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Original study

Obstetric outcomes after general anaesthesia for acute intra-abdominal pathology during pregnancy in a non-university teaching hospital: a retrospective cohort study

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Abstract

Background: **Non-obstetric surgery during pregnancy is required in approximately 0.4–1% of pregnant women and has been associated with adverse obstetric outcomes, such as preterm labour and low birth weight. However, these data originate from secondary and tertiary hospitals usually treating high-risk populations, hence potentially overestimating both incidence and risk.**
Objectives: **To analyse the risk of adverse obstetric outcomes after general anaesthesia for acute intra-abdominal pathology during pregnancy in a non-university teaching hospital.**
Design: **Retrospective cohort study.**
Setting: **Non-university teaching hospital.**
Methods: **Women delivering in 2000-2023 were retrospectively identified from surgical and birth registries. Exposed women received general anaesthesia during pregnancy for laparoscopy or laparotomy for appendicectomy, adnexal pathology, cholecystectomy, or diagnostic procedures. Unexposed women lacked this exposure. Inverse probability of treatment weighting was applied to mitigate confounding by maternal age and parity.**
Main Outcome Measures: **The primary outcome was gestational age at delivery. Secondary outcomes included the incidence of surgery, birth weight, and the risk of preterm delivery, low birth weight, and caesarean section.**
Results: **The study included 47 exposed and 470 unexposed women. Most exposed patients (96%) underwent a single anaesthetic exposure of 54 ± 23 minutes (mean ± standard deviation). For the primary outcome, no significant difference was observed (weighted mean difference: –0.48 weeks, 95% CI: –0.99 to 0.04; p = 0.0686). For the secondary outcomes, the unexposed group had a significantly lower risk of preterm delivery (weighted absolute risk reduction: 14.6%, 95% CI: 1.0–28.2%; p = 0.0359), however, significance was lost in sensitivity analysis. Other secondary outcomes did not differ significantly. 0.31% of patients undergoing intra-abdominal surgery in the study centre were pregnant.**
Conclusions: **This study found no robust evidence linking general anaesthesia for acute intra-abdominal pathology during pregnancy to adverse obstetric outcomes.**

Key words: **Pregnancy, Obstetric Outcome, Anaesthesia, Abdominal surgery, Incidence.**

Introduction

Non-obstetric surgery under general or locoregional anaesthesia is required in 0.4-1.0% of pregnant women[1-4]. Abdominal procedures are most commonly performed, including surgery for appendicitis, adnexal pathology, explorative laparoscopy/laparotomy and cholecystectomy[1,3, 4,7-9], the majority of cases being emergencies[4,6,9]. Surgery is mostly required in the first and second trimester and less frequently in the third trimester[1,3,4,6,9,10]. The majority of procedures are performed under general anaesthesia (70-81%)[1,5,6].

Non-obstetric surgery during pregnancy has been associated with adverse obstetric outcomes in several retrospective studies: preterm (<37 weeks) labour[1-3], lower birth weight[1,2,6], miscarriages[2,3], pregnancy terminations[3] and stillbirths[2]. While a significantly increased risk for delivery via caesarean section was reported in two studies[2,3], one study found no significant difference after a matched analysis1.

An important limitation of all above-mentioned studies is that these studies have been performed in secondary/tertiary hospitals. In these hospitals, both the most complex types of non-obstetric surgery and high-risk pregnancies are overrepresented. Hence, these studies may overestimate both the incidence of non-obstetric surgery during pregnancy and the risks of adverse obstetric outcomes.

The aim of this retrospective cohort study is to report the incidence and risk for adverse obstetric outcomes of general anaesthesia for acute intra-abdominal pathology during pregnancy in a non-university teaching hospital. The hypothesis is that the gestational age at delivery will be lower after exposure to general anaesthesia for acute intra-abdominal pathology during pregnancy.

Methods

Study design and setting

A retrospective cohort study was performed in a non-university teaching hospital (Imelda Hospital, Bonheiden, Belgium) during the period 2000-2023. Ethical approval was obtained from the local ethics committee (Imelda Hospital, Bonheiden, Belgium) on the 12th of September 2023. The manuscript adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

Participants, eligibility criteria

Exposed women underwent general anaesthesia during pregnancy in the study centre to allow laparoscopy or laparotomy for appendicectomy, adnexal pathology, cholecystectomy or for diagnostic procedures. Delivery could take place either at the study centre or at other hospitals.

