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Original article

Gestational weight gain and postpartum weight retention after bariatric surgery: data from a prospective cohort study

Dries Ceulemans, M.D.[a,b], Paulien De Mulder, M.D.[c], Barbara Lebbe, M.D.[d], Marc Coppens, M.D.[e], Ben De Becker, M.D.[f], Bruno Dillemans, M.D.[g], Jean-Paul Saey, M.D.[h], Luc Lemmens, M.D.[i], Hilde Logghe, M.D.[j], Ann Loccufier, M.D.[d], Bart Van der Schueren, M.D., Ph.D.[k,l], Ann Mertens, Ph.D.[k,l], Christophe Matthys, Ph.D.[k,l], Ellen Deleus, M.D.[k,m], Johan Verhaeghe, M.D., Ph.D.[a,b], Lore Lannoo, M.D.[a,b], Matthias Lannoo, M.D., Ph.D.[k,m], Lode Godderis, M.D., Ph.D.[n,o], Kristien Roelens, M.D., Ph.D.[c], Lieveke Ameye, Ph.D.[a], Annick Bogaerts, Ph.D.[a,p], Roland Devlieger, M.D., Ph.D.[a,b,f,*]

[a]*Department of Development and Regeneration, KU Leuven, Leuven, Belgium*
[b]*Department of Obstetrics and Gynaecology, University Hospitals Leuven, Leuven, Belgium*
[c]*Department of Obstetrics and Gynaecology, Ghent University Hospital, Gent, Belgium*
[d]*Department of Obstetrics and Gynaecology, AZ Sint-Jan, Brugge, Belgium*
[e]*Department of Obstetrics and Gynecology, ZNA Middelheim, Antwerp, Belgium*
[f]*Department of Obstetrics, Gynecology and Reproduction, St. Augustinus Hospital, Wilrijk, Belgium*
[g]*Department of Abdominal Surgery, St. Jan Hospital, Bruges, Belgium*
[h]*Medicosurgical Unit for Metabolic Diseases, CHR, Mons, Belgium*
[i]*Department of Abdominal Surgery, St. Nikolaas Hospital, St. Niklaas, Belgium*
[j]*Department of Obstetrics and Gynecology, St. Lucas Hospital, Bruges, Belgium*
[k]*Clinical and Experimental Endocrinology, Department of Chronic Diseases and Metabolism, KU Leuven, Leuven, Belgium*
[l]*Department of Endocrinology, University Hospitals Leuven, Leuven, Belgium*
[m]*Department of Abdominal Surgery, University Hospitals Leuven, Leuven, Belgium*
[n]*Department of Public Health and Primary Care, Centre for Environment and Health, KU Leuven, Leuven, Belgium*
[o]*Idewe, External Service for Prevention and Protection at Work, Heverlee, Belgium*
[p]*Faculty of Medicine and Health Sciences, Centre for Research and Innovation in Care (CRIC), University of Antwerp, Antwerp, Belgium*

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Abstract

Background: It is unknown whether international guidelines on gestational weight gain can be used in pregnancies after bariatric surgery.

Objectives: To investigate gestational weight gain, intrauterine growth, and postpartum weight retention in postbariatric women.

Setting: 8 Belgian hospitals.

Methods: Prospective data from 127 postbariatric pregnancies from September 2014 through October 2018. Patients were grouped according to achievement of 2009 Institute of Medicine (IOM) guidelines.

Results: In 127 patients with a mean age of 30.2 years (standard deviation [SD], 4.7), the mean gestational weight gain was 12.5 kg (SD, 6.7). Of these patients, 24% (30 of 127) showed insufficient

* Correspondence: Roland Devlieger, M.D., Ph.D., Department of Obstetrics and Gynaecology, University Hospitals Leuven, Herestraat 49, B-3000 Leuven, Belgium.

E-mail address: roland.devlieger@uzleuven.be (R. Devlieger).

