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Neonatal outcomes following maternal bariatric surgery: A systematic review and meta-analysis

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Abstract

To evaluate neonatal outcomes in pregnancies following maternal bariatric surgery, focusing on preterm birth, small for gestational age (SGA), large for gestational age (LGA), congenital anomalies, perinatal mortality, and neonatal intensive care unit (NICU) admission, while exploring maternal health impacts and long-term neonatal effects. PubMed, Embase, Scopus, CINAHL, and Google Scholar were searched (inception to July 31, 2025) for observational studies and meta-analyses comparing neonatal outcomes in post-bariatric surgery pregnancies to controls (obese, BMI-matched, or general population). Random-effects meta-analyses calculated pooled odds ratios (ORs) with 95% confidence intervals (CIs). Subgroup analyses assessed surgery type (Roux-en-Y gastric bypass [RYGB], sleeve gastrectomy [SG], laparoscopic adjustable gastric banding [LAGB], biliopancreatic diversion [BPD]) and surgery-to-conception interval. Quality was evaluated using the Newcastle-Ottawa Scale and ROBINS-I tool. From 48 studies (20,500 post-bariatric surgery pregnancies, >4.5 million controls), bariatric surgery increased preterm birth (OR 1.58, 95% CI 1.39–1.80), SGA (OR 2.22, 95% CI 1.88–2.62), congenital anomalies (OR 1.31, 95% CI 1.05–1.63), perinatal mortality (OR 1.36, 95% CI 1.03–1.80), and NICU admission (OR 1.41, 95% CI 1.25–1.59), but reduced LGA (OR 0.39, 95% CI 0.31–0.49). SG showed lower risks for preterm birth (OR 1.33 vs. RYGB OR 1.78) and SGA (OR 1.33 vs. RYGB OR 2.52). Pregnancies <18 months post-surgery had higher SGA risks (OR 2.75). Maternal nutritional deficiencies (e.g., folate, B12) were linked to adverse outcomes. Maternal bariatric surgery increases neonatal risks, particularly with RYGB, driven by malabsorption. SG appears safer. Delayed conception (12–18 months), nutritional optimization, and multidisciplinary care are critical. Further research on SG-specific outcomes and long-term neonatal health is needed.

Keywords: bariatric surgery, Neonatal outcomes, Preterm birth, Small for gestational age, Perinatal care, Nutritional deficiencies

Introduction

Maternal obesity is a well-established risk factor for adverse neonatal outcomes, including large for gestational age (LGA) infants, congenital anomalies, and preterm birth [1]. Bariatric surgery, encompassing procedures like Roux-en-Y gastric bypass (RYGB), sleeve gastrectomy (SG), laparoscopic adjustable gastric banding (LAGB), and biliopancreatic diversion (BPD), achieves 50–70% excess weight loss, mitigating obesity-related complications such as gestational diabetes and hypertension [2,3]. However, these procedures, particularly malabsorptive ones like RYGB and BPD, may compromise neonatal health due to nutritional deficiencies (e.g., folate, vitamin B12, iron, calcium) that affect fetal growth and development [3,4,5]. Recent studies (2023–2025) suggest SG, a restrictive procedure, may pose fewer neonatal risks than RYGB due to reduced malabsorption [6,7,8,9]. This systematic review and meta-analysis synthesize evidence from 48 studies, including 10 new 2023–2025 publications, to evaluate neonatal outcomes (preterm birth, SGA, LGA, congenital anomalies, perinatal mortality, NICU admission) following maternal bariatric surgery. We also explore maternal health impacts (e.g., nutritional status, gestational complications) and long-term neonatal outcomes (e.g., neurodevelopment, metabolic health), providing a comprehensive framework for optimizing perinatal care. Our objectives are to quantify risks, compare surgery types, assess the impact of surgery-to-conception intervals, and propose evidence-based clinical recommendations.

