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Original Article

Impact of gestational weight gain on perinatal outcomes after a bariatric surgery

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ABSTRACT

Background: Recommendations by the Institute of Medicine (IOM) on gestational weight gain (GWG) for women with histories of bariatric surgery have yet to be studied.
Objectives: To describe GWG in women with histories of bariatric surgery and to investigate the relationship between GWG and maternal and neonatal outcomes.
Study design: A bicentric retrospective study on the medical charts of pregnant women with histories of bariatric surgery who delivered between 2003 and 2017 in two level III maternity units. In accordance with IOM guidelines, GWG was classified as insufficient, adapted, or excessive.
Results: At least 337 pregnancies from 264 patients were included in this study. Of these pregnancies, 154 (45.7%) occurred after gastric banding, 135 (40.1%) after Roux-en-Y gastric bypass, and 48 (14.2%) after sleeve gastrectomy. GWG was adapted in 90 of the pregnancies (26.7%), insufficient in 11 of the pregnancies (35%), and excessive in 129 of pregnancies (38.3%). Gestational age at birth was significantly lower when GWG was insufficient (37.7 ± 4.2 weeks vs. 38.8 ± 2.9 weeks for adequate GWG and 39.4 ± 1.8 weeks for excessive GWG). When compared to normal GWG, insufficient GWG was indicated to be a risk factor for preterm labor (adjusted OR, 3.05, 95% CI 1.30–7.17). When compared to excessive GWG, insufficient GWG increased the rates of small for gestational age (SGA) newborns (OR, 1.96, 95% CI 1.04–3.68), preterm labor (OR, 4.13, 95% CI 1.84–9.24), and preterm delivery (OR, 6.40, 95% CI 2.41–17.0).
Conclusion: In our study, adequate GWG was associated with better obstetrical outcomes, resulting in the conclusion that IOM recommendations applied to pregnant women who had undergone bariatric surgery. Our findings suggest that the large proportion of women with insufficient GWG may account for increased rates of SGA and preterm birth.

Introduction

In its facilitation of significant and lasting weight loss, bariatric surgery has seen several years of development due to its effective treatment of class III obesity or in class III if there are comorbidities [1]. According to French data, 78% of the patients who have used this procedure are women (and more than 40% are on childbearing age) [2]. The management of pregnant patients with histories of bariatric surgery has become a major concern in perinatology.

The effect of these surgeries on pregnancy has been widely studied, confirming that they have reduced the maternal and neonatal morbidity of these patients when compared to patients with obesity [3]. In particular, there is a greater reduction in the incidence of gestational diabetes and gestational hypertension in patients who have undergone bariatric surgery than in obese individuals who have gone without this kind of surgery. However, in the pregnant population, there have also been higher incidences of preterm births and small for gestational age (SGA) newborns [4,5], the cause of which is not yet clear.

Abbreviations: IOM, Institute of Medicine; GWG, gestational weight gain; SGA, small for gestational age; BMI, body mass index; LGA, large for gestational age.

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In 2009, the Institute of Medicine (IOM) established new recommendations for GWG based on pre-conception body mass indexes (BMI) [6]. The aim of these recommendations was to improve maternal and child health and to reduce the risk of obstetric complications. These recommendations have proven particularly significant due to the increased prevalence of obesity [7–9] amongst women of childbearing age [10,11].

While GWG has been studied in both obese patients and in the general population [11–13], very little data are available on women who have undergone bariatric surgery. Significantly, these procedures are capable of changing metabolic homeostasis.

Although the largest study to evaluate the impact of bariatric surgery on pregnancy was conducted in 2015, it did not indicate any values for GWG [4]. In addition, while other authors have determined lower GWGs in patients with histories of bariatric surgery, GWG have also varied considerably from one study to another (from 3.7 kg to 15 kg) [14–19]. These studies involved small retrospective cohorts of patients, most of whom had gastric rings, and their primary objectives were to evaluate the impact of bariatric surgery on maternal and neonatal morbidity. Regardless, the role of GWG went unstudied. In a 124 patient-cohort study, Berglind et al [20]. confirmed lower GWG in pregnancies that followed bariatric surgery and reported that fetal birth weight increased with GWG. More recently, Stentebjerg et al [21] evaluated the impact of IOM recommendations on the maternal and neonatal outcomes of 71 patients who had undergone gastric bypass surgery. They found a near significant difference in the impact of the GWG on fetal birth weight ($p = 0.07$). As this is one of the larger series on this topic, the authors recognized that studies with larger cohorts could prove useful.

