

# Pregnancy outcome following bariatric surgery

Rahat Khan MBBS MRCOG,<sup>a,\*</sup> Bashir Dawlatly MSc FRCOG,<sup>b</sup> Oliver Chappatte MBBS FRCS FRCOG<sup>c</sup>

<sup>a</sup>Consultant Obstetrician and Gynaecologist, Princess Alexandra Hospital NHS Trust, Harlow, Essex CM20 1QX, UK

<sup>b</sup>Consultant Obstetrician and Gynaecologist, Whipps Cross University Hospital NHS Trust, Leytonstone E11 1NR, UK

<sup>c</sup>Consultant Obstetrician and Gynaecologist, Tunbridge Wells Hospital NHS Trust, Pembury TN2 4QJ, UK

\*Correspondence: Rahat Khan. Email: rahatanwarkhan@hotmail.com

Accepted on 30 January 2012

## Key content

- There is an exponential increase in the number of morbidly obese women of childbearing age undergoing bariatric surgery as the ultimate treatment for their obesity.
- Pregnancy after bariatric surgery is safer, with fewer complications, than pregnancy in morbidly obese women.
- Patients should be strongly advised not to get pregnant for at least 12–18 months following bariatric surgery.
- Multidisciplinary care before, during and after pregnancy following bariatric surgery helps to prevent nutrition-related and surgical complications.

## Learning objectives

- To outline the safety, advantages and limitations of bariatric surgery procedures in relation to maternal and neonatal outcomes.
- To understand that the key to a healthy pregnancy after weight-loss surgery is paying attention to nutrition.

- To learn the importance of the multidisciplinary management of post-surgery pregnancies, including prepregnancy counselling.

## Ethical issues

- Often GPs and obstetricians are not fully informed about the management of pregnant individuals who have had bariatric surgery.
- There are no recommendations that detail the nutrients that women should consume during pregnancy if they have had previous weight loss surgery.
- A literature review demonstrates both positive and negative associations of weight loss procedures with fertility.

**Keywords:** bariatric surgery / malnutrition / pregnancy / surgical complications

Please cite this paper as: Khan R, Dawlatly B, Chappatte O. Pregnancy outcome following bariatric surgery. *The Obstetrician & Gynaecologist* 2013;15:37–43.

## Introduction

The UK Centre for Maternal and Child Enquiries (2006–2008) reported that 47% of mothers who died from direct causes were either overweight or obese, as were 50% of women who died from indirect causes. Overall, 49% of women who died and for whom the body mass index (BMI) was known were either obese or overweight.<sup>1</sup> In the UK, the prevalence of obesity among women of reproductive age is expected to rise from 24.2% in 2005 to 28.3% in 2015.<sup>2</sup> Obesity increases the risk of obstetric complications (Table 1).

NICE recommends bariatric surgery as an option in morbidly obese patients (BMI >40 kg/m<sup>2</sup>) where lifestyle and/or medications have been found to be ineffective.<sup>8</sup> The majority of bariatric surgery candidates are women of childbearing age. Between 2003 and 2005, 49% of all inpatient bariatric procedures in the USA were performed in women aged 18–45 years.<sup>9</sup> The Centre for Maternal and Child Enquiries and the Royal College of Obstetricians and Gynaecologists (RCOG) have published a joint guideline for

the management of women with obesity in pregnancy.<sup>10</sup> The guideline does not address the management of pregnancy following bariatric surgery. Increasingly, obstetricians,

**Table 1.** Maternal and fetal risks in obese women

Risks	Study location	Odds ratio (95% confidence interval)
Spontaneous abortion	(Meta-analysis) <sup>3</sup>	3.5 (1.03–12.01)
Gestational diabetes	UK <sup>4</sup>	3.6 (3.3–4.0)
Hypertensive disorders	UK <sup>4</sup>	2.1 (1.9–2.5)
Emergency caesarean section	UK <sup>4</sup>	1.8 (1.7–1.9)
Thromboembolism	Denmark <sup>5</sup>	9.7 (3.1–30.8)
Wound infection	UK <sup>4</sup>	2.24 (1.9–2.64)
Postpartum haemorrhage	UK <sup>4</sup>	1.4 (1.2–1.6)
Congenital anomalies	Australia <sup>6</sup>	1.6 (1.0–2.5)
Macrosomia	UK <sup>4</sup>	2.4 (2.2–2.5)
Shoulder dystocia	Sweden <sup>7</sup>	3.14 (1.86–5.31)
Admission to neonatal unit	UK <sup>4</sup>	1.3 (1.3–1.4)
Stillbirth	(Meta-analysis) <sup>3</sup>	2.79 (1.94–4.02)

surgeons and primary care clinicians will be required to address questions posed by their patients regarding the safety of pregnancy after weight loss surgery.

