Annals of Medicine and Surgery 72 (2021) 103038

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.elsevier.com/locate/amsu

Systematic Review / Meta-analysis

Bariatric surgery and its impact on fertility, pregnancy and its outcome: A narrative review

Dg Marshitah Pg Baharuddin [a], Alvin Oliver Payus [b,*], Ehab Helmy Abdel Malek Fahmy [a], Waidah Sawatan [c], Win Win Than [a], Mohsen MA. Abdelhafez [a], Nang Kham Oo Leik [a], D. Maryama Ag Daud [d], Mohd Nazri Mohd Daud [e], Zulkhairul Naim Sidek Ahmad [f]

[a] Department of Obstetrics & Gynaecology, Faculty of Medicine & Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia
[b] Department of Medicine, Faculty of Medicine & Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia
[c] Department of Nursing, Faculty of Medicine & Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia
[d] Department of Medical Education, Faculty of Medicine & Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia
[e] Department of Family Medicine, Faculty of Medicine & Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia
[f] Department of Public Health Medicine, Faculty of Medicine & Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia

ARTICLE INFO

Keywords:
Bariatric surgery
Pregnancy
Obstetrics outcome
Perinatal outcome

ABSTRACT

Bariatric procedures are on the rise as a surgical treatment for morbid obesity. In reproductive age of women, bariatric surgeries will improve factors related to anovulation and lead to spontaneous fertility. Spontaneous pregnancy can happen within a year after bariatric surgery due to higher level of sex hormone binding globulin and follicular stimulating hormone and reduction in androgens level. Reduction of length of follicular phase of menstrual cycle was reported and contribute to improved ovulatory status.

The major impact to pregnant women is development of small for gestational age babies due to persistent weight loss but this can be minimized by avoiding pregnancies too soon after bariatric surgery and good nutrition supplement. Risk of developing gestational diabetes mellitus and preeclampsia reduced among post bariatric surgery compared to no surgery. Another benefit observed are reduction in the risk of caesarean section and admission to neonatal intensive care unit. There are no significant changes in composition of breast milk in postpartum women without bariatric surgery and with women whom undergone surgery although more study needed to evaluate this effect.

Good prenatal care, micronutrient supplement during antenatal follow up and close supervision from expert managing this pregnancy are essential component to ensure good outcome to mothers and their newborn.

1. Introduction

Bariatric surgery is a group of surgeries which are performed on stomach or intestine with the intention to treat obesity. Since its introduction in the 1960s, bariatric procedures gradually gaining acceptance and become the major procedures done in treating severe obesity. Severe obesity defined by World Health Organization as body mass index (BMI) of 40 kg/m^2 or more is associated with problem like diabetes mellitus, hypertension, osteoarthritis, gall stones, gastro oesophageal reflux disease and sleep apnea are becoming more prevalent globally and the cost managing these diseases and its complications are high. In women, obesity is associated with reproductive disorder such as menstrual disturbances, anovulatory cycle, polycystic ovarian syndrome (PCOS) and certain cancers such as breast and endometrial cancer.

Data from the United States (US) in 2002 showed that up to 5.1% of its population had a BMI of more than 40 kg/m^2 [1]. Since the prevalence of morbidly obese population is increasing, there is a high demand for bariatric surgery as from 4925 in 1990's to be as high as 41 000 procedures done in 2000 [2]. Out of 267, 000 obese population in France, up to 86% of female with obesity undergone bariatric surgery from year 2005–2014 with average age of 40.3 years old [3]. However, there are trend in selection of type of bariatric surgery performed in the US. From mid of 2000s, the choice of performing sleeve gastrectomy is much higher compared to RYBG and laparoscopic adjustable banding

* Corresponding author. Internal Medicine, Medicine Based Department, Faculty of Medicine and Health Science, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, Malaysia.
E-mail address: dralvinpayus@ums.edu.my (A.O. Payus).

https://doi.org/10.1016/j.amsu.2021.103038
Received 29 September 2021; Received in revised form 5 November 2021; Accepted 9 November 2021
Available online 11 November 2021

gastric bypass surgery [4]. Similarly in Malaysia, the prevalence of obesity has increased exponentially from 4.4% in 1996 to 17% in 2015. Thus, this has shown the increasing trend of the use of bariatric surgery to treat morbid obesity that are associated with complications in Malaysia [5].