In Johansson's study [4], pregnancy and birth outcomes were adjusted for GWG in the subgroup of patients for which data were available (33%). This adjustment did not modify the results that were obtained by comparing the patients who had undergone bariatric surgery with the patients from the control group (non-operated women) who were matched by age, grade, parity, smoking, year of delivery, and BMI before surgery. These data did not conclude on the impact of bariatric surgery on GWG or on the relevance of the IOM recommendations for the studied population.

The current study's objective was to first describe the GWG in a population of patients with a history of bariatric surgery and to then compare maternal and neonatal complications according to GWG. This enabled evaluations on whether IOM [6] recommendations have been adapted to this population.

Material and methods

This study's protocol was approved by the Ethics Committee for Research in Obstetrics and Gynecology at the French National College of Obstetricians and Gynecologists (Collège National des Gynécologues et Obstétriciens Français). We conducted a multi-center retrospective study in two level III maternities. All patients gived informed consent at the beginning of follow-up. They had to sign a specific document. We analyzed the charts of women who had delivered between March 1 in 2003 and March 30 in 2017 (Fig. 1). Patients who became pregnant after bariatric surgery (gastric banding, Roux-en-Y gastric bypass, or sleeve gastrectomy) were included in the study, and their different pregnancies were studied. Multiple pregnancies, those that led to a medical termination of pregnancy, and patients with severe cardiac disease or other severe progressive illnesses that conditioned the prognosis of pregnancy were excluded from the study. Pregnancies where the weight data during pregnancy (the last known weight during pregnancy more than five weeks before delivery) proved insufficient and patients whose gastric bands had been removed before pregnancy were also excluded from the study. Concerning the other patients with gastric bands, there was no systematic adjustment during the pregnancy. For each patient, multivitamin supplementation was recommended to patients during the pregnancy.

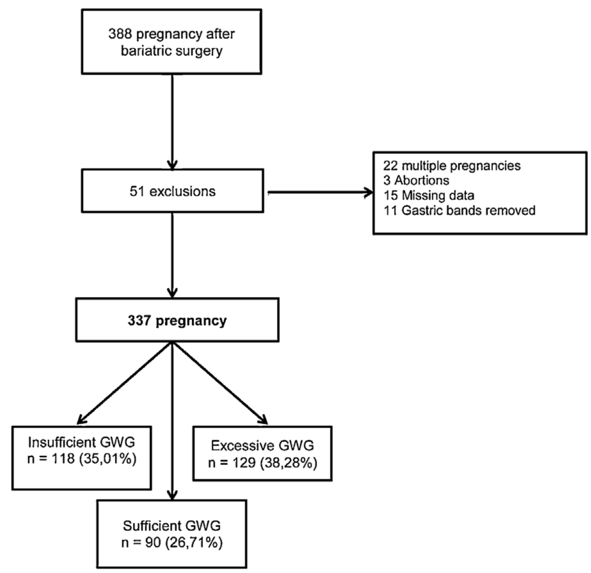

Fig. 1. Flow chart of the study.

For every studied pregnancy, we collected maternal characteristics, such as age, height, parity, smoking, cicatricial uterus, pre-pregnancy weight, final pregnancy weight, arterial hypertension, thromboembolic disease, type of bariatric surgery, operation-to-birth interval, weight before bariatric surgery, and history of pre-pregnancy diabetes or gestational diabetes.

In addition, we calculated the BMIs of patients using the pre-conception weights and heights that they had reported. Before pregnancy, the IOM recommends that weight be gained according to BMI. Therefore, we assessed GWG by accounting for pregestational BMI (e.g., normal, overweight, or obese BMI). GWG, which allowed us to assess whether weight gain was insufficient, adequate, or excessive in accordance with IOM recommendations, is the difference between pre-pregnancy weight and the final weight before delivery.