Unexposed women were pregnant women not exposed to general or locoregional anaesthesia for any surgery. For each included exposed woman, 10 unexposed women were selected: five who delivered closest before, and five who delivered closest after the exposed woman, based on delivery date. Regarding the outcomes of this study, these unexposed women can be considered as random unexposed women (i.e., there is no matching of exposed and unexposed women).

In both groups, delivery took place between 2000 and 2023. Patients who underwent obstetric surgery, foetal surgery or foetal interventions during the same pregnancy were excluded. As early miscarriages (i.e. before 12 weeks of pregnancy) were not consistently registered in birth lists, all early miscarriages < 12 weeks were excluded in both groups.

If an exposed woman was excluded, no set of 10 unexposed women was identified for her. If an unexposed woman was excluded, she was replaced by another unexposed woman.

Informed consent was not obtained for this study. The research team consulted the local ethics committee (Imelda Hospital), which determined that informed consent was not required, as the study was retrospective in nature and utilized only previously collected patient data.

Endpoints

Primary endpoint of this study was the gestational age at delivery in weeks.

Secondary endpoints included birth weight in kilograms, the risk of preterm delivery (< 37 weeks), the risk of low birth weight (i.e., < 2.5 kg), the risk of caesarean section and the incidence for each procedure. The incidence of intra-abdominal surgery during pregnancy was calculated for each procedure relative to the total number of those procedures in the study centre [i.e., the number of pregnant patients undergoing the procedure divided by the total number of patients undergoing the procedure in the study centre (i.e., pregnant plus non-pregnant)].

Statistical methods

For the analysis of the characteristics of the study participants, continuous variables were compared with the student t-test and were summarized as mean + standard deviation (all variables had a normal distribution); categorical variables were compared using the Fisher exact test and were summarized as the numbers and percentages for each category.

For the analysis of the pregnancy outcomes, potential confounding bias induced by the age of the mother at birth and the parity[11] was reduced using propensity scores in an inverse probability of treatment weighting approach. Briefly, for every woman, a weight was calculated to account for these confounders[12,13]. These weights were taken into account when comparing the outcomes of exposed versus unexposed women by linear (continuous variables) and Poisson (dichotomous variables) regression models. The residuals of these regression models had a normal distribution.

Data are expressed as [weighted mean difference or weighted absolute risk reduction, 95% confidence interval; p-value]. These differences represent exposed minus unexposed children, e.g., a negative gestational age at delivery represents a lower gestational age at delivery in exposed children when compared to unexposed children.

For the sensitivity analysis, we used multivariate regression models with adjustment for the confounders and the analysis was also repeated without taking the confounders into account.

As the above-mentioned outcomes are basic and obligatory data in the patient files, missing data was not expected. In case of missing data, for each outcome parameter, the number of subjects with missing data were reported. These subjects were deleted from the dataset before analysis.

A p-value < 0.05 was considered as statistically significant. No correction for multiple testing was used. SAS software (SAS System for Windows version 9.4, SAS Institute Inc, USA) was used for all analyses.

As this study had not been performed previously for acute intra-abdominal pathology in a non-university teaching hospital, no sample size could be calculated a priori and all eligible patients were included.

Results

Participants

The study flow diagram is presented in Figure 1. A total of 47 exposed patients and 470 unexposed patients were included in the analysis.

Characteristics of study participants

There were no statistically significant or clinically relevant differences between the two groups concerning pregnancy characteristics (Table I). In the study centre, 0.31% of acute intra-abdominal surgical procedures were performed in pregnant patients (Table II).

For the exposed group, characteristics of the general anaesthesia exposure for the intra-abdominal surgery can be found in Table III. The majority of patients underwent a single exposure to general anaesthesia with a duration of 54 ± 23 minutes. The most commonly performed procedure was an appendectomy, followed by cholecystectomy, interventions for adnexal pathologies, and diagnostic laparoscopy. Anaesthesia induction was performed with propofol, while maintenance was conducted using desflurane (59%) or sevoflurane (41%). Standard American Society of Anaesthesiologists (ASA) monitoring was employed in all cases.

Pregnancy outcomes

No significant difference was observed in gestational age at delivery (weighted mean difference: -0.48 weeks, 95% CI: -0.99 to 0.04; p = 0.0686). Among secondary outcomes, the unexposed group exhibited a significantly lower risk of preterm delivery (weighted absolute risk reduction: 14.6%, 95% CI: 1.0 to 28.2%; p = 0.0359). No significant differences were identified for birth weight, the risk of low birth weight, or the risk of caesarean delivery (Table IV).

