GYNECOLOGY

Association between hospital procedure volume, socioeconomic status, comorbidities, and adverse events related to surgical abortion: a nationwide population-based cohort study

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BACKGROUND: Limited evidence exists on the influence of hospital procedure volume, socioeconomic status, and comorbidities on surgical abortion outcomes.

OBJECTIVE: Our study aimed to assess the association between hospital procedure volume, individual and neighborhood deprivation, comorbidities, and abortion-related adverse events.

STUDY DESIGN: A nationwide population-based cohort study of all women hospitalized for surgical abortion was conducted from January 1, 2018 to December 31, 2019 in France. Annual hospital procedure volume was categorized into 4 levels based on spline function visualization: very low (<80), low ([80−300]), high ([300−650]), and very high-volume (≥650) centers. The primary outcome was the occurrence of at least one surgical-related adverse event, including hemorrhage, retained products of conception, genital tract and pelvic infection, transfusion, fistulas and neighboring lesions, local hematoma, failure of abortion, and admission to an intensive care unit or death. These events were monitored during the index stay and during a subsequent hospitalization up to 90 days. The secondary outcome encompassed general adverse events not directly linked to surgery.

RESULTS: Of the 112,842 hospital stays, 4951 (4.39%) had surgical-related adverse events and 256 (0.23%) had general adverse events. The multivariate analysis showed a volume-outcome relationship, with lower rates of surgical-related adverse events in very high-volume (2.25%, aOR=0.34, 95% CI [0.29−0.39], $P<.001$), high-volume (4.24%, aOR=0.61, 95% CI [0.55−0.69], $P<.001$), and low-volume (4.69%, aOR=0.81, 95% CI [0.75−0.88], $P<.001$) wh en compared to very low-volume centers (6.65%). Individual socioeconomic status (aOR=1.69, 95% CI [1.47−1.94], $P<.001$), neighborhood deprivation (aOR=1.31, 95% CI [1.22−1.39], $P<.001$), and comorbidities (aOR=1.79, 95% CI [1.35−2.38], $P<.001$) were associated with surgical-related adverse events. Conversely, the multivariate analysis of general adverse events did not reveal any volume-outcome relationship.

CONCLUSION: The presence of a volume-outcome relationship underscores the need for enhanced safety standards in low-volume centers to ensure equity in women's safety during surgical abortions. However, our findings also highlight the complexity of this safety concern which involves multiple other factors including socioeconomic status and comorbidities that policymakers must consider.

Key words: abortion, surgery, social deprivation, health services research, public health

Introduction

Induced abortion is one of the most frequently performed medical procedures worldwide,[1,2] with surgical abortion among the available techniques.[2] In countries where it is legal and well-supervised, the rate of adverse events related to surgical abortion is typically low[3−5]; however, some studies report rates of 5% or higher,[6,7] indicating variability in safety for women. This suggests the presence of especially vulnerable subgroups, potentially pointing to health inequities within these populations.[8] The primary adverse events associated with surgical abortion include retention with or without the need for secondary treatment, hemorrhage, uterine perforation, and infectious complications.[5,6,9−11] While these adverse events are rarely life-threatening,[11,12] they require additional care and can affect fertility and subsequent obstetric outcomes.[13,14] Access to safe abortion is a human right and a fundamental component of reproductive health[15,16]; thus, understanding the factors associated with adverse events is crucial for addressing inequalities in women undergoing surgical abortion.

Recognized as a significant factor in organizational health policies, the relationship between hospital volume and surgical outcomes has been extensively studied, establishing a volume-outcome relationship in complex surgical procedures.[17] However, limited evidence exists on the influence of hospital procedure volume on low-risk surgery outcomes such as surgical abortion. To the best of our knowledge, only one study has suggested that low surgeon procedure volume was associated with an increased risk of complications following surgical abortion.[4] However, this study was based on dated data from 2003 to 2015 and did not include certain complications[18] nor did it address hospital procedure abortion volume. Surgeon procedure volume is just one of many factors influencing health outcomes; hospital procedure volume encompasses not only the surgeon's experience but also other key aspects, such as planning and resource allocation.[19−21] Analyzing hospital

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AJOG at a Glance

Why was this study conducted?

The relationship between annual hospital volume and surgical outcomes is well-established in complex surgical procedures, highlighting a clear volume-outcome relationship. However, there is limited research on how hospital procedure volume affects outcomes in low-risk surgeries, such as surgical abortion.

Key findings

In this nationwide cohort of 112,842 hospital stays for surgical abortion between January 1, 2018 and December 31, 2019, the surgical-related adverse event rates were 4.39%. We identified a volume-outcome relationship, with lower rates in very high-volume centers (2.25%, adjusted odds ratio [aOR]=0.34, 95% CI [0.29−0.39], $P<.001$) than very low-volume centers (6.65%). Additionally, socioeconomic factors and comorbidities significantly influenced these outcomes.

What does this add to what is known?

The presence of a volume-outcome relationship underscores the need for better safety in low-volume centers for equitable women's care in surgical abortions. Our findings also point to the complexity involving socioeconomic status and comorbidities. Policymakers should target improving safety in lower-volume facilities, avoiding politically driven solutions like closing low-volume centers, which could hinder abortion access for the most vulnerable.

volume provides a comprehensive and organizational perspective, essential for enhancing abortion-related healthcare, ensuring patient safety at the healthcare facility level, and better informing public health policy decisions. Additionally, it is important to recognize that populations in high- and low-volume centers may vary significantly, necessitating consideration of their differences in analytical models.[17] Most studies have predominantly focused on hospital volume, overlooking essential patient characteristics such as socioeconomic status[22] and comorbidities,[23,24] which could potentially explain or bias the volume-outcome relationship. We hypothesize that these individual factors play an important role in contributing to increased safety risks for women.

Our study aimed to assess the relationship between hospital procedure volume and surgical abortion adverse events, taking into account often-neglected elements like individual and neighborhood deprivation and patient comorbidities.

