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ORIGINAL PAPER

Maternal and fetal outcomes after bariatric surgeries

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Abstract

Introduction: Obesity is the most common medical problem affecting reproductive-age women. To detect the prevalence of obesity, and bariatric surgeries (BSs) in reproductive-age women, and the impact of obesity vs. BSs on the subsequent pregnancy outcomes.

Material and methods: Obese-pregnant women, and women underwent BSs before the current pregnancy, with complete antenatal, and delivery records were included in the current study. Collected data were analyzed using MedCalc 20.106 to calculate the odd ratio (OR), and relative risk (RR) of adverse maternal, and fetal outcomes in relation to maternal obesity vs. BSs.

Results: Data of 14,474 pregnant women were collected during this study; 33.94% (4912/14474) of them were obese, and 3.8% (546/14474) of them had previous BSs before the current pregnancy. The obese group has significantly higher odds, and RR of gestational diabetes mellitus (GDM) [OR 1.9 (p = 0.0001), and RR 1.79 (p = 0.0001)], gestational hypertension [OR 1.7 (p = 0.0002), and RR 1.6 (p = 0.0003)], and preeclampsia (PE) [OR 1.7 (p = 0.0001), and RR 1.6 (p = 0.0001)] compared to BSs group. The obese group has also significantly higher odds, and RR of cesarean sections (CSs) [OR 1.3 (p = 0.008), and RR 1.25 (p = 0.01)], and large for gestational age [OR 1.39 (p = 0.01), and RR 1.3 (p = 0.02)] compared to BSs group.

Conclusions: About 33.94% of the reproductive-age women in Kuwait are obese, and 3.8% of them had previous BSs. Obese-pregnant women are at increased risks of GDM, gestational hypertension, PE, and CSs. Bariatric surgeries reduced the rates of GDM, gestational hypertension, PE, and CSs significantly.

Key words: maternal, outcomes, fetal, bariatric surgeries.

Introduction

Obesity is a global medical problem, affecting > 650 million adults all-over the world [1]. Obesity is the most common medical problem affecting reproductive-age women [1]. Maternal obesity, defined as pre-pregnancy body mass index (BMI) ≥ 30 kg/m^2 [1].

The Global Health Observatory found the age-standardized prevalence rate of obesity in Kuwait had increased from 18.6% in 1975 to 37.9% in 2016 [2]. A cross-sectional study reported an obesity rate of 36.5, and 44.0% for Kuwaiti men, and women, respectively [3].

Maternal obesity increases the risk of adverse maternal outcome (i.e., gestational diabetes, hypertension, and preeclampsia) [4]. In addition, maternal obesity increases the risk of adverse perinatal outcome (i.e., pre-term, post-term deliveries, large for gestational age (LGA), and perinatal mortality) [5].

Bariatric surgeries (BSs) are the most effective long-term intervention used for reduction of maternal obesity, and for improvement of the pregnancy outcomes (> 50% of BSs performed for reproductive-age women) [6, 7].

The development of gestational diabetes and/or hypertensive disorders with pregnancy are less likely after BSs [8].

The gastric bypass procedures are associated with micronutrients (iron, folic and vitamin D) deficiency [9, 10], compared to laparoscopic sleeve gastrectomy (LSG) or gastric banding [11], which may adversely affect the fetal development [9, 10].

The available guidelines recommend avoiding pregnancy for 1–2 years after BSs [12, 13]. Previous studies have focused on the maternal outcome after BSs, and there is limited available data of perinatal outcome after BSs [5].

Maternal obesity increases the maternal, and fetal obesity-related complications. Bariatric surgeries before pregnancy improves the maternal obesity-related complications but may reduce the absorption of micronutrients

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needed for fetal development. Therefore, this cross-sectional study designed to detect the prevalence of obesity and BSs in reproductive-age women, and the impact of obesity vs. BSs on the subsequent pregnancy outcomes.

Material and methods

This cross-sectional study was conducted over the year 2019, after approval of the Medical Research Standing Committee (No. 2234/2023), and informed consents following the Helsinki Declaration.

Obese-pregnant women [pre-pregnancy BMI ≥ 30 kg/m^2], and women underwent BSs before the current pregnancy, > 20 < 40 years-old, with complete antenatal, and delivery records were included in this study.

