


Fertility, pregnancy and post partum management after bariatric surgery: a narrative review

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Obesity is increasingly prevalent in the Australian population, particularly in women of childbearing age.¹ Obesity increases the risk of infertility for men and women² and decreases the effectiveness of fertility therapies.³ It increases the risks of fetal morbidity and mortality⁴ and maternal pregnancy complications as well as the likelihood of complex delivery. Pre-pregnancy weight loss reduces the hormonal imbalances of polycystic ovary syndrome (PCOS) and favourably affects fertility.² Lifestyle interventions alone are insufficient for many patients; therefore, multimodality therapies including very low energy diets, pharmacotherapy and, ultimately, bariatric surgery should be considered.⁵ Bariatric surgery generally leads to more than 20% of total body weight loss,⁶ which is sufficient to ameliorate PCOS, diabetes and hypertension.⁷ It has been shown to improve fertility⁸ and pregnancy-related outcomes for mother and child.⁹ However, in the absence of well constructed trials, bariatric surgery for fertility reasons has to be prescribed on a case-by-case basis. Almost 60% of female patients who have bariatric surgery are within the age range of 20–44 years,⁶ and these women need appropriate advice and management around contraception, peri-conception nutrition and supplementation, and weight management during and after pregnancy.

The bariatric surgical landscape has changed significantly in the past decade, with the laparoscopic adjustable gastric band (LAGB) being replaced by laparoscopic sleeve gastrectomy (LSG), gastric bypass, and other procedures. These procedures carry with them differing risks that can affect fertility, pregnancy and childbirth. The craft groups of general practice, bariatric surgery, and fertility medicine of which the authors are members have observed a number of suboptimally managed patients presenting to public hospital emergency departments and high risk pregnancy clinics across Australia recently. Most reviews on this topic have been published in specialist journals that do not aim to a broader audience. This article will help health care professionals to adopt a shared care model when managing female bariatric surgical patients on the issues of fertility, pregnancy, and the post partum period.

The range of outcomes being discussed has been shaped by both frequently encountered problems in the authors' clinical practice; gaps in Australian-specific guidance in the management of female bariatric surgery patients before, during and after conception; and identified the educational needs of general practitioners and other health care professionals involved in the care of pregnant women. This has been compounded by the fact that, i) increasingly, more bariatric surgery is being performed in Australian public hospitals with limited resources, and aftercare is often limited to one year after surgery;¹⁰ and ii) despite bariatric clinics trying to encourage these patients to return for follow-up, attrition rates increase over time, and thus a greater spectrum of health care professionals need to be cognisant of the health care needs of such individuals.¹¹

Summary

- Of the women who gave birth in Australia in 2018, 47% had overweight or obesity, with obesity being associated with both maternal and fetal complications.
- Bariatric surgery improves fertility and some pregnancy-related outcomes.
- Following bariatric surgery, pregnancy should be delayed by at least 12–18 months due to adverse pregnancy outcomes associated with rapid weight loss.
- Contraception should be prescribed after bariatric surgery, although the effectiveness of the oral contraceptive pill may be reduced due to malabsorption and contraceptive devices such as intrauterine devices should be considered as first line therapy.
- After bariatric surgery, women should undergo close monitoring for nutritional insufficiencies before, during and after pregnancy. Expert opinion recommends these women undergo dietary assessment and supplementation to prevent micronutrient deficiencies.
- Bariatric surgeons, bariatric medical practitioners, bariatric dietitians, the patient's usual general practitioner, obstetricians, and maternity specialists should be involved to assist in the multidisciplinary management of these complex patients.

Methods

We conducted a literature search on the MEDLINE and PubMed electronic databases for articles published from 2000 to 2021 to include data relevant to the laparoscopic era. We included English language articles and studies in humans only. The search strategy used combinations of the keywords "overweight", "obesity", "pregnancy", "antenatal", "fertility", "bariatric surgery" and "metabolic surgery". Abstracts were screened for relevance, in particular to the Australian health care landscape. Specialist society publications and guidelines were screened including the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), the British Obesity and Metabolic Surgery Society (BOMSS) and the American Society for Metabolic and Bariatric Surgery (ASMBS). There were no exclusions on article type, and abstracts, review articles, letters and editorials were considered.

Obesity in Australia

Obesity during pregnancy is typically defined as a body mass index (BMI) ≥ 30 kg/m² either before pregnancy or at the first antenatal consultation.¹² The global prevalence of obesity in pregnant women is rapidly rising, with estimates of nearly 40 million pregnant women with either overweight or obesity in the world in 2014.¹³ The percentage of Australians classified as having obesity has risen from 19% in 1995 to 31% in 2017–18, and data collected by the Australian Institute of Health and Welfare in 2018 recorded almost half (47%) of the women who gave birth in that year in Australia as either having overweight (27%) or obesity (20%).^{14,15}

