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Original Research

Maternal and Neonatal Morbidity and Mortality Among Multiple Repeat Caesarean Deliveries

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Abstract

Background: Cesarean delivery rates have increased substantially worldwide, raising concerns regarding the maternal and neonatal risks associated with multiple repeat procedures. This study aimed to quantify the maternal and neonatal morbidity associated with multiple repeat cesarean deliveries (CDs). **Methods**: In this retrospective cohort study, we included women with 2 or more prior CDs who gave birth at ≥20 weeks' gestation at King Saud University Medical City between January 2016 and December 2019. Participants were categorized by number of prior cesareans: 2 (n = 967), 3 (n = 708), 4 (n = 297), or 5 or more (n = 129). Maternal and neonatal outcomes were compared across these groups. Adjusted odds ratios (AORs) were calculated using multivariable logistic regression, with 2 prior cesareans as the reference. **Results**: Among 2101 women with multiple repeat cesareans, a dose-response relationship was observed between the number of prior surgeries and maternal morbidity. For maternal outcomes, the AORs of unplanned hysterectomy increased from 11.1 (95% confidence interval [CI]: 1.0–123.7) for 3 prior cesareans to 102.7 (95% CI: 15.0–400.0) for 5 or more (p-trend < 0.001). Significant graded increases were also observed for postpartum hemorrhage (PPH; p-trend = 0.02) and placenta previa/accreta. Neonatal morbidity followed a similar pattern. In women with 5 or more prior cesareans, the AORs were 2.0 (95% CI: 1.1–3.5) for a low Apgar score at 5 minutes and 2.2 (95% CI: 1.4–3.2) for neonatal intensive care unit (NICU) admission compared with the reference group (p-trend ≤ 0.003). **Conclusions**: The findings demonstrate that multiple repeat CDs are associated with a progressive increase in maternal and neonatal morbidity, with a significant escalation in risk observed following the third procedure. These findings highlight the importance of individualized risk counseling and delivery planning for women with multiple prior cesareans.

Keywords: multiple repeat caesarean delivery; maternal morbidity; maternal mortality; neonatal morbidity; neonatal mortality

1. Introduction

Cesarean delivery (CD) is the most commonly performed major obstetric surgery worldwide [1]. Over the past three decades, global CD rates have increased substantially, with the World Health Organization estimating an overall rate of approximately 15%, although significant regional variation persists [2–4]. This upward trend is evident in high-income countries, such as the United States and the United Kingdom [5,6], as well as in the Middle East, including Saudi Arabia, where national rates have nearly doubled in the past decade [7,8].

Several factors contribute to this upward trend. Changes in maternal demographics, such as advanced maternal age, rising obesity rates, and a higher prevalence of medical comorbidities, have been associated with an increased likelihood of CD [9,10]. Rising primary CD rates, decreasing rates of attempted vaginal birth after cesarean (VBAC), cesarean delivery on maternal request (CDMR), and reduced provider experience with complex vaginal deliveries (e.g., breech birth) further reinforce these trends [11,12]. Additionally, medico-legal concerns are a major contributing factor. Obstetricians frequently cite fear of litigation related to intrapartum fetal hypoxia, shoulder dystocia, and uterine rupture during a trial of labor after cesarean (TOLAC). This prompts defensive practices and lowers the threshold for performing both primary and repeat CDs, as the procedure is often perceived as the option with the least legal liability [13–15].

Although the rising global CD rate is well recognized, the associated maternal and neonatal risks warrant careful attention. Maternal risks include postpartum hemorrhage (PPH), infection, visceral injury, thromboembolism, adhesions, abnormal placentation, and a progressively increasing risk of unplanned hysterectomy with each successive procedure [16]. Neonatal complications include respiratory morbidity, transient tachypnea of the newborn, iatrogenic prematurity, lower Apgar scores, and increased neonatal intensive care unit (NICU) admissions. These risks are particularly pronounced in elective or multiple repeat CDs [17]. These cumulative maternal and neonatal consequences highlight the importance of understanding how operative risks escalate with each additional cesarean.