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weight gain, 20% (26 of 127) showed adequate weight gain, and 56% (71 of 127) showed excessive weight gain. Of 127 patients, 27 (21%) had small-for-gestational-age infants. This peaked in the group with insufficient weight gain (47%; 95% confidence interval [CI], 29%–65%; $P < .001$). The prevalence of large-for-gestational-age infants was comparable between groups, although highest in the group with excessive weight gain (0% in those with insufficient weight gain, 4% in those with adequate weight gain, and 8% in those with excessive weight gain). Preterm births were recorded more in patients with insufficient weight gain (23%; 95% CI, 8%–38%; $P = .048$). The mean amounts of postpartum weight retained were 4.0 kg (SD, 7.4) at 6 weeks and 3.0 kg (SD, 9.1) at 6 months. Weight retention at 6 weeks (7.1 kg; 95% CI, 5.5–8.7; $P < .001$) and 6 months (8.3 kg; 95% CI, 4.5–12.2; $P < .001$) was highest in women gaining excessive weight.

Conclusion: Achievement of IOM guidelines is low in postbariatric pregnancies. Insufficient weight gain increases the risk for small-for-gestational-age babies. Excessive weight gain increases weight retention after delivery and could precipitate weight regain. After bariatric surgery, women should be encouraged to achieve IOM recommendations. (Surg Obes Relat Dis 2021;17:659–666.)

Key words: IUGR; Gastric bypass; Sleeve gastrectomy; Gastric banding; BPD; Billiopancreatic diversion

As the worldwide prevalence of obesity continues to rise, an increasing number of patients choose to undergo bariatric surgery (BS). Around 80% of these patients are female, and many of them are of reproductive age [1]. Studies on the effects of BS on pregnancy outcomes show reduced incidences of gestational diabetes, macrosomia, and hypertensive complications [2–4]. However, pregnant women with a history of BS are at risk for other adverse outcomes, such as surgical complications, congenital malformations, micronutrient deficiencies, preterm delivery, and intrauterine growth restriction (IUGR) [2,5–7].

The Institute of Medicine (IOM) has released guidelines regarding optimal gestational weight gain (GWG) during pregnancy, which are summarized in Table 1 [8]. Excessive GWG has been associated with increased risks for large-for-gestational-age (LGA) infants, macrosomia, caesarean delivery, and gestational diabetes mellitus. Insufficient GWG, in contrast, is correlated with increased risks for IUGR, small-for-gestational-age (SGA) infants, preterm birth, and more neonatal intensive care unit admissions [9].

It remains unclear whether the IOM guidelines for GWG can be used safely in a postbariatric population. On one hand, weight regain is an important complication in postbariatric patients [3,10,11], and limiting GWG and postpartum weight retention is therefore important. On the other hand, pregnant postbariatric patients are at an increased risk of IUGR and SGA infants, which might also be triggered by insufficient weight gain. To study this, we evaluated GWG, attained according to IOM guidelines, as well as pregnancy outcomes and postpartum weight retention, using data from a prospective cohort study (Ariatric sUrgery Registration in wOmen of Reproductive Age [AURORA]) [12].

Methods

Data collection

The data used are from the AURORA study, an ongoing multicenter prospective cohort study examining the reproductive outcomes of female patients after BS. The study protocol has been described in detail elsewhere [12]. In short, women aged 18–45 years who have BS planned or who have undergone BS are recruited. Patients should have a working Internet connection and an email address. Infertile women (e.g., women with a hysterectomy or already in menopause) are excluded. Data from patients included before surgery are gathered completely prospectively. Data of those who are included after surgery are gathered partially retrospectively for the measurements before surgery. Inclusion is possible until the end of the first trimester of pregnancy (14 + 6 wk). Several forms of BS were included in the analysis, and the choice of the type of surgery depended on body mass index (BMI), comorbidities, and the expertise of the surgeon. The study was approved by the local ethical committees of the participating hospitals, and informed consent was obtained from each of the participants. The trial is registered at ClinicalTrials.gov (NCT02515214).