Methods

Ethical statement

This study, a secondary analysis of published data, involved no human or animal subjects and required no ethics committee approval. It adheres to the Declaration of Helsinki and PRISMA guidelines. No financial relationships or conflicts of interest influenced this work.

Search strategy

We searched PubMed, Embase, Scopus, CINAHL, and

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Google Scholar from inception to July 31, 2025, using terms such as "bariatric surgery," "pregnancy," "neonatal outcomes," "preterm birth," "small for gestational age," and "congenital anomalies." Hand-searching of references from 2023–2025 studies in *Obesity Surgery*, *American Journal of Obstetrics and Gynecology*, and *Surgery for Obesity and Related Diseases* identified additional sources. No language restrictions were applied.

Inclusion/Exclusion criteria

Eligible studies were observational cohort studies, case-control studies, or meta-analyses comparing neonatal outcomes in post-bariatric surgery pregnancies to controls (obese, BMI-matched, or general population), reporting adjusted odds ratios (ORs) or risk ratios (RRs) with 95% CIs for preterm birth, SGA, LGA, congenital anomalies, perinatal mortality, or NICU admission. We excluded case reports, non-controlled studies, studies with unclear outcome definitions, or those lacking adjusted effect estimates. Studies focusing solely on maternal outcomes were included only if they reported neonatal data.

Data extraction and quality assessment

Two independent reviewers extracted data on study design, sample size, surgery type (RYGB, SG, LAGB, BPD), surgery-to-conception interval, control group type, and neonatal outcomes. Adjusted ORs were prioritized to account for confounders (e.g., maternal age, BMI, smoking). Study quality was assessed using the Newcastle-Ottawa Scale (NOS; high quality: ≥7/9) and the ROBINS-I tool for risk of bias. Discrepancies were resolved through consensus.

Statistical analysis

Random-effects models (DerSimonian-Laird) calculated pooled ORs with 95% CIs. Heterogeneity was assessed using I^2 (<40% low, 40–70% moderate, >70% high). Subgroup analyses stratified outcomes by surgery type (malabsorptive: RYGB, BPD; restrictive: SG, LAGB), surgery-to-conception interval (<12, 12–18, >18 months), and control group type (obese vs. general population). Sensitivity analyses excluded low-quality studies (NOS <7). Publication bias was evaluated using funnel plots and Egger's test. Meta-regression explored the impact of maternal BMI and nutritional status. Software: Review Manager 5.4, Stata 18.0.

Results

Study selection and characteristics

Of 1,800 records screened, 48 studies were included (20,500 post-bariatric surgery pregnancies, >4.5 million controls), incorporating 10 new studies from 2023–2025 [6,7,8,9,10,11,12,13,14,15]. Most studies were retrospective cohorts from high-income countries (Europe, USA, Canada, Australia, Israel). Procedures included RYGB (48%), SG (38%), LAGB (10%), and BPD (4%). The mean surgery-to-conception interval ranged from 1.5 to 3.5 years. Study quality was high, with 92% of studies scoring NOS ≥7. ROBINS-I indicated low to moderate risk of bias, primarily due to unadjusted confounders in older studies.

Neonatal outcomes

Table 1 summarizes pooled outcomes. Maternal bariatric surgery significantly increased risks of:

Preterm birth (<37 weeks)

Based on 30 studies (19,000 pregnancies), the pooled OR was 1.58 (95% CI 1.39–1.80, I^2=47%, p<0.001). Subgroup analysis by surgery type showed higher risks for RYGB (OR 1.78, 95% CI 1.53–2.07, I^2=50%, 15 studies) compared to SG (OR 1.33, 95% CI 1.08–1.64, I^2=40%, 10 studies) and LAGB (OR 1.18, 95% CI 0.88–1.58, I^2=30%, 5 studies). Pregnancies conceived <18 months post-surgery had a higher risk (OR 1.82, 95% CI 1.50–2.20, I^2=45%, 8 studies) than those >18 months (OR 1.40, 95% CI 1.20–1.64, I^2=42%, 12 studies).

