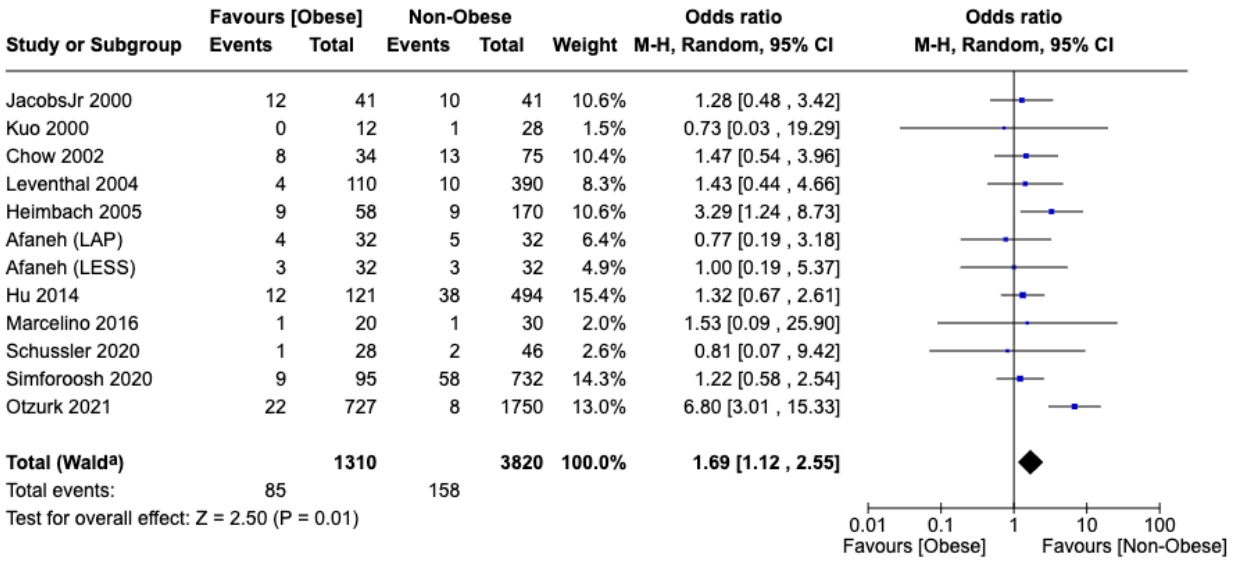


G. Warm Ischemia Time


Obese
Non-Obese
Std. Mean Difference
Std. Mean Difference
Study or Subgroup Mean SD Total Mean SD Total Weight IV, Random, 95% CI Year
IV, Random, 95% CI
JacobsJr 2000 156.4 46.3 41 167.2 111.5 41 2.2% -0.13 [-0.56, 0.31] 2000
Mateo 2003 227 101 12 208 89 35 1.0% 0.20 [-0.45, 0.86] 2003
Afaneh (LAP) 240.6 33 32 240 49.2 32 1.7% 0.01 [-0.48, 0.50] 2012
Afaneh (LESS) 228.6 37.8 32 231 31.2 32 1.7% -0.07 [-0.56, 0.42] 2012
Marcelino 2016 267.6 174.6 20 223.2 185.4 30 1.3% 0.24 [-0.33, 0.81] 2016
Raber 2017 112.7 27.6 160 119.4 49.7 338 11.7% -0.15 [-0.34, 0.04] 2017
Barlas 2019 81.76 28.04 152 81.88 26.69 413 12.0% -0.00 [-0.19, 0.18] 2019
Simforoosh 2020 408 192.6 95 420 186.6 732 9.1% -0.06 [-0.28, 0.15] 2020
Rizvi 2020 159.1 49.7 160 152.5 20.09 40 3.5% 0.14 [-0.20, 0.49] 2020
Otzurk 2021 268 275.5 727 265.3 379 1750 55.7% 0.01 [-0.08, 0.09] 2021
Total (95% CI) 1431 3443 100.0% -0.01 [-0.08, 0.05]
Heterogeneity: Tau² = 0.00; Chi² = 4.85, df = 9 (P = 0.85); I² = 0%
Test for overall effect: Z = 0.41 (P = 0.68)
-4
-2
0
2
4
Favours [Obese]
Favours [Non-Obese]