Infertility

In the general population, the conception rate is about 20% per cycle, with a cumulative success rate of 84% at one year.¹⁶ Current literature reports the relative risk of infertility being threefold higher in women with obesity compared with women without obesity and an estimated reduction in the probability of pregnancy of 5% per unit of BMI exceeding 29 kg/m².¹⁷ Women with obesity also experience a twofold longer time to conceive compared with women without obesity.¹⁸ Obesity also has a negative impact on the response to fertility treatment, with a 10% reduction in the success rate for in vitro fertilisation in overweight women, a lower clinical pregnancy rate (risk ratio [RR], 0.90; 95% CI, 0.85–0.94; $P < 0.0001$), and a higher miscarriage rate (RR, 1.31; 95% CI, 1.18–1.45; $P < 0.0001$).^{3,19} It is important to note that the effect of BMI on fertility and miscarriage rates is not linear and instead follows a U-shaped curve, as being underweight also holds a negative impact.²⁰

Obesity exacerbates features of PCOS, a common cause of ovulation failure and, therefore, infertility. This disorder has a prevalence of 12–21% in women of reproductive age in Australia.²¹ Women with overweight or obesity and concurrent PCOS undergoing in vitro fertilisation exhibited improved fertility outcomes when subjected to weight loss through lifestyle modifications compared with those who received immediate treatment with clomiphene. A secondary analysis of two randomised controlled trials reported a 2.5-fold increase in the live birth rate (RR, 2.5; 95% CI, 1.3–4.7; $P = 0.01$) and an increase in the rate of ovulation, from 44.7% to 62.0% (RR, 1.4; 95% CI, 1.1–1.7; $P = 0.003$), in the group with pre-conception weight loss.²²

Compared with lifestyle modifications, very low energy diets and anti-obesity pharmacotherapy, bariatric surgery remains the most clinically effective and cost-effective intervention in the population with severe obesity, with 73.5% of subjects with obesity who previously underwent a gastric bypass maintaining a weight loss of at least 20% of their initial body weight at the 10-year follow-up.²³ Rates of bariatric surgery are increasing, and greater collaboration between surgeons and bariatric centres in local health districts is set to increase uniformity in access across Australia. However, publicly funded bariatric clinics have limited resources and aftercare is often limited to one year after surgery, with patients often being discharged back to their GP early on for ongoing care. Bariatric surgery before pregnancy is increasing, with demonstrated improvements in postoperative conception rates ranging from 33% to 100%, likely due to an improvement in women's hormone profile, restoration of menstrual cycle, and ovulation.²⁴

Contraception after bariatric surgery — timing to conception

Delaying pregnancy after bariatric surgery

A clinical practice guideline by the American Association of Clinical Endocrinology (AACE), The Obesity Society (TOS) and the ASMBS recommends that pregnancy be delayed from 12 to 18 months after surgery due to the rapid and significant weight loss and nutritional insufficiencies which may lead to adverse pregnancy outcomes.^{25,26} Delaying pregnancy enables identification and correction of nutritional insufficiencies that may not be initially evident and allows the patient to achieve their full weight-loss goals.²⁷ Patients should be counselled appropriately by their surgeon and bariatric health care

professional as part of routine preoperative management, as this time delay may have an impact on oocyte quality, which is known to decline in older women.²⁸

Post-bariatric surgery contraception

Bariatric health care professionals, obstetricians and GPs play key roles in discussing options for contraception following bariatric surgery. Reliable contraception is recommended before the patient begins the preoperative very low energy diet and should be continued during the postoperative period. Oral contraceptive pills (OCPs), one of the most commonly used contraceptive methods worldwide, has a failure rate of 5.5% per year in normal circumstances.²⁹ This raises concerns of increased failure rates after bariatric surgery given that most procedures significantly affect digestive physiology.³⁰ Various agencies³¹ have recommended avoiding OCPs in patients having bariatric surgery with significant malabsorptive components, but determining whether an individual patient will have sufficient gastrointestinal changes from their procedure to experience malabsorption is not feasible. While patients with LAGB are unlikely to malabsorb their OCPs, this is not known with either the LSG or the Roux-en-Y gastric bypass (RYGB) procedures, which account for the majority of bariatric surgery currently performed in Australia.

The absence of evidence that OCPs are potentially ineffective after bariatric surgery does not alter the concern that with the known OCP-failure rate in women who did not undergo bariatric surgery, reliance on its effectiveness constitutes a higher risk than what most patients would wish to take, especially during the first 6–9 months after the procedure, when most weight loss will occur.^{9,31} A few small case series have looked at intrauterine devices and contraceptive implants as long-acting reversible contraception methods, with studies suggesting that intrauterine devices should be considered as the first line contraceptive method for patients after bariatric surgery.^{31–33}

Pregnancy occurring in the 12 months following bariatric surgery appears to be generally well tolerated,³⁴ as do the majority of potential micronutrient insufficiencies encountered;³⁵ however, this is a higher risk outcome than pregnancy in a patient with a stable weight and who is nutritionally replete.

