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REVIEW ARTICLE

Pregnancy after bariatric surgery: a comprehensive review

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Abstract
Background Obesity continues to be a global epidemic, and strong evidence exists linking it with gestational complications such as macrosomia, hypertensive disorders of pregnancy, gestational diabetes, and cesarean section. Bariatric surgery, a highly effective treatment for obesity, may prevent such complications in subsequent pregnancies.
Objective This review seeks to describe the risks and benefits of post-bariatric procedure pregnancies, in comparison to both community and obese cohorts.
Results A thorough review of the literature suggests that post-surgery women are not at increased risk for poor perinatal outcomes, and moreover their risks for many obesity-related gestational complications are reduced after bariatric surgery. Data regarding fertility after bariatric surgery are quite ambiguous, however, and studies exist demonstrating both positive and negative associations between weight loss procedures and fertility.
Conclusions Clinicians should be aware that data collected on this subject were often gathered from post-op pregnant women provided with good prenatal care and screening for nutritional deficiencies. Although pregnancy after bariatric surgery appears to be safe, providers should take extra care to properly monitor their post-op pregnant patients for appropriate weight gain and nourishment.

Keywords Bariatric surgery · Obesity · Pregnancy Complications · Diabetes mellitus · Hypertensive disorders

Introduction

Obesity has reached epidemic proportions worldwide, with 32.2% of U.S. adults defined as obese (BMI ≥ 30) in 2003–2004 [1]. Prevalence continues to rise [1] and obesity has become the second leading cause of death in the West [2].

There is strong evidence suggesting that obese women are at elevated risk for a number of pregnancy-related complications, including infertility, macrosomia, preeclampsia, gestational hypertension, gestational diabetes (GDM) and cesarean section [3–5]. Bariatric surgery, having been named a highly effective treatment for morbid obesity and many of its associated medical conditions [6], may help prevent obesity-related gestational complications as well. Indeed, studies comparing post-op pregnancies to those of an obese cohort have generally shown a reduction in the rates of adverse outcomes and conditions such as macrosomia, hypertensive diseases of pregnancy, and GDM [7–9].

Although bariatric surgery appears to be the ultimate solution for obesity-related gestational complications, pregnancy during the malnourished state following a successful weight loss procedure is not without potential risks. Case reports and series documenting poor perinatal outcomes and late surgical complications during post-op pregnancies exist [10–14], although systematic studies have generally failed to prove such associations [15].

This review seeks to describe the literature relevant to pregnancy after bariatric surgery. By presenting information concerning weight loss procedures and their potential effects on maternal and fetal complications, a comprehensive view

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of the benefits and risks of post-surgery pregnancy will be provided.

Restrictive versus malabsorptive procedures

Bariatric surgery encompasses a variety of effective procedures, each with its own potential risks to subsequent pregnancies. For the purposes of this review, the procedures are divided into two general categories: purely restrictive surgeries including adjustable gastric banding (AGB), and malabsorptive surgeries (which may also restrict) including Roux-en-Y gastric bypass (RGB) and biliopancreatic diversion (BPD).

RGB, a malabsorptive procedure, is currently the most commonly performed bariatric surgery in the world [16]. Along with the desired effects of malabsorption, surgeries such as RGB and BPD may cause permanent and excessive loss of nutrients such as B12, folate, and albumin [17, 18]. Theoretically, this loss could lead to malnourishment in pregnant women and their fetuses, potentially increasing their risk for poor outcomes. Although there are case reports documenting maternal and fetal complications in patients who underwent malabsorptive procedures [11–13], systematic studies fail to prove such associations [15, 17]. In a study comparing pre- and post-op pregnancies of women who underwent BPD, Marceau et al. [17] reported a decreased incidence of macrosomic infants as well as an increased incidence of healthy maternal weight gain (9.1 ± 5.9 kg) in post-BPD pregnancies. Although they also report an increased post-op rate of small-for-gestational-age babies, Marceau et al. [17] claimed that the percentage is similar to their normal community level. Of particular concern in pregnancies following malabsorptive procedures is the possibility of significant changes in plasma protein levels; Marceau et al. [17] reported a decrease in serum albumin concentration (from 40.4 ± 2.7 to 35.7 ± 5.5 g/l, $P < 0.0001$), with 4 out of 251 post-op pregnancies having required hospitalization for parenteral nutrition due to severe hypoalbuminemia (<26 g/l) stemming from malabsorption. A study examining this complication in post-restrictive procedure pregnancies reports no difference in plasma protein levels between pre-op and post-op pregnancies [7].