Women with incomplete records (i.e., delivery and/or antenatal), spontaneous abortion, twins or triplets, pre-existing medical diseases, gastroesophageal reflux, hiatal hernia, and inflammatory bowel disorders were excluded from this study.

Collected maternal data include maternal age, parity, pre-pregnancy BMI, BSs type, BS-to-conception interval, medical disorders with pregnancy [i.e., gestational diabetes mellitus (GDM), and preeclampsia (PE)], mode of delivery [cesarean sections (CSs) or vaginal].

Collected fetal data include gestational age at delivery [i.e., full term (> 37–40 weeks) or preterm delivery (PTD < 37 weeks)], fetal birth weight [normal, small for gestational age (SGA), or LGA], and adverse fetal outcome [intrauterine growth retardation (IUGR), low Apgar score (< 7) at 5 min., and neonatal intensive care unit (NICU) admission].

The participants` weight, and height were used to calculate their BMI (kg/m^2). The World Health Organization considered ≤ 24.9 kg/m^2 (normal weight), 25.0–29.9 kg/m^2 (overweight), 30–34.9 (obesity class I), 35.0–39.9 (obesity class II), and ≥ 40 kg/m^2 (obesity class III) [14].

The bariatric surgeries classified into; malabsorptive surgeries (i.e., Roux-en-Y gastric bypass) which associated with micronutrients (i.e., iron, folic and vitamin D) deficiency [9, 10], and restrictive surgeries [i.e., LSG and laparoscopic gastric banding (LGB)] which reduce the stomach capacity] [11].

Gestational diabetes mellitus is glucose intolerance occurs during pregnancy and diagnosed by the OGTT at 24–28 weeks` [15].

PE is hypertension (blood pressure ≥ 140/90 mm Hg measured twice over ≥ 4-hrs.), and proteinuria after 20 weeks` without history of hypertension [16–18]. The proteinuria is ≥ 300 mg proteins/24-hrs. urine and/or protein/creatinine ratio ≥ 0.3 [16, 19].

The normal fetal birth weight at term pregnancy (> 37–40 weeks) is > 2.5–4 kg [20]. Fetal birth weight < 10th percentile at term pregnancy was considered SGA, and fetal birth weight > 90th percentile was considered LGA irrespective the gestational age at delivery [21].

Weight-for-age percentiles were calculated using the Dutch Perined-birth weight charts, stratified for sex and gestational age at delivery in days [22].

Intrauterine growth retardation is an intrauterine fetal growth less than the normal potential growth as per the fetal race and gender [23].

Collected data analyzed to detect the prevalence of obesity and BSs in reproductive-age women (primary outcome), and the impact of obesity vs. BSs on the subsequent pregnancy outcomes (secondary outcome).

Statistical analysis

The sample size was calculated using data from a previous study [24], and G Power software. The collected data were analyzed using the *t*-test (for quantitative data), and the χ^2 test (for qualitative data). The MedCalc 20.106 (MedCalc Ltd, Belgium) was used to calculate the odd ratio (OR), and relative risk (RR) of adverse maternal and fetal outcomes in relation to maternal obesity vs. BSs. $P < 0.05$ considered significant.

Declaration of consent

The current study was conducted after approval of the Medical Research Standing Committee (No. 2234/2023), and after informed consent.

Results

During this cross-sectional study, data of 14,474 pregnant women collected; 33.94% (4912/14474) of them were obese (pre-pregnant BMI ≥ 30 kg/m^2), and 3.8% (546/14474) of them had previous BSs before the current pregnancy.

Characteristics of obese-pregnant women (obese group) vs. pregnant women underwent BSs before the current pregnancy (BSs group) were presented in Table 1.

The obese group, and the BSs group were matched with no significant difference regarding the maternal age (28.2 ±2.4 vs. 31.3 ±2.6 years, respectively), ($p = 0.9$), and parity (3.2 ±1.7 vs. 2.6 ±1.8, respectively), ($p = 0.9$). The pre-pregnancy BMI was significantly higher in the obese group compared to BSs group to (32.5 ±3.5 vs. 26.8 ±3.1 kg/m^2, respectively), ($p = 0.0001$), and the number of women with pre-pregnancy infertility was significantly higher in the obese group compared to BSs group [28.9% (1418/4912) vs. 20.5% (112/546), respectively] ($p = 0.001$) (Table 1).