The majority of exposed patients delivered at the study centre, while five patients delivered at other

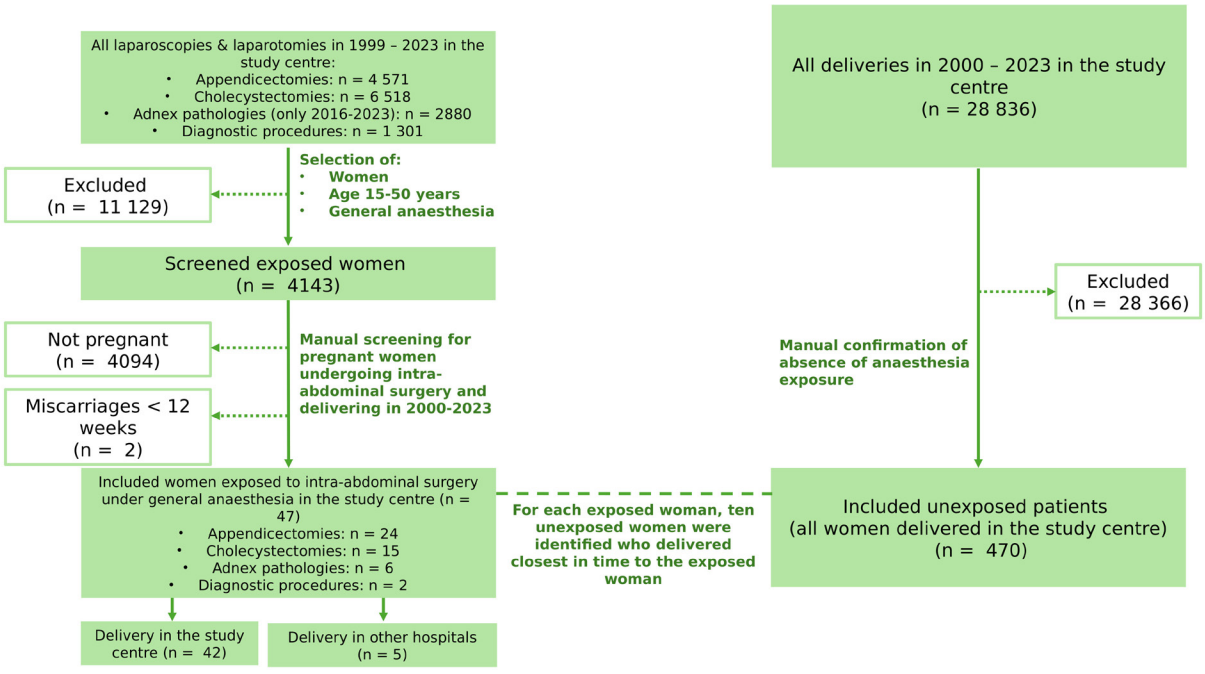

Fig. 1 — Study flowchart.

Table I. — Characteristics of pregnancies of study participants.

	Exposed (n = 47)	Unexposed (n = 470)	P value
Age of mother at birth of child (years)	30.9 ± 4.0	30.6 ± 4.3	0.5738
Parity			0.3790
0	21 (44.7%)	263 (56.0%)	
1	21 (44.7%)	161 (34.3%)	
2	3 (6.4%)	35 (7.5%)	
3	2 (4.3%)	8 (1.7%)	
4	0 (0%)	2 (0.4%)	
7	0 (0%)	1 (0.2%)	
Number of foetuses			0.5789
1	46 (97.9%)	462 (98.3%)	
2	1 (2.1%)	8 (1.7%)	
Radiography or CT-scan during pregnancy			0.0678
No	45 (95.7%)	467 (99.4%)	
Yes	2 (4.3%)	3 (0.6%)	
Smoking during pregnancy			0.7017
No	45 (95.7%)	452 (96.2%)	
Yes	2 (4.3%)	18 (3.8%)	
Alcohol consumption during pregnancy			1
No	47 (100%)	464 (98.7%)	
Yes	0 (0%)	6 (1.3%)	
Illegal drug use during pregnancy			1
No	47 (100%)	468 (99.6%)	
Yes	0 (0%)	2 (0.4%)	
Neuraxial analgesia during delivery			0.7226
No	10 (21.3%)	117 (24.9%)	
Yes	37 (78.7%)	353 (75.1%)	
Sex of the child			0.2218
Male	28 (59.6%)	233 (49.6%)	
Female	19 (40.4%)	237 (50.4%)	

This table describes the characteristics of the pregnancies of the study participants. Continuous variables are presented as mean ± standard deviation and were compared with the student t-test (all variables had a normal distribution). Categorical variables were presented as number of women (percentage) and were compared using the Fisher exact test.