Pregnancy in post-bariatric surgery patients

Bariatric surgery with regards to fertility and pregnancy has both potential complications and benefits. A large prospective cohort study from Sweden showed that pregnancy in obesity was associated with increased rates of complications including the development of pre-eclampsia (adjusted odds ratio [aOR], 4.82; 95% CI, 4.04–5.74), fetal macrosomia (aOR, 3.82; 95% CI, 3.50–4.16), stillbirths (aOR, 2.79; 95% CI, 1.94–4.02) and post partum haemorrhage (aOR, 1.70; 95% CI, 1.45–1.98) compared with non-obese counterparts.³⁶ There is also an increased risk of instrumental and caesarean deliveries, miscarriage, and development of neural tube defects in the maternal obesity group compared with their non-obese counterparts.³⁷

There is increasing evidence suggesting that bariatric surgery improves pregnancy outcomes. A systematic review from 2008 found three cohort studies showing a decrease in the rate of gestational diabetes mellitus (0% *v* 22.1%; $P < 0.05$) and pre-eclampsia (0% *v* 3.1%; $P < 0.05$) in patients who had undergone bariatric surgery compared with women with obesity who had not undergone surgery.⁹ Furthermore, bariatric surgery has also been shown to improve neonatal outcomes, specifically

macrosomia (7.7% *v* 14.6%; $P < 0.05$)⁹ and large for gestational age infants (OR, 0.31; 95% CI, 0.17–0.59).³⁸

However, it is important to note that there is an increased risk of a small for gestational age (SGA) neonate in patients who undergo certain types of bariatric surgery before pregnancy, as a retrospective matched-control cohort study found a significantly higher risk for SGA neonates in women following RYGB (OR, 2.16; 95% CI, 1.43–3.32; $P = 0.0003$).³⁹

Glycaemic control

Gestational diabetes mellitus is a well known antenatal complication in women with obesity. The World Health Organization and the Australasian Diabetes in Pregnancy Society (ADIPS) recommends the 75 g pregnancy oral glucose tolerance test as a screening test for gestational diabetes mellitus performed at 24–28 weeks gestation for the general population, but this is likely inappropriate in women who have undergone LSG or RYGB due to rapid gastric emptying. These results are difficult to interpret and the glucose bolus may trigger dumping syndrome and reactive hypoglycaemia, which places the pregnant woman at risk.^{40,41} Although there are no specific guidelines for screening for gestational diabetes mellitus in women who have previously undergone bariatric surgery, it is suggested to measure the glycated haemoglobin level during the first trimester to exclude pre-existing diabetes.⁴² Thresholds for the diagnosis of diabetes in pregnant and non-pregnant women are summarised in **Box 1**. Furthermore, they should be screened using either capillary blood glucose monitoring starting at 14–16 weeks' gestation and continuing throughout the pregnancy, or capillary blood glucose monitoring daily before and after meals during one week at 24–28 weeks' gestation⁴⁴ (**Box 1**). Continuous glucose monitoring for 2–3 days between 24 and 28 weeks' gestation may be considered in high risk patients as an alternative screening method for gestational diabetes mellitus, but it is costly and not widely available.⁴⁵ It is vital that obstetricians and endocrinologists are aware of these patients and manage them appropriately in collaboration with the bariatric surgeon.

Bariatric surgical complications

A patient presenting after bariatric surgery with abdominal pain and/or vomiting requires a surgical assessment and preferably direct contact with a bariatric surgeon. Gallstones, reflux, complex gastric ulcer disease, and small bowel obstruction are more common after bariatric surgery^{46,47} and the surgery itself can lead to vomiting, which can both be misinterpreted in pregnancy as hyperemesis gravidarum and can lead to acute thiamine deficiency. While the overall risk for an individual patient of a surgical complication during pregnancy is low,^{48,49} and severe adverse events are predominantly anecdotal, many of these conditions are time-critical in their management, so an abundance of caution with early consultation is warranted.

While bariatric surgery reduces the risk of pre-eclampsia and metabolic disorders and may therefore reduce the risk of ICU admissions related to these conditions, this is balanced against the risk of post-surgical complications. Any patient in the advanced stages of pregnancy presenting with a putative diagnosis of post-bariatric surgery complications is likely to be admitted to the intensive care unit for monitoring of maternal and fetal wellbeing.

Nutritional screening and supplementation

Post-bariatric surgery patients should undergo close monitoring of their diet and nutrition from the pre-conception stage to the postnatal period. Pre-conception or at the first antenatal visit, patients should have their full blood count, ferritin, iron, vitamin B12, folate, thiamine, calcium, and vitamin D checked, with repeat testing at least once per trimester and during the post partum period if breastfeeding.⁴² The ASMBS, AACE, and TOS recommend that obstetrician management should be complemented with a multidisciplinary approach of bariatric dietitians, bariatric medical practitioners and bariatric surgeons.^{24,41}

It is known that metabolic and nutritional changes occur after bariatric surgery due to reduced intake and alterations in digestive anatomy and physiology.⁴² The recommended nutritional supplementation following LAGB, LSG, RYGB, biliopancreatic diversion (BPD), and duodenal switch are summarised in **Box 2**. If oral supplementation is inadequate, particularly in cases of severe vomiting or decreased oral intake, parenteral supplementation of certain micronutrients, such as thiamine and vitamin B complexes, and iron should be considered.^{42,50} The recommended daily intake of these vitamins and minerals during the prenatal and perinatal periods for women with a history of bariatric surgery are summarised in **Box 3**.