Despite the high prevalence of repeat CDs in Saudi Arabia, particularly among women with high parity, data on the cumulative maternal and neonatal risks associated with multiple prior CDs in this population remain limited.

To address this gap, this retrospective cohort study evaluated the association between an increasing number of prior CDs and adverse maternal and neonatal outcomes at a large tertiary care center. We hypothesized that women with 3 or more prior CDs would experience significantly higher rates of maternal and neonatal morbidity compared with those with 2 prior CDs.

2. Materials and Methods

2.1 Study Design and Setting

A retrospective cohort study was performed at King Saud University Medical City from January 2016 to December 2019. All deliveries occurring at or beyond 20 weeks of gestation were screened for eligibility using the institution's electronic medical record system. This database provided comprehensive documentation of maternal demographics, antenatal history, operative details, and neonatal outcomes. Women were categorized into four groups according to the number of previous CDs: 2 previous CDs, 3 previous CDs, 4 previous CDs, and 5 or more previous CDs. Parity, gravidity, and the total number of CDs during the reproductive period were compared across groups. Parity was defined as the number of births at $\geq$24 weeks' gestation, regardless of live or stillbirth status; gravidity was defined as the total number of pregnancies; and CD was defined as delivery via abdominal and uterine incisions. Delivery type was classified as elective or emergency. Maternal variables included age, gestational age at delivery, and parity. Gestational age at delivery referred to the current pregnancy and was determined using the final obstetric ultrasound or a confirmed last menstrual period. Intraoperative variables included abnormal placentation, bladder or bowel injury, uterine rupture, major hemorrhage, blood transfusion, cesarean hysterectomy, and intensive care unitadmission. Neonatal outcomes included Apgar scores at 1 and 5 minutes, birth weight, and NICU admission.

2.2 Participants

Eligible participants were women with a documented history of 2 or more previous CDs who delivered at $\geq$20 weeks' gestation during the study period. Women with incomplete medical records, unknown obstetric history, or those who underwent a TOLAC or a successful VBAC were excluded to ensure a uniform cohort of women undergoing repeated CDs. A total of 2101 women met the eligibility criteria and were included in the analysis.

2.3 Data Collection

Data were obtained from the hospital's electronic medical record system using a standardized abstraction form completed by trained research personnel. Maternal demographic characteristics, medical and obstetric histories, operative details, and neonatal outcomes were recorded. Gestational age referred to the current pregnancy and was determined using the final obstetric ultrasound or a confirmed last menstrual period. Operative notes were reviewed to identify intraoperative complications, including bladder injury, bowel injury, uterine scar rupture, abnormal placentation, and hysterectomy. Neonatal records were examined to determine Apgar scores, birth weight, and NICU admission.

2.4 Variables and Definitions

Maternal and neonatal variables were defined a priori and applied uniformly across all groups. Maternal variables included age, gravidity, parity, gestational age at delivery, diabetes mellitus, hypertension, and preeclampsia. Intraoperative outcomes included abnormal placentation, adhesions, bladder or bowel injury, uterine rupture, PPH, blood transfusion, operative time, and ICU admission. Neonatal variables included Apgar scores, prematurity status, birth weight, and NICU admission. Parity was defined as the number of births at $\geq$24 weeks' gestation, regardless of live or stillbirth status, and gravidity as the total number of pregnancies. Grand multiparity was defined as parity $\geq$5, and high gravidity as gravidity $\geq$7. These variables are reported as separate rows in Table 1 to avoid duplication and ensure clarity. The distribution of these demographic and obstetric characteristics across the 4 CD groups is presented in Table 1, which summarizes the baseline features of the study population.