Methods

Study design and data source

A nationwide population-based cohort study was conducted utilizing the French national hospital database, Programme de Médicalisation des Systèmes d'Information (PMSI). This database contains standardized administrative and medical data for all hospital stays in obstetrical and acute care facilities, coded using the International Classification of Diseases, 10th version (ICD-10) for diagnoses and the French classification of procedures for medical and surgical interventions. Coding guidelines are in place for all structures, and regular controls are conducted to minimize coding error rates. In accordance with the French law,[25] data in the PMSI are anonymized and can be reused for research purposes and no informed consent was necessary. The unique anonymous identifier enables to link the different hospital stays. This study was declared to the French National Data Protection Commission in accordance with the methodological reference MR005 (declaration number: F20230421092740). This manuscript follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[26]

Study population and French context

The study population included all women hospitalized for surgical abortion in metropolitan France from January 1, 2018, through December 31, 2019. Surgical abortion was defined as a termination of pregnancy occurring between 4 and 14 weeks' gestation by a surgical procedure, identified using diagnostic codes and procedure codes (Supplemental Table 1). In France, abortion is allowed on request for women of all ages, including minors.[27] During the study period, surgical abortion was allowed up to the end of the 14th week of gestation, with electric vacuum aspiration being the recommended procedure.[28] All surgical abortions were performed during a brief hospital stay (day surgery) in accordance with French regulations. Hospital stays with both surgical and medical abortion codes were excluded, as it was not possible to determine which type of abortion was actually performed (ie, coding errors). Stays with incorrect or missing personal identification numbers were also excluded.

Outcomes

The primary outcome was the occurrence of at least one surgical-related adverse event during hospital stay, based on the procedural abortion incident reporting and surveillance (PAIRS) framework.[29] This includes hemorrhage, retained products of conception, genital tract and pelvic infection, transfusion, fistulas and neighboring lesions, local hematoma, failure of abortion, and major adverse events such as admission to an intensive care unit or death. Adverse events mandating overnight hospital stay, supplementary surgery, or blood transfusion were classified as major adverse events, while all remaining events were considered minor.

The secondary outcome was the occurrence of at least one general adverse event not directly linked to surgery, such as acute heart failure, acute liver disease, acute myocardial infarction, acute renal failure, acute respiratory distress, coma, delirium, acute blood or metabolic disorders, puerperal/cerebrovascular disorders, pulmonary edema, pulmonary embolism, sepsis, bacterial sepsis or candida shock, status asthmaticus, and status epilepticus.

Adverse events outlined in both primary and secondary outcomes were identified during the initial stay for surgical induced abortion (index stay) and any subsequent rehospitalizations (including those at different centers) occurring up to 90 days following the index stay. All adverse events were identified using ICD-10 codes (Supplemental Tables 2 and 3).

Exposure

Annual hospital procedure surgical abortion volume, based on data from the years 2018 and 2019, was categorized into 4 levels based on spline function visualization derived from successive logistic regression models[30]: very low-volume (<80), low-volume ([80−300]), high-volume ([300−650]), and very high-volume (≥650) centers. Odds Ratios were calculated through consecutive computations of logistic regressions, modeling the occurrence of at least one adverse event per hospital stay according to dichotomized annual hospital volume using increasing cut-offs. Notable increases or decreases in the spline associated with the minimum *P*-value approach indicated appropriate cut-points (Supplemental Figure).[31]

Collected data

The data collected included age, gestational age (categorized as: ≤7 gestational weeks; >7 and≤11 gestational weeks; >11 and≤14 gestational weeks), universal complementary health coverage (ie, public insurance for those unable to afford it) as a proxy of individual deprivation, neighborhood deprivation based on the French Deprivation Index,[32] the obstetric comorbidity index[33,34] (Supplemental Table 4), the use of general anesthesia, and the category of hospital (university, other public, and private).

Statistical analysis

The characteristics of the study population were compared according to the 4 levels of hospital procedure volume using the Chi^2 test for categorical data and ANOVA tests for quantitative data. To determine whether hospital volume was associated with primary or secondary outcomes, multivariate logistic regression was conducted with generalized estimating equations (GEE) to account for the hospital-cluster effect, adjusting for all the covariates. In a post hoc analysis, we stratified our analysis based on the use of general anesthesia due to a significant imbalance in the practice between low and high volume centers. Results are presented as adjusted Odds Ratios (aOR), along with their 95% confidence intervals (95% CI) and *P*-values. All *P*-values presented were for two-sided tests, and the level of significance was set at $P<.05$. All statistical analyses were conducted using SAS Software, with GEE performed using PROC GLIMMIX.

Results

The database included 123,850 hospital stays with surgical abortions during the study period. Of these, 11,008 were excluded based on the exclusion criteria defined above and detailed in the flow chart (Figure 1). Of the 112,842 analyzed hospital stays, 4951 (4.39%) had at least one surgical-related adverse event, and 256 (0.23%) had at least one general adverse event. Characteristics of women and the hospitals are detailed based on hospital procedure volume in Table 1. From very low-volume to very high-volume centers, there was a noticeable trend in several women characteristics and outcomes. Specifically, very low-volume centers had a higher proportion of women with universal complementary health coverage, living in deprived areas, with multiple comorbidities, and undergoing general anesthesia. Concurrently, these very low-volume centers reported higher frequencies of surgical-related adverse events, major adverse events, and rehospitalizations.

Univariate and multivariate analysis revealed the presence of a volume-outcome relationship, with significantly lower rates of surgical-related adverse events in very high-volume centers (2.25%, aOR=0.34, 95% CI [0.29−0.39], $P<.001$), high-volume centers (4.24%, aOR=0.61, 95% CI [0.55−0.69], $P<.001$), and low-volume centers (4.69%, aOR=0.81, 95% CI [0.75−0.88], $P<.001$) than very low-volume centers (6.65%) (Table 2 and Figure 2). Other factors were associated with surgical-related adverse events, including individual socioeconomic status (aOR=1.69, 95% CI [1.47−1.94], $P<.001$), neighborhood deprivation (aOR=1.31, 95% CI [1.22−1.39], $P<.001$), comorbidity (aOR=1.79, 95% CI [1.35−2.38], $P<.001$), gestational age (≤7 weeks and from 12 to 13 weeks vs from 8 to 11 weeks: aOR=1.45, 95% CI [1.34−1.56], $P<.001$; and aOR=1.10, 95% CI [1.02−1.19], $P<.001$; respectively), anesthesia use (aOR=2.17, 95% CI [1.94−2.42], $P<.001$), and hospital category (private vs public hospitals: aOR=1.35, 95% CI [1.24−1.48], $P<.001$). The most common surgical-related adverse events were retained