## Types of bariatric surgery procedures

Procedures are classified as restrictive, malabsorptive or both (Box 1). The most commonly used procedures, laparoscopic adjustable gastric banding (LAGB) and Roux-en-Y gastric bypass (RYGB), are associated with lower immediate and long-term complication rates than other types of bariatric surgery procedure.<sup>11</sup> Complications occur in approximately 5% of cases with both procedures.<sup>11</sup> Surgery should be performed by a specialist team in a tertiary centre. Preoperative discussion is important. Follow-up requires regular specialist dietetic review and micronutrients should be monitored. Patient support groups should be offered.

Bariatric surgery is popular among morbidly obese women of child bearing age.<sup>9</sup> The literature reporting on pregnancy outcome after bariatric surgery is limited but encouraging. A literature review of 75 observational studies by Maggard et al.<sup>12</sup> reported that rates of adverse maternal and neonatal outcomes are lower following LAGB and gastric bypass as compared to other bariatric surgery procedures. Few studies have assessed pregnancy outcomes following biliopancreatic diversion (BPD).<sup>13,14</sup> Shekelle et al.<sup>15</sup> reviewed the evidence on the impact of bariatric surgery on fertility and subsequent pregnancy. They found that fertility improves, and maternal and fetal outcomes are acceptable with LAGB and gastric bypass.

## Ideal timing for conception following bariatric surgery

Current recommendations advise delaying pregnancy for at least 1 year following bariatric surgery because this is when rapid weight loss occurs.<sup>16</sup> In addition, it is during this period that nutritional deficiencies or electrolyte imbalance can arise. However, data validating this recommendation is lacking. A study by Dao et al.<sup>17</sup> found no difference in outcomes between pregnancies within the first year versus pregnancies occurring >1 year after gastric bypass surgery. A retrospective study of 104 pregnancies by Sheiner et al.<sup>18</sup> concluded that pregnancies conceived during the first postoperative year had comparable short-term perinatal outcomes compared with pregnancies conceived after the first postoperative year (1.9% versus 1.3%;  $P = 0.485$ ). No significant differences were noted regarding hypertensive disorders (15.4% in the early versus 11.2% in the late postoperative group;  $P = 0.392$ ) or diabetes mellitus (11.5% versus 7.3%;  $P = 0.392$ ). Patel et al.<sup>19</sup> found that early pregnancies were associated with more preterm deliveries (50% for <12 months, 25% for 13–24 months and 20% for  $\geq 24$  months). One study<sup>20</sup> found a higher spontaneous miscarriage rate among pregnancies occurring within 18 months of having BPD compared with those pregnancies occurring more than 18 months after BPD (31% versus 18%). This was not confirmed by other studies. Marceau et al.<sup>13</sup> found no difference in miscarriage rates between pre-BPD and post-BPD pregnancies (21.6% pre-BPD versus 26% post-BPD). A lower mean birthweight was found in the post-BPD group compared with obese controls (3 kg versus 3.5 kg,

**Box 1. Types of bariatric surgery with their potential complications**

Type	Technique	Potential complications
<b>Restrictive:</b> aims to reduce caloric intake by reducing gastric capacity.	Laparoscopic adjustable gastric banding (LAGB); silastic ring (SRG); vertical-banded gastroplasty (VBG)	Band adjustment used to regulate weight gain. Complications: gastric prolapse, stomal obstruction, pouch dilatation, gastric erosion and necrosis.
	Sleeve gastrectomy	Irreversible. Involves removing most of the stomach leaving a sleeve-shaped cylinder of stomach with reduced capacity.
<b>Malabsorptive:</b> includes malabsorptive procedures. Iron, calcium, folate, thiamine, B12 and fat-soluble vitamin deficiencies can occur leading to malnutrition.	Biliopancreatic diversion (BPD)	Produces more extreme malabsorption than other procedures.
	Jejunioleal bypass	High morbidity and mortality. Hepatic and renal failure.
<b>Mixed:</b> combining food restriction with malabsorption by shortening the length of the intestinal tract.	Roux-en-Y gastric bypass (RYGB)	Dumping syndrome experienced by ingestion of large quantities of carbohydrates or the standard 75 or 50 g glucose challenge test. Complications: stomal stenosis, icers, intestinal hernias and nutrient deficiencies.