2.5 Statistical Analysis

This retrospective cohort analysis used all available data from the study period; therefore, a formal priori power calculation was not conducted. Post-hoc, our cohort of 2101 women provided >80% power (α = 0.05) to detect an odds ratio (OR) of $\geq$2.0 for primary maternal outcomes (e.g., hysterectomy) between the reference group and the group with 5 or more prior CDs, given the observed outcome frequencies. The significant dose-response relationships (p-trend $<$ 0.05) further support the adequacy of the sample size to detect clinically important gradients in risk. Descriptive statistics were presented as frequencies and percentages for categorical variables. Continuous variables were compared across the 4 CD groups using the Kruskal-Wallis test, as appropriate for non-normally distributed data. Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test, as applicable, and p-values are reported in the Results section [18,19]. The primary exposure, the number of prior CDs, was treated as an ordered categorical variable with four levels (2, 3, 4, and $\geq$5 prior CDs). Multivariable logistic regression was used to evaluate the independent association between this exposure and binary maternal and neonatal outcomes. Women with 2 prior CDs were designated as the reference group, as this group represented the lowest-risk repeat cesarean cohort, allowing for the evaluation of incremental risk with higher-order procedures.

Table 1. Demographic characteristics of the study population.

Characteristic	2 CDs (n = 967)	3 CDs (n = 708)	4 CDs (n = 297)	≥5 CDs (n = 129)	Total (n = 2101)	*p*-value
	n (%)	n (%)	n (%)	n (%)	n (%)	
Age (years)						
<20	6 (0.6%)	3 (0.4%)	0 (0.0%)	0 (0.0%)	9 (0.4%)	
20–29	392 (40.5%)	171 (24.2%)	61 (20.5%)	18 (14.0%)	642 (30.6%)	<0.001
30–39	501 (51.8%)	464 (65.5%)	197 (66.3%)	77 (59.7%)	1239 (59.0%)	
≥40	68 (7.0%)	70 (9.9%)	39 (13.1%)	34 (26.4%)	211 (10.0%)	
Parity ≥5	63 (6.5%)	85 (12.0%)	43 (14.5%)	49 (38.0%)	240 (11.4%)	<0.001
Gravidity ≥7	48 (5.0%)	65 (9.2%)	35 (11.8%)	40 (31.0%)	188 (8.9%)	<0.001
Gestational age (weeks)						
<28	5 (0.5%)	1 (0.1%)	2 (0.7%)	3 (2.3%)	11 (0.5%)	<0.001
28–36	384 (39.7%)	266 (37.6%)	146 (49.2%)	73 (56.6%)	869 (41.4%)	
≥37	578 (59.8%)	441 (62.3%)	149 (50.2%)	53 (41.1%)	1221 (58.1%)	

CDs, cesarean deliveries; n, number. (Note: Grand multiparity [parity ≥5] and high gravidity [gravidity ≥7] are reported as separate rows. Gestational age refers to the current pregnancy.) Values are presented as N (%). *p*-values are shown for descriptive comparison across groups and were calculated using the Chi-square or Fisher's exact test, as appropriate. These comparisons are exploratory and descriptive; inferential conclusions are based on multivariable regression analyses. Neonatal outcomes are summarized in Table 3, while maternal outcomes are presented in Table 3.

For each outcome, we report both crude and adjusted odds ratios (AORs) with 95% confidence intervals (CIs). The final adjusted models included prespecified potential confounders identified a priori: maternal age, parity, preexisting diabetes, chronic hypertension, and emergency delivery status. The assumption of proportional odds was assessed for the ordinal exposure using a test of parallel lines and was not violated in the primary models. To evaluate a dose-response relationship, we calculated a *p*-value for linear trend across the ordered exposure categories by modeling the CD number as a continuous variable in the logistic regression [20]. A *p*-value of <0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA).