In obstetrics patients, morbidly obese pregnant mother has been shown to have increase in complications such as gestational diabetes mellitus, preeclampsia, abnormal labour which result in operative delivery and admission to neonatal intensive care unit.

Pregnancy following bariatric surgery are more commonly encountered as more obese women choose these procedures to manage their obesity. In this article we will discuss the effects of bariatric surgery on fertility and obstetrics outcome of pregnancy following it.

2. Overview of bariatric surgery

Bariatric surgery can be divided into restrictive, malabsorptive, or mixed types of procedures. The most widely used surgical procedures previously are the Roux-en-Y gastric bypass (RYGB), the sleeve gastrectomy, and the adjustable gastric band. Other procedures such as biliopancreatic diversion are becoming less common nowadays compared to in the early 1990's. In RYGB, the upper part of the stomach is partitioned to create a gastric pouch. About 75–150 cm, part of the small intestine will be used to create another limb that carries ingested food to the bowel. Sleeve gastrectomy is a restrictive procedure and is performed as laparoscopic gastric resection, which creates a small gastric pouch. It can also combine with the duodeno-ileostomy as part of a biliopancreatic bypass.

Gastric banding is normally performed as a laparoscopic procedure and consists in placing a band 1–2 cm below the gastroesophageal junction. The intention in adjustable gastric banding is to create an upper gastric pouch with a capacity of 20–30 ml. The introduction of saline can adjust the degree of constriction through the port.

Other less invasive procedures include placement of intragastric balloon with a volume of at least 400 ml gastric space is occupied, and gastric motility is altered. Bariatric endoscopy procedure is associated with improvement in hypercholesterolaemia, hypertriglyceridemia, and diabetes mellitus [6].

2.1. Improvement in menstrual cycle and fertility factors

Weight loss because of surgery can be as much as 50–100 kg in a period over six months to one year, thus bariatric surgery should be only considered in a patient with severe obesity who fail to lose weight via conventional lifestyle interventions or pharmacological treatment.

Improvement in menstrual cycle and hormonal profiles are seen immediately after bariatric surgery and these changes can lead to spontaneous pregnancy in infertile women [7]. A sudden increase in the level of sex hormone binding globulin (SHBG), reduction in androgens level and increase in follicular stimulating hormone (FSH) are seen after surgery. Other improvement in menstrual cycle is reduction in the length of follicular phase after gastric bypass surgery as reported by Legro RS et al. (2012) in a three years prospective study involving 29 obese pregnant women [8].

2.2. Timing to conceive after bariatric surgery

The persistent weight loss induces by bariatric surgery will eventually improve ovulation rate but these effects may be hazardous to developing foetus if pregnancy is allowed to occur immediately after bariatric surgery. A small retrospective review showed that no significant different in birth weight of babies delivered if woman pregnant within same year after bariatric surgery or more than a year after surgery [9].

Based on the clinical practice guideline by the American Association of Clinical Endocrinologist, the Obesity Society and the American Society for Metabolic & Bariatric Surgery recommended that conception should be avoided for 12–18 months after bariatric surgery [10]. However, other professional bodies such as American College of Obstetrician and Gynaecologists recommends duration of 12–24 months before conception whereas the Royal College of Obstetricians and Gynaecologists suggests individualised approach which depend on the age of women and its effect in delaying pregnancy for older women [11]. Another important factor that must be considered is the type of bariatric surgery. SGA babies were found to be more related with women who underwent Roux-en-Y gastric bypass (RYGB) or adjustable gastric banding thus recommendation is to wait for twelve to eighteen months post-surgery. Based on a retrospective case-control study by Rottenstreich A et al. (2018) there was no increase in adverse outcome in 150 pregnancies that occur within first 18 months after LSG procedure [12].