$P < 0.001$ ). Dixon et al.<sup>21</sup> reported no differences in perinatal outcomes or pregnancy complications ( $P < 0.05$ ) in pregnancies conceived within 1 year of LAGB. They also reported lower maternal gestational weight gain (GWG) in early post-surgery pregnancies.

All studies consistently report no difference in birthweight, intrauterine growth restriction (IUGR), the incidence of caesarean section (CS), pregnancy induced hypertension (PIH) or gestational diabetes mellitus (GDM) between pregnancies conceived within the first postbariatric surgery year and those conceived thereafter. In light of the available evidence, patient education and prepregnancy counselling regarding benefits of delaying pregnancy for at least 12 months following weight loss surgery is pivotal in morbidly obese women who are considering pregnancy after bariatric surgery.

### Fertility and bariatric surgery

A retrospective analysis by Gosman et al.<sup>22</sup> of 1538 women offered bariatric surgery (mean BMI = 47.2 kg/m<sup>2</sup>) showed that self-reporting obesity by 18 years of age appears to be related to reproductive morbidity. These women were more likely to report polycystic ovaries and were less likely to have ever been pregnant. Case-control studies<sup>12</sup> demonstrate increased fertility following bariatric surgery, although these studies lack complete data and statistical significance due to small sample sizes. One study found that after bariatric surgery, the need for fertility treatment is low (6.7%) but exceeds that of the community (2.3%,  $P < 0.001$ ). Data suggest that weight loss surgery can result in normalisation of hormones in polycystic ovaries, which can improve anovulation and endocrine fertility.<sup>15</sup> Little is published on the impact of surgical weight loss on spontaneous or in vitro fertilisation-treatment related pregnancy rates.<sup>23</sup>

A systematic review of the literature evaluated evidence on the safety and effectiveness of contraceptive use among women with a history of bariatric surgery; no substantial decrease in effectiveness was identified and evidence on safety for all contraceptive methods was not identified.<sup>24</sup> Randomised trials comparing women who had previously undergone weight loss surgery versus controls are required to assess the efficacy of contraceptive methods following bariatric surgery.

### Nutritional deficiencies

Based on limited evidence, it seems that gastric bypass and LAGB present minimal risk for nutrient problems, however, most clinicians monitor supplemental adherence.<sup>12</sup> Sheiner et al.<sup>25</sup> demonstrated favourable outcomes in pregnant women who were put on multivitamins and mineral supplementation following different types of bariatric surgery. Special consideration should be given to prenatal supplementation in women considering pregnancy following

bariatric surgery. Mild nutritional deficiencies are frequent after bariatric surgery. Malabsorptive procedures can cause permanent and excessive loss of nutrients, such as vitamin B12 and folate and can significantly reduce plasma protein levels.<sup>13</sup> Women will require additional levels of iron, calcium, folate, vitamin B12, protein and fat-soluble vitamins alongside diagnosis and treatment of other nutritional deficiencies.<sup>16</sup> Dumping syndrome can be provoked by an excessive carbohydrate diet as well as the standard 75 or 50 g glucose tolerance test.<sup>26</sup> The poor nutritional status of the mother can be exacerbated by nausea and vomiting.

### Optimal gestational weight gain (GWG)

As GWG is an important predictor for birthweight, postpartum weight retention and weight gain should be limited in such pregnancies.<sup>27</sup> Some studies suggest ideal GWG between 7–11 kg. A significantly lower GWG has been observed in women who have undergone prior bariatric surgery in several case-control studies compared with a BMI-matched control group or compared with pregnancies prior to surgery ( $P < 0.009$ ).<sup>21,28,29</sup> A review by Guelinckx et al.<sup>29</sup> showed no difference in GWG after restrictive and malabsorptive procedures. LAGB is considered more 'physiologic' since the banding can be adjusted to increase the patient's food intake. A recent retrospective study by Sheiner et al.<sup>25</sup> ( $n = 449$ ) reported higher weight gain during pregnancy in the LAGB group (13.1±9.6 kg) as compared with VBG (8.5±8.0 kg) and RYGB (11.6±9.6 kg,  $P < 0.001$ ). Dixon et al.<sup>21</sup> strongly advise band adjustments be made in view of the favourable maternal weight outcomes in their study. The interval between surgery and conception influences GWG. Dias and colleagues<sup>30</sup> reported high GWG and various comorbidities among women who conceived within 24.2±21.6 months following RYGB. However, the neonates were born in good condition. Adherence to dietary supplementation was significantly suboptimal in this retrospective study.