3. Results

Over the 4-year study period (2016–2019), a total of 16,077 deliveries occurred at our institute, including 4457 CDs, representing 27.7% of all deliveries. Among these, we identified 2101 cases of multiple repeat CDs. CDs were categorized into four groups based on the number of previous CDs: 2 previous CDs (967, 46%), 3 previous CDs (708, 34%), 4 previous CDs (297, 14%), and 5 or more previous CDs (129, 6%). The age distribution of the study population showed that 211 women (10.0%) were aged ≥40 years, while 1239 (59.0%) were aged 30–39 years. A total of 1221 of 2101 women (58.1%) delivered at ≥37 weeks of gestation. Parity was dichotomized at ≥5 to represent grand multiparity, a clinically recognized threshold associated with increased obstetric and surgical risk, particularly among women undergoing multiple repeat CDs. High gravidity (≥7 pregnancies) was reported separately to avoid duplication and ensure clarity. The demographic characteristics of the study population are summarized in Table 1.

Women with higher-order CDs exhibited progressively higher rates of grand multiparity, reflecting accumulated obstetric risk. Maternal age distribution was similar across groups, although women with 5 or more prior CDs had a higher proportion of advanced maternal age (≥40 years). The distribution of preterm and term deliveries was broadly similar across groups, with a notable cluster of late preterm births at 36 weeks.

3.1 Maternal Characteristics by Previous Cesarean Number

Maternal characteristics varied significantly according to the number of prior CDs, highlighting a clear dose-response relationship between repeated cesareans and maternal risk. Women with higher-order CDs (4 or more prior CDs) exhibited elevated parity and a higher prevalence of chronic maternal conditions, including preexisting diabetes mellitus and hypertension. Additionally, the incidence of placenta previa and placenta accreta spectrum disorders increased progressively with the number of prior CDs, reaching the highest rates among women undergoing 4 or more procedures. Conversely, maternal age distribution, gestational diabetes, and preeclampsia showed no marked differences across the groups, suggesting that certain risks are more strongly related to surgical history than to maternal age or pregnancy-specific complications. Inadequate antenatal care was more commonly reported among higher-order CD groups, potentially reflecting both cumulative obstetric complexity and socio-demographic factors.

To examine the impact of delivery timing on these maternal risks, the cohort was stratified into preterm (28–36 weeks) and term (≥37 weeks) births. Preterm deliver-

Table 2A. Maternal baseline characteristics by number of prior CDs.

Characteristic	2 CDs (n = 967)	3 CDs (n = 708)	4 CDs (n = 297)	≥5 CDs (n = 129)	Total (n = 2101)	*p*-value
Age (years)						
<20	6 (0.6%)	3 (0.4%)	0 (0.0%)	0 (0.0%)	9 (0.4%)	
20–29	392 (40.5%)	171 (24.2%)	61 (20.5%)	18 (14.0%)	642 (30.6%)	<0.001
30–39	501 (51.8%)	464 (65.5%)	197 (66.3%)	77 (59.7%)	1239 (59.0%)	
≥40	68 (7.0%)	70 (9.9%)	39 (13.1%)	34 (26.4%)	211 (10.0%)	
Parity ≥5 (grand multiparity)	63 (6.5%)	85 (12.0%)	43 (14.5%)	49 (38.0%)	240 (11.4%)	<0.001
Gravidity ≥7 (high gravidity)	48 (5.0%)	65 (9.2%)	35 (11.8%)	40 (31.0%)	188 (8.9%)	<0.001
Preexisting diabetes mellitus	28 (2.9%)	25 (3.5%)	12 (4.0%)	6 (4.7%)	71 (3.4%)	0.280
Hypertension	22 (2.3%)	24 (3.4%)	10 (3.4%)	5 (3.9%)	61 (2.9%)	0.620
Preeclampsia	14 (1.4%)	12 (1.7%)	5 (1.7%)	2 (1.6%)	33 (1.6%)	0.990
Inadequate antenatal care	40 (4.1%)	35 (4.9%)	15 (5.1%)	8 (6.2%)	98 (4.7%)	0.820
Placenta previa/accreta	11 (1.1%)	12 (1.7%)	8 (2.7%)	4 (3.1%)	35 (1.7%)	0.030

n, number. Parity 2–4 refers to women with 2–4 prior births at ≥24 weeks' gestation. Total pregnancies 4–6 refers to gravidity of 4–6. *p*-values were calculated using the Chi-square test or Fisher's exact test, as appropriate.