The compliance of long term multivitamin supplementation is suboptimal following bariatric surgery.⁵² There is poor compliance with prescribed multivitamins long term, despite recommendations from the ASMBS and BOMSS that all patients should have micronutrient supplementation after bariatric surgery⁵² (**Box 3**).

Mental health

The relationship between obesity and mental health is bidirectional and deserves special consideration.⁵³ Many patients self-report seeking bariatric surgery to improve their mental health related to their body image; however, it seems that improvements in physical health and function after surgery do not reliably lead to improvements in body image⁵⁴ or mental health.⁵⁵ Compounding this, people living with obesity perceive a significant degree of weight bias and stigmatisation from health care professionals⁵⁶ and while seeking obstetric care.⁵⁷ Suicide is a significant preventable cause of maternal death,⁵⁸ and since

1 Thresholds for diagnosis of diabetes in pregnant and non-pregnant people⁴³

	Non-pregnant women*		Pregnant women†	
	HbA _{1c} (%)	Fasting capillary blood glucose (mmol/L)	HbA _{1c} (%)	Fasting capillary blood glucose (mmol/L)
Diabetes unlikely	< 6.0%	< 5.5	No clear guidelines	≤ 5.0
Diabetes possible	6.0–6.4%	5.6–6.9		> 5.0
Diabetes likely	≥ 6.5%	≥ 7.0		

HbA_{1c} = glycated haemoglobin level. * Based on the Royal Australian College of General Practitioners. † Based on the Australasian Diabetes in Pregnancy Society. ♦

2 Recommended micronutrient supplementation following different types of bariatric surgery⁴²

Supplement	LAGB	LSG and Roux-en-Y gastric bypass	BPD and duodenal switch
Standard multivitamin and mineral tablet including iron, folic acid, and thiamine	✓	✓	✓
1200–1500 mg elemental calcium	Optional, depending on serum levels	✓	✓
≥ 3000 IU of vitamin D, titrated to achieve normal serum levels	✓	✓	✓
Vitamin B12, titrated to achieve normal serum levels	Optional, depending on serum levels	✓	✓
Fat-soluble vitamins (vitamins A, E, K)	Optional	Optional	✓

BPD = biliopancreatic diversion; IU = international units; LAGB = laparoscopic adjustable gastric band; LSG = laparoscopic sleeve gastrectomy. ♦

mental health admissions and suicidality may be more common in the post-bariatric surgery population,⁵⁹ these patients can be potentially considered as being at higher risk but less prone to seeking health care professional attention, prompting early psychology referral.

Venous thromboembolism

Venous thromboembolism (VTE) is a significant cause of pregnancy and post partum morbidity and mortality.

Population studies have shown a strong association between higher BMI and risk of VTE,^{60,61} and obesity is an increased risk factor for VTE in pregnancy.⁶² But pregnancy is in itself a hypercoagulable state, with the dominant risks being a previous history of VTE, the presence of thrombophilia, immobilisation, and post partum complications.⁶³ Any reduction in risk caused by post-bariatric surgery weight loss and metabolic improvements may be dwarfed by these other factors, so patients will still require individualised risk assessment as per current guidelines.⁶⁴

3 Recommended daily intake (RDI) of micronutrients following bariatric surgery adapted from international guidelines^{*,42,51}

Recommended vitamin or mineral	RDI during prenatal and postnatal period	RDI during perinatal period
Selenium	50 µg	50 µg
Copper	2 mg	2 mg
Zinc	<ul style="list-style-type: none"> 15 mg (8–15 mg of zinc for each 1 mg copper) 	
Iron	<ul style="list-style-type: none"> 45–60 mg elemental iron (> 18 mg after LAGB) 	
Vitamin C (in conjunction with iron to aid in absorption)	≥ 75 mg	≥ 75 mg
Folic acid	<ul style="list-style-type: none"> 400 µg 800 µg if planning for pregnancy 4–5 mg if the patient has obesity or diabetes 	<ul style="list-style-type: none"> 800 µg during the first 12 weeks of pregnancy, with a maximum of 1 mg daily 4–5 mg if the patient has obesity, diabetes, or has a history of neural tube defects
Vitamin B12	<ul style="list-style-type: none"> 1 mg intramuscular injection every 3 months Alternatively, 350–500 µg/day, but expect reduced absorption 	
Calcium	<ul style="list-style-type: none"> 1200–2000 mg of elemental calcium; the citrate formulation is preferred over carbonate due to better absorption in the absence of gastric acid 	
Vitamin D	<ul style="list-style-type: none"> 3000–6000 IU daily initially if depleted, then 1000 IU daily — aim to keep vitamin D levels > 50 nmol/L and serum PTH within normal limits 	
Fat soluble vitamins A, E, K (supplementation recommended after BPD and duodenal switch)	<ul style="list-style-type: none"> Vitamin A: 5000 IU Vitamin E: 400 IU Vitamin K: 300 µg Consider additional supplements if the patient complains of steatorrhea β-carotene version of vitamin A is preferred over retinol during pregnancy, with a limit of 5000 IU per day If vitamin K deficiency is measured or if there are coagulation defects, recommend oral supplementation of 10 mg weekly 	
Thiamine	100 mg	<ul style="list-style-type: none"> Consider 300 mg thiamine daily if the patient experiences prolonged vomiting Consider early and urgent referral to a bariatric centre or hospital admission for emergent care and administration of IV thiamine before any IV administration of glucose-containing fluids