### Surgical complications during pregnancy

Post-LAGB pregnancies are not without complications. Band slippage and migration can result in severe vomiting. Band leakage is reported in 24% of cases.<sup>29</sup> Gastric prolapse was reported in 4% of patients, necessitating removal of the gastric band at laparotomy.<sup>31</sup> One case of pouch dilatation was reported in one study.<sup>25</sup>

Aside from nutritional deficiencies, case reports have documented risks of intestinal hernia (most commonly reported), intestinal obstruction, perforation and death in pregnant women post-RYGB.<sup>12,13,19</sup> Most cases of intestinal obstruction are due to adhesions from previous surgery. Correct diagnosis can be a problem, since the symptoms of epigastric pain or vomiting are common in pregnant women.

An exploratory laparotomy might be necessary. Computed tomography scan with contrast is suggested to be reliable for diagnosis.<sup>29</sup>

## Maternal outcome

Sheiner et al.<sup>25</sup> found no statistically significant differences between maternal and perinatal outcomes following different types of bariatric surgeries. No statistically significant differences were noted between the restrictive and malabsorptive group regarding hypertensive disorders ( $P = 0.999$ ), GDM ( $P = 0.397$ ), placenta praevia ( $P = 0.858$ ), abruption ( $P = 0.727$ ) and wound infection ( $P = 0.665$ ). Bebbler et al.<sup>32</sup> followed 39 pregnancies after restrictive-malabsorptive procedures with care delivered by a multidisciplinary team. They found that pregnancy after bariatric surgery is safe and has fewer complications than pregnancy in morbidly obese women (76.9% of pregnancies completed 37 weeks of gestation; 79.2% had no complication during the pregnancy; and 8.3% presented with intestinal hernia). Most studies report a reduced incidence of GDM in patients following bariatric surgery.<sup>12,17,21,28,31</sup> Ducarme et al.<sup>33</sup> showed that the incidence of GDM (0% versus 22.1%,  $P < 0.05$ ) and pre-eclampsia (0% versus 3.1%,  $P < 0.05$ ) were lower in the LAGB group than in the obese comparison group. GDM screening in malabsorptive patients, however, requires special considerations. In order to prevent the induction of dumping syndrome, obstetric physicians may choose to screen them for GDM by monitoring home fasting and 2-hour postprandial blood glucose levels for a week at 26–28 weeks of gestation.<sup>34</sup>

Studies comparing pre- and postbariatric surgery pregnancies consistently show that the incidence of PIH and pre-eclampsia is lower following surgically induced weight loss than the risks in obese women and may approach community levels.<sup>12</sup> Bennett et al.<sup>35</sup> conducted a retrospective analysis of 585 women. The results showed that bariatric surgery was associated with lower rates of pre-eclampsia (odds ratio [OR] 0.20, 95% confidence interval [CI] 0.09–0.44) and chronic hypertension (OR 0.39, 95% CI 0.20–0.74) complicating subsequent pregnancy.

## Caesarean delivery (CD)

There is no evidence that CD complications are higher in the post-surgery group but data are limited.<sup>15</sup> Overall, bariatric surgery does not appear to reduce the risk of CD. In the review by Maggard et al.,<sup>12</sup> rates of CD ranged from 0% to 65.8% for post-surgery pregnancy and from 5.6% to 64.5% for comparison groups. The authors suggest that caregiver bias may contribute to this elevated CD rate, as there was no known physiological reason necessitating higher CD in women who had previously undergone weight loss surgery. Sheiner et al.<sup>25</sup>

demonstrated a higher CD rate (29.4%) in all groups of bariatric surgery (29.9% in the restrictive versus 25.6% in the malabsorptive group;  $P = 0.493$ ). Another study<sup>14</sup> showed higher labour induction rates as compared with non-obese comparison groups (23.8% versus 10.9%,  $P < 0.001$ ).

