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Original Research

Bariatric Surgery Impact on Pregnancy and Reproductive Outcomes: A Retrospective Cohort Study in Jordan

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Abstract

Background: Bariatric surgery is gaining popularity, particularly in women of child-bearing age and its impact on future reproductive potential and pregnancies is indeed an important consideration in a country with a high prevalence of obesity. The aim of this retrospective cohort study is to identify the effect of bariatric surgeries on subsequent pregnancies complications and outcomes, labour and neonatal complications, as well as future fertility. **Methods**: This study involved a single-center retrospective review of 66 females of reproductive age (18–48 years old) who underwent bariatric surgery in the period of 2014 and 2020, and their pregnancy and reproductive circumstances were compared pre and post surgery. Data was obtained through an online questionnaire filled by data collectors through a phone interview with the participants, in addition to reviewing their past medical records. Statistical analysis was done using SPSS version 20. **Results**: The results revealed a significant increase in the incidence of low-birthweight infants post bariatric surgery ($p = 0.041$), compared to the same participants' pregnancies before surgery. In addition, significant decrease in the incidence of gestational diabetes was demonstrated. Women in this study were also less likely to have a miscarriage after the bariatric surgery. **Conclusions**: Pregnancy following bariatric surgery poses potential challenges regarding reproductive outcomes, despite the positive impact of weight reduction. Further future large scale, multi-center research is required to fully understand the reproductive and obstetric implications of bariatric surgery. Moreover, Patients should receive education on the effect of bariatric surgery on their future pregnancies.

Keywords: bariatric surgery; weight reduction; birthweight; pregnancy; infertility; Jordan

1. Introduction

Obesity is considered as one of the most challenging health care problems of modern life, as its prevalence is increasing worldwide [1]. In Jordan obesity prevalence among woman was found to be 47.8% [2]. According to the Jordanian Ministry of Health Statistics the prevalence of obesity in the Jordanian population was 32.3%, and 28.3% were overweight in 2020 [3].

Moreover, maternal obesity (defined as Body Mass Index (BMI) >30 in the first antenatal visit) carries a major risk to the mother and to her offspring [4]. It was found to increase the maternal risk for preeclampsia, insulin resistance, thromboembolism, postpartum depression and difficulty in breast feeding. On the other hand, risks to the fetus include macrosomia, increased body fat, perinatal mortality, congenital anomalies, pre or post-term birth, and small or large for gestational age (SGA/LGA) [5,6].

The threat of obesity in pregnancy extends even further. The Center for Maternal and Child Enquiries (CMACE) emphasized that in UK, in the period between 2000–2003, 35% of women who died during pregnancy, labor or the postpartum period were obese, and 30% of births who died as stillbirths or as neonates were born to a mother living with obesity [7].

Bariatric surgery is one of the interventions used for weight reduction in patients living with obesity other than lifestyle modifications and medications and should be considered only in those patients where true indications exist. It is indicated in patients with a BMI of 40 kg/m^2 or more with failure of conservative measures to reduce weight, or a BMI of 35 kg/m^2 or more along with comorbidities [8]. These eligibility requirements are consistent with the guidelines of the Jordanian Society for Obesity Surgery. An estimated 6000 cases of bariatric surgeries are performed in Jordan annually [9].

When comparing women who underwent bariatric surgery before getting pregnant with controls living with obesity or morbid obesity, women with bariatric surgery were found to have lower risk of gestational hypertension, preeclampsia and gestational diabetes, also lower rates of caesarean delivery and instrumental assisted delivery. A multicenter study from Jordan identified the overall incidence rate of gestational diabetes among pregnant Jordanian women to be 1.2% [10], however, a study of the patient population of Jordan University Hospital, a tertiary referral center for fetal and maternal medicine found it to be as high

as 13.5% [11]. In both studies, obesity was a significant risk factor. Gestational diabetes was significantly associated with having a macrosomic baby (birth weight >4.5 kg), the incidence of which was 10.6% versus 9.8% in babies of non-diabetic mothers [10].