FIGURE 1
Study flowchart

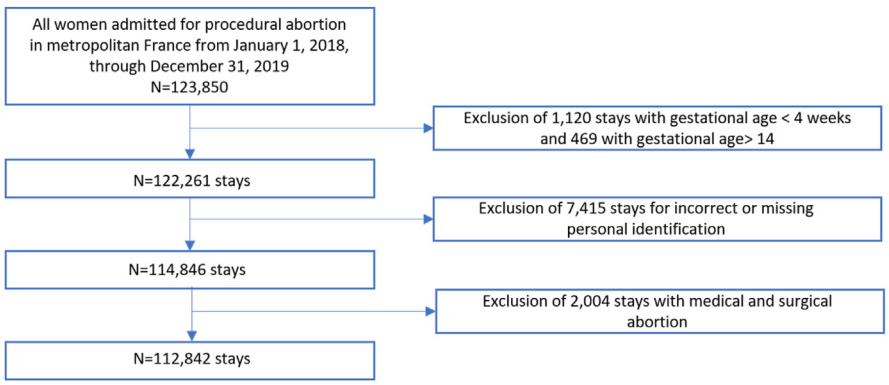


TABLE 1
Characteristics according to hospital procedure volume

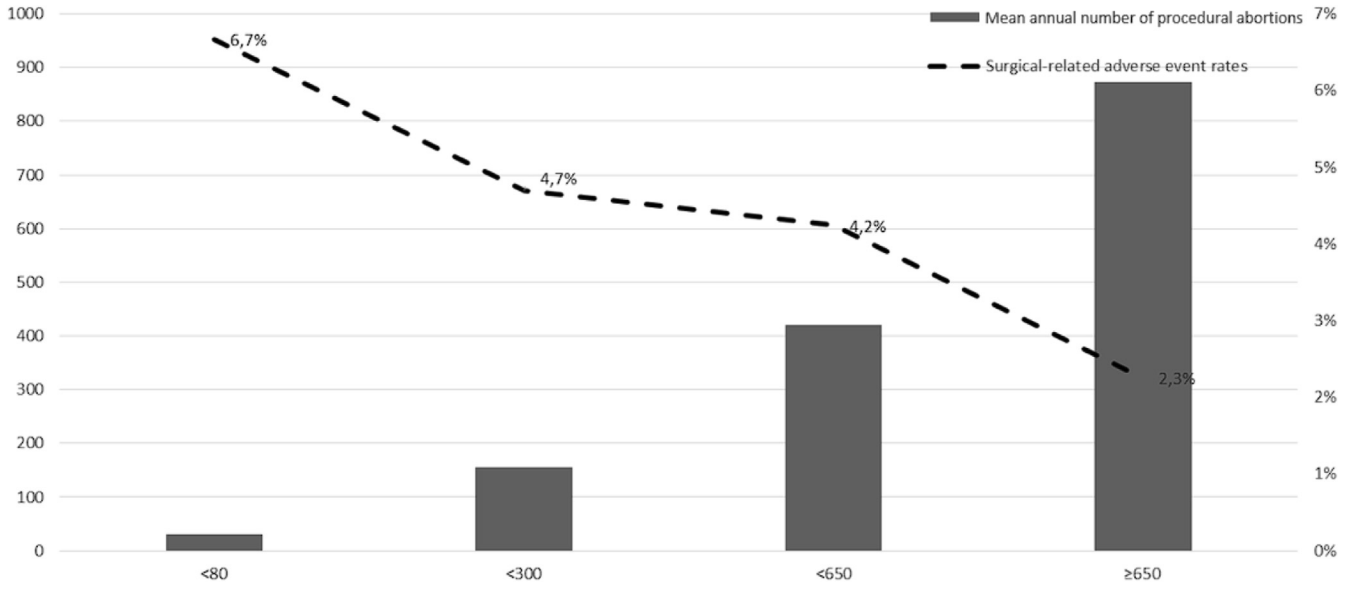
	All	Very low-volume <80	Low-volume <300	High-volume <650	Very high-volume ≥650	*P* value
Hospital characteristics, N (%)	502	302 (60.0%)	148 (29.5%)	39 (7.8%)	13 (2.6%)	
Category of hospitals						<.001
University	53 (11.6%)	7 (2.3%)	12 (8.1%)	23 (59.0%)	11 (84.6%)	
Other public	297 (59.2%)	170 (56.3%)	113 (76.4%)	14 (35.9%)	0 (0%)	
Private	152 (30.3%)	125 (41.4%)	23 (15.5%)	2 (5.1%)	2 (15.4%)	
Annual number of surgical abortions (mean ± SD)	119.8 ± 173.7	30.9 ± 22.1	154.6 ± 65.1	420.1 ± 101.2	872.0 ± 198.2	<.001
Women's characteristics, N (%)	112,842	16,799 (14.9%)	42,969 (38.1%)	31,268 (27.7%)	21,806 (19.3%)	
Age (y)						
Mean ± SD	27.93 ± 7.15	28.90 ± 7.2	28.15 ± 7.16	27.39 ± 7.05	27.54 ± 7.06	<.001
≤17	5336 (4.7)	685 (4.0)	1978 (4.6)	1668 (5.3)	1005 (4.6)	<.001
17–19	8641 (7.6)	1128 (6.7)	3156 (7.3)	2570 (8.2)	1787 (8.1)	
20–24	27,885 (24.7)	3500 (20.8)	10,176 (23.6)	8359 (26.7)	5850 (26.8)	
25–29	25,503 (22.6)	3649 (21.7)	9751 (22.6)	7074 (22.6)	5029 (23.0)	
30–34	21,721 (19.2)	3548 (21.1)	8546 (19.8)	5717 (18.2)	3910 (17.9)	
35–39	16,618 (14.7)	3017 (17.9)	6487 (15.1)	4169 (13.3)	2945 (13.5)	
40–44	6487 (5.7)	1151 (6.8)	2624 (6.1)	1560 (4.9)	1152 (5.2)	
≥44	651 (0.5)	121 (0.7)	251 (0.5)	151 (0.4)	128 (0.5)	
Gestational age (wk)						<.001
≤7	17,911 (15.8)	2814 (16.7)	5864 (13.6)	4405 (14.0)	4828 (22.1)	
8–11	75,581 (66.9)	11,899 (70.8)	29,513 (68.6)	20,692 (66.1)	13,477 (61.8)	
12–14	19,350 (17.1)	2086 (12.4)	7592 (17.6)	6171 (19.7)	3501 (16.0)	
Universal complementary health coverage	3025 (2.6)	660 (3.9)	1375 (3.2)	651 (2.0)	339 (1.5)	<.001
Neighborhood deprivation	58,011 (51.4)	11,811 (70.3)	24,340 (56.6)	15,747 (50.3)	6113 (28.0)	<.001
Metcalfe comorbidity index ≥1	24,430 (21.6)	4350 (25.8)	9570 (22.2)	5987 (19.1)	4343 (19.9)	<.001
General anesthesia	88,957 (78.8)	16,186 (96.3)	38,293 (89.1)	23,391 (74.8)	11,087 (50.8)	<.001
Category of hospitals						<.001
University	42,752 (37.9)	72 (0.4)	4704 (11.0)	18,778 (60.1)	19,198 (88.0)	
Public	53,231 (47.2)	10,657 (63.4)	32,250 (75.1)	10,324 (33.0)	0 (0.0)	
Private	16,859 (14.9)	6070 (36.1)	6015 (14.0)	2166 (6.9)	2608 (12.0)	
Safety, N (%)						
Surgical-related adverse events	4951 (4.4)	1118 (6.6)	2015 (4.6)	1327 (4.2)	491 (2.2)	<.001
General adverse events	256 (0.2)	43 (0.3)	103 (0.2)	68 (0.2)	42 (0.2)	.533
Admission to an intensive care unit	11 (0.0)	2 (0.0)	9 (0.0)	0 (0.0)	0 (0.0)	.013
Death	1 (0.0)	0 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)	.654
Major adverse events	3285 (2.9)	779 (4.6)	1323 (3.1)	792 (2.5)	285 (1.3)	<.001
Rehospitalization	5472 (4.9)	1046 (6.2)	2100 (4.9)	1433 (4.6)	893 (4.1)	<.001