Most women in the BSs group underwent LSG (81.3%), while 10.1% of them underwent Gastric bypass, and 8.6% underwent LGB.

Although, the guidelines recommend avoiding pregnancy for 12–24 months after BSs, 45.2% of the studied women in the BSs group had 12–24 months BS-to-

Table 1. Characteristics, maternal and fetal outcomes of obese-pregnant group versus BS-pregnant group

Parameters	Obese group, *N* = 4912 (%)	BS group, *N* = 546 (%)	*p*-value (95% CI)
Maternal age (years)	28.2 ±2.4	31.3 ±2.6	0.9 (–3.3, –3.1, –2.9)
Parity	3.2 ±1.7	2.6 ±1.8	0.9 (0.4, 0.6, 0.77)
Pre-pregnancy BMI [kg/m^2]	32.5 ±3.5	26.8 ±3.1	**0.0001* (5.4, 5.7, 5.9)**
Pre-pregnancy infertility	1418 (28.9)	112 (20.5)	**0.001***
Type of BSs			
Gastric bypass		55 (10.1)	
LSG		444 (81.3)	
LGB	–	47 (8.6)	
BS- to-conception interval			
< 12 months		163 (29.9)	
12–24 months		247 (45.2)	
> 24 months	–	136 (24.9)	
Gestational diabetes	692 (14.1)	43 (7.9)	**0.0003***
Gestational hypertension	831 (16.9)	58 (10.6)	**0.001***
Preeclampsia	912 (18.6)	63 (11.5)	**0.0005***
Mode of delivery			
Vaginal deliveries	3621 (73.7)	431 (78.9)	0.3
Cesarean sections	1291 (26.3)	115 (21.1)	**0.03***
Large for gestational age	732 (14.9)	61 (11.2)	**0.03***
Gestational age at delivery			
Term deliveries	4380 (89.2)	490 (89.7)	1.0
Preterm deliveries	532 (10.8)	56 (10.3)	0.7
Small for gestational	573 (11.7)	51 (9.3)	0.1
IUGR	504 (10.3)	45 (8.2)	0.1
Low Apgar score at 5 min. (< 7)	25 (0.5)	6 (1.1)	0.1
NICU admission	136 (2.8)	14 (2.6)	0.7

BMI – body mass index, BSs – bariatric surgery, CI – confidence interval, IUGR – intrauterine growth retardation, LGB – laparoscopic gastric banding, LSG – laparoscopic sleeve gastrectomy, NICU – neonatal intensive care unit
χ^2 test used for statistical analysis when data presented as number and percentage (%).
Data presented as mean and standard deviation (SD) and number (*n*) and percentage (%).
Student *t*-test used for statistical analysis when data presented as mean ± SD.

conception interval, 29.9% had < 12 months BS-to-conception interval, and 24.9% had > 24 months BS-to-conception interval (Table 1).

Maternal outcome

The incidence of GDM, gestational hypertension, and PE was significantly higher in the obese group (14.1%, 16.9% and 18.6%, respectively) compared to BSs group (7.9%, 10.6% and 11.5%, respectively), (*p* = 0.0003, 0.001 and 0.0005, respectively). The incidence of CSs was also significantly higher in the obese group (26.3%) compared to BS group (21.1%), (*p* = 0.03) (Table 1).

Fetal outcome

The incidence of LGA was significantly higher in the obese group (14.9%) compared to BSs group (11.2%), (*p* = 0.03).

There was no significant difference between the obese group, and BSs group regarding, the incidence of PTD (10.8% vs. 10.3%, respectively), (*p* = 0.7), SGA (11.7% vs. 9.3%, respectively), (*p* = 0.1), and IUGR (10.3% vs. 8.2%, respectively), (*p* = 0.1). There was also no significant difference between the obese group, and BSs group regarding, the incidence of low Apgar score at 5 min. (0.5% vs. 1.1%, respectively), (*p* = 0.1), and NICU admission (2.8% vs. 2.6%, respectively), (*p* = 0.7) (Table 1).