For this study, we selected all patients in the AURORA cohort (total inclusions, n = 396) for which data on at least 1 completed pregnancy were available (n = 127). Women were weighed wearing indoor clothing without shoes, using calibrated scales. Height was only measured once at inclusion. Preconception weight was self-reported. Twin gestations were excluded from the analysis.

Data analysis

The statistical analysis was performed using R statistical software (version 3.5.1, htpp://www.r-project.org). GWG was defined as the difference between measured weight at the time of childbirth and the self-reported preconception weight. Patients were grouped according to their achievement of the 2009 IOM guidelines [8]. An overview of these recommendations is provided in Table 1. Patients gaining less weight than recommended were considered to have

Table 1
Institute of Medicine guidelines on gestational weight gain

Weight category	Recommended gestational weight gain
Underweight (BMI <18.5 kg/m^2)	12.5–18 kg
Normal weight (BMI 18.5–25 kg/m^2)	11.5–16 kg
Overweight (BMI 25–30 kg/m^2)	7–11 kg
Obese (BMI >40 kg/m^2)	5–9 kg

BMI = body mass index.

insufficient weight gain. Patients who gained more than the recommended weight were defined as having excessive GWG. Pregnancy outcomes were compared between groups. Primary outcomes studied were the prevalences of LGA or SGA and postpartum weight retention at 6 weeks and 6 months after delivery. Birth weight was compared to the general population of the region of Flanders using data from the Centre of Perinatal Epidemiology (SPE) [13], taking into account the neonatal sex, gestational age, and parity. SGA and LGA infants were defined as those having a birth weight below the 10th percentile or above the 90th percentile, respectively. Macrosomia was defined as a birth weight >4000 g. Postpartum weight retention was calculated as the difference between the maternal weight at 6 weeks and 6 months after delivery and the preconception weight. Early and late preterm births were defined as delivery before 34 and 37 weeks of pregnancy, respectively. The definition of gestational hypertension was >140 mm Hg systolic blood pressure or >90 mm Hg diastolic blood pressure in patients with no known hypertension before pregnancy. Preeclampsia was defined as new-onset hypertension with signs of significant end-organ dysfunction (e.g., proteinuria, IUGR, etc.). Plots correlating birth weight, gestational age, parity, child sex, and attainment to IOM guidelines were constructed. Box plots on postpartum weight retention at 6 weeks and 6 months postpartum were also created. The Shapiro-Wilk test was used to determine whether variables were normally distributed. A 1-way analysis of variance was used to examine differences in continuous variables between groups. A chi-square or Fisher's exact test was used to compare the prevalence of co-morbidities and other variables between groups. A P value of <.05 was considered statistically significant.

Results

Patient characteristics

There were 127 patients included in the analysis. Of these, 74% (94 of 127) underwent a Roux-en-Y gastric bypass (RYGB), 17% underwent laparoscopic adjustable gastric banding (LAGB) (21 of 127), 7% (9 of 127) underwent sleeve gastrectomy (SG), and 2% (3 of 127) underwent biliopancreatic diversion (BPD).

Gestational weight gain and pregnancy outcomes

Overall, the mean GWG was 12.5 kg (standard deviation [SD], 6.7). There were 30 patients (24%) with a lower-than-recommended GWG (insufficient), 26 (20%) who gained weight within the recommended range (adequate), and 71 (56%) who gained more weight than recommended by the IOM (excessive). These data are detailed in Table 2. One patient lost weight during pregnancy (−.7 kg).

Pregnancy outcomes according to achievement of IOM guidelines are shown in Table 3.

There was no statistical difference between groups in regard to age, smoking status, type of surgery, parity, BMI at conception, and surgery-to-conception interval.