If the interval of pregnancy and surgery is longer, the risk of underlying deficiency in micronutrients is higher as patients can be lost to follow up after first- or two-years post-surgery [13]. Thus, supplementation and baseline level of nutrients should be checked prior to attempt pregnancy in those group with long interval of surgery and pregnancy.

In the latest guideline from European Association for Endoscopic Surgery, pregnancy should be delayed during weight loss phase. The justifications are lower admissions for neonatal intensive care unit thus minimising foetal adverse outcome [14].

2.3. Risk of nutritional deficiencies

Although bariatric surgery successfully maintains the weight loss, it is not without long term risk. Risk such as nutritional and micronutrient deficiency has been reported from procedures such as with RYGB [15–18]. Among deficiencies that can occur are protein malnutrition, deficiencies in trace elements, essential minerals and water- or fat-soluble vitamins. Metabolic bone diseases such as osteoporosis and osteomalacia may developed if vitamin D level is profoundly low which was seen in cases operated via RYGB procedures [19]. A small randomised control trial comparing the effect of RYGB and laparoscopic biliopancreatic diversion with duodenal switch in Scandinavia showed that RYGB had resulted in reduction in the level of vitamin D, vitamin A and thiamine whereas in duodenal switch procedure, reduction in haemoglobin and total cholesterol were the main findings [20]. Level of vitamin A was consistently low in a pregnant lady whom undergone restrictive type of surgery such as laparoscopic adjustable gastric banding.

Important micronutrient such as iron, calcium, vitamin B12 and folate can be affected from bariatric procedures. These micronutrients are essential during pregnancy and severe deficiency can lead to adverse pregnancy outcome such as anaemia, congenital anomaly such as neural tube defect and megaloblastic anaemia. In pregnancy, placental transfer of vitamin K is very limited thus prophylaxis of vitamin K injection for all newborns are become routine in many countries nowadays to prevent vitamin K bleeding deficiency. Deficiency in vitamin A during pregnancy can be associated with neonatal microphthalmia [21] and severe vitamin K deficiency will be associated with intracranial haemorrhage [22]. Similarly, Eerderkens A et al. (2010) reported five cases of severe intracranial bleeding secondary to vitamin K deficiency after RYGB and biliopancreatic diversion [23]. Whether RYGB or sleeve gastrectomy, both procedures will affect iron absorption through changes in secretion of hypochloric acid and reduce surface area important for iron absorption [24].

2.4. Risk associated with gestational diabetes mellitus (GDM) and preeclampsia

Based on retrospective review of all deliveries between 1988 and 2002 that developed gestational diabetes by Sheiner E et al. (2006) it was found that no significant difference between the outcome of GDM between pregnancy without bariatric surgery and GDM pregnancy

following bariatric surgery [25]. However, Maggard MA et al. (2008) in a systematic review of pregnancy following bariatric surgery had shown that risk of developing gestational diabetes mellitus and preeclampsia were lower in women undergone bariatric surgery compared to obese women without bariatric surgery [26]. A larger Swedish population based study reported by Johansson K et al. (2015) consisting of 670 women who conceived after bariatric surgery showed increased risk of small for gestational age baby without increased risk of gestational diabetes mellitus and slightly shorter duration of gestation compared to their control group [27].

Preeclampsia is another life-threatening complication and it is more common in pregnancy with obesity. Hypertensive disorders affect about 10% of all pregnancy and responsible for about 14% of maternal death globally [28]. Obese women have a threefold increased risk for the development of preeclampsia compared to normal weight pregnant women [29]. Since the sudden surge of increasing number of reproductive obese women undergone bariatric surgeries in the 2000's, it is normal to predict their risk of developing preeclampsia is very much reduced after bariatric surgery. Bennet WL et al. reported that rates of pregnancy induced hypertension were 2.5% lower in post-surgery group compared to 13% in obese pregnant lady without surgery [30].