TABLE 2
Factors associated with surgical-related adverse events

	Surgical-related adverse event rates	Crude OR [95% CI]	Crude *P* value	Adjusted[a] OR [95% CI]	Adjusted[a] *P* value
Hospital volume, N (%)			<.001		<.001
Very low-volume <80	1118 (6.65)	1		1	
Low-volume <300	2015 (4.69)	0.69 [0.64–0.74]	<.001	0.81 [0.75–0.88]	<.001
High-volume <650	1327 (4.24)	0.62 [0.57–0.68]	<.001	0.61 [0.55–0.69]	<.001
Very high-volume ≥650	491 (2.25)	0.32 [0.29–0.36]	<.001	0.34 [0.29–0.39]	<.001
Women characteristics, N (%)					
Age (y)			.006		.032
≤17	228 (4.27)	1		1	
17–19	400 (4.63)	1.09 [0.92–1.28]	.324	1.13 [0.95–1.34]	.162
20–24	1143 (4.10)	0.96 [0.83–1.11]	.558	1.00 [0.86–1.16]	.997
25–29	1080 (4.23)	0.99 [0.86–1.15]	.325	1.04 [0.90–1.21]	.607
30–34	996 (4.59)	1.14 [0.98–1.32]	.097	1.11 [0.96–1.30]	.167
35–39	802 (4.83)	1.01 [0.85–1.21]	.907	1.16 [1.00–1.36]	.055
40–44	280 (4.32)	0.78 [0.50–1.22]	.283	1.04 [0.87–1.27]	.644
≥44	22 (3.38)	0.88 [0.78–0.99]	.032	0.84 [0.54–1.33]	.466
Gestational age (wk)			<.001		<.001
≤7	952 (5.31)	1.30 [1.22–1.41]	<.001	1.45 [1.34–1.56]	<.001
8–11	3105 (4.11)	1		1	
12–14	894 (4.62)	1.13 [1.05–1.22]	.001	1.10 [1.02–1.19]	<.001
Universal complementary health coverage					
No	4696 (4.28)	1		1	
Yes	242 (8.00)	1.94 [1.70–2.23]	<.001	1.69 [1.47–1.94]	<.001
Neighborhood deprivation					
No	1933 (3.60)	1		1	
Yes	2993 (5.16)	1.46 [1.37–1.55]	<.001	1.31 [1.22–1.39]	<.001
Previous surgical abortion (last 6 y)					
No	4267 (4.39)	1			
Yes	684 (4.40)	1.03 [0.97–1.11]	.436		
Metcalfe comorbidity index ≥1					
No	4892 (4.35)	1		1	
Yes	59 (9.34)	2.26 [1.72–2.97]	<.001	1.79 [1.35–2.38]	<.001
General anesthesia					
No	442 (1.85)	1		1	
Yes	4509 (5.07)	2.83 [2.56–3.13]	<.001	2.17 [1.94–2.42]	<.001
Category of hospitals			<.001		
University	1646 (3.85)	0.87 [0.93–0.82]	<.001	1.75 [0.59–0.94]	.233
Public	2337 (4.39)	1		1	
Private	968 (5.74)	1.33 [1.23–1.43]	<.001	1.35 [1.24–1.48]	<.001

[a] Results are also adjusted on the region of patient residence but are not presented in this table.

FIGURE 2
Surgical-related adverse event rates according to the 4 levels of annual center procedure volume



products of conception (2.9%), hemorrhage (1.0%), and genital tract and pelvic infection (0.3%) (Table 3). The rate of retained products of conception was significantly lower in very high-volume centers (0.7%) than others. In post hoc analyses focusing on subpopulations stratified by the use of general anesthesia, no significant change was observed in the volume-outcome relationship. Regardless of whether general anesthesia was used, there were consistently fewer surgery-related adverse events in high-volume centers than low-volume ones (Supplemental Tables 5–7). Conversely, the multivariate analysis of general adverse events did not reveal any volume-outcome relationship, but it identified associations with individual socioeconomic status (aOR=2.79, 95% CI [1.70–4.59], $P<.001$), comorbidity (aOR=10.32, 95% CI [6.05–17.60], $P<.001$), and general anesthesia (aOR=1.64, 95% CI [1.06–1.51],

TABLE 3
Details of surgical-related adverse events according to hospital procedure volume

	All	Very low-volume <80	Low-volume <300	High-volume <650	Very high-volume ≥650
	112,842	16,799	42,969	31,268	21,806
Surgical-related adverse event rates, N (%)					
Hemorrhage	1093 (1.0)	236 (1.4)	475 (1.1)	255 (0.8)	127 (0.6)
Retained products of conception	3262 (2.9)	648 (3.9)	1450 (3.4)	1017 (3.3)	147 (0.7)
Genital tract and pelvic infection	385 (0.3)	49 (0.3)	96 (0.2)	60 (0.2)	180 (0.8)
Transfusion	118 (0.1)	22 (0.1)	66 (0.2)	21 (0.1)	9 (0.0)
Fistulas and neighboring lesions	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Local hematoma	3 (0.0)	1 (0.0)	1 (0.0)	1 (0.1)	0 (0.0)
Failure of abortion	211 (0.2)	60 (0.4)	83 (0.2)	49 (0.2)	19 (0.1)
Instrumental damage	32 (0.0)	3 (0.0)	8 (0.0)	15 (0.1)	6 (0.0)
Other complications including surgical intra uterine evacuation procedure	1085 (1.0)	387 (2.3)	357 (0.8)	217 (0.7)	124 (0.6)

P=.003) (Table 4). The general adverse events are described in Table 5.