The odds and risks of adverse outcomes

The obese group has significantly higher odds, and risks of GDM [OR 1.9 (*p* = 0.0001), and RR 1.79 (*p* = 0.0001)], gestational hypertension [OR 1.7 (*p* = 0.0002), and RR 1.6 (*p* = 0.0003)], and PE [OR 1.7 (*p* = 0.0001), and RR 1.6 (*p* = 0.0001)] compared to BSs group. The obese group has also significantly higher

Table 2. The odd ratios, and relative risks of adverse maternal and fetal outcomes in the two-studied groups

Parameters	Obese group, *N* = 4912	BS group, *N* = 546	OR [*p*-value (95% CI)] RR [*p*-value (95% CI)]
Gestational diabetes			
Positive	692	43	1.9 [*p* = 0.0001* (95% CI: 1.4–2.65)]
Negative	4220	503	1.79 [*p* = 0.0001* (95% CI: 1.3–2.4)]
Gestational hypertension			
Positive	831	58	1.7 [*p* = 0.0002* (95% CI: 1.3–2.3)]
Negative	4081	488	1.6 [*p* = 0.0003* (95% CI: 1.2–2.05]
Preeclampsia			
Positive	912	63	1.7 [*p* = 0.0001* (95% CI: 1.3–2.3)]
Negative	4000	483	1.6 [*p* = 0.0001* (95% CI: 1.27–2.04)]
Cesarean sections			
Positive	1291	115	1.3 [*p* = 0.008* (95% CI: 1.08–1.65)]
Negative	3621	431	1.25 [*p* = 0.01* (95% CI: 1.05–1.48)]
Large for gestational age			
Positive	732	61	1.39 [*p* = 0.01* (95% CI: 1.05–1.8)]
Negative	4180	485	1.3 [*p* = 0.02* (95% CI: 1.04–1.7)]
Preterm deliveries			
Positive	532	56	1.06 [*p* = 0.6 (95% CI: 0.8–1.4)]
Negative	4380	490	1.06 [p = 0.7 (95% CI: 0.8–1.4)]
Small for gestational			
Positive	573	51	1.28 [*p* = 0.1 (95% CI: 0.95–1.7)]
Negative	4339	495	1.25 [*p* = 0.1 (95% CI: 0.95–1.6)]
IUGR			
Positive	504	45	1.27 [*p* = 0.1 (95% CI: 0.93–1.8)]
Negative	4408	501	1.25 [*p* = 0.1 (95% CI: 0.93–1.6)]
Low Apgar score at 5 min. (< 7)			
Positive	25	6	0.46 [*p* = 0.08 (95% CI: 0.19–1.13)]
Negative	4887	540	0.46 [*p* = 0.08 (95% CI: 0.19–1.12)]
NICU admission			
Positive	136	14	1.08 [*p* = 0.7 (95% CI: 0.62–1.89)]
Negative	4776	532	1.07 [*p* = 0.7 (95% CI: 0.63–1.9)]

BSs – bariatric surgery, CI – confidence interval, IUGR – intrauterine growth retardation, NICU – neonatal intensive care unit, ORs – odd ratios, RRs – relative risks

odds, and risks of CSs [OR 1.3 (*p* = 0.008), and RR 1.25 (*p* = 0.01)], and LGA [OR 1.39 (*p* = 0.01), and RR 1.3 (*p* = 0.02)] compared to BSs group (Table 2).

The odds, and risks of PTD [OR 1.06 (*p* = 0.6), and RR 1.06 (*p* = 0.7)], SGA [OR 1.28 (*p* = 0.1), and RR 1.25 (*p* = 0.1)], and IUGR [OR 1.27 (*p* = 0.1), and RR 1.25 (*p* = 0.1)] were statistically insignificant between the two-studied groups. The odds, and risks of low Apgar score at 5 min. [OR 0.46 (*p* = 0.08), and RR 0.46 (*p* = 0.08)], and NICU admission [OR 1.08 (*p* = 0.7), and RR 1.07 (*p* = 0.7)] were also statistically insignificant between the two-studied groups (Table 2).

Discussion

Data of 14,474 pregnant women were collected for this cross-sectional study to detect the prevalence of obesity and BSs in reproductive-age women, and the impact of obesity vs. BSs on the subsequent pregnancy outcomes. About 33.94% (4912/14474) of the studied-pregnant women were obese, and 3.8% (546/14474) of them had previous BSs before the current pregnancy.