Incidence of pregnancy induced hypertension post bariatric surgery varies. Studies showed reduction in incidence of preeclampsia after bariatric surgery were many [26,31,32,33]. An increase in incidence of pregnancy induced hypertension was reported in meta-analysis involving 13 studies by Young B et al. (2018) [34]. The increase in incidence could be attributed by older age group and white patients.

2.5. Miscarriages

Spontaneous miscarriages are more common in women with obesity compared to pregnant women with normal BMI [35]. Whether the pregnancy is natural or conceived via assisted reproductive technique, obesity itself or with combination of other factors such as PCOS will increase miscarriage rates. In a meta-analysis involving 16 studies by Metwally M et al. (2008), patients with a BMI of more than 25 kg/m^2 has been found to have increase miscarriage rate despite method of conception [36]. Bilenka B et al. (1995) reported in a small case series of 18 pregnancies which showed decline of miscarriage rate from 33.3% to 7.8% after bariatric surgery [37].

Persistent high miscarriage rate was also noted in pregnancies following biliopancreatic diversion in comparison with control prior to surgery in a prospective study involving by Marceau P et al. (2004) [38]. This may indicate other factors that contribute to persistent miscarriage rate after surgery such as poor oocyte quality or underlying genetic causes.

2.6. Perinatal outcome

Most studies about bariatric surgeries and its impact to pregnancy will also include foetal outcome of it [39–41]. Earlier comprehensive study by Karmon A et al. (2008) suggested that previous reviews failed to significantly show adverse perinatal outcome following bariatric surgeries, but data were mostly collected from adequate prenatal care and maintaining good, important micronutrient supplement prior and throughout pregnancies [42]. Obesity in pregnancy and macrocosmic baby is a well-known risk factor for increase in perinatal morbidity and mortality. Numerous observational studies have shown that reduction in BMI after bariatric surgery reduces the risk of delivering macrocosmic baby [11,26,39,43,44].

Similarly, a systematic review of maternal and neonatal outcomes after bariatric surgery by Kwong W et al. (2018) they have found that reduction of occurrence of large for gestational age babies after bariatric surgery [45].

A small for gestational age baby (SGA) is defined as estimated fetal weight or birth weight of less than 10th centile for gestational age [46]. Several studies previously relate the risk of foetus being small could be related to the amount of weight loss by the mother and the surgical technique used during bariatric surgery.

A cohort retrospective study based on 57 pregnancies from 48 pregnant women who undergone bariatric surgery in France between 2004 and 2014 showed that up to 40% developed SGA babies [47]. Similarly, lower mean birthweight was also the finding of pregnant women after biliopancreatic surgery [38]. A retrospective population-based study by Sheiner E et al. (2004) that involved 298 pregnant post bariatric surgery women showed no significant increase in adverse perinatal outcome [41]. A small prospective study by Dixon JB et al. (2005) who followed up 79 pregnancies after previous laparoscopic adjustable gastric banding procedures found that the complications and adverse outcome were not higher compared to general population. It was mentioned that the effect might be due to adjustability of the procedure that adapt to the nutritional requirements for fetal growth during pregnancy [39].

2.7. Mode of delivery and role of breastfeeding

Bariatric surgery is not a contraindication for trial of vaginal delivery unless absolute obstetrics factors come into play such as presence of placenta praevia, macrosomia and abnormal foetal lie. Earlier systematic review by Vrebosch L et al. (2012) reported that lower rate of caesarean section in the post bariatric surgery group [31] whereas a meta-analysis involving 11 studies by Yi X et al. (2015) have shown no significant difference in Caesarean delivery [48]. However, a retrospective cohort study by Getahun D et al. (2021) reported reduction in Caesarean delivery and also subsequent reduction in neonatal intensive care unit admission [44]. Breastfeeding is an essential part in newborn and provide various health benefits to both mother and her newborn. Little is known about the effect of bariatric surgery on breastfeeding.

In a small multicenter prospective study reported by Jans G et al. (2018) the composition of breastmilk from women after bariatric surgery was found to be comparable with women without bariatric surgery [49]. However, previous failure to thrive was reported in a newborn of a mother undergone gastric bypass surgery [50]. Thus, it is recommended to continue nutritional supplement during breastfeeding period and to practice breastfeeding for at least six months after delivery.