Appendix 8: Sub-group Analysis 2 - Laparoscopic surgery only

A. Surgical complications



Study or Subgroup	Favours [Obese] Events	Total	Non-Obese Events	Total	Weight	Odds ratio M-H, Random, 95% CI
JacobsJr 2000	12	41	10	41	10.6%	1.28 [0.48 , 3.42]
Kuo 2000	0	12	1	28	1.5%	0.73 [0.03 , 19.29]
Chow 2002	8	34	13	75	10.4%	1.47 [0.54 , 3.96]
Leventhal 2004	4	110	10	390	8.3%	1.43 [0.44 , 4.66]
Heimbach 2005	9	58	9	170	10.6%	3.29 [1.24 , 8.73]
Afaneh (LAP)	4	32	5	32	6.4%	0.77 [0.19 , 3.18]
Afaneh (LESS)	3	32	3	32	4.9%	1.00 [0.19 , 5.37]
Hu 2014	12	121	38	494	15.4%	1.32 [0.67 , 2.61]
Marcelino 2016	1	20	1	30	2.0%	1.53 [0.09 , 25.90]
Schussler 2020	1	28	2	46	2.6%	0.81 [0.07 , 9.42]
Simforoosh 2020	9	95	58	732	14.3%	1.22 [0.58 , 2.54]
Otzurk 2021	22	727	8	1750	13.0%	6.80 [3.01 , 15.33]
Total (Wald[a])		**1310**		**3820**	**100.0%**	**1.69 [1.12 , 2.55]**
Total events:	85		158			

Test for overall effect: Z = 2.50 (P = 0.01)

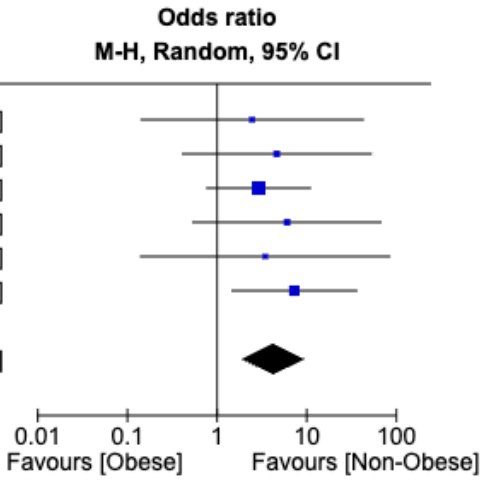
Heterogeneity: Tau² (DL[b]) = 0.17; Chi² = 16.85, df = 11 (P = 0.11); I² = 35%

Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

B. Conversion rate



Study or Subgroup	Obese Events	Total	Non-Obese Events	Total	Weight	Odds ratio M-H, Random, 95% CI
Kuo 2000	1	12	1	28	8.1%	2.45 [0.14 , 42.82]
Chow 2002	2	34	1	75	11.1%	4.63 [0.40 , 52.85]
Leventhal 2004	4	110	5	390	37.3%	2.91 [0.77 , 11.01]
Heimbach 2005	2	58	1	170	11.3%	6.04 [0.54 , 67.84]
Simforoosh 2020	0	95	1	988	6.4%	3.45 [0.14 , 85.19]
Otzurk 2021	6	727	2	1750	25.8%	7.27 [1.46 , 36.12]
Total (Wald[a])		**1036**		**3401**	**100.0%**	**4.20 [1.86 , 9.47]**
Total events:	15		11			

Test for overall effect: Z = 3.46 (P = 0.0005)

Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 1.00, df = 5 (P = 0.96); I² = 0%

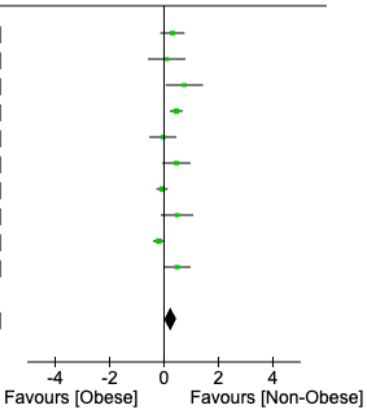
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

C. Estimated blood loss

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	170.1	201.6	41	112.9	162.4	41	9.9%	0.31 [-0.13 , 0.75]
Kuo 2000	310	302	12	278	325	28	6.4%	0.10 [-0.58 , 0.78]
Mateo 2003	296	232	12	170	139	35	6.4%	0.74 [0.07 , 1.42]
Leventhal 2004	184	145	110	125	126	390	14.0%	0.45 [0.24 , 0.67]
Afaneh (LAP)	100	99.8	32	104	104	32	9.0%	-0.04 [-0.53 , 0.45]
Afaneh (LESS)	106	90.5	32	73	46.2	32	8.8%	0.45 [-0.04 , 0.95]
Hu 2014	36.4	21.6	121	41	70.9	494	14.2%	-0.07 [-0.27 , 0.13]
Marcelino 2016	230	165.75	20	165	106.6	30	7.7%	0.48 [-0.09 , 1.05]
Raber 2017	45.7	45.2	160	59.2	79.3	338	14.4%	-0.19 [-0.38 , -0.00]
Schussler 2020	43.33	14.8	28	35	18.5	46	9.2%	0.48 [0.00 , 0.96]
Total (Wald[a])			**568**			**1466**	**100.0%**	**0.23 [0.01 , 0.45]**