Kuwait is ranked as one of the top countries in obesity [3]. A cross-sectional population-based survey found the obesity was relatively greater in Kuwaiti-women (47.9%) compared to men (38.5%) [2]. The genetic susceptibility, high-caloric diet, and cultural barriers to physical activity can explain the prevalence of obesity in the Gulf countries [3].

The number of women with pre-pregnancy infertility was significantly higher in the obese group compared to BSs group (28.9% vs. 20.5%, respectively), (*p* = 0.001). Obesity decreases the reproductive ability through insulin resistance, which adversely affects the ovarian follicle growth and maturation, with subsequent oligo-amenorrhea, and hyperandrogenemia [25]. Obesity associated with impaired ART treatment outcome (i.e., decreased oocyte number, and quality) [25], and a meta-analysis reported 58% spontaneous conception rate after BSs [26].

Maternal outcome

The incidence of GDM, gestational hypertension, and PE in this study was significantly higher in the obese group (14.1%, 16.9% and 18.6%, respectively) compared to BSs group (7.9%, 10.6% and 11.5%, respectively), (p = 0.0003, 0.001 and 0.0005, respectively). The obese group has significantly higher odds, and risks of GDM [OR 1.9 (p = 0.0001), and RR 1.79 (p = 0.0001)], gestational hypertension [OR 1.7 (p = 0.0002), and RR 1.6 (p = 0.0003)], and PE [OR 1.7 (p = 0.0001), and RR 1.6 (p = 0.0001)] compared to BSs group.

Similarly, a prospective study found the incidence of pregnancy-induced hypertension, and GDM (38% and 19%, respectively) were significantly higher in obese cohort compared to controls (10% and 6.3%, respectively) [27]. An observational study also found the incidence of GDM, and hypertension was significantly less after LGB [28].

Moreover, a case-control study, reported significantly lower rates of gestational hypertension (9.6% vs. 23.5%, respectively), PE/eclampsia (12.0% vs. 20.8%, respectively), and CSs (45.9% vs. 65.8%, respectively) after LGB compared to obese controls [29].

The incidence of CSs in this study was significantly higher in the obese group (26.3%) compared to BSs group (21.1%), (p = 0.03), and the obese group has significantly higher odds, and risks of CSs [OR 1.3 (p = 0.008), and RR 1.25 (p = 0.01)] compared to BSs group.

An observational, descriptive study found maternal obesity increases the risk of CSs, [30], and a historical study found obese women had a higher risk of CSs compared to controls [31]. A retrospective analysis of 287,213 singleton pregnancies, found the rate of emergency CSs was significantly higher in obese women compared to controls [32]. Rottenstreich *et al.,* reported a lower CSs rate after LGS [33], and a meta-analysis reported decreased CSs rate after BSs [34].

Moreover, Giannini *et al.* [35] studied the surgically treated women with endometrial cancers in a retrospective-observational study to evaluate the effect of obesity, comorbidities, and fragility, on the postoperative (PO) complications after surgery for endometrial cancer. The fragility was evaluated using the modified fragility index (mFI) calculated from the number of the comorbidities in each studied woman [35]. Women with class III obesity (BMI ≥ 40) were more likely to have mFI > 3. At multivariate analysis Giannini *et al.* [35] found laparotomy, and mFI > 3 were independent predictors of overall PO complications. At univariate analysis, Giannini *et al.* [35] found BMI ≥ 40, smoking, and mFI > 3 were significant predictors of severe PO complications.

Recently, A recent narrative review (including 85957 women) was conducted by Ottavia *et al.* [36] to highlight the importance of the peri-operative frailty assessment in women with gynecological cancer, and to discuss the commonly used scores to predict the adverse PO outcomes, and overall survival.

Ottavia *et al.* [36], found the mFI was the commonly used tool for perioperative definition of frail women. They also found frail women had lower disease-free survival rates, lower overall survival rates, and had higher risk of developing 30-day PO complications, non-home discharge, and ICU admission than non-frail women [36].

Fetal outcome

The incidence of LGA in this study was significantly higher in the obese group (14.9%) compared to BSs group (11.2%), (p = 0.03), and the obese group has significantly higher odds, and risks of LGA [OR 1.39 (p = 0.01), and RR 1.3 (p = 0.02)] compared to BSs group.