The gestational age at delivery was also comparable, but late preterm births were more frequent in those patients who gained insufficient weight (23% [7 of 30] in the group with insufficient weight gain versus 8% [2 of 23] and 7% [5 of 71] in the groups with normal weight gain and excessive weight gain, respectively; $P < .05$). Only 1 patient delivered before 34 weeks of gestation. Overall, there were 14 preterm births (11%). We found no difference in outcomes regarding method of delivery, neonatal sex, incidences of gestational hypertension, and gestational diabetes. Birth weight, however, did differ significantly between GWG groups, with the lowest mean birth weight being found in the lower-than-recommended weight gain group (2838 g; 95% CI, 2672–3005 g; $P < .001$). Concordantly, we also found a significant difference in the prevalence of SGA infants, with 47% (14 of 30) in patients with lower-than-recommended weight gain versus 15% (4 of 26) and 13% (9 of 71) in those with normal weight gain and excessive weight gain, respectively ($P < .001$). The patient who lost weight during pregnancy delivered an SGA infant (2230 g at 38 wk gestational age). The prevalence of LGA was comparable between all groups. Overall, 27 patients delivered an SGA infant (21%), 93 had a normal-weight child (73%) and 7 had a LGA neonate (6%). Fig. 1 shows the relationship between birth weight and gestational age for the complete group of patients. Table 3 shows the achievement of IOM guidelines per type of surgery. Although patients with malabsorptive surgery types (RYGB or BPD) seemed to have an increased risk of gaining insufficient weight compared to those with restrictive types (LAGB or SG), this finding failed to reach significance ($P = .08$).

Gestational weight gain and postpartum weight retention

Data on postpartum weight retention at 6 weeks and 6 months were available in 75 and 32 patients, respectively. Patients with excessive GWG retained significantly more weight at 6 weeks postpartum (7.1 kg; 95% CI, 5.5–8.7; $P < .001$), and these patients even gained weight at 6 months postpartum (8.3 kg; 95% CI, 4.5–12.2; $P < .001$). Patients

Table 2
Overview of adherence to Institute of Medicine guidelines per BMI category

	Underweight (BMI <18.5 kg/m^2), n = 1	Normal weight (BMI 18.5–25 kg/m^2), n = 38	Overweight (BMI 25–30 kg/m^2), n = 47	Obese (BMI >30 kg/m^2), n = 41	Total, n = 127
GWG lower than IOM, n (%)	0 (0%)	14 (37%)	9 (19%)	7 (17%)	30 (24%)
GWG according to IOM, n (%)	0 (0%)	9 (24%)	9 (19%)	8 (20%)	26 (20%)
GWG higher than IOM, n (%)	1 (100%)	15 (39%)	29 (62%)	26 (63%)	71 (56%)

BMI = body mass index; GWG = gestational weight gain; IOM = Institute of Medicine.

with insufficient weight gain lost weight at 6 weeks and 6 months postpartum, compared with their preconception weight (−3.3 kg [95% CI, −6.3 to −.3] and −5.5 kg [95% CI, −9.6 to −1.5], respectively), whereas patients with normal GWG returned to their preconception weight (3.2 kg [95% CI, −1.4 to 7.7], and .1 kg [95% CI, −2.6 to 2.8], respectively). These data are presented in Table 3 and Fig. 2.

Discussion

In this prospective multicenter study, we show that only 20% of bariatric patients met international GWG guidelines, and that achievement of the guidelines is associated with the lowest rate of complications. The guidelines were met by substantially fewer post-BS patients than patients in the general population of Flanders (28% with insufficient GWG, 38% with normal GWG, and 34% with excessive GWG) or in a comparable population with obesity [14,15]. The overall risk of having an SGA infant after BS was increased compared with the risk in the general population in Belgium and was alarmingly high in patients who gained less weight than recommended. These patients were also at an increased risk of delivering preterm. Excessive GWG, in contrast, was associated with a significant amount (8 kg) of weight retention after birth and could precipitate weight regain in post-BS women.