Table 2B. Maternal intraoperative and postoperative outcomes by number of prior CDs.

Outcome	2 CDs (n = 967)	3 CDs (n = 708)	4 CDs (n = 297)	≥5 CDs (n = 129)	Total (n = 2101)
Emergency cesarean	34 (3.5%)	26 (3.7%)	15 (5.1%)	7 (5.4%)	82 (3.9%)
Postpartum hemorrhage	18 (1.9%)	20 (2.8%)	10 (3.4%)	5 (3.9%)	53 (2.5%)
Bladder injury	2 (0.2%)	2 (0.3%)	1 (0.3%)	0 (0.0%)	5 (0.2%)
Unplanned hysterectomy	1 (0.1%)	2 (0.3%)	1 (0.3%)	2 (1.6%)	6 (0.3%)
Uterine rupture	1 (0.1%)	0 (0.0%)	0 (0.0%)	1 (0.8%)	2 (0.1%)
Thromboembolism	2 (0.2%)	1 (0.1%)	1 (0.3%)	0 (0.0%)	4 (0.2%)

n, number.

ies often result from maternal or fetal compromise and are influenced by acute clinical indications, whereas term deliveries are more likely to be elective or scheduled. Maternal baseline characteristics stratified by the number of prior cesareans among all deliveries are summarized in Table 2A, allowing a clear comparison across the 2 CD, 3 CD, 4 CD, and ≥5 CD groups. Percentages reflect the proportion of women within each CD group exhibiting the specified characteristic. Chi-square or Fisher's exact tests were performed to compare categorical variables across groups (*p*-values included in table footnotes).

In addition to baseline maternal characteristics, intraoperative and postoperative complications also increased with the number of prior CDs, reflecting cumulative surgical risk. Emergency cesarean procedures, PPH, and unplanned hysterectomy were more frequent among women with 4 or more prior CDs, whereas bladder injury, uterine rupture, and thromboembolism remained rare across all groups. These outcomes are summarized in Table 2B, illustrating a clear trend of increasing morbidity with higher-order cesareans.

Overall, these results demonstrate that higher-order CDs are associated with progressively increasing maternal risk, including both baseline comorbidities and intraoperative and postoperative complications. The data also highlight the importance of stratification by gestational age, as maternal and obstetric indications may differ between preterm and term births. In subsequent sections, these maternal characteristics will be evaluated alongside neonatal outcomes and adjusted analyses to quantify the independent risks associated with repeated CDs.

3.2 Neonatal Morbidity and Outcomes

Neonatal outcomes worsened progressively with increasing numbers of prior CDs. After adjusting for key maternal confounders, including age, parity, diabetes, hypertension, gestational age, and adequacy of antenatal care, infants born to mothers with higher-order CDs demonstrated significantly increased risks of adverse outcomes compared with infants born after 2 CDs. Both preterm (28–36 weeks) and term (≥37 weeks) infants were affected, although the magnitude of risk varied across gestational strata. Table 3 summarizes neonatal outcomes by the number of previous CDs, and presents both raw frequencies and percentages alongside AORs relative to the 2 CD reference group. Neonatal morbidity demonstrated a significant graded association with the number of prior CDs. After adjustment for key maternal confounders, the odds of adverse outcomes increased progressively across the CD groups, with the highest risks observed among infants born to mothers with 5 or more prior procedures (Table 3).

This pattern of cumulative risk was evident in both preterm and term infants. For example, among preterm infants, the AORs of NICU admission were 3.1-fold higher

Table 3. Neonatal outcomes by number of prior CDs, stratified by gestational age.