3. Conclusion

Pregnancy following bariatric surgery is one of a high-risk pregnancy and need multidisciplinary follow up to ensure optimal outcome to mother and baby. The choice of bariatric surgery and its subsequent effects, monitoring and possible complication should be discussed in detail with patients.

Ethical approval

This article does not require ethical approval.

Sources of funding

The authors did not receive any source of funding for this article.

Author contribution

Dg Marshitah Pg. Baharuddin – First author, literature search and final editing. Alvin Oliver Payus – supervisor, writing of the manuscript and correspondence. Waidah Sawatan – literature search and editing. Ehab Helmy Abdel Malek – help in the process of writing the manuscript. Win Win Than – literature search and editing. Mohsen MA Abdelhafez – literature search and manuscript writing. Nang Kham Oo Leik – manuscript writing. D. Maryama Ag Daud – help in the process of writing the manuscript. Mohd Nazri Mohd Daud - manuscript writing. Zulkhairul

Naim Sidek Ahmad – editing.

Registration of research studies

1. Name of the registry:
2. Unique Identifying number or registration ID:
3. Hyperlink to your specific registration (must be publicly accessible and will be checked):

Guarantor

Alvin Oliver Payus.

Consent

No consent is required for narrative review.

Declaration of competing interest

All authors declare that there are no conflicts of interest.

References

[1] A.A. Hedley, C.L. Ogden, C.L. Johnson, M.D. Carroll, L.R. Curtin, K.M. Flegal, Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002, Jama 291 (23) (2004 Jun 16) 2847–2850.

[2] H.P. Santry, D.L. Gillen, D.S. Lauderdale, Trends in bariatric surgical procedures, Jama 294 (15) (2005 Oct 19) 1909–1917.

[3] T. Debs, N. Petrucciani, R. Kassir, A. Iannelli, I.B. Amor, J. Gugenheim, Trends of bariatric surgery in France during the last 10 years: analysis of 267,466 procedures from 2005–2014, Surg. Obes. Relat. Dis. 12 (8) (2016 Sep 1) 1602–1609.

[4] S. Kizy, C. Jahansouz, M.C. Downey, N. Hevelone, S. Ikramuddin, D. Leslie, National trends in bariatric surgery 2012–2015: demographics, procedure selection, readmissions, and cost, Obes. Surg. 27 (11) (2017 Nov) 2933–2939.

[5] N.R. Kosai, R. Rajan, History and progress of bariatric surgery in Malaysia, Obes. Surg. 28 (8) (2018 Aug) 2572–2577.

[6] V. Falcone, T. Stopp, M. Feichtinger, H. Kiss, W. Eppel, P.W. Husslein, G. Prager, C. S. Göbl, Pregnancy after bariatric surgery: a narrative literature review and discussion of impact on pregnancy management and outcome, BMC Pregnancy Childbirth 18 (1) (2018 Dec) 1–3.

[7] D.M. Baharuddin, N.K. Leik, F. Hayati, M.N. Daud, E. See, S.Z. Sharif, N.A. Lah, Successful pregnancy in morbidly obese lady with polycystic ovary syndrome after bariatric surgery: a case report, Int. J. Surg. Case Rep. 85 (2021 Aug 1), 106235.

[8] R.S. Legro, W.C. Dodson, C.L. Gnatuk, S.J. Estes, A.R. Kunselman, J.W. Meadows, J. S. Kesner, E.F. Krieg Jr., A.M. Rogers, R.S. Haluck, R.N. Cooney, Effects of gastric bypass surgery on female reproductive function, J. Clin. Endocrinol. Metabol. 97 (12) (2012 Dec 1) 4540–4548.

[9] T. Dao, J. Kuhn, D. Ehmer, T. Fisher, T. McCarty, Pregnancy outcomes after gastric-bypass surgery, Am. J. Surg. 192 (6) (2006 Dec 1) 762–766.