Overall, the average GWG was 12.5 kg in our study, with 1 patient losing weight during pregnancy. Few other studies have reported on GWG in postsurgical mothers. Our findings are in line with those of Hammeken et al. [16], who compared 151 RYGB patients with 151 non-RYGB patients in a retrospective matched-cohort study. GWG in the RYGB group was 11.5 ± 9.9 kg. Of these patients, 15.2% had lower-than-recommended GWG, 25.8% gained adequate weight, and 39.7% gained more weight than recommended. Compared with the control population, there was no significant difference in attainment of the guidelines between the 2 groups. The participants reported a large number of missing data in regard to achievement of the guidelines, with 19.2% of data missing from the study population and 13.9% missing from the control group.

Stentebjerg et al. [17] reported pregnancy outcomes from 71 RYGB patients. Data on GWG was available from only 54 women. They found a much higher (42.6%) rate of insufficient weight gain in their study compared with our data. However, a higher percentage of patients in their study presented with obesity, which influences GWG. Another explanation could be the fact that in general, the surgery-to-conception interval was shorter in their study. As such, more patients would still be in the catabolic state after surgery, leading to lesser weight gain. This is further suggested by the fact that in their population, the mean GWG was higher in those patients who conceived more than 18 months after surgery. Patients who conceived more than 18 months after surgery also had lower rates of insufficient GWG (28.6%) and higher rates of excessive GWG (47.6%), which are more in line with our findings.

Finally, in a retrospective analysis of 337 pregnancies after BS, Grandfils et al. [18] reported that 27% of patients achieved GWG guidelines, 35% had insufficient GWG, and 38% gained excessive weight. Women with insufficient GWG had a higher pre-pregnancy weight and BMI compared with those with adequate or excessive GWG, something we did not find in our data.

In our study, there was an increased risk for delivering an SGA infant, compared with the general population of Flanders (21% versus 10%) [15]. In this recent analysis of GWG and various pregnancy outcomes, the risk for SGA was highest in patients with insufficient GWG, at 15%. This is still substantially lower than the reported 47% in our data set. Furthermore, when comparing the prevalence of SGA to that in mothers in varying BMI categories, a persistently increased risk is noticed in patients after bariatric surgery. For instance, in this analysis in nonbariatric patients, the prevalence of SGA was highest in those patients with underweight and insufficient GWG, but increased only to 24%, whereas nonbariatric patients with obesity and insufficient GWG had a risk of 10%. This dropped even further in patients with class III obesity (8.5%). In comparison, patients with bariatric surgery saw a decrease in the risk of having an LGA infant, with only 6% of patients delivering an LGA infant. These data suggest that bariatric surgery is an independent risk factor for SGA regardless of BMI category, with the risk for SGA increasing even further if GWG guidelines are not achieved. The link between BS and low birth weights has already been described [2]. Studies by Kjaer et al. [19] and Roos et al. [20] found

Table 3
Pregnancy outcomes according to adherence to Institute of Medicine guidelines