The course of pregnancy and the occurrence of certain complications, such as preterm labor, preeclampsia, gestational diabetes, arterial hypertension, thromboembolic disorder, intra-uterine fetal death, and intrauterine growth retardation, were noted. We also collected data on the course of delivery and the postpartum period, which included type of analgesia, breastfeeding mode, modality of delivery, induced or spontaneous labor, and neonatal parameters at birth, such as sex, weight, umbilical cord arterial pH, and Apgar scores at one and five minutes of life.

To identify large for gestational age (LGA = birth weight >90th percentile for gestational age) and small for gestational age (SGA = birth weight <10th percentile for gestational age) birth weights, fetal weight assessments were based on adjusted fetal weight curves (M2 curve) [22]. Complications related to bariatric surgery were defined as the occurrence of any event requiring hospitalization for severe symptoms related to internal hernia, dumping syndrome, occlusive syndrome, and complication of the gastric ring.

Statistical methods

The qualitative parameters were described in terms of frequency and percentage. Gaussian numerical parameters were described in terms of mean and standard deviation and non-Gaussian numerical parameters in terms of median and inter-quartile range. The normality of the numerical parameters was checked graphically and tested using the Shapiro-Wilk test. Comparisons of the three groups of patients (insufficient, adequate and excessive GWG) on maternal, pregnancy, and newborn characteristics were performed using a Chi-square test for qualitative parameters (or Fisher's exact test if the frequency of cells was <5), a linear regression for Gaussian quantitative parameters (or a Welch test when the hypothesis of equality of variances was not respected), or a Kruskal-Wallis test for non-Gaussian quantitative parameters. Bivariate analyses were performed to test the effect of GWG on newborn weight, preterm labor, or term of pregnancy (<37 weeks of amenorrhea) through logistic regressions.

The results were expressed in odds ratios and their confidence intervals. These analyses were then adjusted to predefined confounding factors (e.g., parity, term of labor, smoking status, pre-pregnancy BMI, operation-to-birth interval, age at the beginning of pregnancy, and history of arterial hypertension) to calculate the newborn weight percentile at birth. The level of significance was set at 5%. SAS statistical software (version 9.4) was used to analyze the data (SAS Institute, Cary, NC).

Results

A total of 337 pregnancies by 264 patients were included in the study, with 154 (45.7%) after gastric banding, 135 (40.1%) after gastric bypass, and 48 (14.2%) after sleeve gastrectomy. The average weight gain according to the type of surgery was 10.8 kg for gastric banding, 8.2 kg for bypass, and 8.8 kg for sleeve gastrectomy (p = 0.033).

GWG was adapted according to the recommendations in only 26.7% of the pregnancies (n = 90) and was insufficient in 35% (n = 118) and excessive in 38.3% (n = 129) of the cases (Fig. 1).

There were no significant differences between the three groups for history of arterial hypertension (p = 0.2) or pre-pregnancy diabetes (p = 0.87). By comparison, weight (p = 0.002) and BMI (p = 0.008) before pregnancy were significantly different between every group (Table 1). Women with insufficient GWG had higher pre-pregnancy weights and BMIs when compared to women with normal or excessive GWG. On the other hand, women with excessive GWG had higher end-pregnancy weights than women with normal or inadequate GWG (overall p-value < 0.0001) (Table 1).

Maternal complications are reported in Table 2. GWG did not affect the incidence of preeclampsia (p = 0.32), gestational diabetes (p = 0.36), or gestational hypertension (p = 0.53).

Gestational age at birth was significantly different between the three groups (p < 0.0001). It appeared earlier when the GWG was insufficient, with 37.7 weeks of amenorrhea (±4.2) versus 38.8 (±2.9) in cases of adequate weight gain and 39.4 (±1.8) in cases of excessive weight gain (Table 3).