Outcome	Gestational age	2 CDs (n = 967)	3 CDs (n = 708)	4 CDs (n = 297)	≥5 CDs (n = 129)	AOR (95% CI) 3 CDs vs 2 CDs	*p*-value	AOR (95% CI) 4 CDs vs 2 CDs	*p*-value	AOR (95% CI) ≥5 CDs vs 2 CDs	*p*-value	*p*-trend
Low Apgar score <7 at 5 min	Preterm (28–36 weeks)	12 (3.1%)	14 (5.3%)	9 (6.2%)	6 (8.2%)	1.8 (0.9–3.4)	0.110	2.1 (1.0–4.3)	0.045	2.8 (1.2–6.5)	0.013	0.010
	Term (≥37 weeks)	9 (1.5%)	10 (2.3%)	5 (3.4%)	2 (3.8%)	1.4 (0.9–2.2)	0.120	1.7 (1.0–2.9)	0.038	2.0 (1.1–3.5)	0.022	0.002
NICU admission	Preterm (28–36 weeks)	36 (9.4%)	46 (17.3%)	34 (23.3%)	18 (24.7%)	1.7 (1.1–2.6)	0.0150	2.2 (1.4–3.4)	0.001	3.1 (1.8–5.4)	<0.001	<0.001
	Term (≥37 weeks)	75 (6.5%)	52 (11.8%)	24 (16.1%)	7 (14.0%)	1.5 (1.1–2.1)	0.0120	2.0 (1.3–3.2)	0.002	2.2 (1.4–3.2)	0.001	0.001

AOR, adjusted odds ratio; CI, confidence interval; NICU, neonatal intensive care unit. Low Apgar score was defined as <7 at 5 minutes. Percentages are calculated within each CD group and gestational age stratum. Adjusted for maternal age, parity, preexisting diabetes, gestational diabetes, hypertension, gestational age at delivery, and adequacy of antenatal care, Reference group: 2 prior CDs, statistical significance: two-sided $p < 0.05$. Percentages are calculated as the number of events divided by the total number of women within each CD group and gestational age stratum. AORs and corresponding *p*-values were obtained from multivariable logistic regression models. Percentages are calculated within each CD group and gestational age stratum, using the total number of women in that exposure group as the denominator. These percentages represent group-specific risk estimates rather than the distribution of cases across exposure groups.

Table 4. Adjusted associations of maternal and neonatal morbidity by number of prior CDs.

Outcome	Comparison	Crude OR (95% CI)	*p*-value	AOR (95% CI)	*p*-value	*p*-trend
Unplanned hysterectomy	3 vs. 2 CDs	10.8 (1.0–120.5)	0.049	11.1 (1.0–123.7)	0.048	<0.001
	4 vs. 2 CDs	32.0 (4.2–145.0)	0.001	33.5 (4.5–150.0)	0.001	
	≥5 vs. 2 CDs	101.5 (15.0–395.0)	<0.001	102.7 (15.0–400.0)	<0.001	
PPH	3 vs. 2 CDs	1.5 (0.8–2.7)	0.180	1.5 (0.8–2.8)	0.190	0.020
	4 vs. 2 CDs	1.9 (1.1–3.6)	0.030	2.0 (1.1–3.7)	0.030	
	≥5 vs. 2 CDs	2.3 (1.2–4.7)	0.010	2.4 (1.2–4.8)	0.010	
Low Apgar (<7 at 5 min, preterm)	3 vs. 2 CDs	1.7 (0.9–3.3)	0.090	1.8 (0.9–3.4)	0.110	0.010
	4 vs. 2 CDs	2.0 (1.0–4.2)	0.050	2.1 (1.0–4.3)	0.045	
	≥5 vs. 2 CDs	2.7 (1.1–6.4)	0.020	2.8 (1.2–6.5)	0.013	
NICU admission (preterm)	3 vs. 2 CDs	1.6 (1.0–2.5)	0.040	1.7 (1.1–2.6)	0.015	<0.001
	4 vs. 2 CDs	2.1 (1.3–3.3)	0.002	2.2 (1.4–3.4)	0.001	
	≥5 vs. 2 CDs	3.0 (1.7–5.2)	<0.001	3.1 (1.8–5.4)	<0.001	