LAGB = laparoscopic adjustable gastric band; BPD = biliopancreatic diversion; IU = international units; IV = intravenous; PTH = parathyroid hormone. * The doses may need to be adjusted depending on pre-existing deficiencies. ♦

4 Institute of Medicine guidelines on weight gain for singleton pregnancy, based on the World Health Organization classification of body mass index (BMI) and with an assumption of a standard weight gain in the first trimester for all BMI classifications⁶⁶

BMI (kg/m ²)	Classification	Total weight gain range (kg)	Rates of weight gain in 2nd and 3rd trimester* (kg/week)
< 18.5	Underweight	12.5–18	0.51 (0.44–0.58)
18.5–24.9	Normal	11.5–16	0.42 (0.35–0.50)
25–29.9	Overweight	6.8–11.3	0.28 (0.23–0.33)
≥ 30	Obese	5–9.1	0.22 (0.17–0.27)

* Data presented as mean (range). Source: Adapted from the Royal Australian and New Zealand College of Obstetricians and Gynaecologists.⁶⁶ ♦

Weight management

Ideal weight management during pregnancy in the post-bariatric surgery population is complicated, with sparse and conflicting literature. Gestational weight gain guidelines attempt to balance the risks of macrosomia and a SGA fetus, as well as preterm births and post partum weight retention.⁶⁵ The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG) guidelines on healthy weight gain in pregnancy propose a standard weight gain of 0.5–2 kg in the first trimester for all women, and a linear gain of 0.22 kg/week in the second and third trimesters for obese women with singleton pregnancies^{65,66} (Box 4).

The effects of a gestational weight gain lower than the above recommendation on maternal and fetal outcomes remains controversial, with some studies reporting there being no harm and other studies reporting an increased rate of preterm birth, SGA fetuses, and perinatal mortality.⁶⁷ Women who conceive within 12 months of their bariatric surgery have a higher risk of inadequate gestational weight gain compared with women who conceive within 12–24 months (75.0% v 24.4%; $P < 0.001$), with no difference in the risk of SGA neonates.⁶⁸

Post-LAGB patients who received multidisciplinary care involving bariatric health care professionals were more likely to have optimal mean gestational weight gain, similar to the RANZCOG recommendations, compared with patients who were not seen at all or not seen until after the first trimester (mean, 9.6 kg [standard deviation (SD), 9.0] v 14.4 kg [SD, 9.7]; $P < 0.001$).⁶⁸ A review of the literature establishes that despite possible caloric restriction and low gestational weight gain, LAGB does not seem to have a negative impact on birth weight.⁶⁹ In comparison, RYGB has been associated with an increased risk of SGA fetuses (OR, 2.16; 95% CI, 1.43–3.32; $P = 0.0003$), which is presumed to be secondary to associated anatomical and neuro-hormonal changes.³⁹ Interestingly, a retrospective case–control study involving post-LSG patients demonstrated a significantly higher proportion of SGA fetuses in the LSG group compared with BMI-matched controls (14.3% v 4.2%; $P = 0.01$).⁷⁰ Given that LSG per se does not induce malabsorption, this finding suggests that the observed risk of SGA may involve other factors. Nonetheless, it is

increasingly evident that a multidisciplinary approach including the obstetrician, bariatric health care professionals, and the patient's usual GP is necessary to provide individualised care and clinical judgement when caring for this population.

The optimal strategy for weight reduction post partum is uncertain. A systematic review on the effects of diet and/or exercise for post partum weight loss in the non-bariatric population found that diet alone, or with exercise, facilitates weight loss and is safe for both breastfeeding and non-breastfeeding women.⁷¹ Women who took part in diet alone or diet and exercise programs lost significantly more weight than women in the usual care group.⁷¹ In addition, women who lost all pregnancy weight by 6 months post partum experienced a lower overall weight increase at 8–10 years follow-up compared with women who retained the weight gained during pregnancy.⁷² Therefore, the review suggests that both diet and exercise help with weight reduction and weight maintenance post partum, particularly in the first 6 months.

Conclusion

Bariatric surgery can improve fertility rates and reduce the risk of pregnancy-related complications. However, post-bariatric surgery pregnant women are at increased risk of nutritional insufficiencies during their pregnancy and of preterm or SGA fetuses. It is important that these women are managed early on in the prenatal period with a multidisciplinary team beyond the traditional obstetricians and maternity specialists to also involve bariatric surgeons, bariatric medical practitioners, bariatric dieticians and the patient's usual GP to improve pregnancy-related outcomes.

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- 1 Australian Institute of Health and Welfare. Overweight and obesity: an interactive insight [Cat. No. PHE 251]. Canberra: AIHW. 2020. <https://www.aihw.gov.au/reports/overweight-obesity/overweight-and-obesity-an-interactive-insight/contents/what-is-overweight-and-obesity> (viewed Sept 2020).
- 2 Best D, Avenell A, Bhattacharya S. How effective are weight-loss interventions for improving fertility in women and men who are

overweight or obese? A systematic review and meta-analysis of the evidence. *Hum Reprod Update* 2017; 23: 681–705.