Obstetricians need to be aware of caregiver bias and avoid operation without clear and definitive indications. A pooled study by Abodeedy and colleagues<sup>36</sup> demonstrated that 30.4% of post-surgery pregnant women had a CD. Previous CD and cephalopelvic disproportion were the most frequent indications reported. The presence of large areas of redundant skin can result in loss of landmarks and make access difficult intraoperatively. Postoperatively, wound infection rates can be increased because of the warm and moist area underneath the pannus. Early mobilisation, chest physiotherapy, thromboprophylaxis and adequate pain control are essential components of effective postoperative care. Antenatal and postnatal thromboprophylaxis should be considered in accordance with the RCOG Green-top Guideline No 37.<sup>37</sup>

## Breastfeeding

Morbid obesity is associated with a reduction in breastfeeding frequency because of positional difficulties and a reduced prolactin response to suckling. Obese women should receive appropriate specialist advice and support regarding initiation and maintenance of breast feeding.<sup>10</sup> Significant malabsorption in the mother can affect the energy content of breast milk and may affect the postnatal growth of the baby.<sup>38</sup> Therefore, specific supplementation of micronutrients may be indicated prenatally and during pregnancy to overcome these problems.

## Perinatal outcome

Miscarriage rates following BPD may be higher.<sup>12</sup> The incidence of spontaneous miscarriage reported after RYGB and BPD was 34.7% and 4% respectively.<sup>29</sup> There is no strong evidence that adverse neonatal outcome rates are higher following LAGB and gastric bypass procedures as compared with obese groups. Sheiner et al.<sup>25</sup> showed no statistically significant difference between preterm delivery ( $P = 0.720$ ) and perinatal mortality rates (6.6/1000 versus 14.8/1000 in their obstetrical population) between restrictive and malabsorptive groups. Similarly, there were no statistical differences in low birthweight ( $<2.5$  kg,  $P = 0.789$ ), macrosomia ( $>4$  kg,  $P = 0.851$ ) or umbilical artery pH ( $7.28 \pm 0.089$ ,  $P = 0.111$ ) and low Apgar scores ( $<7$  at 1 min,  $P = 0.884$ ;  $<7$  at 5 min,  $P = 0.996$ ) were noted. However, a French retrospective study of 24 pregnancies showed that RYGB surgery was associated with reduced birthweight as compared with normal BMI and BMI-

matched control groups (2.948 kg versus 3.368 kg versus 3.441 kg, respectively,  $P < 0.0001$ ).<sup>39</sup> This was suggestive of possible nutritional growth restriction in these pregnancies. Ducarme et al.<sup>33</sup> found rates of low birthweight among individuals who had LAGB versus obese comparison group who did not undergo LAGB (7.7% versus 10.65%,  $P < 0.05$ ).

Guelinckx et al.<sup>29</sup> reported higher congenital malformation rates following BPD, including diaphragmatic hernia, intestinal obstruction and rectal atresia (0.4%), and neural tube defects (NTDs; 0.8%).<sup>29</sup>

Folic acid supplementation is required in all women who have undergone weight loss surgery to prevent NTDs. They should be screened for NTDs through second trimester alpha-fetoprotein and ultrasound. Elevated homocysteine levels have been reported in pregnant women post-LAGB, potentially putting fetuses at an elevated risk for NTDs.<sup>21</sup> Further research is needed to establish the correct pre-conception dosage of folic acid in women who have undergone weight loss surgery. A literature review by Abodeely et al.<sup>35</sup> identified ten cases (1.6%) of congenital defects in infants of women who had undergone bariatric surgery as compared to the general population (0.7%). Sheiner et al.<sup>14</sup> did not show an increased risk of congenital malformations after controlling for diabetes and hypertensive disorders.

The positive association between premature rupture of membranes (PROM) and bariatric surgery was shown in one study.<sup>14</sup> A retrospective review by Dias et al.<sup>30</sup> revealed higher incidence of postmaturity and PROM following RYGB. They also reported good infantile growth 1–3 years postdelivery, however, mothers continued to exhibit clinical derangements requiring hospitalisation, confirming their high risk status. Overall, there is no strong evidence that adverse neonatal outcomes are higher following gastric bypass procedures compared with obese groups.<sup>12</sup>

## Cosmetic surgery following bariatric surgery

More than 80% of postbariatric surgery patients state a desire for body contouring but as few as 12% undergo plastic surgery.<sup>40</sup> Women who have been pregnant postbariatric surgery are likely to undergo cosmetic surgery to get rid of loose, damaged and redundant skin that can cause poor self-esteem and also interfere with their daily activities. Residual medical problems, nutritional status and psychosocial issues require assessment before surgery, with appropriate consultation in centres of excellence.