In Table 4, an insufficient GWG is illustrated as more of a risk factor for preterm labor than normal GWG (adjusted OR, 3.05, 95% CI 1.30–7.17). In addition, when compared to the excessive GWG group, insufficient GWG increased the rates of SGA (OR, 1.96, 95% CI, 1.04–3.68), preterm labor (OR, 4.13, 95% CI 1.84–9.24), and preterm delivery before 37 weeks of amenorrhea (OR, 6.40; 2.41–17.0).

Finally, when compared with normal weight gain during pregnancy, excessive weight gain was not associated with increased risks of SGA, preterm labor, or delivery before 37 weeks of amenorrhea.

Neonatal morbidity was not different between the three groups (pH levels < 7.10 (p = 0.34), and Apgar scores at five minutes or less than seven minutes produced similar results (p = 0.13).

Discussion

This study's primary objective was to describe a cohort of pregnant patients who had previously undergone bariatric surgery. The study primarily assessed the patients' GWGs and compared those with IOM recommendations [6]. In addition, after classifying GWG according to IOM recommendations as insufficient, adequate, or excessive, this study aimed to evaluate its importance on maternal and neonatal outcomes.

Literature that has evaluated the course of pregnancy after bariatric surgery have primarily consisted of retrospective studies with small patient populations. Moreover, they have mostly studied patients who have undergone gastric banding or gastric bypass surgery. The current study assessed 337 pregnancies in patients who had one of the three most common bariatric interventions in Western medicine. To our knowledge, this is the largest study to have evaluated GWG in this population.

While GWG appears to be less important in patients with histories of bariatric surgery (10 kg to 13.15 kg) than in the general population, this varies from one study to another [18]. GWG can be higher in patients who have lower pre-conception BMIs [23]. In a recent prospective series, Chagas et al. [24] found a mean GWG of 7.68 kg in pregnant patients who had undergone gastric bypass (34.5% of the patients had adapted GWG, 13.8% of the patients had excessive GWG, and 51.7% of the patients had insufficient GWG). In 2016, Stentebjerg et al. [21] determined that 43% of their patients had insufficient GWG (74% of these pregnancies occurred within 18 months after surgery).

Table 1
description of the population.

	Insufficient GWG n = 118	Adapted GWG n = 90	Excessive GWG n = 129	p-Value
Age (years), mean (SD)	30.6 (4.9)	30.8 (5.8)	31.0 (5.5)	0.81
Nulliparous	37 (31.4)	29 (32.2)	41 (31.8)	0.99
Pre-pregnancy weight (kg), mean (SD)	97.0 (26.5)	86.5 (20.1)	90.0 (18.0)	0.002
Pre-pregnancy BMI (kg/m^2), mean (SD)	35.1 (9.0)	31.6 (7.2)	32.7 (6.1)	0.008
Weight at the end(kg), mean (SD)	98.7 (24.6)	94.9 (18.73)	107.2 (18.6)	<0.0001
Mean GWG (kg)	1.7 (4.19)	8.5 (2.52)	17.3 (7.37)	<.0001
Chronic hypertension	11 (9.32)	7 (7.87)	19 (12.6)	0.20
Pregestational diabetes mellitus	7 (5.93)	4 (4.49)	6 (4.72)	0.87
Smokers	25/117 (21.4)	18/89 (20.2)	32/127 (25.2)	0.64
Surgery to conception interval (months), median (IQR)	24.0 (10–50)	30.0 (17.5–52)	36.0 (20–58)	0.24

Values expressed as no/total no. (%) unless otherwise indicated. GWG: gestational weight gain. p-Value obtained using a Chi-square test for qualitative parameters (or Fisher's exact test if the frequency of cells was < 5), a linear regression for Gaussian quantitative parameters (or a Welch test when the hypothesis of equality of variances was not respected), or a Kruskal-Wallis test for non-Gaussian quantitative parameters.

Table 2
Maternal outcomes.