	Lower than IOM, n = 30	According to IOM, n = 26	Higher than IOM, n = 71	*P* value
Age, yr (SD)	29 (4)	29 (4)	30 (4)	.14
Smoking, n (%)				
NA = 7	6 (21%)	4 (16%)	12 (18%)	.91
Type of surgery, n (%)				
LAGB	4 (13%)	2 (8%)	15 (21%)	.09*
RYGB	26 (87%)	21 (81%)	47 (66%)	
BPD	0 (0%)	1 (4%)	2 (3%)	
SG	0 (0%)	2 (8%)	7 (10%)	
Nulliparous, n (%)	10 (33%)	9 (35%)	23 (32%)	.98
Presurgery BMI, kg/m^2 (SD)	41 (6)	42 (8)	44 (8)	.20
Maximum weight loss, kg (SD)	40 (10)	47 (15)	47 (18)	.09
Preconception BMI, kg/m^2 (SD)	28 (7)	28 (5)	29 (5)	.40
% Excess weight loss at conception	90 (28)	81 (34)	80 (25)	.26
% Total weight loss at conception	33 (10)	33 (14)	33 (11)	.98
Weight category at conception, n (%)				
Underweight	0 (0%)	0 (0%)	1 (1%)	.28
Normal weight	14 (47%)	9 (35%)	15 (21%)	
Overweight	9 (30%)	9 (35%)	29 (41%)	
Obese	7 (23%)	8 (31%)	26 (37%)	
Surgery-to-conception interval				
Mo (SD)	47 (40)	47 (35)	57 (41)	.34
NA = 2				
>18 mo (%)	19 (63%)	20 (77%)	57 (80%)	.19
GWG, kg (SD)	5 (4)	10 (3)	17 (5)	<.001†
PPWR at 6 wk, kg (SD, n)				
NA = 33	−3 (6, n = 17)	3 (8, n = 15)	7 (5, n = 43)	<.001†
PPWR at 6 mo, kg (SD, n)				
NA = 95	−6 (6, n = 10)	0 (2, n = 5)	8 (8, n = 17)	<.001†
Gestational age at delivery, wk (SD)	38 (2)	39 (1)	39 (2)	.20
Preterm delivery <37 wk, n (%)	7 (23%)	2 (8%)	5 (7%)	.048
Preterm delivery <34 wk, n (%)	0 (0%)	0 (0%)	1 (1%)	.67
Delivery method, n (%)				
Uncomplicated vaginal	24 (80%)	21 (81%)	47 (66%)	.68
Assisted vaginal	2 (7%)	2 (8%)	8 (11%)	
Primary caesarean	2 (7%)	1 (4%)	10 (14%)	
Secondary caesarean	2 (7%)	2 (8%)	6 (8%)	
Birth weight, g (SD)	2838 (446)	3189 (402)	3328 (489)	<.001†
SGA, n (%)	14 (47%)	4 (15%)	9 (13%)	<.001†
LGA, n (%)	0 (0%)	1 (4%)	6 (8%)	.21
Macrosomia, n (%)	0 (0%)	1 (4%)	7 (10%)	.15
Male sex, n (%)	12 (40%)	15 (58%)	42 (59%)	.20
Gestational diabetes, n (%)				
NA = 6	8 (31%)	6 (24%)	15 (21%)	.64
Gestational hypertension, n (%)				
NA = 2	1 (3%)	2 (8%)	4 (6%)	.77

IOM = Institute of Medicine; SD = standard deviation; NA = not available; LAGB = laparoscopic adjustable gastric banding; RYGB = Roux-en-Y gastric bypass; BPD = billiopancreatic diversion; SG = sleeve gastrectomy; BMI = body mass index; GWG = gestational weight gain; PPWR postpartum weight retention; SGA = small for gestational age; LGA = large for gestational age.

Values are presented as mean (SD) or n (%).

* Result of χ^2 test comparing RYGB and BPD versus SG and LAGB. Surgery types were grouped due to small numbers in the BPD group.

† Significant after correction for multiple comparisons ($P < .002$).

increased incidences of SGA, but did not relate it to GWG. In the study by Hammeken et al. [16], SGA, defined as a birth weight 22% below the average in the normal population, had a prevalence of 10.6% in the RYGB group, versus 4.0% in the control group (P = .040). LGA (birth weight 22% above the average in the normal population) was present in .7% of the study population and 4.6% of the control population (P = .069). As mentioned earlier, they did not examine the relationship between the prevalence of SGA and achievement of the IOM guidelines. Stentebjerg et al. [17] also defined SGA and LGA as a <22% or >22% deviation from the mean, respectively. In their study, they only found 1 case of SGA and LGA each, both of which