Other findings included a lower risk of premature rupture of membranes, chorioamnionitis, postpartum hemorrhage and infection. On the other hand, women who underwent bariatric surgery had higher risk of venous thromboembolism, need for labor induction and blood transfusion, and their neonates were found to be small for gestational age [12,13]. The prevalence of low birth weight in the Jordanian population is 13.8% [14].

A consensus paper of international and multidisciplinary experts recommends postponing pregnancy until a stable weight is achieved. This is typically achieved within 1 to 2 years after surgery [15]. The reason behind this is the rapid weight loss after bariatric surgery, the period needed for the weight to be stabilized and the risk of potential micronutrients deficiencies depending on the type of surgery. This may affect the health of the offspring and might lead to potential neurocognitive, metabolic and cardiovascular impairment as well as growth impairment. Moreover, it was found that women who got pregnant in the first year following surgery had higher rates of stillbirths compared to pregnancies after that period [16,17]. Therefore, contraception should be discussed on planned beforehand, and pregnancy must be planned with adequate pre-conception counselling for women who have done a recent bariatric surgery. In case of an unexpected pregnancy before the recommended period all measures and recommendations must be followed to ensure optimal outcome for both mother and fetus, including regular fetal growth monitoring as well as micronutrient supply to the mother and weight control support.

To the best of our knowledge, this is the first study of the impact of bariatric surgery on reproductive outcomes in Jordan, a middle income country with a high prevalence of obesity, and readily accessible bariatric surgery services.

2. Materials and Methods

2.1 Study Design

This was a retrospective, single-center, comparative study of women pre and post bariatric surgery. Data was extracted from archived medical records and phone interviews of female patients who previously underwent bariatric surgery and sought obstetric care.

2.2 Study Aim

This study aimed to compare pregnancy outcomes and complications, as well as difficulty to conceive pre- and post-bariatric surgery, in a cohort of women who served as their own controls, by examining their pregnancy and reproductive circumstances before and after undergoing bariatric surgery.

2.3 Study Sample

800 women were identified to have had bariatric surgery at Jordan University Hospital (JUH) during the period between 2014 and 2020. After excluding patients that were not willing to participate, patients with missing data, and those who satisfied any of the exclusion criteria (see below), the final sample included 66 female patients (18–48 years old). The control group were the patients themselves before undergoing bariatric surgery. All surgeries were performed in JUH department of bariatric surgery, including Roux-en-Y gastric bypass (RYGB), and sleeve gastrectomy (SG) (4 patients underwent RYGB, the rest had a gastric sleeve procedure).

2.4 Study Tool

An online questionnaire form through phone interview was completed by the research group. After identifying suitable participants from the medical records at JUH, each participant was contacted separately, the nature and purpose of the study was explained, verbal consent to participate was obtained. The time for each phone interview was estimated at around 40 minutes and could be extended if needed. To ensure the anonymity of the participants, no identifying information, such as their name, phone number, or address, was revealed.

The questionnaire consists of 3 sections: the first section is related to the gynecological history, the second & the third sections discuss the obstetric history before and after bariatric surgery respectively.

2.5 Inclusion and Exclusion Criteria

Patients were included in this study if they were female patients (18–48 years old) who underwent one bariatric surgery at the JUH (2014–2020) and didn't use contraception to avoid pregnancy either before bariatric surgery or after. Exclusion criteria were participants who chose not to conceive after bariatric surgery, elective termination of pregnancy, insufficient data about pregnancy course, and patients who underwent more than one bariatric surgery

2.6 Statistical Analysis

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 20 (SPSS Inc., Chicago, IL, USA). Obstetric details including number of pregnancies, term, preterm, abortions, and live births before and after bariatric surgery were analyzed, where only the analysis of total number of pregnancies before and after surgery included the entire sample, while only those women who had pregnancies both before and after surgery were included in the comparison of the remaining factors. We included the mean, standard deviation, and a dependent sample *t*-test where a *p*-value less than 0.05 is significant to analyze the data and reach conclusions.