	Insufficient GWG n = 118	Adapted GWG n = 90	Excessive GWG n = 129	p Value
Gestational hypertension	12/118 (10.2)	7/89 (7.9)	16/129 (12.4)	0.53
Gestational diabetes mellitus	35/118 (29.7)	25/89 (28.1)	28/127 (22.1)	0.36
Preeclampsia	6/118 (5.1)	1/89 (1.1)	4/127 (3.2)	0.32
Induction of labor	38/118 (32.2)	31/89 (34.83)	48/126 (38.1)	0.63
Caesarean section	30/118 (25.4)	22/89 (24.7)	36/127 (28.4)	0.80
Instrumental delivery	15/118 (12.7)	12/89(13.5)	11/127 (7.9)	0.34
Epidural analgesia	80/117 (68.4)	67/89 (75.3)	97/126 (77)	0.28
Spinal anesthesia	24/117 (20.5)	15/89 (16.9)	26/126 (20.6)	0.75
General anesthesia	7/117 (6.0)	1/89 (1.1)	3/127(2.4)	0.16
Shoulder dystocia	2/111 (1.8)	2/87 (2.3)	2/120 (1,7)	1
Post-partum hemorrhage	13/115 (11.3)	3/88 (3.4)	9/119 (7.6)	0.073
Breastfeeding	48/94 (51.1)	45/78 (57.7)	63/101 (62.4)	0.28

Values expressed as no/total no (%) GWG: gestational weight gain. p-Value obtained using a Chi-square test for qualitative parameters (or Fisher's exact test if the frequency of cells was < 5).

Table 3
Neonatal outcomes.

	Insufficient GWG n = 118	Adapted GWG n = 90	Excessive GWGn = 129	p Value
Birth weight (grams), mean (SD)	2814 (840)	3012 (635)	3233 (543)	<.0001
Small for gestational age	40/118 (33.9)	23/90 (25.6)	24/129 (18.6)	0.023
Macrosomia	2/118 (1.7)	4/90 (4.4)	6/129 (4.7)	0.40
Gestational age at delivery (weeks), mean (SD)	37.7 (4.2)	38.8 (2.9)	39.4 (1.8)	<.0001
Apgar <7 at 5 minutes	10/118 (8.5)	3/89 (3.4)	4/127 (3.2)	0.11
Arterial pH (ombilical) <7.1	4/100 (4.0)	1/81 (1.2)	6/113 (5.3)	0.34

Values expressed as no/total no. (%) GWG: gestational weight gain. p-Value obtained using a Chi-square test for qualitative parameters (or Fisher's exact test if the frequency of cells was < 5), a linear regression for Gaussian quantitative parameters (or a Welch test when the hypothesis of equality of variances was not respected), or a Kruskal-Wallis test for non-Gaussian quantitative parameters.

Table 4
multivariate analysis of impact of GWG on perinatal outcomes.

GWG	SGA[a]		Preterm labor[b]		<37SA birth[b]	
	Non-adjusted OR	Adjusted OR	Non-adjusted OR	Adjusted OR	Non-adjusted OR	Adjusted OR
Insufficient versus adapted	1.49 (0.81–2.74)	1.32 (0.69–2.53)	2.34 (1.07–5.14)	3.05 (1.3–7.17)	2.04 (0.92–4.53)	2.18 (0.92–5.18)
Insufficient versus excessive	2.24 (1.25–4.03)	1.96 (1.04–3.68)	3.47 (1.6–7.54)	4.13 (1.84–9.24)	5.53 (2.06–13.32)	6.40 (2.41–17.0)
Excessive versus adapted	0.67 (0.35–1.27)	0.67 (0.34–1.32)	0.68 (0.27–1.7)	0.74 (0.28–1.94)	0.39 (0.14–1.12)	0.34 (0.11–1.04)

(GWG: gestational weight gain, SGA: small for gestational age, OR: odds ratio).
p-Value obtained by logistic regression unadjusted and adjusted to predefined confounding factors (e.g., parity, term of labor, smoking status, pre-pregnancy BMI, operation-to-birth interval, age at the beginning of pregnancy, and history of arterial hypertension).
[a] Adjusted on smoking, parity, maternal age, chronic hypertension, bariatric surgery to pregnancy interval, pre-pregnancy BMI, term of pregnancy.
[b] Adjusted on smoking, parity, maternal age, chronic hypertension, bariatric surgery to pregnancy interval, pre-pregnancy BMI.