SGA

Across 32 studies (19,500 pregnancies), the pooled OR was 2.22 (95% CI 1.88–2.62, I^2=43%, p<0.001). RYGB was associated with the highest risk (OR 2.52, 95% CI 2.12–2.99, I^2=45%, 16 studies), followed by LAGB (OR 1.48, 95% CI 1.08–2.03, I^2=35%, 4 studies), while SG showed a lower and less certain risk (OR 1.33, 95% CI 0.68–2.60, I^2=48%, 12 studies). Pregnancies <18 months post-surgery had a higher SGA risk (OR 2.75, 95% CI 2.10–3.60, I^2=50%, 10 studies) compared to >18 months (OR 1.90, 95% CI 1.60–2.26, I^2=40%, 14 studies).

Congenital anomalies

Based on 18 studies (11,000 pregnancies), the pooled OR was 1.31 (95% CI 1.05–1.63, I^2=23%, p=0.016). RYGB showed the highest risk (OR 1.41, 95% CI 1.11–1.79), followed by SG (OR 1.21, 95% CI 0.91–1.61) and LAGB (OR 1.17, 95% CI 0.81–1.69).

Perinatal mortality

From 18 studies (11,000 pregnancies), the pooled OR was 1.36 (95% CI 1.03–1.80, I^2=9%, p=0.029), with RYGB showing the highest risk (OR 1.46, 95% CI 1.06–2.01).

NICU admission

Across 16 studies (10,000 pregnancies), the pooled OR was 1.41 (95% CI 1.25–1.59, I^2=0%, p<0.001), with RYGB again showing the highest risk (OR 1.51, 95% CI 1.31–1.74).

LGA

Based on 32 studies (19,500 pregnancies), bariatric surgery reduced LGA risk (OR 0.39, 95% CI 0.31–0.49, I^2=63%, p<0.001), with the strongest reduction in RYGB (OR 0.24, 95% CI 0.17–0.34).

Subgroup analyses

Surgery type

SG consistently showed lower risks for preterm birth and SGA compared to RYGB, likely due to reduced malabsorption. LAGB had the lowest risks but was underrepresented. BPD risks were similar to RYGB but based on fewer studies (4 studies).

Surgery-to-conception interval

Pregnancies <18 months post-surgery had higher risks for preterm birth and SGA compared to >18 months, reflecting nutritional instability during rapid weight loss [16].

Control group type

Risks were higher when compared to obese controls (SGA OR 2.40, 95% CI 2.00–2.88) than general population controls (SGA OR 1.95, 95% CI 1.60–2.38).

Maternal health impacts

Ten studies reported maternal nutritional deficiencies (folate, B12, iron, vitamin D) post-surgery, correlating with SGA and congenital anomalies [4,8,9,12]. Gestational hypertension and diabetes were reduced post-surgery (OR 0.45 and 0.38, respectively), likely contributing to lower LGA rates [3,13].

Sensitivity and bias

Sensitivity analyses excluding low-quality studies (NOS <7) confirmed robustness (e.g., preterm birth OR 1.60, 95% CI 1.40–1.82). No publication bias was detected (Egger's p>0.05). Meta-regression suggested maternal pre-pregnancy BMI and folate levels as significant predictors of SGA (p=0.02).

Table 1. Neonatal outcomes after maternal bariatric surgery

Outcome	Studies	Post-Surgery Pregnancies	Pooled OR (95% CI)	I^2 (%)	p-value	Subgroup Findings	Conclusion
Preterm Birth	30	19,000	1.58 (1.39–1.80)	47	<0.001	RYGB: OR 1.78; SG: OR 1.33; LAGB: OR 1.18	Highest risk with RYGB due to malabsorption.
SGA	32	19,500	2.22 (1.88–2.62)	43	<0.001	RYGB: OR 2.52; SG: OR 1.33; LAGB: OR 1.48	Nutrient deficiencies drive SGA, lower with SG.
LGA	32	19,500	0.39 (0.31–0.49)	63	<0.001	RYGB: OR 0.24; SG: OR 0.44; LAGB: OR 0.51	Reduced due to improved glycemic control.
Congenital	18	11,000	1.31 (1.05–	23	0.016	RYGB: OR 1.41; SG:	Folate supplementation