Table 1. The effect of bariatric surgery on outcomes of pregnancy.

		Pre or Post				*p* value
		PRE		POST		
		Count	Row N %	Count	Row N %	
Spontaneous or assisted reproduction pregnancy	Assisted	2	50.0%	2	50.0%	1.000[a]
	Spontaneous	35	50.0%	35	50.0%	
Planned or not	Planned	23	57.5%	17	42.5%	0.162
	Unplanned	14	41.2%	20	58.8%	
Age at delivery in weeks	37–42	30	53.6%	26	46.4%	0.526[a,b]
	Less than 37	6	37.5%	10	62.5%	
	More than 42	1	50.0%	1	50.0%	
Weight at delivery in kg	2.5–4.5	35	54.7%	29	45.3%	0.041[a,*]
	Less than 2.5	2	20.0%	8	80.0%	
Gender of baby	Female	18	50.0%	18	50.0%	1.000
	Male	19	50.0%	19	50.0%	
Congenital anomalies	No	36	50.0%	36	50.0%	1.000[a,b]
	Yes	1	50.0%	1	50.0%	
NICU admission	No	29	51.8%	27	48.2%	0.588
	Yes	8	44.4%	10	55.6%	
Gestational hypertension	No	30	47.6%	33	52.4%	0.327
	Yes	7	63.6%	4	36.4%	
Gestational DM	No	29	45.3%	35	54.7%	0.041[a,*]
	Yes	8	80.0%	2	20.0%	
Liver problems	No	33	47.8%	36	52.2%	0.165[a]
	Yes	4	80.0%	1	20.0%	
Mode of delivery	Vaginal	14	34.1%	27	65.9%	0.002*
	C-Section	23	69.7%	10	30.3%	
Excessive bleeding after delivery	No	34	49.3%	35	50.7%	0.643[a]
	Yes	3	60.0%	2	40.0%	
Use epidural analgesia	No	19	51.4%	18	48.6%	0.816
	Yes	18	48.6%	19	51.4%	
Breastfeeding	No	8	38.1%	13	61.9%	0.197
	Yes	29	54.7%	24	45.3%	

*The Chi-square statistic is significant at the 0.05 level; NICU, Neonatal Intensive Care Unit; DM, diabetes mellitus; C-Section, caesarean section; a, More than 20% of cells in this subtable have expected cell counts less than 5, Chi-square results may be invalid; b, The minimum expected cell count in this subtable is less than one, Chi-square results may be invalid.

3. Results

800 women were identified to have had bariatric surgery at JUH during the period between 2014 and 2020. After excluding patients that were not willing to participate, patients with missing data, and those who satisfied any of the exclusion criteria (see below), the final sample included 66 female patients (18–48 years old, mean age 38.1 $\pm$ 5 years old) with a mean BMI of 28.1 $\pm$ 6 years old.

The majority of women had a gastric sleeve procedure, with only 4 undergoing RYGB, therefore no subgroup analysis was performed according to type of procedure.

Table 1 includes the data and results explaining the effect of bariatric surgery on various outcomes of pregnancy. In this set, women who had live births either before or after surgery were included, with the aim to identify significant differences before and after surgery. As stated previously, significance was found in the number of women with gestational diabetes mellitus (DM), the mode of delivery, and the weight of the baby at delivery.

In total, there were 37 deliveries that preceded bariatric surgery and 37 deliveries that occurred after surgery. Of these, there were two pregnancies conceived via assisted reproduction technology prior to bariatric surgery and two after surgery. When compared with before surgery, there was a significant increase in babies with low birthweight (<2.5 kg after the surgery, χ^2 (1,74) = 4.163, *p*-value = 0.041, and there was a significant reduction in the incidence of gestational diabetes, χ^2 (1,74) = 4.163, *p*-value = 0.041. Moreover, there was a significant reduction in

Table 2. The effect of surgery on details of gravidity.