Comment

Principal findings

In this nationwide population-based cohort study of 112,842 hospital stays for surgical abortions in France between 2018 and 2019, our study confirms that these procedures are predominantly safe with a low rate of adverse events. However, disparities in safety were observed, emphasizing the need to refine public health, hospital, and procedural policies to further enhance women's safety. Findings indicate higher adverse events in centers with low procedure volumes; however, consistent with other experts,[18] centralizing surgical abortions as done in complex surgery is not deemed relevant. The undeniable right to abortion access must remain paramount, especially given the international landscape where some countries are revisiting this fundamental right.[35] Efforts should thus target improving safety in lower-volume facilities, while considering other major factors such as socioeconomic status and comorbidities that influence outcomes.

Results in the context of what is known

To the best of our knowledge, this is the first study to identify a volume-outcome relationship between hospital procedure volume and adverse events. As suggested by the higher rate of retained products of conception in low volume centers, the surgeon's experience appears to be a contributing factor. A Canadian study confirmed that surgeons conducting fewer procedures experienced higher adverse event rates.[4] Additionally, another study reported an association between surgeon's seniority and patient outcomes, but not procedure volume,[36] suggesting that surgeon factors other than volume could influence outcomes. Postoperative outcomes for complex surgical procedures can be comparable between high- and low-volume centers when surgeons undergo similar training and mentoring.[37] This suggests benefits of training programs that emphasize both skill and mentorship in reducing adverse events in surgical abortions. Furthermore, another study examining both the profession and seniority of medical staff—including roles such as senior doctors, junior doctors, midwives, and nurses—identified no significant disparities among these groups.[38] This contrasting finding suggests that other organizational and systemic factors, beyond individual training and seniority, might also play a pivotal role. We can hypothesize that high-volume centers benefit from streamlined organizational and management protocols.[39] Such centers might have comprehensive infection prevention measures,[40–43] access to advanced technical equipment for accurate assessment of adverse events (like specific lab tests and ultrasounds[44,45]), and the ability to consult or collaborate with specialized colleagues when needed. To enhance outcomes, low-volume centers could form partnerships with higher-volume institutions, sharing both expertise and protocols. Prior research has indicated that a partnership model between high- and low-volume hospitals can enhance postoperative outcomes in low-volume facilities.[46] For instance, the hub-and-spoke model, in which a primary hub delivers comprehensive care while peripheral spokes offer more basic services and refer complex cases to the hub, might present an effective strategy for enhancing surgical abortion outcomes.[47] The underlying factors contributing to morbidity disparities based on volume necessitate further investigation to inform policy makers and guide future interventions.

Clinical and research implications

A striking finding was the predominant use of general anesthesia in very low and low volume centers, with rates of 96% and 89% respectively. This finding suggests that these centers seldom offer local anesthesia, despite the fact that general anesthesia is not routinely recommended for abortion procedures.[41,42,48] Several explanations may be suggested, such as the absence of specific organizational structures for local anesthesia in these hospitals (eg, specific rooms, dedicated departments, or trained nurses) or the possibility that practitioners with lower activity volumes in these hospitals have less experience in performing local anesthesia. This finding is unlikely to have impacted the main result, as both the adjusted analysis and the stratified analysis continued to show an association between the volume of the center and the occurrence of surgery-related events. Furthermore, higher complication rates were observed in abortions performed in very low-volume centers using anesthesia (6.7%). It is thus necessary that every center can provide both local and general anesthesia options, empowering women to select according to their preferences.

The association between socioeconomic deprivation and surgical-related and general adverse events are in accordance with a US study which reported that women utilizing Medicaid had higher odds of major incidents than those who did not.[8] Interestingly, our study considered both individual and neighborhood deprivation, aligning with past research showing worsened health effects for those with lower education in disadvantaged areas.[49] Such findings underscore that health disparities in abortion outcomes relate to both personal and community-level socioeconomic factors. Therefore, interventions should address individual challenges and wider neighborhood deprivation.

Finally, our study identified a significant association between comorbidities and adverse events, especially pronounced for general adverse events. These findings underscore the impact of preexisting chronic conditions on the risk of adverse events after a surgical abortion. While our findings contrast with a study suggesting that chronic health conditions did not elevate the risk among women undergoing abortions,[50] they are consistent with a more recent study.[8] Moreover, women with chronic health conditions often face heightened pregnancy-related complications.[51] Comprehensive preabortion assessments and the development of care plans tailored to the distinct needs of women with identified comorbidities are necessary.

Strengths and limitations

The strength of this study stems from its utilization of comprehensive and up-to-

TABLE 4
Factors associated with general adverse events

	General adverse event rates, N (%)	Crude OR [95% CI]	Crude *P* value	Adjusted[a] OR [95% CI]	Adjusted[a] *P* value
Hospital volume			.535		.993
Very low-volume <80	43 (0.2)	1		1	
Low-volume <300	103 (0.2)	0.94 [0.66–1.34]	.717	1.03 [0.70–1.53]	.876
High-volume <650	68 (0.2)	0.85 [0.58–1.25]	.402	1.00 [0.62–1.61]	.982
Very high-volume ≥650	42 (0.1)	0.75 [0.49–1.15]	.189	0.96 [0.54–1.72]	.901
Patients characteristics					
Age (y)			.167		.116
≤17	15 (0.2)	1		1	
17–19	15 (0.1)	0.62 [0.30–1.26]	.186	0.75 [0.36–1.59]	.456
20–24	54 (0.1)	0.69 [0.39–1.22]	.201	0.84 [0.46–1.56]	.587
25–29	57 (0.2)	0.79 [0.45–1.40]	.428	0.91 [0.49–1.68]	.759
30–34	46 (0.2)	0.75 [042–1.35]	.340	0.94 [0.51–1.76]	.853
35–39	48 (0.2)	1.03 [0.57–1.84]	.926	1.32 [0.71–2.45]	.381
40–44	17 (0.2)	0.93 [0.46–1.87]	.842	1.19 [0.58–2.47]	.636
≥44	4 (0.6)	2.19 [0.73–6.62]	.164	2.81 [0.90–8.74]	.074
Gestational age (wk)			.135		.296
≤7	38 (0.2)	1		0.99 [0.68–1.43]	.938
8–11	162 (0.2)	1.01 [0.71–1.44]	.954	1	
12–14	56 (0.2)	1.36 [0.90–2.06]	.139	1.27 [0.93–1.74]	.131
Universal complementary health coverage					
No	231 (0.2)	1		1	
Yes	18 (0.6)	2.84 [1.75–4.61]	<.001	2.79 [1.70–4.59]	<.001
Neighborhood deprivation					
No	120 (0.2%)	1		1	
Yes	135 (0.2%)	1.04 [0.81–1.33]	.745	0.95 [0.72–1.25]	.552
Previous surgical abortion (last 6 y)					
No	217 (0.2)	1			
Yes	39 (0.2)	1.12 [0.80–1.58]	.503		
Metcalfe comorbidity index ≥1					
No	239 (0.2)	1		1	
Yes	17 (2.6)	12.99 [7.81–21.28]	<.001	10.32 [6.05–17.6]	<.001
General anesthesia					
No	32 (0.1)	1		1	
Yes	224 (0.2%)	1.88 [1.30–2.73]	<.001	1.64 [1.06–1.51]	.002
Category of hospitals			.733		
Private	34 (0.2%)	1		1	
University	97 (0.2%)	0.89 [0.60–1.31]	.554	1.16 [0.76–1.78]	.488
Public	125 (0.2%)	0.86 [0.59–1.25]	.431	1.26 [0.78–2.04]	.351