Table II. — Incidence.

	Incidence relative to the total number of surgical procedures
Appendicectomies (1999-2023)	24 / 4 571= 0.53%
Cholecystectomies (1999-2023)	15 / 6 518 = 0.23%
Adnex pathologies (2016-2023)	6 / 2 880 = 0.21%
Diagnostic procedures (1999-2023)	2 / 1 301 = 0.15%
Total: intra-abdominal procedures	47 / 15 270 = 0.31%

The incidence was calculated for each procedure relative to the total number of each procedure in the study centre [i.e., the number of pregnant patients undergoing the procedure divided by the total number of patients undergoing the procedure in the study centre (i.e., pregnant plus non-pregnant)].

Table III. — Characteristics of general anaesthesia exposure for intra-abdominal surgery.

	Exposed (n = 47)
Gestational age at exposure (weeks)	16.7 ± 8.3
Number of exposures	
1	45 (95.7%)
2*	2 (4.2%)
Duration of general anaesthesia (minutes)	54 ± 23
Procedure	
Adnexal pathology - laparoscopy	6
Appendicectomy – laparoscopy	16
Appendicectomy – open surgery	8
Cholecystectomy – laparoscopy	15
Diagnostic - laparoscopy	2
Induction agent for general anaesthesia	
Propofol	43 (100%)
Missing data	4
Maintenance agent for general anaesthesia	
Sevoflurane	16 (41.0%)
Desflurane	23 (59.0%)
Missing data	8
Monitoring during anaesthesia	
Electrocardiography	
Yes	47 (100%)
No	0 (0%)
Blood pressure measurements	
Yes	47 (100%)
No	0 (0%)
Pulse oximetry	
Yes	47 (100%)
No	0 (0%)
Capnography	
Yes	47 (100%)
Missing data	0 (0%)

This table describes the characteristics of general anaesthesia exposure of study participants. Continuous variables are presented as mean + standard deviation. Categorical variables are presented as the number of women (percentage).
* The first patient underwent an ureteroscopy one week after a laparoscopic appendicectomy, both under general anaesthesia. The second patient underwent procedural sedation with midazolam for a failed endoscopic retrograde cholangiopancreatography. Later, a laparoscopic cholecystectomy was performed.

hospitals. Two of these deliveries required referral to tertiary centres due to obstetric complications, i.e. premature labour at 29 weeks because of salpingitis and at 32 weeks following premature rupture of membranes.

Sensitivity analyses

Multivariate regression analysis, adjusted for maternal age at delivery and parity, revealed that the association between exposure and preterm delivery was no longer statistically significant (Supplementary Table 1). No other significant differences were observed in this adjusted analysis. When confounders were not accounted for the conclusions remained consistent with the primary analysis (Supplementary Table 2).

Discussion

Principal findings

In the present study, pregnant women undergoing general anaesthesia for acute intra-abdominal pathology at a non-university teaching hospital did not have a statistically robust increased risk of adverse obstetric outcomes including gestational age at delivery, low birth weight, preterm delivery, and caesarean section.

Interpretation of results

The only statistically significant difference observed in our analysis was an increased risk of preterm delivery; however, this finding lacks statistical robustness. First, it was no longer statistically significant in the sensitivity analysis. Second, the variable "preterm delivery"

Table IV. — Pregnancy outcomes.

			Weighted mean difference (Exposed – Unexposed)			
				95% confidence interval		
	Mean exposed	Mean unexposed	Estimate	Lower limit	Upper limit	P value for estimate ≠ 0
PRIMARY OUTCOME						
Gestational age at delivery (weeks)	38.37	38.85	-0.48	-0.99	0.04	0.0686
SECUNDARY OUTCOMES						
Birth weight (kg)	3.27	3.37	-0.11	-0.27	0.06	0.2122

			Weighted absolute risk reduction (%) (Exposed – Unexposed)			
				95% confidence interval		
	Risk exposed (%)	Risk unexposed (%)	Estimate	Lower limit	Upper limit	P value for ARR ≠ 0
SECUNDARY OUTCOMES						
Low birth weight (< 2.5 kg)	11.7	5.3	6.3	-3.7	16.3	0.2140
Preterm deliveries (< 37 weeks)	22	7.4	14.6	1.0	28.2	0.0359
Caesarean section	27.2	21.2	5.9	-9.5	21.4	0.4519