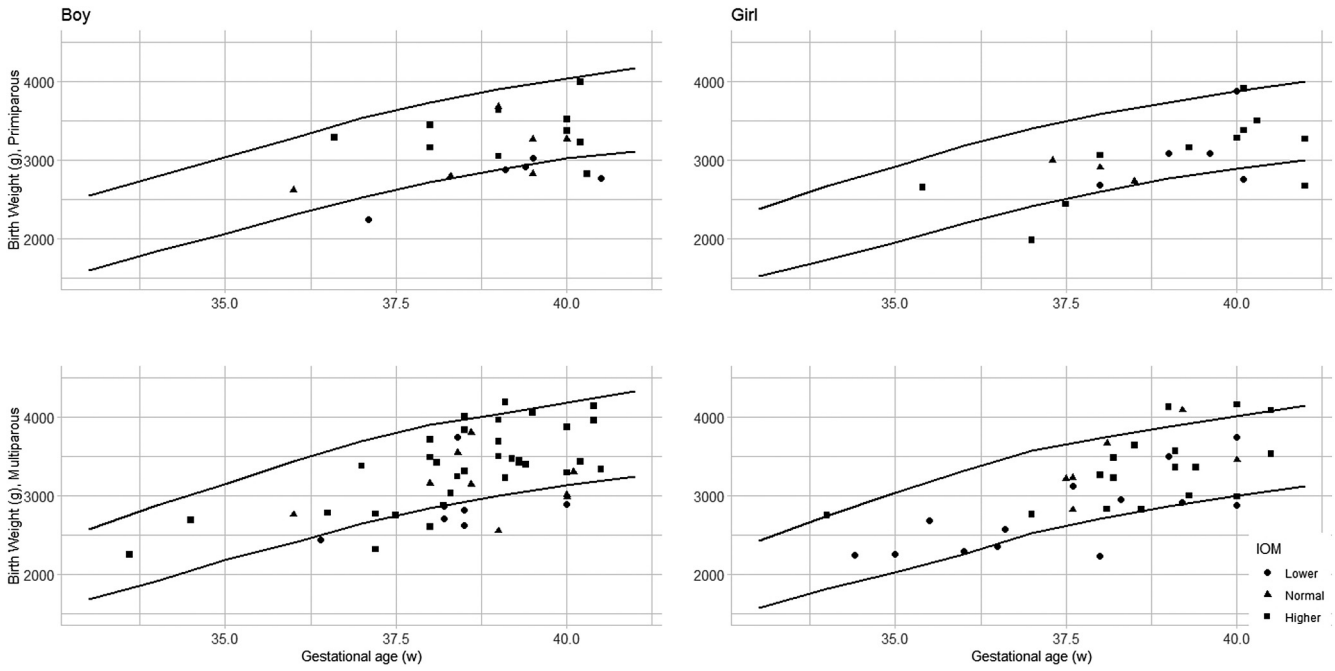

Fig. 1. Birth weight in relation to gestational age at delivery. The solid lines represent cutoffs for the 10th and 90th percentiles of the SPE data. The symbols describe the relationship to IOM guidelines, with circles representing lower-than-recommended weight gain, triangles representing normal weight gain, and squares representing higher-than-recommended weight gain. SPE = Centre of Perinatal Epidemiology; IOM = Institute of Medicine.

were found in the insufficient-GWG group. Similar to our own findings, Grandfils et al. [18] found insufficient GWG to increase the risk for SGA (34% in the insufficient-GWG group versus 27% in the adequate-GWG group and 19% in the excessive-GWG group).

In general, our findings support the evidence surrounding the increased risk for SGA infants after BS. Further follow-up of these infants is necessary to investigate the long-term effects of BS on the offspring, as IUGR is associated with the development of metabolic syndrome later in life [21,22].