Test for overall effect: Z = 2.03 (P = 0.04)

Heterogeneity: Tau² (DL[b]) = 0.08; Chi² = 33.21, df = 9 (P = 0.0001); I² = 73%

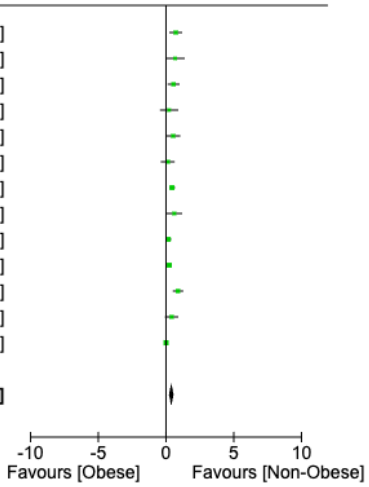
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

D. Operative time

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	236.5	60.1	41	194.7	54.8	41	6.8%	0.72 [0.27 , 1.17]
Kuo 2000	182	31	12	165	22	28	4.1%	0.67 [-0.03 , 1.36]
Chow 2002	216.6	44.9	34	191.6	44.8	75	7.3%	0.55 [0.14 , 0.97]
Mateo 2003	307	75	12	291	67	35	4.4%	0.23 [-0.43 , 0.89]
Afaneh (LAP)	149	37.9	32	129	36.9	32	6.1%	0.53 [0.03 , 1.03]
Afaneh (LESS)	160	29.9	32	156	29.3	32	6.2%	0.13 [-0.36 , 0.62]
Hu 2014	221.3	39.1	121	206.3	32.4	494	10.8%	0.44 [0.24 , 0.64]
Marcelino 2016	275.75	48.23	20	246.93	45.04	30	5.2%	0.61 [0.03 , 1.19]
Raber 2017	153.6	32.9	160	147.6	36.2	338	11.0%	0.17 [-0.02 , 0.36]
Barlas 2019	106.37	34.99	152	99.23	27.49	413	11.0%	0.24 [0.05 , 0.43]
Rizvi 2020	140.6	14.2	160	127.5	17.4	40	8.2%	0.88 [0.52 , 1.23]
Schussler 2020	200.9	44.2	28	182.1	45	46	6.4%	0.42 [-0.06 , 0.89]
Otzurk 2021	108	125.9	727	107.3	125.9	1750	12.2%	0.01 [-0.08 , 0.09]
Total (Wald[a])			**1531**			**3354**	**100.0%**	**0.39 [0.22 , 0.56]**



Test for overall effect: Z = 4.46 (P < 0.00001)

Heterogeneity: Tau² (DL[b]) = 0.06; Chi² = 52.95, df = 12 (P < 0.00001); I² = 77%

Footnotes

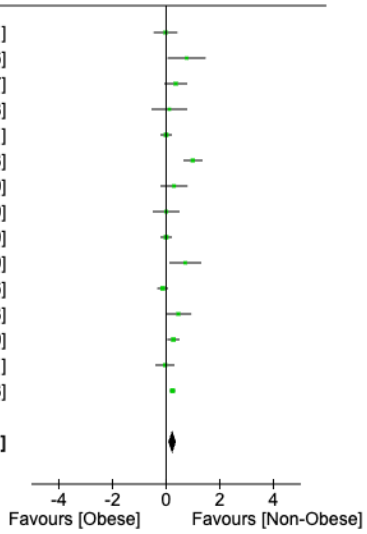
[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

E. Length of stay

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	2.72	0.87	41	2.74	0.88	41	5.7%	-0.02 [-0.46 , 0.41]
Kuo 2000	2.1	0.9	12	1.6	0.5	28	3.1%	0.76 [0.06 , 1.46]
Chow 2002	2.4	0.9	34	2.1	0.8	75	6.0%	0.36 [-0.05 , 0.77]
Mateo 2003	4.17	1.42	12	4	1.38	35	3.4%	0.12 [-0.54 , 0.78]
Leventhal 2004	1.7	0.7	110	1.7	0.7	390	9.2%	0.00 [-0.21 , 0.21]
Heimbach 2005	2.4	0.1	58	2.3	0.1	104	7.1%	1.00 [0.66 , 1.33]
Afaneh (LESS)	2.06	0.49	32	1.92	0.44	32	5.0%	0.30 [-0.20 , 0.79]
Afaneh (LAP)	2.11	0.49	32	2.11	0.51	32	5.0%	0.00 [-0.49 , 0.49]
Hu 2014	1.4	0.6	121	1.4	0.6	494	9.5%	0.00 [-0.20 , 0.20]
Marcelino 2016	4.55	1.57	20	3.63	1.04	30	4.0%	0.71 [0.13 , 1.29]
Raber 2017	3.1	0.7	160	3.2	0.8	338	9.6%	-0.13 [-0.32 , 0.06]
Schussler 2020	2.67	0.74	28	2.33	0.74	46	5.2%	0.45 [-0.02 , 0.93]
Simforoosh 2020	4.13	1.71	95	3.78	1.21	732	9.2%	0.27 [0.06 , 0.49]
Rizvi 2020	2.45	0.78	160	2.48	0.71	40	7.0%	-0.04 [-0.39 , 0.31]
Otzurk 2021	4.67	5.18	727	3.67	3.7	1750	11.0%	0.24 [0.15 , 0.33]
Total (Wald[a])			**1642**			**4167**	**100.0%**	**0.22 [0.08 , 0.37]**