## Conclusion and recommendations

An increasing number of women of childbearing age are undergoing bariatric surgery procedures and need information and guidance regarding reproductive issues. Optimising success for a healthy maternal and neonatal

outcome requires a multidisciplinary team including surgeons, primary care clinicians, obstetricians, anaesthetists, fertility specialists, nutritionists, psychologists and plastic surgeons as well as patients themselves. LAGB and gastric bypass are the most widely performed bariatric surgeries. Women who have had bariatric surgery generally tolerate pregnancy well.

### Box 2. Management of pregnancy following bariatric surgery

#### Pre-conception

- Contraceptive counselling – reliable contraception (preferably, non-oral) to delay pregnancy for approximately 12 months after surgery. Adequate patient education is key.
- Follow-up with nutritionist/dietitian to monitor nutritional status and weight gain.
- Folic acid, vitamin B12, calcium and iron supplementation.

#### Antenatal care

- Patients should be managed in a multidisciplinary setting to optimise pregnancy outcome.
- Keep the bariatric surgeon in the loop.
- Early antenatal consultation.
- Offer emotional support.
- Determine baseline nutritional status and monitor adherence to nutritional supplementation. Tailor nutritional status to individual needs and the type of bariatric surgery (chewable or liquid multivitamin).
- Regular blood tests may be required following malabsorptive surgery to check for micronutrient deficiency.
- Weigh the individual at every visit to monitor gestational weight gain (GWG). Active band management following a laparoscopic adjustable gastric band procedure results in the least GWG.
- Inform anaesthetist and paediatric department of maternal bariatric surgery history.
- Take fasting and 2-hour postprandial glucose monitoring for a week to detect gestational diabetes mellitus as the standard (the glucose tolerance test can induce dumping syndrome).
- Screen for neural tube defects and arrange serial ultrasound scans focussing on intrauterine growth restriction and malformations.
- Even if there is slight suspicion of intestinal obstruction, perform clinical examination and imaging studies. Surgical exploration may be required.
- Assess for thromboprophylaxis.

#### Intrapartum

- There is no medical reason that pregnant women postbariatric surgery require delivery via caesarean section.
- It is important to anticipate problems and effectively prepare equipment and personnel.
- Fetal scalp monitoring may be required.

#### Postpartum care

- Adequate pain control, early mobilisation, thromboprophylaxis, physiotherapy.
- Encourage breast feeding.
- Follow up with nutritionist to ensure a healthy diet and to guide further weight loss, if required.
- Women considering body contouring surgery postbariatric surgery should wait until they have completed their family as future pregnancies can reverse the effects of cosmetic surgery.

Low plasma levels of the oral contraceptive pill have been reported in patients after jejunio-ileal bypass surgery and

could be contributing to the unplanned pregnancies in this group<sup>41</sup> but Paulen et al.<sup>24</sup> found no substantial decrease in the effectiveness of oral contraceptives.<sup>24</sup> No randomised controlled trials exist to assess pregnancy outcome; the best available evidence comes from observational cohort, case-control studies and case reports. The available evidence suggests lower incidence of GDM, PIH, macrosomia and low birthweight following bariatric surgery. The risk for premature rupture of membranes is increased, but the risk for preterm delivery, congenital anomalies and perinatal death is not increased. Bariatric surgery should not be performed with the intention of treating infertility; however, fertility may improve with rapid postoperative weight loss.

The incidence of CD remains high in women following bariatric surgery. There is uncertainty regarding the correct dosage of micronutrient supplementation in these women. The most commonly reported complication is intestinal hernia. Nutritional problems during pregnancy following LAGB or gastric bypass are uncommon and many are attributed to problems with adherence to nutritional supplements. Additional multivitamin and micronutrients with dietary modifications may be required to suit the needs of patients after gastric bypass. Following BPD, 21% of women may require parenteral nutrition.<sup>27</sup>

Controversy exists regarding the optimal GWG in these pregnancies. GWG should be limited. Both obstetricians and surgeons should consider postbariatric surgery pregnant women as high risk. Optimal education should be encouraged in these individuals so that they can make well informed decisions about planning pregnancy after weight loss surgery. Research is required to clarify the extent to which surgery and subsequent weight loss improves fertility and pregnancy outcomes. The American College of Obstetricians and Gynaecologists advice to delay pregnancy for 1 year following bariatric surgery appears beneficial. Box 2 summarises the authors' recommended management plan for pregnancy after previous bariatric surgery.

### Conflict of interest

None declared.