[10] J.I. Mechanick, A. Youdim, D.B. Jones, W.T. Garvey, D.L. Hurley, M.M. McMahon, L.J. Heinberg, R. Kushner, T.D. Adams, S. Shikora, J.B. Dixon, 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 & Bariatric Surgery, Surg. Obes. Relat. Dis. 9 (2) (2013 Mar 1) 159–191.

[11] K.K. Mahawar, Y. Graham, P.K. Small, Optimum time for pregnancy after bariatric surgery, Surg. Obes. Relat. Dis. 12 (5) (2016 Jun 1) 1126–1128.

[12] A. Rottenstreich, U. Elchalal, G. Kleinstern, N. Beglaibter, A. Khalaileh, R. Elazary, Maternal and perinatal outcomes after laparoscopic sleeve gastrectomy, Obstet. Gynecol. 131 (3) (2018 Mar 1) 451–456.

[13] J. Thereaux, T. Lesuffleur, M. Païta, S. Czernichow, A. Basdevant, S. Msika, B. Millat, A. Fagot-Campagna, Long-term follow-up after bariatric surgery in a national cohort, J. Br. Surg. 104 (10) (2017 Sep) 1362–1371.

[14] N. Di Lorenzo, S.A. Antoniou, R.L. Batterham, L. Busetto, D. Godoroja, A. Iossa, F. M. Carrano, F. Agresta, I. Alarçon, C. Azran, N. Bouvy, Clinical practice guidelines of the European Association for Endoscopic Surgery (EAES) on bariatric surgery: update 2020 endorsed by IFSO-EC, EASO and ESPCOP, Surg. Endosc. 34 (6) (2020 Jun) 2332–2358.

[15] A. Victor, V. Odlind, J.G. Kral, Oral contraceptive absorption and sex hormone binding globulins in obese women: effects of jejunoileal bypass, Gastroenterol. Clin. N. Am. 16 (3) (1987 Sep 1) 483–491.

[16] E.G. Gerrits, R. Ceulemans, R. van Hee, L. Hendrickx, E. Totté, Contraceptive treatment after biliopancreatic diversion needs consensus, Obes. Surg. 13 (3) (2003 Jun) 378–382.

[17] L. Busetto, D. Dicker, C. Azran, R.L. Batterham, N. Farpour-Lambert, M. Fried, J. Hjelmesæth, J. Kinzl, D.R. Leitner, J.M. Makaronidis, K. Schindler, 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 10 (6) (2017) 597–632.

[18] R.H. Clements, V.G. Katasani, R. Palepu, R.R. Leeth, T.D. Leath, B.P. Roy, S. M. Vickers, Incidence of vitamin deficiency after laparoscopic Roux-en-Y gastric bypass in a university hospital setting, Am. Surg. 72 (12) (2006 Dec 1) 1196–1204.

[19] B.S. Bal, F.C. Finelli, T.R. Shope, T.R. Koch, Nutritional deficiencies after bariatric surgery, Nat. Rev. Endocrinol. 8 (9) (2012 Sep) 544–556.

[20] E.T. Aasheim, S. Björkman, T.T. Søvik, M. Engström, S.E. Hanvold, T. Mala, T. Olbers, T. Bøhmer, Vitamin Status after Bariatric Surgery: a Randomized Study of Gastric Bypass and Duodenal Switch [Erratum: 2010 Jan., vol. 91, American journal of clinical nutrition AJN, 2009, pp. 239–240, 1.

[21] R. Devlieger, I. Guelinckx, G. Jans, W. Voets, C. Vanholsbeke, G. Vansant, Micronutrient levels and supplement intake in pregnancy after bariatric surgery: a prospective cohort study, PLoS One 9 (12) (2014 Dec 3), e114192.

[22] K.J. Smets, T. Barlow, P. Vanhaesebrouck, Maternal vitamin A deficiency and neonatal microphthalmia: complications of biliopancreatic diversion? Eur. J. Pediatr. 165 (7) (2006 Jul 1) 502–504.