- 3 Koning AMH, Mutsaerts MAQ, Kuchenbecher WKH, et al. Complications and outcome of assisted reproduction technologies in overweight and obese women. *Hum Reprod* 2012; 27: 457–467.
- 4 Aune D, Saugstad OD, Henriksen T, Tonstad S. Maternal body mass index and the risk of fetal

death, stillbirth, and infant death: a systematic review and meta-analysis. *JAMA* 2014; 311: 1536–1546.

- 5 Mutsaerts MAQ, van Oers AM, Groen H, et al. Randomized trial of a lifestyle program in obese infertile women. *N Engl J Med* 2016; 374: 1942–1953.
- 6 Backman B, Brown D, Cottrell J, et al. The Bariatric Surgery Registry annual report, 2020. Melbourne: Monash University, 2020.

- https://www.monash.edu/_data/assets/pdf_file/0004/2582131/2021-Bariatric-Surgery-Registry-8th-Annual-Report-Amended-May.pdf (viewed Sept 2020).
- 7 Li YJ, Han Y, He B. Effects of bariatric surgery on obese polycystic ovary syndrome: a systematic review and meta-analysis. *Surg Obes Relat Dis* 2019; 15: 942–950.
 - 8 Guelinckx I, Devlieger R, Vansant G. Reproductive outcome after bariatric surgery: a critical review. *Hum Reprod Update* 2009; 15: 189–201.
 - 9 Maggard MA, Yermilov I, Li Z, et al. Pregnancy and fertility following bariatric surgery: a systematic review. *JAMA* 2008; 300: 2286–2296.
 - 10 Meyer SB, Booth S, Gray J, et al. Quantitative analysis of bariatric procedure trends 2001–13 in South Australia: implications for equity in access and public healthcare expenditure. *Aust Health Rev* 2014; 39: 63–69.
 - 11 Parretti HM, Hughes CA, Jones LL. “The rollercoaster of follow-up care” after bariatric surgery: a rapid review and qualitative synthesis. *Obes Rev* 2019; 20: 88–107.
 - 12 Kominarek MA, Junghem ES, Hoeger KM, et al. American society for metabolic and bariatric surgery position statement on the impact of obesity and obesity treatment on fertility and fertility therapy Endorsed by the American College of Obstetricians and Gynecologists and the Obesity Society. *Surg Obes Relat Dis* 2017; 13: 750–757.
 - 13 Chen C, Xu X, Yan Y. Estimated global overweight and obesity burden in pregnant women based on panel data model. *PLoS One* 2018; 13: e0202183.
 - 14 Australian Institute of Health and Welfare. Data tables: overweight and obesity, 23 July 2020. <https://www.aihw.gov.au/reports/australias-health/overweight-and-obesity> (viewed Sept 2020).
 - 15 Australian Institute of Health and Welfare. Australia's mothers and babies 2014 — in brief [Cat. No. PER 87]. <https://www.aihw.gov.au/reports/mothers-babies/australias-mothers-babies-2014-in-brief/contents/table-of-contents> (viewed Sept 2020).
 - 16 Wilkes S, Murdoch A. Obesity and female fertility: a primary care perspective. *J Fam Plann Reprod Health Care* 2009; 35: 181–185.
 - 17 Dağ ZÖ, Dilbaz B. Impact of obesity on infertility in women. *J Turk Ger Gynecol Assoc* 2015; 16: 111–117.
 - 18 Hassan MA, Killick SR. Negative lifestyle is associated with a significant reduction in fecundity. *Fertil Steril* 2004; 81: 384–392.
 - 19 Rittenberg V, Seshadri S, Sunkara SK, et al. Effect of body mass index on IVF treatment outcome: an updated systematic review and meta-analysis. *Reprod Biomed Online* 2011; 23: 421–439.
 - 20 Veleva Z, Tiitinen A, Vilksa S, et al. High and low BMI increase the risk of miscarriage after IVF/ICSI and FET. *Hum Reprod* 2008; 23: 878–884.
 - 21 Teede HJ, Misso ML, Deeks AA, et al. Assessment and management of polycystic ovary syndrome: summary of an evidence-based guideline. *Med J Aust* 2011; 195 (Suppl): S65–S112. <https://www.mja.com.au/journal/2011/195/6/assessment-and-management-polycystic-ovary-syndrome-summary-evidence-based>
 - 22 Legro RS, Dodson WC, Kunselman AR, et al. Benefit of delayed fertility therapy with pre-conception weight loss over immediate therapy in obese women with PCOS. *J Clin Endocrinol Metab* 2016; 101: 2658–2666.
 - 23 Picot J, Jones J, Colquitt JL, et al. The clinical effectiveness and cost-effectiveness of bariatric (weight loss) surgery for obesity: a systematic review and economic evaluation. *Health Technol Assess* 2009; 13: 1–190, 215–357, iii–iv.
 - 24 Guelinckx I, Devlieger R, Vansant G. Reproductive outcome after bariatric surgery: a critical review. *Hum Reprod Update* 2009; 15: 189–201.
 - 25 Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient — 2013 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic and Bariatric Surgery. *Obesity (Silver Spring)* 2013; 21 (Suppl): S1–S27.
 - 26 Abodeedy A, Roye GD, Harrington DT, Cioffi WG. Pregnancy outcomes after bariatric surgery: maternal, fetal, and infant implications. *Surg Obes Relat Dis* 2008; 4: 464–471.
 - 27 Wax JR, Pinette MG, Cartin A, Blackstone J. Female reproductive issues following bariatric surgery. *Obstet Gynecol Surv* 2007; 62: 595–604.
 - 28 Baird DT, Collins J, Egozcue J, et al; ESHRE Capri Workshop Group. Fertility and ageing. *Hum Reprod Update* 2005; 11: 261–276.
 - 29 Polis CB, Bradley SE, Bankole A, et al. Typical-use contraceptive failure rates in 43 countries with Demographic and Health Survey data: summary of a detailed report. *Contraception* 2016; 94: 11–17.