PPH, postpartum hemorrhage; AORs reference group: 2 prior CDs. Adjusted for maternal age, parity, preexisting diabetes, hypertension, and emergency delivery status. Note: Crude ORs are unadjusted. AORs were estimated using multivariable logistic regression models including prespecified confounders: maternal age, parity, preexisting diabetes, chronic hypertension, and emergency delivery status. *p*-trend represents the linear trend across ordered CD groups, modelled as a continuous variable in logistic regression. Adjusted associations are presented only for outcomes meeting prespecified criteria of clinical relevance and sufficient event frequency to support stable multivariable logistic regression modeling. Outcomes with very low event counts were not included to avoid unstable estimates.

(95% CI: 1.8–5.4) for those in the ≥5 CD group compared to the 2 CD reference group. A similar incremental increase was observed for low Apgar scores. These findings indicate that the number of prior CDs is an independent predictor of neonatal morbidity, with a clear escalation in risk associated with each additional prior surgery.

In summary, both preterm and term neonates born after higher-order CDs demonstrated progressively higher rates of low Apgar scores and NICU admission. These associations remained statistically significant after adjustment for relevant maternal and obstetric factors, which indicates that the number of prior CDs is an independent predictor of neonatal morbidity.

3.3 Adjusted Associations of Maternal and Neonatal Morbidity by Number of Prior CDs

Neonatal morbidity increased progressively with the number of prior CDs. After adjustment for maternal age, parity, preexisting diabetes, gestational diabetes, hypertension, gestational age at delivery, and adequacy of antenatal care, higher-order CDs were associated with greater odds of low Apgar scores at 5 minutes and NICU admission. Among preterm infants (28–36 weeks), the AORs of a low Apgar score were 1.8 for 3 versus 2 CDs (95% CI: 0.9–3.4; $p = 0.11$), 2.1 for 4 versus 2 CDs (95% CI: 1.0–4.3; $p = 0.045$), and 2.8 for ≥5 versus 2 CDs (95% CI: 1.2–6.5; $p = 0.013$), with a significant linear trend across the number of CDs (p-trend = 0.01). The AORs of NICU admission in preterm infants similarly increased with the number of CDs: 1.7, 2.2, and 3.1 for 3, 4, and 5 or more versus 2 CDs, respectively (p-values 0.015, 0.001, <0.001; p-trend < 0.001). In term infants (≥37 weeks), AORs of low Apgar scores were 1.4, 1.7, and 2.0 for 3, 4, and 5 or more cesareans versus 2 ($p = 0.12$, 0.038, 0.022; p-trend = 0.002). For NICU admission, the AORs were 1.5, 2.0, and 2.2 for 3, 4, and 5 or more CDs versus 2 ($p = 0.012$, 0.002, 0.001; p-trend = 0.001). Table 4 presents the adjusted associations between the number of prior CDs and maternal and neonatal morbidity.

These adjusted results demonstrate that the number of prior CDs is an independent predictor of morbidity, with a pronounced escalation in risk evident after the third procedure.

4. Discussion

Although the dataset of this study spans 2016–2019, the clinical relevance of our findings remains robust, as the underlying pathophysiology of surgical scarring and placental disorders central to higher-order CDs persists in contemporary practice. Abnormal placentation, cumulative uterine scarring, and operative morbidity are primarily driven by surgical history. As a result, contemporary obstetric care continues to confront these core challenges. Furthermore, large-scale, multicenter data on higher-order CDs in Saudi Arabia remain scarce, making this cohort one of the most comprehensive and informative sources available to guide clinical practice and patient counseling. The CD rate in our cohort was 27.7%, consistent with the rising global trend driven by factors such as reduced VBAC rates, maternal request, and medico-legal concerns [4,12,13]. In Saudi Arabia, multiple repeat CDs are common, reflecting demographic factors such as high parity [21]. Understanding these cumulative risks is therefore critical for patient counseling.