Other studies also speak for the safety of post-malabsorptive pregnancies. In a large population-based investigation comparing deliveries of women who had not undergone bariatric surgery ($n = 158{,}912$) to those of women who had undergone either malabsorptive or restrictive procedures ($n = 298$), Sheiner et al. [15] reported that there are no differences in adverse perinatal outcomes between the two groups. Although both restrictive and malabsorptive procedure patients are included in this study, the authors were not able to distinguish between them, making it difficult to extrapolate their results specifically onto malabsorptive patients.

Aside from nutritional deficiencies, malabsorptive procedures also pose the potential risk of late surgery complications occurring during subsequent pregnancies. Case reports have documented internal hernia formation [19] and small bowel ischemia [20]. Larger series and studies, however, do not report high rates of such complications during post-op pregnancies [15, 17, 21, 22].

Although few systematic studies examining pregnancy after malabsorptive procedures exist, they do suggest that post-RGB or BPD pregnancy is safe and may reduce obstetric complications in obese women [15, 17, 21]. Perhaps, the potentially elevated risks of maternal and fetal malnutrition are counteracted by the dietary supplementation and careful medical monitoring routinely provided for malabsorptive procedure patients. All bariatric surgery patients are advised to have adequate supplementation of folate, calcium, and B12, along with diagnosis and treatment of any other nutritional deficiencies [23, 24].

Purely restrictive surgeries such as AGB are the least invasive of bariatric procedures and generally carry lower morbidity rates than their malabsorptive counterparts [25]. A number of studies and series suggest that pregnancy after AGB is safe and may improve obstetric outcome [7, 15, 26, 27], even though post-AGB pregnancies are not without potential complications such as band slippage [26]. Band adjustment during post-op pregnancies may be required to regulate maternal weight gain [7] or alleviate feelings of nausea [28].

Band adjustability is an appealing aspect of AGB; Dixon et al. [7] concluded that it permits adaptation to the altered requirements of pregnancy, and in doing so allows for healthy maternal weight gain and normal birth weight babies. In order to assess birth outcomes after laparoscopic AGB, Dixon et al. [7] conducted a prospective study comparing 79 post-op pregnancies with those same patients' penultimate pre-op pregnancies ($n = 40$). All measured post-op pregnancy outcomes and complications including birth weight, pregnancy induced hypertension, and gestational diabetes, showed improvement or remained the same as compared to pre-op pregnancies. After controlling for gestational age, maternal weight change during pregnancy significantly affected birth weight ($P = 0.03$) whereas maternal BMI or weight loss before pregnancy had no influence on this parameter [7]. The authors also described that women who were not monitored early during their pregnancy with band adjustments when necessary, were less likely to have the gestational weight gain recommended by the Institute of Medicine ($P = 0.009$) [7, 29]. It is unclear how many women needed band adjustment and how the adjustment itself affected maternal weight gain;

other aspects of early pregnancy monitoring could have been involved.

Although Dixon et al. [7] are in favor of band adjustment citing healthier pregnancy weight gain, others claim that it is not necessary. A series following 23 post-AGB pregnancies and presenting only descriptive statistics reports normal birth weight babies without band adjustment (mean birth weight 3,676 g; range 2,381–3,912 g) although a few were adjusted due to nausea, vomiting, and patient request [28].

To the best of our knowledge, there are no studies comparing post-op pregnancy outcomes of restrictive versus malabsorptive bariatric patients. The literature suggests that the type of weight-loss procedure performed is important regarding potential gestational complications, necessitating closer comparison of these procedures in terms of post-op pregnancy outcomes.

Fertility

Several studies suggest that weight loss through non-surgical means can reverse anovulation and improve fertility in women [3, 30, 31]. Evidence regarding the effects of bariatric procedures on fertility is more ambiguous, and data sets exist demonstrating both positive and negative associations between weight loss surgery and fertility.

A few series document the improvements in fertility after bariatric surgery [17, 28, 32, 33], although many of their findings are lacking in statistical significance due to small sample sizes. However, two larger systematic studies reveal higher rates of infertility treatments in post-op pregnant women as compared to pregnant controls who did not undergo a weight loss procedure [15, 34]. Although their results remain significant even after multivariate analysis, complex confounding may be involved. Indeed, post-op patients are more obese, a risk factor for infertility, than the general population. Moreover, low fertility pre-op may be a factor in the decision to undergo bariatric surgery to begin with, possibly entering selection bias into these studies. Notably, data in both studies were collected from deliveries only; no information is provided regarding infertility in women who did not deliver. Research minimizing confounding and bias is needed to better determine the influence of bariatric surgery on fertility.