 - 30 Edelman AB, Cherala G, Stanczyk FZ. Metabolism and pharmacokinetics of contraceptive steroids in obese women: a review. *Contraception* 2010; 82: 314–323.
 - 31 Schlatter J. Oral contraceptives after bariatric surgery. *Obes Facts* 2017; 10: 118–126.
 - 32 Ciangura C, Corigliano N, Basdevant A, et al. Etonogestrel concentrations in morbidly obese women following Roux-en-Y gastric bypass surgery: three case reports. *Contraception* 2011; 84: 649–651.
 - 33 Hillman JB, Miller RJ, Inge TH. Menstrual concerns and intrauterine contraception among adolescent bariatric surgery patients. *J Womens Health (Larchmt)* 2011; 20: 533–538.
 - 34 Malakauskienė L, Nadišauskienė R, Ramašauskaitė D, et al. Is it necessary to postpone pregnancy after bariatric surgery: a national cohort study. *J Obstet Gynaecol* 2020; 40: 614–618.
 - 35 Rottenstreich A, Elazary R, Goldenshluger A, et al. Maternal nutritional status and related pregnancy outcomes following bariatric surgery: a systematic review. *Surg Obes Relat Dis* 2019; 15: 324–332.
 - 36 Cedergren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome. *Obstet Gynecol* 2004; 103: 219–224.
 - 37 Huang HY, Chen HL, Feng LP. Maternal obesity and the risk of neural tube defects in offspring: a meta-analysis. *Obes Res Clin Pract* 2017; 11: 188–197.
 - 38 Kwong W, Tomlinson G, Feig DS. Maternal and neonatal outcomes after bariatric surgery; a systematic review and meta-analysis: do the benefits outweigh the risks? *Am J Obstet Gynecol* 2018; 218: 573–580.
 - 39 Adams TD, Hammoud AO, Davidson LE, et al. Maternal and neonatal outcomes for pregnancies before and after gastric bypass surgery. *Int J Obes (Lond)* 2015; 39: 686–694.
 - 40 Andrade HF, Pedrosa W, MdeF Diniz, Passos VM. Adverse effects during the oral glucose tolerance test in post-bariatric surgery patients. *Arch Endocrinol Metab* 2016; 60: 307–313.
 - 41 Nankervis A, McIntyre HD, Moses R, et al. ADIPS consensus guidelines for the testing and diagnosis of hyperglycaemia in pregnancy in Australia and New Zealand. Australasian Diabetes in Pregnancy Society, 2014. https://www.adips.org/downloads/2014ADIPSGDMGuidelinesV18.11.2014_000.pdf (viewed Oct 2020).
 - 42 Busetto L, Dicker D, Azran C, et al. Practical recommendations of the obesity management task force of the European association for the study of obesity for the post-bariatric surgery medical management. *Obes Facts* 2017; 10: 597–632.
 - 43 Royal Australian College of General Practitioners. Management of type 2 diabetes: a handbook for general practice. Melbourne: RACGP, 2020. <https://www.racgp.org.au/getattachment/41fee8dc-7f97-4f87-9d90-b7af337af78/Management-of-type-2-diabetes-A-handbook-for-general-practice.aspx> (viewed July 2021).
 - 44 Adam S, Ammori B, Soran H, Syed AA. Pregnancy after bariatric surgery: screening for gestational diabetes. *BMJ* 2017; 356: j533.
 - 45 Bonis C, Lorenzini F, Bertrand M, et al. Glucose profiles in pregnant women after a gastric bypass: findings from continuous glucose monitoring. *Obes Surg* 2016; 26: 2150–2155.
 - 46 Narayanan RP, Syed AA. Pregnancy following bariatric surgery — medical complications and management. *Obes Surg* 2016; 26: 2523–2529.
 - 47 Lim R, Beekley A, Johnson DC, Davis KA. Early and late complications of bariatric operation. *Trauma Surg Acute Care Open* 2018; 3: e000219.
 - 48 Rasmussen AS, Christiansen CF, Uldbjerg N, Nørgaard M. Obstetric and non-obstetric surgery during pregnancy: A 20-year Danish. Population-based prevalence study. *BMJ Open* 2019; 9: e028136.
 - 49 Stuart A, Källen K. Risk of abdominal surgery in pregnancy among women who have undergone bariatric surgery. *Obstet Gynecol* 2017; 129: 887–895.
 - 50 ACOG practice bulletin no. 105: bariatric surgery and pregnancy. *Obstet Gynecol* 2009; 113: 1405–1413.
 - 51 Dagan SS, Goldenshluger A, Globus I, et al. Nutritional recommendations for adult bariatric surgery patients: clinical practice. *Adv Nutr* 2017; 8: 382–394.
 - 52 Rand CS, Macgregor AM. Adolescents having obesity surgery: a 6-year follow-up. *South Med J* 1994; 87: 1208–1213.
 - 53 Rajan TM, Menon V. Psychiatric disorders and obesity: a review of association studies. *J Postgrad Med* 2017; 63: 182–190.
 - 54 Meneguzzo P, Behrens SC, Favaro A, et al. Body image disturbances and weight bias after obesity surgery: Semantic and visual evaluation in a controlled study, findings from the BodyTalk project. *Obes Surg* 2021; 31: 1625–1634.
 - 55 Szmulewicz A, Wanis KN, Gripper A, et al. Mental health quality of life after bariatric surgery: A systematic review and meta-analysis of randomized clinical trials. *Clin Obes* 2019; 9: e12290.
 - 56 Phelan SM, Burgess DJ, Yeazel MW, et al. Impact of weight bias and stigma on quality of care and outcomes for patients with obesity. *Obes Rev* 2015; 16: 319–326.
 - 57 Mulherin K, Miller YD, Barlow FK, et al. Weight stigma in maternity care: women's experiences and care providers' attitudes. *BMC Pregnancy Childbirth* 2013; 13: 19.