Potential confounding bias induced by the age of the mother at birth and the parity was reduced by using propensity scores in an inverse probability of treatment weighting approach. Weighted mean difference or weighted absolute risk reduction were calculated using linear (continuous variables) and Poisson (dichotomous variables) regression models. These differences represent exposed minus unexposed children.

reflects a binary categorisation of the continuous variable gestational age at delivery, for which no statistically significant difference was observed. While deliveries in the exposed group occurred on average 3.4 days earlier than in the unexposed group, and birth weight was 110 grams lower in the exposed group, these differences were not statistically significant. Hence, these findings should therefore be interpreted with caution and we suggest that our study does not provide statistically robust evidence of an association between general anaesthesia for acute intra-abdominal pathology during pregnancy and adverse obstetric outcomes.

It could be argued that the lack of robustness is due to a lack of statistical power. While an a priori sample size calculation was not feasible (see above), a posteriori, it was calculated that for the primary outcome a difference of 5 days in gestational age could be detected (using a power of 0.8, an alpha of 0.05, 47 exposed patients, 470 unexposed patients, and an observed pooled standard deviation of 1.70 weeks). This calculation demonstrates that the study's sample size was sufficient to detect a clinically meaningful difference of 5 days.

Previous work

The absence of evidence for adverse pregnancy outcomes following exposure to anaesthesia and surgery during pregnancy in this study contrasts with the conclusions of several previous retrospective studies[1-3,6]. However, key methodological differences between those previous studies and the present investigation may explain these divergent findings. First, most previous studies included all types of non-obstetric surgery, encompassing even high-risk, invasive procedures such as prolonged cardiac surgery requiring intensive care unit admission. Second, several of these studies were conducted in, or included data from, secondary and tertiary hospitals, in which high-risk pregnancies and high-risk patients are overrepresented. Consequently, these studies may have overestimated the risks of adverse pregnancy outcomes. In contrast, the present study focuses on the most common types of surgical procedures performed in the patient population of a non-university teaching hospital. Third, many of these previous studies included excessively large patient cohorts, which can lead to the identification of statistically significant differences that are not clinically meaningful.

Strengths and limitations

This study has several strengths. Firstly, it is the first to investigate the risk of adverse obstetric outcomes and the incidence of general anaesthesia for acute intra-abdominal pathology during pregnancy in a non-university teaching hospital. Secondly, the sample size is sufficiently large to enable the detection of clinically relevant differences. Third, our study included pregnant patients who underwent general anaesthesia over the most recent 23 years. Moreover, standard

ASA monitoring was applied in all cases, and only modern anaesthetic agents—still considered the standard of care in pregnant patients—were used. Therefore, the findings of this study are representative of contemporary clinical practice.

We acknowledge that our study also suffers from certain limitations. Firstly, while confounding bias related to maternal age at birth and parity11 was mitigated through the use of inverse probability of treatment weighting, additional potential confounders, such as sociodemographic variables and several unmeasurable confounders, may still be present. Secondly, early miscarriages (<12 weeks) were excluded, as these cases were not consistently registered in birth records. Consequently, the risk of early miscarriage could not be analysed. Thirdly, there were slight differences between the exposed and unexposed populations. Unexposed women were identified through the birth records of the study centre, meaning that, by definition, all unexposed women delivered at the study centre. In contrast, exposed women were identified from databases of surgical procedures performed at the study centre, with five of these women delivering in other hospitals. The standards of obstetric care in these hospitals may have differed slightly from those of the study centre. However, excluding these exposed women who delivered elsewhere would not have been a preferable approach, as exposure to general anaesthesia for intra-abdominal surgery could potentially lead to obstetric complications necessitating delivery in a secondary or tertiary hospital. In fact, two exposed women required transfer to a more specialised centre due to obstetric complications. Excluding these patients with potentially adverse obstetric outcomes from the exposed group would have introduced significant attrition bias. Theoretically, the optimal approach would have been to recruit both exposed and unexposed patients from one registry of individuals receiving pregnancy follow-up care at the study centre. Unfortunately, such registry was not available and the chosen methodology represented the only feasible approach.

Need for further research

Several retrospective observational studies, including the present study, have analysed short-term outcomes following prenatal exposure to general anaesthesia[1-3,6]; however, only a limited number of clinical studies have investigated long-term outcomes[14-16]. Future research should prioritise the evaluation of long-term outcomes associated with prenatal exposure to general anaesthesia.