### References

- 1 Saving mothers' lives: reviewing maternal deaths to make motherhood safer: 2006–2008. *BJOG* 2011;**118**:1–203.
- 2 Ono T, Guthold R, Strong K. *WHO Global Comparable Estimates*. 2005 [https://apps.who.int/infobase/].
- 3 Davies GA, Maxwell C, McLeod L, Gagnon R, Basso M, Bos H, et al. Obesity in pregnancy. *J Obstet Gynaecol Can* 2010;**32**:165–73.
- 4 Sebire NJ, Jolly M, Harris JP, Wadsworth J, Joffe M, Beard RW, et al. Maternal obesity and pregnancy outcome: a study of 287, 213 pregnancies in London. *Int J Obes Relat Metab Disord* 2001;**25**:1175–82.
- 5 Larsen TB, Srensen HT, Gislum M, Johnsen SP. Maternal smoking, obesity, and risk of venous thromboembolism during pregnancy and the puerperium: a population-based nested case-control study. *Thromb Res* 2007;**120**:505–9.
- 6 Callaway LK, Prins JB, Chang AM, McIntyre HD. The prevalence and impact of overweight and obesity in an Australian obstetric population. *Med J Aust* 2006;**184**:56–9.
- 7 Cedergren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome. *Obstet Gynecol* 2004;**103**:219–24.
- 8 National Institute for Health and Clinical Excellence, National Collaborating Centre for Primary Care. *Obesity: the Prevention, Identification, Assessment and Management of Overweight and Obesity in Adults and Children*. London: NICE; 2006.
- 9 American Society for Metabolic & Bariatric Surgery. *Bariatric Surgical Society Takes on New Name, New Mission and New Surgery*. Gainesville, FL: American Society for Metabolic & Bariatric Surgery; 2007 [http://asmbs.org/benefits-of-bariatric-surgery/].
- 10 Centre for Maternal and Child Enquiries, Royal College of Obstetricians and Gynaecologists. *Management of Women with Obesity in Pregnancy*. London: RCOG; 2010.
- 11 Sjöström L, Narbro K, Sjöström CD, Karason K, Larsson B, Wedel H, et al. Effects of bariatric surgery on mortality in Swedish subjects. *N Eng J Med* 2007;**357**:741–52.
- 12 Maggard MA, Yermilov I, Li Z, Maglione M, Newberry S, Suttrop M, et al. Pregnancy and fertility following bariatric surgery: a systematic review. *JAMA* 2008;**300**:2286–96.
- 13 Marceau P, Kaufman D, Biron S, Hould F, Lebel S, Marceau S, et al. Outcome of pregnancies after biliopancreatic diversion. *Obes Surg* 2004;**14**:318–324.
- 14 Sheiner E, Levy A, Silverberg D, Menes TS, Levy I, Katz M, et al. Pregnancy after bariatric surgery is not associated with adverse perinatal outcome. *Am J Obstet Gynecol* 2004;**190**:1335–40.
- 15 Shekelle PG, Newberry S, Maglione M, Li Z, Yermilov I, Hilton L, et al. Bariatric surgery in women of reproductive age: special concerns for pregnancy. *Evid Rep Technol Assess (Full Rep)* 2008;**169**:1–51.
- 16 American College of Obstetricians and Gynaecologists. ACOG Committee opinion number 315, September 2005. Obesity in pregnancy. *Obstet Gynecol* 2005;**106**:671–5.
- 17 Dao T, Kuhn J, Ehmer D, Fisher T, McCarty T. Pregnancy outcomes after gastric bypass surgery. *Am J Surg* 2006;**192**:762–6.
- 18 Sheiner E, Edri A, Balaban E, Levi I, Aricha-Tamir B. Pregnancy outcome of patients who conceive during or after the first year following bariatric surgery. *Am J Obstet Gynecol* 2011;**204**:50.e1–6.
- 19 Patel JA, Patel NA, Thomas RL, Nelms JK, Colella JJ. Pregnancy outcomes after laparoscopic Roux-en-Y gastric bypass. *Surg Obes Relat Dis* 2008;**4**:39–45.
- 20 Biron S, Hould F, Simard S, Lebel S, Marceau S, Marceau P. Birth weight after biliopancreatic diversion (abstract). *Obes Surg* 1999;**9**:126.
- 21 Dixon JB, Dixon ME, O'Brien PE. Birth outcomes in obese women after laparoscopic adjustable gastric banding. *Obstet Gynecol* 2005;**106**:965–72.
- 22 Gosman GG, King WC, Schrope B, Steffen KJ, Strain GW, Courcoulas AP, et al. Reproductive health of women electing bariatric surgery. *Fertil Steril* 2010;**94**:1426–31.
- 23 Shah DK, Ginsburg ES. Bariatric surgery and fertility. *Curr Opin Obstet Gynecol* 2010;**22**:248–54.
- 24 Paulen ME, Zapata LB, Cansino C, Curtis KM, Jamieson DJ. Contraceptive use among women with a history of bariatric surgery: a systematic review. *Contraception* 2010;**82**:86–94.
- 25 Sheiner E, Balaban E, Dreier J, Levi I, Levy A. Pregnancy outcome in patients following different types of bariatric surgeries. *Obes Surg* 2009;**19**:1286–92.
- 26 Wax JR, Heersink D, Pinette MG, Cartin A, Blackstone J. Symptomatic hypoglycaemia complicating pregnancy following Roux-en-Y gastric bypass surgery. *Obes Surg* 2007;**17**:698–700.
- 27 Friedman D, Cuneo S, Valenzano M, Marinari GM, Adami GF, Gianetta E, et al. Pregnancies in an 18 year follow-up after biliopancreatic diversion. *Obes Surg* 1995;**5**:308–13.