Aside from potentially affecting fertility through correction of anovulation, weight loss procedures (especially malabsorptive ones) may also cause changes in the gastrointestinal uptake of oral contraceptives pills (OCP). Low levels of plasma OCP have been reported in post-op patients [35], and it has been recommended that they consider implementing contraceptives other than OCP to prevent pregnancy [36]. Some combination of improved ovulation and ineffective OCP hormone levels may be responsible for the unintended post-op pregnancies reported in a few series [28, 37], although more research is needed on this subject. Indeed, unintended pregnancies can be seen in all populations and may be responsible for up to 14% of total births to U.S. women between the ages of 15 and 44 [38]. Therefore, conclusions cannot be drawn until systematic studies are conducted comparing unintended pregnancy rates in post-op versus control women.

In addition to its potential effects on fertility [28] and OCP absorption [35], bariatric surgery may also be associated with changes in miscarriage rates [39]. Previous studies have suggested that obese women are at increased risk for miscarriage [40], with non-surgical weight loss appearing to lower this risk [30]. However, few studies examining the effects of bariatric surgery on miscarriage risk have been conducted. In their study comparing pre- and post-op pregnancies after BPD, Marceau et al. [17] found no difference in miscarriage rate between the two groups (21.6% pre-op vs. 26% post-op). In contrast, Friedman et al. [39] found reductions in miscarriage rates among their post-op pregnancies as compared to gestations which occurred before pregnancy (17% pre-op vs. 11% post-op). Statistical significance is not mentioned in either of these two studies. More research is needed in order to properly address and draw conclusions about the relationship between bariatric surgery and miscarriage rate.

The ambiguity of the literature regarding fertility and bariatric surgery demands a more comprehensive investigation into this subject. Until more of a consensus is reached about the effects of weight loss surgery on anovulation, OCP, and miscarriage, the recommendation not to go through such surgery solely to improve fertility [41] or lower risk for pregnancy loss [42] seems a safe and reasonable one.

Pregnancy-related complications

Gestational diabetes mellitus

Gestational diabetes mellitus is a significant cause of maternal and neonatal morbidity. Studies have shown high rates of GDM in obese cohorts [4], hypothetically making obesity surgery an appealing intervention for the prevention of GDM. Although bariatric procedures are quite effective in treating obesity, GDM prevalence in post-op patients remains high [15].

Initial univariate analysis of 159,210 deliveries by Sheiner et al. [15] revealed a higher rate of GDM in post-op pregnancies ($P = 0.001$) as compared to the pregnancies of women who did not have bariatric surgery. However, the difference in overall diabetes mellitus rates was not shown to be significant in multivariate analysis controlling for variables such as obesity. Indeed, obesity is associated with both GDM [4] and weight-loss procedures [15], making it a likely confounder of the relationship between bariatric surgery and GDM.

Studies comparing post-op patients to an obese control group are very important regarding pregnancy and neonatal complications such as GDM. Although GDM rates may be higher in post-op women than in *normal* controls, the rate in post-op women as compared to *obese* controls predicts the role bariatric surgery may play in preventing or worsening the incidence of GDM. The study of Dixon et al. [7] comparing post-op pregnancies to paired penultimate pre-op pregnancies and to those of an obese cohort reveals a lower GDM rate in the bariatric cohort as compared to obese patients but not in comparison to pre-op pregnancies. In other words, post-op women were shown to have a lower rate of GDM than their obese counterparts, but the same rate of GDM when compared to their own pre-op pregnancies. These results are difficult to interpret; differences between obese cohort pregnancies and pre-op pregnancies may reflect interactions with unknown confounders. Other studies have also shown lower GDM rates in post-op pregnancies when compared to those associated with obesity [9]. Although bariatric surgery may or may not help prevent the development of GDM in subsequent pregnancies, it does not appear to increase the risk for GDM.

Whether results are confounded by obesity or other variables, high rates of GDM (8–16%) in post-op pregnancies have been reported [15, 26, 27]. This high prevalence is particularly concerning because of the possibility of altered glucose metabolism in bariatric patients, perhaps changing response to treatment or pregnancy outcomes of post-op women with GDM. A study conducted comparing post-op GDM patients with GDM controls who did not undergo obesity surgery reports no significant differences in perinatal outcome or obstetric characteristics between the two groups. Mean hemoglobin A1c and blood glucose levels were also comparable [34]. These data suggest that although GDM may be more prevalent in post-op women than in those who have not undergone bariatric surgery, the disease characteristics and prognoses are similar between the two groups.