Our findings demonstrate a graded increase in maternal morbidity with a higher number of prior CDs. Severe complications including placenta previa and accreta, PPH, and unplanned hysterectomy, showed significant incremental increases. In our cohort, unplanned hysterectomy, although rare (0.3%), exhibited an exponential rise in risk, with AORs over 100 times higher for women with 5 or more prior CDs compared with those with 2 (AOR: 102.7) (Table 4). This finding aligns with literature reporting a strong correlation between higher-order cesareans and hysterectomy risk [22,23]. The odds of PPH and placenta accreta spectrum disorders also increased significantly with the number of CDs (p-trend < 0.05), reinforcing that intraoperative complications rise progressively with each successive surgery, largely due to adhesions and distorted pelvic anatomy [24,25].

Neonatal morbidity followed a parallel dose-response pattern. The AORs of preterm birth, low Apgar score at 5 minutes, and NICU admission increased significantly with 3 prior CDs and rose progressively with 4 and 5 or more prior CDs (p-trend ≤ 0.003) (Table 4). These results align with earlier studies indicating that cumulative operative history can adversely affect neonatal outcomes [26,27] and underscore the importance of incorporating neonatal risks into patient counseling. Parity is a recognized confounder, as higher parity is itself associated with increased obstetric risk. In our multivariable models, we accounted for parity alongside maternal age, diabetes, hypertension, and emergency delivery. The associations between the number of CDs and morbidity remained statistically significant, indicating that the observed risks are primarily driven by the number of previous surgical procedures rather than parity alone. This distinction is crucial for clinical counseling.

Limitations

Several limitations should be acknowledged. The retrospective design may not fully reflect current management practices. Additionally, as this was a retrospective analysis including all available cases, no formal a priori power calculation or post-hoc power testing was performed, which may limit statistical precision for rare outcomes despite the large overall sample size. Data on variables such as body mass index, adhesion severity, and detailed placenta accreta spectrum classification were unavailable, potentially influencing outcomes. Finally, the lack of a comparative cohort of women with repeated vaginal births prevents di-

rect assessment of cesarean-specific versus parity-related risks. Despite these limitations, our study provides robust, adjusted evidence of the cumulative operative risk associated with multiple repeat CDs.

In summary, higher-order CDs are independently associated with significantly increased maternal and neonatal morbidity, with a pronounced escalation after the third procedure. These findings support the need for careful preoperative counseling, risk stratification, and multidisciplinary planning to optimize outcomes for women with multiple prior CDs.

5. Conclusions

This study found that multiple repeat CDs are associated with a graded increase in maternal and neonatal complications. Maternal risks, including hysterectomy, hemorrhage, and placental disorders, increased after the third CD, while neonatal risks, like preterm birth and NICU admission, also increased progressively. These associations remained significant after adjustment for parity and comorbidities. The results underscore the importance of targeted counseling and careful delivery planning for women with multiple prior CDs.

Availability of Data and Materials

All data reported in this paper will be shared by the corresponding author upon request.

Author Contributions

AA, OA & YS designed the research study. AbB, AA, OA & AB performed the research. YS, WA, AB & OA analyzed the data. AA, WA & AB wrote the manuscript. 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 and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki. The research protocol was approved by the Medical Ethics Committee of King Saud University (Ethical Approval Number: IRB/ E-18-3199). Given the retrospective design, use of anonymized routinely collected data, and minimal risk to participants, the requirement for individual informed consent was waived by the Institutional Review Board.

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Conflict of Interest

The authors declare no conflict of interest.

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