- 28 Dixon JB, Dixon ME, O'Brien PE. Pregnancy after lap-band surgery: management of the band to achieve healthy outcomes. *Obes Surg* 2001;**11**:59–65.
- 29 Guelinckx I, Devlieger R, Vansant G. Reproductive outcome after bariatric surgery: a critical review. *Hum Reprod Update* 2009;**15**:189–201.
- 30 Dias MC, Fazio Ede S, de Oliveira FC, Nomura RM, Faintuch J, Zugaib M. Body weight changes and outcome of pregnancy after gastroplasty for morbid obesity. *Clin Nutr* 2009;**28**:169–72.
- 31 Skull AJ, Slater GH, Duncombe JE, Fielding GA. Laparoscopic adjustable banding in pregnancy: safety, patient tolerance and effect on obesity-related pregnancy outcomes. *Obes Surg* 2004;**14**:230–5.
- 32 Bebbler FE, Rizzolli J, Casagrande DS, Rodrigues MT, Padoin AV, Mottin C, et al. Pregnancy after bariatric surgery: 39 pregnancies follow-up in a multidisciplinary team. *Obes Surg* 2011;**21**:1546–51.
- 33 Ducarme G, Revaux A, Rodrigues A, Aissaoui F, Pharisien I, Uzan M. Obstetric outcome following laparoscopic adjustable gastric banding. *Int J Gynaecol Obstet* 2007;**98**:244–7.
- 34 Wax JR, Wolff R, Cobean R, Pinette MG, Blackstone J, Cartin A. Intussusception complicating pregnancy following laparoscopic Roux-en-Y gastric bypass. *Obes Surg* 2007;**17**:977–9.
- 35 Bennett WL, Gilson MM, Jamshidi R, Burke AE, Segal JB, Steele KE, et al. Impact of bariatric surgery on hypertensive disorders in pregnancy: retrospective analysis of insurance claims data. *BMJ* 2010;**340**:c1662.
- 36 Abodeely A, Roye GD, Harrington DT, Cioffi WG. Pregnancy outcomes after bariatric surgery: maternal, fetal and infant complications. *Surg Obes Relat Dis* 2008;**4**:464–71.
- 37 Royal College of Obstetricians and Gynaecologists. *Green-top Guideline No. 37a. Reducing the Risk of Thrombosis and Embolism During Pregnancy and Puerperium*. London: RCOG; 2009.
- 38 Martin LF, Finigan KM, Nolan TE. Pregnancy after adjustable gastric banding. *Obstet Gynecol* 2000;**95**:927–30.
- 39 Santulli P, Mandelbrot L, Facchiano E, Dussaux C, Ceccaldi PF, Ledoux S, et al. Obstetrical and neonatal outcomes of pregnancies following gastric bypass surgery: a retrospective cohort study in a French referral centre. *Obes Surg* 2010;**20**:1501–8.
- 40 Gusenoff JA, Messing S, O'Malley W, Langstein HN. Patterns of plastic surgical use after gastric bypass: who can afford it and who will return for more? *Plast Reconstr Surg* 2008;**122**:951–8.
- 41 Victor A, Odland V, Kral JG. Oral contraception absorption and sex hormone binding globulins in obese women; effects of jejunoileal bypass. *Gastroenterol Clin North Am* 1987;**16**:483–91.