[a] Results are also adjusted on region of patient residence but are not presented in this table.

TABLE 5
Details of general adverse events according to hospital procedure volume

	All	Very low-volume <80	Low-volume <300	High-volume <650	Very high-volume ≥650
	112,842	16,799	42,969	31,268	21,806
General adverse event rates, N (%)					
Bacterial sepsis or candida shock	65 (0.1)	11 (0.1)	21 (0.1)	17 (0.1)	16 (0.1)
Acute liver disease	46 (0.0)	10 (0.1)	14 (0.0)	12 (0.0)	10 (0.1)
Shock	46 (0.0)	8 (0.1)	25 (0.1)	6 (0.0)	7 (0.0)
Pulmonary embolism	43 (0.0)	10 (0.0)	15 (0.0)	14 (0.0)	4 (0.0)
Acute respiratory distress	25 (0.0)	2 (0.0)	11 (0.0)	6 (0.0)	6 (0.0)
Puerperal/cerebrovascular disorders	21 (0.0)	3 (0.0)	8 (0.0)	7 (0.0)	3 (6.0)
Coma	13 (0.0)	3 (0.0)	6 (0.0)	3 (0.0)	1 (2.0)
Acute heart failure	11 (0.0)	0 (0.0)	5 (0.0)	4 (0.0)	2 (0.0)
Acute renal failure	10 (0.0)	1 (0.0)	8 (0.0)	1 (0.0)	0 (0.0)
Status epilepticus	10 (0.0)	2 (0.0)	5 (0.0)	3 (0.0)	0 (0.0)
Status asthmaticus	8 (0.0)	1 (0.0)	3 (0.0)	3 (0.0)	1 (0.0)
Delirium	5 (0.0)	0 (0.0)	3 (0.0)	2 (0.0)	0 (0.0)
P Acute blood or metabolic disorders	4 (0.0)	1 (0.0)	2 (0.0)	1 (0.0)	0 (0.0)
Pulmonary edema	4 (0.0)	0 (0.0)	4 (3.0)	0 (0.0)	0 (0.0)
Sepsis	4 (0.0)	1 (0.0)	2 (0.0)	1 (0.0)	0 (0.0)
Acute myocardial infarction	2 (0.0)	1 (0.0)	0 (0.0)	1 (0.0)	0 (0.0)

date national data, analyzing all hospitalizations for surgical abortion in France over a 2-year period. It provides a robust examination of the volume-outcome relationship, incorporating detailed categorization of hospital volumes and assessing a wide range of adverse events, thereby offering valuable insights for healthcare policy and practice.

Findings from the present study must be interpreted in light of its limitations. Firstly, these results are based on French data and therefore might not be generalizable to all countries. For example, while surgical abortions were mainly conducted in hospitals during the study period, since 2021, France has permitted them in health centers under specific conditions, similar to practices in other countries. In 2022, there were 972 cases of surgical abortions in these health centers. Future studies should examine if our findings are consistent in these low-volume centers, potentially providing insights into the wider relevance of our results across various healthcare environments. However, despite certain differences, many practices are shared and could usefully inform other countries. Our findings can serve as a warning to healthcare systems that have universal health coverage, highlighting the disparities and challenges in surgical abortion care. Furthermore, they provide insights for countries lacking universal health coverage, where these issues might be even more pronounced, intensifying both safety and access disparities. Secondly, although our approach was based on the PAIRS framework,[29] we included adverse events both directly related to the surgical procedure and to the patient's condition not directly linked to the surgery. For events like death or intensive care admission, determining their direct relation to the procedure was challenging, so we classified them as specific abortion-related adverse event stays. Thirdly, our analysis only includes women who were hospitalized. Consequently, adverse events that occurred outside the hospital post-discharge might be underestimated. However, it is improbable that a severe adverse event would not lead to hospitalization. Finally, one limitation of administrative databases is the potential omission of important factors (eg, ethnicity, body mass index) or miscoding of diagnoses during hospital stays.

This can lead to underestimating crucial variables like patient comorbidity, particularly concerning overweight and obesity, which are often inadequately coded in such databases. Obesity has not been shown to increase hemorrhage risk in surgical abortion care[52] but could affect anesthetic-related and other morbidity (eg, venous thromboembolism). Further studies should

complement these results by incorporating the perspectives of women, providing valuable qualitative insights to complement the quantitative findings.

Conclusion

In this comprehensive study of surgical abortions in France, we confirm the procedure's safety while pointing out significant disparities. These findings emphasize the combined effects of hospital procedure volume, socioeconomic factors, and individual health conditions. To ensure optimal safety for women, a comprehensive approach that incorporates individual care, preventive measures, organizational strategies, and social policies is essential in addressing these disparities. Policymakers should concentrate on enhancing safety in lower-volume facilities, avoiding solutions like centralization, which could impede abortion access for the most vulnerable populations.