[23] A. Eerdekens, A. Debeer, G. Van Hoey, C. De Borger, V. Sachar, I. Guelinckx, R. Devlieger, M. Hanssens, C. Vanhole, Maternal bariatric surgery: adverse outcomes in neonates, Eur. J. Pediatr. 169 (2) (2010 Feb) 191–196.

[24] N. Steenackers, B. Van der Schueren, A. Mertens, M. Lannoo, T. Grauwet, P. Augustijns, C. Matthys, Iron deficiency after bariatric surgery: what is the real problem? Proc. Nutr. Soc. 77 (4) (2018 Nov) 445–455.

[25] E. Sheiner, T.S. Menes, D. Silverberg, J.S. Abramowicz, I. Levy, M. Katz, M. Mazor, A. Levy, Pregnancy outcome of patients with gestational diabetes mellitus following bariatric surgery, Am. J. Obstet. Gynecol. 194 (2) (2006 Feb 1) 431–435.

[26] M.A. Maggard, I. Yermilov, Z. Li, M. Maglione, S. Newberry, M. Suttorp, L. Hilton, H.P. Santry, J.M. Morton, E.H. Livingston, P.G. Shekelle, Pregnancy and fertility following bariatric surgery: a systematic review, Jama 300 (19) (2008 Nov 19) 2286–2296.

[27] K. Johansson, S. Cnattingius, I. Näslund, N. Roos, Y. Trolle Lagerros, F. Granath, O. Stephansson, M. Neovius, Outcomes of pregnancy after bariatric surgery, N. Engl. J. Med. 372 (9) (2015 Feb 26) 814–824.

[28] L. Say, D. Chou, A. Gemmill, Ö. Tunçalp, A.B. Moller, J. Daniels, A.M. Gülmezoglu, M. Temmerman, L. Alkema, Global causes of maternal death: a WHO systematic analysis, Lancet Global Health 2 (6) (2014 Jun 1) e323–e333.

[29] A.K. Mbah, J.L. Kornosky, S. Kristensen, E.M. August, A.P. Alio, P.J. Marty, V. Belogolovkin, K. Bruder, H.M. Salihu, Super-obesity and risk for early and late pre-eclampsia, BJOG An Int. J. Obstet. Gynaecol. 117 (8) (2010 Jul) 997–1004.

[30] W.L. Bennett, M.M. Gilson, R. Jamshidi, A.E. Burke, J.B. Segal, K.E. Steele, M. A. Makary, J.M. Clark, Impact of bariatric surgery on hypertensive disorders in pregnancy: retrospective analysis of insurance claims data, BMJ (2010 Apr 13) 340.

[31] L. Vrebosch, S. Bel, G. Vansant, I. Guelinckx, R. Devlieger, Maternal and neonatal outcome after laparoscopic adjustable gastric banding: a systematic review, Obes. Surg. 22 (10) (2012 Oct) 1568–1579.

[32] I. González, A. Lecube, M.Á. Rubio, P.P. García-Luna, Pregnancy after bariatric surgery: improving outcomes for mother and child, Int. J. Wom. Health 8 (2016) 721.

[33] A.M. Carreau, M. Nadeau, S. Marceau, P. Marceau, S.J. Weisnagel, Pregnancy after bariatric surgery: balancing risks and benefits, Can. J. Diabetes 41 (4) (2017 Aug 1) 432–438.

[34] B. Young, S. Drew, C. Ibikunle, A. Sanni, Maternal and fetal delivery outcomes in pregnancies following bariatric surgery: a meta-analysis of the literature, Mini Invasive Surg. (2018 Jun 28) 2.

[35] Boots C, Stephenson MD. Does obesity increase the risk of miscarriage in spontaneous conception: a systematic review. In Seminars in Reproductive Medicine 2011 Nov (Vol. vol. 29, No. 06, pp. 507-513). © Thieme Medical Publishers.

[36] M. Metwally, K.J. Ong, W.L. Ledger, T.C. Li, Does high body mass index increase the risk of miscarriage after spontaneous and assisted conception? A meta-analysis of the evidence, Fertil. Steril. 90 (3) (2008 Sep 1) 714–726.