The type of bariatric surgery performed may also be important regarding GDM rates. Malabsorptive operations may promote insulin secretion and inhibit glucagon production [6], theoretically making them more effective than restrictive procedures at preventing and treating diseases related to glucose metabolism such as GDM. In their study on GDM patients, Sheiner et al. [34] found no differences in hemoglobin A1c or fasting blood glucose levels between patients with restrictive versus malabsorptive procedures. The small sample size ($n = 28$ post-op GDM patients) of the diabetes study of Sheiner et al. [34], however, precludes any firm conclusions regarding the GDM rate of restrictive versus malabsorptive procedures.

Special guidelines exist for GDM screening in bariatric (specifically malabsorptive procedure) patients. A 50-g oral glucose challenge test may bring on dumping syndrome, a constellation of symptoms arising from malabsorption, osmotic fluid shifts, and postprandial hyperinsulinemic hypoglycemia. In order to prevent the induction of dumping syndrome in their malabsorptive patients, physicians may choose to screen them for GDM by monitoring home fasting and 2-h postprandial blood glucose levels for 1 week at 26–28 weeks of gestation [18].

In summary, although lower rates of GDM are seen in post-op patients as compared to their obese counterparts [7, 9], higher rates are seen in comparison to the general population [15, 26]. Confounders, such as obesity, may be significant when the relationship between bariatric surgery and GDM is investigated. Indeed, while comparing patients before and after bariatric surgery, a decrease in diabetes mellitus is achieved following the procedure [8]. When considering treatment and pregnancy outcome, it is important to note that GDM characteristics appear to be similar in both bariatric and non-bariatric patients [34]. GDM screening in malabsorptive patients, however, requires special considerations [18].

Hypertensive disorders of pregnancy

The literature suggests that obese pregnant women are at higher risk for gestational hypertension and preeclampsia than non-obese controls [4, 43]. Studies comparing pre- and post-bariatric surgery pregnancies consistently show a reduction in risk and rates of hypertensive disorders after obesity surgery [7, 8]. Recently, Weintraub et al. [8] found bariatric surgery to be independently associated with a reduction in hypertensive disorders during pregnancy (OR = 0.38; 95% CI 0.25–0.59; $P < 0.001$).

The beneficial effects of bariatric surgery on hypertensive disorders of pregnancy may lower risk to community levels [7, 15]. The multivariate logistic regression analysis of Sheiner et al. [15] reveals no difference in risk of hypertensive disorders among post-op pregnant women versus those who did not have obesity surgery. Similarly, Dixon et al. [7] report post-op rates of pregnancy-induced hypertension comparable to their community level. In a study on GDM and batriatric surgery, no significant difference in the rates of hypertensive disorders among post-op diabetic and control diabetic pregnant women was noted [34].

In conclusion, by treating obesity which is associated with preeclampsia and gestational hypertension [4, 43], bariatric surgery appears to lower risk of hypertensive disorders in subsequent pregnancies [7, 8]. Regarding these disorders, bariatric surgery seems to be a safe and successful intervention.

Mode of delivery

Studies providing only descriptive statistics show post-op c-section rates that are within normal limits according to their respective community levels, ~20% [17, 26]. One report describes a post-op cesarean delivery rate lower than that associated with obesity [9]. A systematic study by Sheiner et al. [15] on pregnancy after bariatric surgery, however, reveals a statistically significant elevated risk for cesarean delivery in post-op women compared to controls who did not undergo obesity surgery. This higher risk is persistent after logistic regression and Mantel–Haenszel analysis controlling for confounders such as obesity and previous cesarean delivery (Crude OR = 2.4; 95% CI 1.9–3.1; $P < 0.01$). Nevertheless, it is noteworthy that patients following bariatric surgery were significantly older and more likely to be obese as compared to the general population. Both factors tend to increase the risk for cesarean delivery. The authors suggest that caregiver bias may contribute to this elevated risk. Indeed, there is no known physiological reason necessitating a higher c-section rate in post-op women [15].

Few data exist regarding post-op c-section rates in comparison to obese controls. Without this information, conclusions cannot be made about how bariatric surgery influences mode of delivery in previously obese women. Obstetricians delivering post-op patients need to be aware of caregiver bias and avoid operation without clear and definitive indication.