Data sharing statement

Anonymized participant data extracted from the nationwide hospital data warehouse are available from the ATIH Institutional Data Access Platform for researchers who meet the legal and ethical criteria for access to confidential data by the French national commission governing the application of data privacy laws. To obtain this dataset for an international researcher, please contact: demande_base@atih.sante.fr. All materials, including the study protocol and statistical analysis plan, are freely available. ■

GLOSSARY

aOR adjusted Odds Ratios
CI confidence interval
GEE generalized estimating equation
PAIRS procedural abortion incident reporting and surveillance

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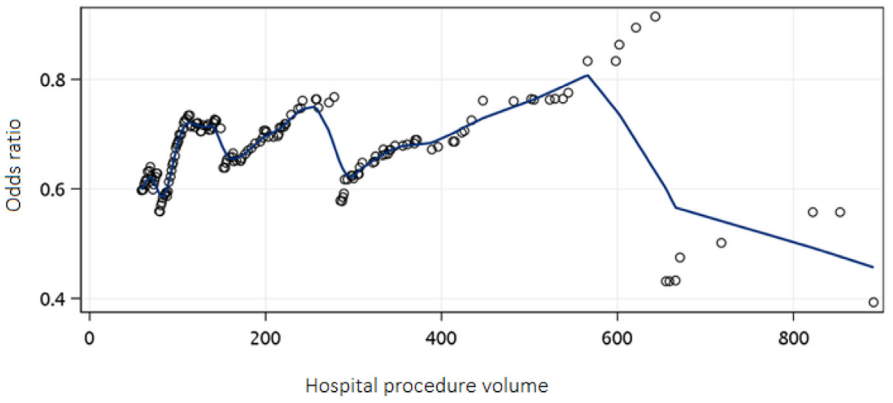
SUPPLEMENTAL FIGURE

Spline function plot that allowed the identification of thresholds for center procedural abortion volume



SUPPLEMENTAL TABLE 1

ICD-10 and procedure codes used to define procedural abortion

Procedure code:
- JNJD002: "Evacuation of a pregnant uterus by aspiration and/or curettage in the 1st trimester of pregnancy"

Associated ICD-10 code:
- Z640: "Problems related to unwanted pregnancy"

Plus, at least one of the following main ICD-10 codes:
- 0040-0049 (before March 2019)
- 004.00, 004.10, 004.20, 004.30, 004.40, 004.50, 004.60, 004.70, 004.80, 004.90 (from March 2019 onwards)

SUPPLEMENTAL TABLE 2
ICD-10 and procedure codes used to identify surgical-related adverse events

	ICD-10 codes	Procedure codes
Surgical-related adverse event		
Hemorrhage	003.1; 003.6; 004.1; 004.6; 008.1; 0208; 0209; 067; 007.1; 007.6; 072.0; 072.1; 072.2	
Retained products of conception	004.4; 004.0; 004.1; 004.2; 004.3; 073	
Genital tract and pelvic infection	004.0; 003.0; 003.5; 004.5; 008.0; 007.0; 007.5; N70.0; N70.9; N71.0; N71.9; N73.0; N73.2; N73.3; N73.5	
Transfusion		FELF001; FELF003; FELF004; FELF006; FELF011
Fistulas and neighboring lesions	N82.0; N82.1; N82.2; N82.3, 071.5	
Local hematoma	N83.6; N83.7; 071.7	
Failure of abortion	007	
Instrumental damage	08.6; 071.4; 071.3; 071.1	
Other complications	004.8; 008.7; 008.8; 008.9	JKGD002; JNMD001

SUPPLEMENTAL TABLE 3
ICD-10 codes used to identify general adverse events

	ICD-10 codes
General adverse event	
Acute heart failure	I46; I5.0; I97.8; I97.9; 075.4; 029.1; 08.8; 074.2
Acute liver disease	K720; K72.9; 026.6; 021.1
Acute myocardial infarction	I21; I22
Acute renal failure	N17; 008.4; 090.4
Acute respiratory distress	J80; J95.2; J95.3; J95.8; J95.9; J96.0; J96.9; J95.4; R09.2; 089.0; 029.0; 074.0; 074.1
Coma	R40.2; E100; E1100; E15; K72.9; 029.2; 089.2
Delirium	F05; F060-1-2-3-4-8
Acute blood or metabolic disorders	D65; 008.5; 072.3
Puerperal/cerebrovascular disorders	G97.8; G97.9; I60 to I63; I674; i676; i678; I97.9; 022.5; 087.3; 099.4; G08; G93.1; G93.4; G93.5; G93.6; G93.7; G93.8; G93.9; 074.3
Pulmonary edema	I50.1; J81; 029.0; 089.0
Pulmonary embolism	I26; 088; 004.2; 004.7; 008.2; 007.2; 003.2
Sepsis	085
Bacterial sepsis or candida shock	A40; A41; B37.7; I075.3; R57.2; R65.0; R65.1
Shock	075.1; R57; T78.2; T80.5; T81.1; T88.2; T88.6; R651; R653; T780; 008.3; 075.4
Status asthmaticus	J46
Status epilepticus	G41

SUPPLEMENTAL TABLE 4
Comorbidity conditions and weights as defined by Metcalfe et al

	ICD-10 codes	Weights
Comorbidity conditions		
Alcohol abuse	F10	1
Asthma	J44; J45	1
Cardiac valvular disease	I05-I09; I34-I39	2
Chronic congestive heart failure	I50.0	5
Chronic ischemic heart disease	I20; I25	3
Chronic renal disease	N02.2; N03-N05; N08; N17.1; N17.2; N18; N25; O26.8	1
Congenital heart disease	Q20-Q26; O99.4	4
Drug abuse	F11-F16; F18; F19	2
Gestational hypertension (without pre-eclampsia/ eclampsia or pre-existing hypertension)	O13; O16	1
Mild/unspecified pre-eclampsia (without severe pre-eclampsia/eclampsia)	O11; O14	2
Human immunodeficiency virus	B20; B24; O98.7; Z21	2
Multiple gestation	O30; O31; Z37.2-Z37.7; Z37.90	2
Placenta previa	O44	2
Pre-existing diabetes mellitus	E10; E11; O24.5-O24.7	1
Pre-existing hypertension	I10-I13; I15; O10; O11	1
Prior cesarean delivery (past year)	O34.20 and procedural codes	1
Pulmonary hypertension	I27.0; I27.2; I27.8; I27.9	4
Severe pre-eclampsia	O14; O15	5
Sickle cell disease	D56; D57	3
Systemic lupus erythematosus	M32	3

SUPPLEMENTAL TABLE 5
Details of Metcalfe comorbidities repartition according to center procedure volume