Similarly, a prospective cross-sectional study found a significant portion of obese mothers had LGA babies [37], another study found the obese women had a higher risk of LGA compared to controls [31]. A retrospective analysis of 287,213 singleton pregnancies, found the LGA rate, was significantly higher in obese pregnant women compared to controls [32]. Moreover, a meta-analysis found a significant reduction in the incidence of LGA, and macrosomia after BSs [34], and a systematic review reported decreased odds of LGA after gastric bypass [5].

Although an observational, descriptive study found maternal obesity increases the risk of PTD [30]. A historical study found the maternal obesity was not associated with PTD [31], and a meta-analysis found the incidence of PTD was similar after BSs compared to controls [34]. This study also found no significant difference between the two-studied groups regarding the incidence of PTD (10.8% for the obese group vs. 10.3% for the BSs group), (p = 0.7).

Although Rottenstreich *et al,* found the LSG was associated with increased risk of SGA [33], and a population-based study reported increased risk of IUGR after BSs [38].

A retrospective controlled study found the incidence of LBW was less after LBG compared to malabsorptive bypass procedure [39]. In addition, Goldman *et al.,* found the fetal birth weight was significantly lower after malabsorptive gastric bypass procedure but not after LGB [40].

This study also found no significant difference between the two-studied groups regarding the incidence of SGA (11.7% for the obese group vs. 9.3% for the BSs group), (p = 0.1), and IUGR (10.3% for the obese group vs. 8.2% for the BS-surgery group), (p = 0.1).

A Danish study reported increased risk of SGA after malabsorptive BSs [41], and a single-center study reported increased risk of IUGR after malabsorptive BSs [42].

Gascoin *et al.,* found an inverse relation between the fetal birth weight, and maternal weight loss after BSs (the greater maternal weight loss after BSs, the lower the fetal birth weight) [9]. The finding explains the birth weight difference between women delivered after LGB or LGS compared to women delivered after malabsorptive bypass [9].

Although a meta-analysis reported increased odds of NICU admission after BSs [5]. This study found no significant difference between the two-studied groups regarding the low Apgar score at 5 min. (0.5% for the obese group vs. 1.1% for the BSs group), (p = 0.1), and NICU admission (2.8% for the obese group vs. 2.6% for the BSs group), (p = 0.7). A retrospective cohort study also found the 5-min Apgar scores, and NICU admissions, were similar with no significant difference in the gastric bypass group compared to controls [43]. In addition, a matched-control study found the neonatal complications were similar with no significant difference after gastric bypass compared to controls [44]. The inconsistent results regarding the low Apgar score at 5 min., and NICU admission may be explained by the BS-to-birth interval. BS-to-birth intervals < 2 years was associated with higher risks of neonatal complications, and NICU admission compared with longer intervals [45]. The inconsistent results regarding the low Apgar score at 5 min. and NICU admission after BSs need further studies.

This study found 33.94% of the reproductive-age women in Kuwait are obese, and 3.8% of them had previous BSs (LSG is the commonest BSs procedure done in Kuwait). Although, the guidelines recommend avoiding pregnancy for 12–24 months after BSs, 45.2% of studied women in the BSs group had 12–24 months BS-to-conception interval, and 29.9% had < 12 months BS-to-conception interval.

Obese-pregnant women are at increased risks of GDM, gestational hypertension, PE, and CSs. The BSs reduced the rates of GDM, gestational hypertension, PE and CSs significantly. Obesity, and BSs did not increase the rate of neonatal complications including, prematurity, SGA, IUGR, low Apgar score at 5 min., and NICU admission.

This study was the first, cross-sectional study conducted in Kuwait, including 14,474 pregnant-women to detect the prevalence of obesity and BSs in reproductive-age women, and the impact of obesity vs. BSs on the subsequent pregnancy outcomes.

Women refused to participate, failure to identify causes of NICU admission, and neonatal outcome after NICU admission were the limitations of this study.

Conclusions

About 33.94% of the reproductive-age women in Kuwait are obese, and 3.8% of them had previous BSs (LSG is the commonest BSs procedure done in Kuwait). Obese-pregnant women are at increased risks of GDM, gestational hypertension, PE and CSs. Bariatric surgeries reduced the rates of GDM, gestational hypertension, PE and CSs significantly.

Disclosure

The authors report no conflict of interest.

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