- 58 Lysell H, Dahlin M, Viktorin A, et al. Maternal suicide — register based study of all suicides occurring after delivery in Sweden 1974–2009. *PLoS One* 2018; 13: e0190133.
- 59 Morgan DJR, Ho KM, Platell C. Incidence and determinants of mental health service use after bariatric surgery. *JAMA Psychiatry* 2020; 77: 60–67.
- 60 Horvei LD, Brækkan SK, Hansen JB. Weight change and risk of venous thromboembolism: the Tromsø Study. *PLoS One* 2016; 11: e0168878.
- 61 Yang G, De Staercke C, Hooper WC. The effects of obesity on venous thromboembolism: a review. *Open J Prev Med* 2012; 2: 499–509.
- 62 James AH, Jamison MG, Brancazio LR, Myers ER. Venous thromboembolism during pregnancy and the postpartum period: incidence, risk factors, and mortality. *Am J Obstet Gynecol* 2006; 194: 1311–1315.
- 63 Devis P, Knuttinen MG. Deep venous thrombosis in pregnancy: incidence, pathogenesis and endovascular management. *Cardiovasc Diagn Ther* 2017; 7 (Suppl): S309–S319.
- 64 Queensland Clinical Guidelines. Venous thromboembolism (VTE) in pregnancy and the puerperium. Guideline MN20.9-V7-R25. Queensland Health, 2020. <https://www.health.qld.gov.au/qcg> (viewed Nov 2021).
- 65 ACOG Committee opinion no. 548: weight gain during pregnancy. *Obstet Gynecol* 2013; 121: 210–222.
- 66 Royal Australian and New Zealand College of Obstetricians and Gynaecologists. Management of obesity in pregnancy. RANZCOG, 2017. [https://ranzocg.edu.au/RANZCOG_SITE/media/RANZCOG-MEDIA/Women's%20Health/State%20ment%20and%20guidelines/Clinical-Obstetrics/Management-of-obesity-\(C-Obs-49\)-Review-March-2017.pdf?ext=.pd](https://ranzocg.edu.au/RANZCOG_SITE/media/RANZCOG-MEDIA/Women's%20Health/State%20ment%20and%20guidelines/Clinical-Obstetrics/Management-of-obesity-(C-Obs-49)-Review-March-2017.pdf?ext=.pd) (viewed Sept 2020).
- 67 Oken E, Kleinman KP, Belfort MB, et al. Associations of gestational weight gain with short- and longer-term maternal and child health outcomes. *Am J Epidemiol* 2009; 170: 173–180.
- 68 Heusschen L, Krabbendam I, van der Velde JM, et al. A matter of timing — pregnancy after bariatric surgery. *Obes Surg* 2021; 21: 2071–2079.
- 69 Dixon JB, Dixon ME, O'Brien PE. Birth outcomes in obese women after laparoscopic adjustable gastric banding. *Obstet Gynecol* 2005; 106: 965–972.
- 70 Rottenstreich A, Elchalal U, Kleinstern G, et al. Maternal and perinatal outcomes after laparoscopic sleeve gastrectomy. *Obstet Gynecol* 2018; 131: 451–456.
- 71 Amorim Adegboye AR, Linne YM. Diet or exercise, or both, for weight reduction in women after childbirth. *Cochrane Database Syst Rev* 2013; (7): CD005627.
- 72 Rooney BL, Schauburger CW. Excess pregnancy weight gain and long-term obesity: one decade later. *Obstet Gynecol* 2002; 100: 245–252. ■