	All	Very low-volume <80	Low-volume <300	High-volume <650	Very high-volume ≥650	*P* value
Asthma	221 (0.20)	21 (0.13)	74 (0.17)	47 (0.15)	79 (0.36)	<.001
Drug abuse	165 (0.15)	18 (0.11)	67 (0.16)	41 (0.13)	39 (0.18)	.250
HIV	41 (0.04)	3 (0.02)	23 (0.05)	8 (0.03)	7 (0.03)	.103
Pre-existing hypertension	64 (0.06)	10 (0.06)	28 (0.07)	17 (0.05)	9 (0.04)	.680
Multiple gestation	47 (0.04)	8 (0.05)	32 (0.07)	4 (0.01)	3 (0.01)	<.001
Pre-existing diabetes mellitus	43 (0.04)	6 (0.04)	22 (0.05)	9 (0.03)	6 (0.03)	.346
Sickle cell disease	23 (0.02)	2 (0.01)	16 (0.04)	2 (0.01)	3 (0.01)	.018
Alcohol abuse	22 (0.02)	4 (0.02)	14 (0.03)	4 (0.01)	0	.031
Previous cesarean delivery	1465 (1.3)	256 (1.5)	547 (1.3)	404 (1.3)	258 (1.2)	<.001
Congenital heart disease	9 (0.01)	0	5 (0.01)	4 (0.01)	0	.194
Chronic renal disease	9 (0.01)	1 (0.01)	6 (0.01)	1 (0.00)	1 (0.00)	.358
Chronic ischemic heart disease	6 (0.01)	0	3 (0.01)	3 (0.01)	0	.340
Cardiac valvular disease	5 (0.00)	1 (0.01)	3 (0.01)	0	1 (0.00)	.551
Chronic hepatic disease	3 (0.00)	1 (0.01)	0	1 (0.00)	1 (0.00)	.539
Chronic congestive heart failure	2 (0.00)	0	1 (0.00)	0	1 (0.00)	.593
Systemic lupus erythematosus	2 (0.00)	0	1 (0.00)	1 (0.00)	0	.773
Pulmonary hypertension	1 (0.00)	0	1 (0.00)	0	0	.654
Mild/unspecified pre-eclampsia	0	0	0	0	0	-
Gestational hypertension	0	0	0	0	0	-
Placenta previa	0	0	0	0	0	-
Severe pre-eclampsia	0	0	0	0	0	-
Metcalfe score of comorbidity ≥1	25.435 (22.54)	4358 (27.01)	10.037 (23.37)	6316 (20.20)	4544 (20.84)	<.001
Metcalfe score of comorbidity without age ≥1	2079 (1.84)	329 (1.96)	814 (1.89)	536 (1.71)	400 (1.83)	.009

SUPPLEMENTAL TABLE 6

Factors associated with surgical-related adverse events with adjustment on prior caesarian delivery

	Surgical-related adverse event rates	Crude OR [95% CI]	Crude *P* value	Adjusted[a] OR [95% CI]	Adjusted[a] *P* value
Center volume, N (%)			<.001		<.001
Very low-volume <80	1118 (6.65)	1		1	
Low-volume <300	2015 (4.69)	0.69 [0.64–0.74]	<.001	0.80 [0.74–0.86]	<.001
High-volume <650	1327 (4.24)	0.62 [0.57–0.68]	<.001	0.82 [0.76–0.90]	<.001
Very high-volume ≥650	491 (2.25)	0.32 [0.29–0.36]	<.001	0.50 [0.44–0.56]	<.001
Women characteristics, N (%)					
Age (y)			.006		.027
≤17	228 (4.27)	1		1	
17–19	400 (4.63)	1.09 [0.92–1.28]	.324	1.14 [0.96–1.35]	.132
20–24	1143 (4.10)	0.96 [0.83–1.11]	.558	1.01 [0.87–1.17]	.873
25–29	1080 (4.23)	0.99 [0.86–1.15]	.325	1.05 [0.91–1.22]	.503
30–34	996 (4.59)	1.14 [0.98–1.32]	.097	1.13 [0.97–1.31]	.124
35–39	802 (4.83)	1.01 [0.85–1.21]	.907	1.18 [1.01–1.38]	.034
40–44	280 (4.32)	0.78 [0.50–1.22]	.283	1.07 [0.89–1.28]	.501
≥44	22 (3.38)	0.88 [0.78–0.99]	.032	0.87 [0.55–1.36]	.530
Gestational age (wk)			<.001		<.001
≤7	952 (5.31)	1.30 [1.22–1.41]	<.001	1.47 [1.36–1.58]	<.001
8–11	3105 (4.11)	1		1	
12–14	894 (4.62)	1.13 [1.05–1.22]	.001	1.11 [1.02–1.20]	.012
Universal complementary health coverage					
No	4696 (4.28)	1		1	
Yes	242 (8.00)	1.94 [1.70–2.23]	<.001	1.60 [1.39–1.84]	<.001
Neighborhood deprivation					
No	1933 (3.60)	1		1	
Yes	2993 (5.16)	1.46 [1.37–1.55]	<.001	1.24 [1.17–1.33]	<.001
Previous procedural abortion (last 6 y)					
No	4267 (4.39)	1			
Yes	684 (4.40)	1.03 [0.97–1.11]	.436		
Prior cesarean delivery (past year)					
No	4865 (4.37)				
Yes	86 (5.87)	1.52 (1.18–1.96)	.001	1.33 [1.06–1.67]	.014
General anesthesia					
No	442 (1.85)	1		1	
Yes	4509 (5.07)	2.83 [2.56–3.13]	<.001	2.22 [1.98–2.48]	<.001
Category of centers			<.001		<.001
University	1646 (3.85)	0.87 [0.82–0.93]	<.001		
Public	2337 (4.39)	1			
Private	968 (5.74)	1.33 [1.23–1.43]	<.001		

[a] Results are also adjusted on region of patient residence but are not presented in this table.

SUPPLEMENTAL TABLE 7

Analysis of the surgical-related adverse events according to center volume, stratified by the use of anesthesia or not (crude and adjusted GEE models)

	Surgical-related adverse event rates	Crude OR [95% CI]	Crude *P*-value	Adjusted[a] OR [95% CI]	Adjusted[a] *P*-value
Population with anesthesia (N=88,957)					
Center volume, N (%)			<.001		<.001
Very low-volume <80	1084 (6.70)	1		1	
Low-volume <300	1906 (4.98)	0.73 [0.67–0.79]	<.001	0.83 [0.76–0.90]	<.001
High-volume <650	1140 (4.87)	0.71 [0.66–0.78]	<.001	0.63 [0.56–0.71]	<.001
Very high-volume ≥650	379 (3.42)	0.49 [0.44–0.56]	<.001	0.36 [0.31–0.42]	<.001
Population without anesthesia (N=23,885)					
Center volume, N (%)			<.001		<.001
Very low-volume <80	34 (5.55)	1		1	
Low-volume <300	109 (2.33)	0.41 [0.27–0.60]	<.001	0.65 [0.41–1.02]	.062
High-volume <650	187 (2.37)	0.41 [0.28–0.60]	<.001	0.53 [0.34–0.84]	.007
Very high-volume ≥650	112 (1.04)	0.18 [0.12–0.27]	<.001	0.26 [0.15–0.45]	<.001

[a] Results are also adjusted on region of patient residence but are not presented in this table.