[37] B. Bilenka, I. Ben-Shlomo, C. Cozacov, C.H. Gold, S. Zohar, Fertility, miscarriage and pregnancy after vertical banded gastroplasty operation for morbid obesity, Acta Obstet. Gynecol. Scand. 74 (1) (1995 Jan 1) 42–44.

[38] P. Marceau, D. Kaufman, S. Biron, F.S. Hould, S. Lebel, S. Marceau, J.G. Kral, Outcome of pregnancies after biliopancreatic diversion, Obes. Surg. 14 (3) (2004 Mar) 318–324.

[39] J.B. Dixon, M.E. Dixon, P.E. O'Brien, Birth outcomes in obese women after laparoscopic adjustable gastric banding, Obstet. Gynecol. 106 (5 Part 1) (2005 Nov 1) 965–972.

[40] A. Weintraub, A. Levy, I. Levy, M. Mazor, A. Wiznitzer, E. Sheiner, 647: downsizing gestational complications: pregnancy outcomes before and after bariatric surgery, Am. J. Obstet. Gynecol. 197 (6) (2007 Dec 1) S186.

[41] E. Sheiner, A. Levy, D. Silverberg, T.S. Menes, I. Levy, M. Katz, M. Mazor, Pregnancy after bariatric surgery is not associated with adverse perinatal outcome, Am. J. Obstet. Gynecol. 190 (5) (2004 May 1) 1335–1340.

[42] A. Karmon, E. Sheiner, Pregnancy after bariatric surgery: a comprehensive review, Arch. Gynecol. Obstet. 277 (5) (2008 May) 381–388.

[43] Z. Akhter, J. Rankin, D. Ceulemans, L. Ngongalah, R. Ackroyd, R. Devlieger, R. Vieira, N. Heslehurst, Pregnancy after bariatric surgery and adverse perinatal outcomes: a systematic review and meta-analysis, PLoS Med. 16 (8) (2019 Aug 6), e1002866.

[44] D. Getahun, M.J. Fassett, S.J. Jacobsen, D.A. Sacks, S.B. Murali, M.R. Peltier, W. Mulugeta, V.Y. Chiu, D.A. Wing, K.J. Coleman, Perinatal outcomes after bariatric surgery, Am. J. Obstet. Gynecol. (2021 Jun 30).

[45] W. Kwong, G. Tomlinson, D.S. Feig, Maternal and neonatal outcomes after bariatric surgery; a systematic review and meta-analysis: do the benefits outweigh the risks? Am. J. Obstet. Gynecol. 218 (6) (2018 Jun 1) 573–580.
[46] Melamed N, Baschat A, Yinon Y, Athanasiadis A, Mecacci F, Figueras F, Berghella V, Nazareth A, Tahlak M, McIntyre HD, Da Silva Costa F. FIGO (International Federation of Gynecology and Obstetrics) Initiative on Fetal Growth: Best Practice Advice for Screening, Diagnosis, and Management of Fetal Growth Restriction.
[47] J. Hazart, D. Le Guennec, M. Accoceberry, D. Lemery, A. Mulliez, N. Farigon, C. Lahaye, M. Miolanne-Debouit, Y. Boirie, Maternal nutritional deficiencies and small-for-gestational-age neonates at birth of women who have undergone bariatric surgery, J. Pregnancy (2017 Sep 10) 2017.
[48] X. Yi, Q. Li, J. Zhang, et al., A meta-analysis of maternal and fetal outcomes of pregnancy after bariatric surgery, Int. J. Gynecol. Obstet. 130 (2015) 3–9.
[49] G. Jans, R. Devlieger, De Preter, et al., Bariatric surgery does not appear to affect women's breast-milk composition, J. Nutr. 148 (7) (2018) 1096–1102.
[50] W.S. Martens, L.F. Martin, C.M. Berlin, et al., Failure of a nursing infant to thrive after the mother's gastric bypass for morbid obesity, Paediatric 86 (5) (1990) 777–778.