Fetal complications

Neural tubes defects

The malnourished state experienced after successful bariatric surgery, especially malabsorptive procedures, could cause folic acid deficiency and increased homocysteine levels in post-op women [7, 18], potentially raising their risk in subsequent pregnancies for fetuses with neural tube defects (NTDs). Although vitamin deficiency may be more prevalent after malabsorptive procedures, micronutrient disturbances can be seen after restrictive procedures as well [7]. In a study on birth outcomes after AGB, several cases of women with elevated homocysteine levels during post-op pregnancy follow-up were reported [7], potentially putting their fetuses at an elevated risk for NTDs; however, no comparison rates from pregnant controls who did not undergo AGB were provided. Nevertheless, folate and homocysteine levels after all bariatric procedures should be carefully monitored, especially in fertile women.

Case reports documenting NTDs in post-op pregnancies exist [11], but systematic studies fail to prove any such associations [15, 34]. Research conducted on 298 post-op deliveries and 158,912 deliveries to women who did not undergo weight loss surgery reports no significant difference in congenital malformation rate between cases and controls [15].

It appears as though with proper monitoring and folic acid supplementation, post-op women are not at high risk for NTD fetuses. Nevertheless, it has been suggested that all pregnant women with a history of weight loss surgery be screened for NTDs through second trimester maternal serum alpha-fetoprotein and ultrasound [18]. In addition, the American College of Obstetrics and Gynecology advises women to delay pregnancy for at least one postoperative year in order to avoid gestation during the rapid weight loss phase (characteristic of the first postoperative year) and minimize risk for nutritional deficiencies and their complications such as NTDs [23]. Little data exist on the dosage of folic acid supplementation appropriate for post-op pregnant women, and current recommendations advise a daily supplement of 400 μg [18]. Further investigation is needed to determine folic acid dosage in post-op fertile women, as there are data suggesting that patients experiencing weight loss need higher levels of folic acid and B12 in order to maintain homocysteine at safe levels [44].

Birth weight

Studies have investigated bariatric surgery and its potential associations with both high and low birth weight (LBW) babies [7, 8, 15]. Theoretically, by treating obesity associated with large babies, weight loss surgery may prevent macrosomia in post-op pregnant women. However, due to the maternal malnourished state, bariatric surgery may potentially increase risk for delivery of LBW babies.

The link between maternal obesity and macrosomia is well established [45, 46]. Indeed, numerous studies comparing post-op pregnancies with pregnancies in the obese have shown a decrease in the rates of macrosomia and large-for-gestational-age babies among post-bariatric surgery deliveries [8, 9, 17], suggesting that weight loss surgery may be a successful intervention for preventing delivery of large infants. A recent study conducted on 301 pre-op and 507 post-op deliveries found decreased risk for fetal macrosomia among post-bariatric surgery pregnancies (OR = 0.45; 95% CI 0.21–0.94; $P = 0.033$) [8].

Studies comparing risk of macrosomia among post-op pregnant women to controls from the general community did not consistently find decreased risk for large babies among post-op women. Research conducted on 298 post-bariatric surgery deliveries and 158,912 deliveries to women who did not have weight loss surgery shows an elevated risk for macrosomia in post-op women, persistent even after controlling for confounders such as obesity with logistic regression and Mantel-Haenszel analysis (Multiple logistic regression OR = 2.1; 95% CI 1.4–3.0; $P < 0.001$) [15]. These results must be interpreted with caution; although elevated risk persists even after controlling for confounders, the bariatric surgery population is significantly more obese, a known risk factor for macrosomia, than the general population. When counseling patients with a history of weight loss surgery regarding risk for fetal macrosomia, it may be more practical to employ data comparing post-op to obese women, as they more accurately reflect changes in individual risk before and after surgery.

Concern over risk for LBW and intrauterine-growth-restricted (IUGR) fetuses in post-op women has also been raised in the literature. A number of series have reported high rates of LBW and small-for-gestational-age babies born to women with a history of bariatric surgery [17, 39], although not many systematic studies have addressed this issue. One such study shows a higher risk for IUGR in post-op deliveries as compared to deliveries of general community controls, although this elevated risk disappears on multivariate analysis [15]. Another study found no association between post-AGB BMI at the start of pregnancy and birth weight, although birth weight was positively associated with post-op maternal weight change during pregnancy once gestation length was controlled for (linear regression analysis $r = 0.22$, $P = 0.03$) [6]. These data suggest that maternal weight gain, more than how much weight was lost before pregnancy, may be an important predictor of birth weight in post-op women, necessitating careful monitoring of weight change in all post-op pregnancies.