Although the gestational age at delivery was comparable between the 3 GWG groups, more patients with insufficient weight gain delivered before 37 weeks. Overall, 11% of patients delivered preterm. In contrast, according to SPE, the overall prevalence of preterm births in Flanders is 7.4% [13]. It is unknown whether the preterm deliveries in our study were spontaneous labors or not. It could be possible that patients with IUGR were induced before 37 weeks, thus explaining this difference. Furthermore, patients who delivered preterm also had less time to gain weight, which would make it more likely that they were classified as having insufficient weight gain. Grandfils et al. [18] found patients with insufficient GWG to be at an increased risk for preterm labor, especially compared with those patients with excessive GWG. Stentebjerg et al. [17] found no difference in the prevalence of preterm deliveries between groups. In the review by Guelinckx et al. [2], there also was no difference in the prematurity rate in pregnancies after BS. Sheiner et al. [23] reported an increased risk for premature rupture of the membranes.

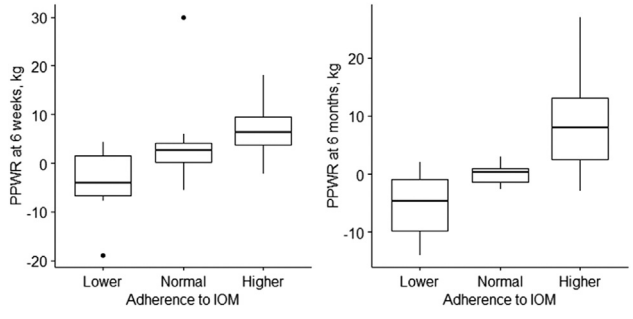

Fig. 2. PPWR at 6 weeks and 6 months in patients, grouped according to adherence to IOM guidelines. IOM = Institute of Medicine; PPWR = postpartum weight retention.

Despite having undergone BS, 37% of our patients were still considered overweight and 32% had residual levels of obesity. As weight regain is an important complication after BS [3,10,11], focusing on possible precipitating factors is important. In our study, we found patients with excessive GWG to be at risk for additional weight gain in the postpartum period. However, in a retrospective observational cohort of 232 women by Alatische et al. [24], 24 women became pregnant. At 30 months of follow-up, there was no difference in weight loss outcomes between pregnant and nonpregnant patients. Similar data were found by Quyên Pham et al.

[25] in their retrospective cohort of 591 women, of whom 84 became pregnant. They found that in general, pregnancy slows down postoperative weight loss but does not affect weight results at 5 years of follow-up. It should be noted that neither of these studies related their findings to achievement of the GWG guidelines. As such, it is possible that a subgroup of patients who did gain weight were missed.

Our study represents obvious limitations. While this is, to the best of our knowledge, the largest reported prospective study in post-BS women, the sample size is too small to make definitive conclusions regarding guidelines to follow in this specific population, as many factors, like postsurgery BMI, type of surgery, and surgery-pregnancy interval, appear to also play a role. It is also not known whether the weight gain existed primarily of muscle or fat mass. Despite this, our study shows convincing data on the association between insufficient GWG and poor outcomes, including SGA. This is very useful information for care providers and patients. It should be recommended that weight be monitored at each antenatal visit in these patients. Also, intrauterine growth scans should be part of antenatal care, especially in mothers gaining insufficient weight [26].

A third possible bias could be that the study took place over the course of several years. As such, possible changes in guidelines might influence pregnancy outcomes. However, all patients in this study are being monitored in line with the protocol of the study. No difference in follow-up of the patients was noticed over the time of recruitment.

Conclusion

Patients who get pregnant after BS only seldom achieve GWG within the recommendations of the IOM. Insufficient weight gain should be avoided, as it increases the risk for SGA. Excessive weight gain is frequent and is associated with postpartum weight retention and weight regain. Therefore, attaining the IOM guidelines appears to be the best recommendation in this group of patients for now. GWG should be monitored during pregnancy, especially to detect insufficient weight gain or weight loss. Estimations of fetal weight should be used to detect IUGR, and specialized follow-up should be provided for these patients. A multidisciplinary follow-up with specialized midwives, dieticians, and specialized obstetricians could be proposed to keep GWG within normal ranges.

Disclosures

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