Std. mean difference
IV, Random, 95% CI



Test for overall effect: Z = 2.99 (P = 0.003)

Heterogeneity: Tau² (DL[b]) = 0.05; Chi² = 51.95, df = 14 (P < 0.00001); I² = 73%

Footnotes

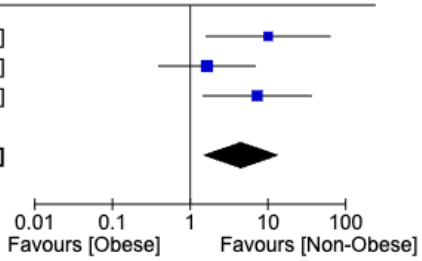
[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

F. Infection rate

Study or Subgroup	Obese Events	Obese Total	Non-Obese Events	Non-Obese Total	Weight	Odds ratio M-H, Random, 95% CI
Heimbach 2005	3	28	2	170	27.8%	10.08 [1.60 , 63.33]
Barlas 2019	3	152	5	413	38.6%	1.64 [0.39 , 6.96]
Otzurk 2021	6	727	2	1750	33.7%	7.27 [1.46 , 36.12]
Total (Wald[a])		**907**		**2333**	**100.0%**	**4.49 [1.44 , 13.93]**
Total events:	12		9			

Odds ratio
M-H, Random, 95% CI



Test for overall effect: Z = 2.60 (P = 0.009)

Heterogeneity: Tau² (DL[b]) = 0.32; Chi² = 2.95, df = 2 (P = 0.23); I² = 32%

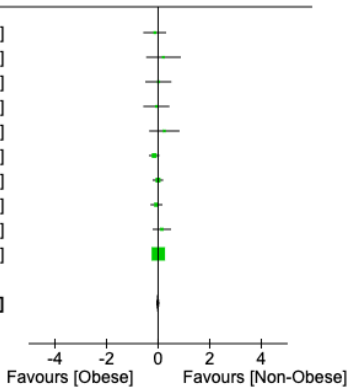
Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.

G. Warm Ischemia Time

Study or Subgroup	Obese Mean	Obese SD	Obese Total	Non-Obese Mean	Non-Obese SD	Non-Obese Total	Weight	Std. mean difference IV, Random, 95% CI
JacobsJr 2000	156.4	46.3	41	167.2	111.5	41	2.2%	-0.13 [-0.56 , 0.31]
Mateo 2003	227	101	12	208	89	35	1.0%	0.20 [-0.45 , 0.86]
Afaneh (LAP)	240.6	33	32	240	49.2	32	1.7%	0.01 [-0.48 , 0.50]
Afaneh (LESS)	228.6	37.8	32	231	31.2	32	1.7%	-0.07 [-0.56 , 0.42]
Marcelino 2016	267.6	174.6	20	223.2	185.4	30	1.3%	0.24 [-0.33 , 0.81]
Raber 2017	112.7	27.6	160	119.4	49.7	338	11.7%	-0.15 [-0.34 , 0.04]
Barlas 2019	81.76	28.04	152	81.88	26.69	413	12.0%	-0.00 [-0.19 , 0.18]
Simforoosh 2020	408	192.6	95	420	186.6	732	9.1%	-0.06 [-0.28 , 0.15]
Rizvi 2020	159.1	49.7	160	152.5	20.09	40	3.5%	0.14 [-0.20 , 0.49]
Otzurk 2021	268	275.5	727	265.3	379	1750	55.7%	0.01 [-0.08 , 0.09]
Total (Wald[a])			**1431**			**3443**	**100.0%**	**-0.01 [-0.08 , 0.05]**



Test for overall effect: Z = 0.41 (P = 0.68)

Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 4.85, df = 9 (P = 0.85); I² = 0%

Footnotes

[a]CI calculated by Wald-type method.

[b]Tau² calculated by DerSimonian and Laird method.