Conclusion

This study found no robust evidence of adverse obstetric outcomes following exposure of pregnant women to general anaesthesia for acute intra-abdominal pathology in a non-university teaching hospital.

Supplementary tables: https://qrco.de/bgFQkg

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Authors' contributions:
AC: acquisition of data (all patients), analysis and interpretation of data, drafting the article.
DV: acquisition of data (all patients), analysis and interpretation of data, drafting the article.
PVDP: acquisition of data (all patients, anaesthesia data), analysis and interpretation of data, revising the article critically for important intellectual content.
TT: acquisition of data (abdominal procedures), revising the article critically for important intellectual content.
JB: acquisition of data (gynaecological procedures, obstetric data), revising the article critically for important intellectual content.
AW: acquisition of data (all patients, anaesthesia data), analysis and interpretation of data, revising the article critically for important intellectual content.
GS: acquisition of data (all patients, anaesthesia data), revising the article critically for important intellectual content.

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All authors: approval of the final version of the manuscript and agreement to be accountable for all aspects of the work thereby ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Devroe S, Bleeser T, Van de Velde M, et al. Anesthesia for non-obstetric surgery during pregnancy in a tertiary referral center: a 16-year retrospective, matched case-control, cohort study. Int J Obstet Anesth 2019; 39: 74-81
2. Balinskaite V, Bottle A, Sodhi V, et al. The Risk of Adverse Pregnancy Outcomes Following Nonobstetric Surgery During Pregnancy: Estimates From a Retrospective Cohort Study of 6.5 Million Pregnancies. Ann Surg 2017; 266: 260-6
3. Yu CH, Weng SF, Ho CH, et al. Pregnancy outcomes following nonobstetric surgery during gestation: a nationwide population-based case-control study in Taiwan. BMC Pregnancy Childbirth 2018; 18: 460
4. Cho S, Chung RK, Jin SH. Factors Affecting Maternal and Fetal Outcomes of Non-Obstetric Surgery and Anesthesia during Pregnancy: a Retrospective Review of Data at a Single Tertiary University Hospital. J Korean Med Sci 2020; 35: e113
5. Baldwin EA, Borowski KS, Brost BC, Rose CH. Antepartum nonobstetrical surgery at ≥23 weeks' gestation and risk for preterm delivery. Am J Obstet Gynecol 2015; 212: 232.e1-5
6. Choi HN, Ng BRJ, Arafat Y, Mendis BAS, Dharmawardhane A, Lucky T. Evaluation of safety and foeto-maternal outcome following non-obstetric surgery in pregnancy: a retrospective single-site Australian study. ANZ J Surg 2021; 91: 627-32
7. R NM, O'Gorman DA. Anesthesia in pregnant patients for nonobstetric surgery. J Clin Anesth 2006; 18: 60-6
8. Chohan L, Kilpatrick CC. Laparoscopy in pregnancy: a literature review. Clin Obstet Gynecol 2009; 52: 557-69
9. Vujic J, Marsoner K, Lipp-Pump AH, Klaritsch P, Mischinger HJ, Kornprat P. Non-obstetric surgery during pregnancy - an eleven-year retrospective analysis. BMC Pregnancy Childbirth 2019; 19: 382
10. Mazze RI, Källén B. Reproductive outcome after anesthesia and operation during pregnancy: a registry study of 5405 cases. Am J Obstet Gynecol 1989; 161: 1178-85
11. Yi Wen P, Broom E, Flatley C, Kumar S. Maternal demographic and intrapartum antecedents of severe neonatal outcomes at term. J Matern Fetal Neonatal Med 2020; 33: 2103-8
12. Austin PC. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate Behav Res 2011; 46: 399-424
13. Curtis LH, Hammill BG, Eisenstein EL, Kramer JM, Anstrom KJ. Using inverse probability-weighted estimators in comparative effectiveness analyses with observational databases. Med Care 2007; 45: S103-7
14. Bleeser T, Devroe S, Lucas N, et al. Neurodevelopmental outcomes after prenatal exposure to anaesthesia for maternal surgery: a propensity-score weighted bidirectional cohort study. Anaesthesia 2023; 78: 159-69
15. Ing C, Landau R, DeStephano D, et al. Prenatal Exposure to General Anesthesia and Childhood Behavioral Deficit. Anesth Analg 2021; 133: 595-605
16. Ing C, Silber JH, Lackraj D, et al. Behavioural disorders after prenatal exposure to anaesthesia for maternal surgery. Br J Anaesth 2024; 132: 899-910

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