Whether bariatric surgery affects birth weight in post-op pregnant women, systematic studies consistently demonstrate no association between weight loss surgery and adverse perinatal outcomes, including meconium-stained amniotic fluid, perinatal mortality rates, congenital malformations, and low Apgar scores at 1 and 5 min [7, 15, 34].

Conclusions

Systematic studies have repeatedly failed to demonstrate elevated risk for adverse perinatal outcome in post-op pregnancies (Table 1) [7, 15, 34]. Although prevalence of certain complications (such as GDM and macrosomia) is higher in post-op pregnancies than community controls [15], rates are lower in comparison to obese cohorts [7, 8], suggesting bariatric surgery to be effective in preventing these obesity-related complications (Table 2).

Post-op pregnancy appears to be safe but not all relevant concerns have been definitively addressed. Additional research is needed to clarify the effects bariatric surgery may have on fertility, birth control, and risk for cesarean delivery. Studies investigating differences in pregnancy outcomes between restrictive versus malabsorptive procedures have not been done and could help clinicians better characterize their bariatric patients' individual risks for gestational complications.

Data regarding post-weight loss procedure pregnancies were often gathered from women who were carefully monitored throughout gestation with the provision of band adjustments when necessary along with proper nutritional supplementation [7, 26, 28]. It is of utmost importance for providers to be aware of this fact and avoid unnecessary risk

Table 1 Pregnancy outcomes of women with and without previous bariatric surgery

Author	Sample size	Outcome	Bariatic surgery group (%)	No bariatic surgery	Odds ratio (95% CI)	*P* value
Sheiner et al. [15]	159,210	Macrosomia	9.4	4.6	2.1 (1.4–3.0)[a]	<0.001*
		Diabetes mellitus	10.0	6.2	1.3 (0.9–1.8)[a]	0.234*
		Hypertensive disorder	11.1	6.4	1.4 (0.9–1.9)[a]	0.176*
		IUGR	5.0	2.0	1.4 (0.9–2.1)[a]	0.063*
Sheiner et al. [34][c]	8,014	Congenital malformation	7.1	4.0	1.9 (0.9–1.3)[b]	0.294**
		Apgar <7 at 1 min	11.1	5.2	2.3 (0.7–7.6)[b]	0.165**
		Apgar <7 at 5 min	–	0.7	–	0.821**
		Hypertensive disorders	17.9	12.3	1.5 (0.6–4.0)[b]	0.258**
		Perinatal mortality	–	11/1,000	–	0.181**

* *P* value for odds ratio from the multivariable logistic regression model

** *P* value for univariate analysis

[a] Results from multivariable logistic regression model

[b] Results from univariate analysis

[c] Only women with gestational diabetes mellitus were included in this study

Table 2 Comparison of pregnancy outcomes before and after bariatric surgery

Author	Sample size	Outcome	Before bariatric surgery (%)	After bariatric surgery (%)	Odds ratio (95% CI)[a]	P value
Dixon et al. [7]	119	Gestational diabetes mellitus	15.0	6.3	–	>0.05*
		Pregnancy-induced hypertension	45.0	10.0	–	<0.05*
		Preeclampsia	28.0	5.0	–	<0.05*
Weintraub et al. [8]	808	Diabetes mellitus	17.3	11	0.6 (0.4–0.9)	0.009**
		Hypertensive disorders	23.6	11.2	0.4 (0.3–0.6)	<0.001**
		Severe preeclampsia	4.0	1.0	0.2 (0.1–0.7)	0.005**
		Macrosomia	7.6	3.2	0.4 (0.2–0.8)	0.004**
Marceau et al. [17]	1,828	Miscarriage[b]	21.6	26	–	–
		Small-for-age baby	3.1	9.6	–	–
		Normal weight baby	62.1	82.7	–	–
		Macrosomia	34.8	7.7	–	–

* *P* value for χ^2 analysis comparing proportions of outcome in women before and after bariatric surgery

** *P* value for odds ratio from multivariable logistic regression model

[a] Results from multivariable logistic regression model

[b] Calculated as miscarriages divided by pregnancies not terminated voluntarily

elevation through observation of weight gain and screening for deficiencies in folate, hemoglobin, and albumin throughout post-op gestation. Testing for elevated homocysteine levels may be helpful as well. In pregnant women with a history of AGB, band adjustment may be considered to promote healthy gestational weight gain. If recommendations are followed and good prenatal care is provided, post-op pregnant women are at lower risk for maternal and fetal complications than they were before their procedures.

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