Anomalies			1.63)			OR 1.21; LAGB: OR 1.17	critical.
Perinatal Mortality	18	11,000	1.36 (1.03–1.80)	9	0.029	RYGB: OR 1.46; SG: OR 1.27; LAGB: OR 1.17	Modest increase needs further study.
NICU Admission	16	10,000	1.41 (1.25–1.59)	0	<0.001	RYGB: OR 1.51; SG: OR 1.26; LAGB: OR 1.21	Tied to preterm and SGA risks.

Discussion

This meta-analysis, expanded with 10 new 2023–2025 studies, confirms that maternal bariatric surgery increases risks of preterm birth, SGA, congenital anomalies, perinatal mortality, and NICU admission, while reducing LGA risk due to improved maternal glycemic control [6,7,8,9,10,11,12,13,14,15]. The higher risks with RYGB compared to SG reflect its malabsorptive nature, which disrupts nutrient absorption (e.g., folate, B12, iron) critical for fetal growth [4,8,17]. SG's restrictive mechanism, preserving intestinal absorption, appears safer, particularly for preterm birth and SGA [6,9]. Early pregnancies (<18 months post-surgery) show elevated risks, likely due to nutritional instability during rapid weight loss [16,18].

Maternal health context

Bariatric surgery reduces maternal risks like gestational diabetes (OR 0.38) and hypertension (OR 0.45), benefiting LGA rates but not fully mitigating neonatal risks [3,13]. Nutritional deficiencies, reported in 60% of post-surgery pregnancies, are a key mechanism for SGA and congenital anomalies [4,9,12]. For example, folate deficiency is linked to neural tube defects [5,19].

Long-term neonatal outcomes

Emerging evidence suggests potential neurodevelopmental and metabolic impacts in offspring. Two 2024 studies reported subtle delays in cognitive milestones among children born post-RYGB, possibly due to B12 deficiency [14,15]. Another study found increased insulin sensitivity in adolescents born post-surgery, warranting further investigation [13].

Clinical implications

Preconception counseling

Delay pregnancy 12–18 months post-surgery to stabilize nutritional status [16,18].

Nutritional supplementation

Routine supplementation of folate (4 mg/day), B12 (1000 μg/month), iron (45–60 mg/day), and calcium (1200 mg/day) is critical [20,12].

Fetal monitoring

Serial ultrasounds to assess growth and anomalies, especially in RYGB pregnancies.

Surgery choice

SG may be preferred for women planning pregnancy due to lower neonatal risks [6,9].

Multidisciplinary care

Involve obstetricians, neonatologists, dietitians, and bariatric specialists for comprehensive management.

Limitations

Heterogeneity in control groups (obese vs. general population) and limited SG-specific data persist. Long-term neonatal outcomes (e.g., neurodevelopment, metabolic health) are understudied. Older studies lacked adjustment for confounders like socioeconomic status or smoking [21,22,23].

Future research

SG-specific randomized controlled trials to confirm its safer profile.

Longitudinal studies on neurodevelopmental and metabolic outcomes in offspring.

Nutritional intervention trials to optimize supplementation protocols.

Exploration of socioeconomic and ethnic disparities in post-surgery pregnancy outcomes.

Conclusion

Maternal bariatric surgery, particularly RYGB, increases neonatal risks of preterm birth, SGA, congenital anomalies, perinatal mortality, and NICU admission, driven by malabsorptive effects and nutritional deficiencies. SG offers a safer profile, with lower risks for preterm birth and SGA. Delayed conception (12–18 months), aggressive nutritional supplementation, and enhanced fetal monitoring are essential to optimize perinatal outcomes. Multidisciplinary care and further research into SG-specific and long-term neonatal outcomes will enhance clinical practice.

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