In the current study, GWG was insufficient for 35% of the pregnancies. This rate was higher than the general population's. In 2009, the IOM described a 25.5% rate of insufficient GWG in obese and normal BMI populations and a 14% rate of insufficient GWG in overweight patients [24]. Additionally, Lindberg et al. [25] identified a rate of 12.2%–25.5% insufficient GWG in patients who were overweight or with grade II obesity.

In the current study's population, patients with insufficient GWG consisted of those with the highest pre-conception BMIs. A more restrictive diet may be able to explain this result.

Our study revealed an earlier birth term in the group of patients with insufficient GWG. Moreover, we observed that the incidence of preterm labor was significantly higher in the insufficient GWG group than in the groups with normal or excessive GWG. Preterm birth (before 37 weeks of amenorrhea) was higher in patients with insufficient GWG than in patients with excessive GWG.

In the general population, an insufficient GWG has been proven to be linked to higher preterm birthrates regardless of pre-conception BMI [12,15]. In addition, Roos et al. determined higher rates of prematurity in patients with a history of bariatric surgery than in adjusted BMI patients who had not undergone surgery [26]. When compared with the current study's results, these data indicate that the IOM's recommendations were adapted to this specific population.

GWG is an important determinant of fetal growth. In the general population, the IOM [6] standards for weight gain during pregnancy are recommended to reduce the risk of growth abnormalities. Specifically, there is a correlation between GWG and fetal birth weight with increased risk of SGA during cases of insufficient GWG. Indeed, Wen et al. determined a higher rate of SGA in patients of normal weight with insufficient GWG [27]. Catalano et al. also identified an increased incidence of SGA in obese or overweight patients with less than 5 kg weight gain during pregnancy [28]. Among patients who had undergone bariatric surgery, while Stentebjerg et al. noted possible reductions in birth weight when maternal weight gain was insufficient, these results were not significant ($p = 0.07$) [21].

Unlike previous studies, which have asserted that the risk of SGA is significantly greater in patients with inadequate GWG than in patients with excessive GWG, data from the current study presented no signs of increased risk for SGA between patients with normal or insufficient GWG (Table 4). As a result, a larger population size could increase the study's accuracy and statistically prove these differences.

The present study contains a few limitations. First, because it was a retrospective observational study, the data collected were dependent on the maintenance of obstetrical files. Moreover, the weight gain of the patients was not always noted during their final consultations. For this reason, patients were excluded if their final weights were recorded more than five weeks before delivery. In addition, patients pre-conception weights may have been underestimated since they reported them themselves. Oken et al. [29] asserted that the discrepancy between self-estimated and measured weight is typically low (about one kilogram).

Data on the risks of SGA and prematurity were not significantly different in comparisons between the groups with normal and insufficient GWG, which may also indicate a limitation of the current study. Although this study presents larger population numbers than previous studies, the number of patients was not always sufficient for analyses of certain rare events.

Coupaye et al recently assessed the impact of the type of bariatric surgery type on the fetal birth weight. No difference was found between patients with sleeve gastrectomy or Roux-en-Y gastric bypass. Our research did not evaluate this aspect but it could be the subject of another study [30].

Conclusion

While a low fetal birth weight and an increased rate of preterm births among pregnancies after bariatric surgery have been determined by numerous studies [5,28], the link between these issues and GWG have yet to be completely explored [4]. According to the current study's results, it appears that the proportion of patients with insufficient GWG is significant among patients who have undergone bariatric surgery.

According to our results, it's seemed that adequate GWG was associated with better obstetrical outcomes and that insufficient GWG is correlated with higher rates of SGA and preterm births. IOM recommendations seems to be adapted to this specific population.

To assess GWG, multidisciplinary follow-ups with nutritionists should be systematically proposed to these patients during their pregnancies. Further studies will also need to analyze the benefits that this type of care can have toward GWG and to evaluate other factors, such as the influence of the operation-to-birth interval, so that patients can be sufficiently advised.

Conflict of interest

The authors report no conflict of interest.

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