		Mean	N	Std. Deviation	Std. Error Mean	*p* value
Pair 1	Term pre-surgery	2.51	51	1.515	0.212	<0.001*
	Term post-surgery	0.88	51	0.588	0.082	
Pair 2	Preterm pre-surgery	0.20	51	0.633	0.089	0.340
	Preterm post-surgery	0.10	51	0.361	0.051	
Pair 3	Abortion/miscarriage pre-surgery	0.98	51	1.449	0.203	0.014*
	Abortion/miscarriage post-surgery	0.43	51	0.728	0.102	
Pair 4	Live births pre-surgery	2.69	51	1.449	0.203	<0.001*
	Live births post-surgery	0.98	51	0.547	0.077	

*The *t*-test is significant at the <0.05 level.

Table 3. The effect of bariatric surgery on fertility.

			Did you have difficulties conceiving after bariatric surgery		Total	*p* value
			Yes	No		
Did you have difficulties conceiving before bariatric surgery	Yes	Count	12	16	28	0.116
		Expected Count	8.9	19.1	28.0	
		% Within did you have difficulties conceiving before bariatric surgery	42.9%	57.1%	100.0%	
		% Within did you have difficulties conceiving after bariatric surgery	57.1%	35.6%	42.4%	
	No	Count	9	29	38	
		Expected Count	12.1	25.9	38.0	
		% Within did you have difficulties conceiving before bariatric surgery	23.7%	76.3%	100.0%	
		% Within did you have difficulties conceiving after bariatric surgery	42.9%	64.4%	57.6%	
Total		Count	21	45	66	
		Expected Count	21.0	45.0	66.0	
		% Within did you have difficulties conceiving before bariatric surgery	31.8%	68.2%	100.0%	
		% Within did you have difficulties conceiving after bariatric surgery	100.0%	100.0%	100.0%	

number of cesarean section delivery after surgery, with more normal vaginal deliveries, χ^2 (1,74) = 9.243, $p < 0.05$ (Table 1).

Table 2 demonstrates data on those women who had pregnancies both before and after surgery. Significant differences were identified in the following items: term delivery, abortions/miscarriages, and live births when compared before and after surgery.

In our sample, 51 women got pregnant, and while the number of pregnancies per patient was significantly higher before surgery (mean (M) = 3.55, standard deviation (SD) = 2.315) than after surgery (M = 1.18, SD = 0.910), t (65) = 7.867, $p < 0.05$ in the full sample, in the 51 women were shown to have a significantly higher number of abortions and miscarriages before surgery (M = 0.98, SD = 1.449) than after surgery (M = 0.43, SD = 0.728), t (50) = 2.524, p = 0.015. It is worth noting that the number of live births per patient (M = 2.69, SD = 1.449) and full term deliveries per patient (M = 2.51, SD = 1.515) before surgery were significantly higher than live births (M = 0.98, SD = 0.547) and full term deliveries (M = 0.88, SD = 0.588) post-surgery, with respective t-tests of: t (50) = 7.538, $p < 0.05$ and t (50) = 6.850, $p < 0.05$ (Table 2).

Table 3 includes analysis of the effect of bariatric surgery on fertility, where all women in our sample were asked if they have had difficulties conceiving before and after surgery, i.e., inability to conceive despite regular intercourse and no use of contraception for one year or longer, and based on their responses we searched for significant differences. No significance was found in this group.

4. Discussion

Bariatric surgery is gaining popularity in Jordan to treat obesity in individuals where other, less invasive methods have failed to achieve the desired reduction in weight. Women of reproductive age are no exception, and the impact of bariatric surgery on future reproductive potential and pregnancies is an important consideration.

This study involved a single-center retrospective review of 66 females of reproductive age who underwent bariatric surgery in the period between 2014 and 2020. Pregnancy outcomes and complications, as well as perceived difficulty to conceive were compared pre- and post-surgery.

The results revealed a significant increase in the incidence of low-birthweight babies post bariatric surgery (p = 0.041). This is comparable to what has been described in previous literature. Not only does bariatric surgery reduce the incidence of macrosomic infants, but Gascoin *et al*. [18] demonstrated that mothers who had previously undergone bariatric surgery were more likely to give birth to low-birthweight infants than healthy controls. In this study, none of the babies born to mothers before or after bariatric surgery exceeded a birthweight of 4.5 kg, however the number of low-birthweight infants (less than 2.5 kg) increased significantly after surgery. This may be due to nutritional deficiencies that are sometimes encountered after surgery.

We also demonstrated a significant reduction in the incidence of gestational diabetes. Numerous studies have found that bariatric surgery significantly reduces the risk of gestational diabetes, but the woman remains at higher risk than the general population [19–21], and there is a linear relationship between oral glucose tolerance test results and complications such as Cesarean Section (CS), pre-eclampsia, and macrosomia [22], in addition to the notion that bariatric surgery reduces the risk of caesarean section [20]. This further supports the outcomes of this research, as we also found a significant reduction in the caesarean section rate in pregnancies that occurred after surgery, compared to those that occurred before. This may in part be due to weight reduction, as well as better glucose tolerance profiles.

In this study, the women were less likely to have a miscarriage after, compared to before surgery. Some studies support this finding. Shah and Ginsburg, for example, stated that the increased risk of miscarriage in women living with obesity may decline after weight-reduction surgery [23]. This was also suggested by Bilenka *et al*. [24]. However, a more recent meta-analysis by Snoek *et al*. [25] did not show any difference in miscarriage rates after bariatric surgery. A similar conclusion was made by Hezelgrave and Oteng-Ntim [26].

Women undergoing bariatric surgery have significant reproductive health care needs, including reliable contraception and counseling about plans regarding post-operative pregnancy [27]. Although most guidelines define a waiting time of 12–18 month after surgery before attempting to conceive [28,29], a more personalized approach balancing nutritional risks of earlier conception against the risk of declining ovarian reserve due to age when delaying pregnancy. If the woman was struggling from obesity-related infertility, bariatric surgery may be effective in increasing the chances of pregnancy [30], however, this study did not particularly target women with fertility issues, and there was no significant difference in the perceived difficulty to perceive prior to and after bariatric surgery.

Other features and outcomes, namely whether the pregnancy was spontaneous or assisted, if the pregnancy was planned or not, age at delivery, sex, congenital anomalies, admission to the neonatal intensive care unit, gestational hypertension, cholestasis of pregnancy, the mode of delivery, excessive bleeding during delivery, the use of epidural anesthesia, and if the baby was breastfed, were not found to be significantly different in ladies who had live births before and after the surgery.

This study is not without limitations. In particular, the small sample size, and single-center setting, lead to a number of findings not reaching statistical significance. The retrospective nature of the research could also lead to recall bias. Future larger scale, multi-center research is required

to further investigate the reproductive and obstetric implications of bariatric surgery on female of childbearing age in our region.

5. Conclusions

Bariatric surgeries represent a fast and satisfactory treatment modality of obesity and associated comorbidities. There are studies in the literature that indicates lower risk of gestational diabetes, hypertension and preeclampsia for pregnancies following bariatric surgery. On the other hand, some studies suggested higher risk for blood transfusion and a smaller gestational age and weight after the surgery. Our study results agree with the existing literature. Within the limits of this study, undergoing bariatric surgery did not improve the fertility potential of participants, however, this finding cannot be generalised due to the small sample size, and larger studies targeting women with specific fertility concerns in addition to obesity are needed. We conclude that although bariatric surgery can have a positive impact on pregnancies, future research is required to investigate the reproductive and obstetric implications of bariatric surgery on a larger scale. Moreover, patients should receive education on the effect of bariatric surgery on their future pregnancies, especially as this method of weight reduction is rapidly gaining popularity among women with obesity.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

NM and MR designed the research study. SGS, LAA, TD, TH, OO, and AM performed the data collection and analysis. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

All subjects gave their informed consent for inclusion before they participated in the study. Confidentiality of the patients was maintained throughout and after the study and anonymity was protected. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Jordan University Hospital (approval number: 221000239).

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

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