Optimal Timing of Elective Cesarean in Women With Multiple Prior Cesareans: A Retrospective Cohort Study

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Abstract

The optimal time for cesarean delivery in women with more than two previous caesarean deliveries is crucial in minimizing risks. The present study analyzed women at a specialized hospital in Saudi Arabia who had at least two last cesarean deliveries between 2022 and 2024. Participants were classified into two groups: those at 37-38 weeks and those at 39 weeks and above. Women with multiple gestations or comorbidities were excluded, and outcome analysis was conducted using multiple logistic regression methods. The results show a mean age of 35.1 years for the study population, with most participants falling within the 30- to 40-year age range. Maternal complications were significantly more related to elective cesarean section at 38 weeks than at 39 weeks or later. Neonatal outcomes, including NICU admission and respiratory morbidity, showed a favorable trend from 39+0 to 39+6 weeks, although this was not statistically significant. Emergency delivery before 39 weeks bore the highest neonatal risk. Elective cesarean delivery timing in women with multiple prior cesareans significantly influences both maternal and neonatal outcomes. Scheduling cesarean deliveries at 39 weeks could avert neonatal complications. However, future studies will be paramount to developing finite, evidence-based recommendations for optimal practice.

Introduction

Cesarean delivery defines the birth of a fetus by laparotomy and then hysterotomy [1]. The vaginal delivery method is the more common form of delivery, whereas the cesarean section (C-section) is the less common option. To deliver one or more neonates, a C-section is one of the most common surgical operations done globally [2, 3]. The number of cesarean deliveries over the past few decades has dramatically increased in both developed and developing nations. According to a 2008 World Health Organization (WHO) survey, there were an estimated 18.5 million C-sections performed annually, with 69 countries having C-section rates higher than 15% [2]. The most common indications of cesarean delivery are previous cesarean delivery, breech presentation, dystocia, and fetal distress [4]. In Saudi Arabia, 10% of all deliveries are caesarean sections, due to Numerous factors, particularly advanced maternal age in primigravida, which have been linked to the significant rise in cesarean deliveries [5]. The characteristics and approaches to care by the obstetricians are additional considerations. An elective cesarean section can be arranged before childbirth. Despite evidence of a higher risk of neonatal adverse respiratory morbidities among uncomplicated term pregnancies following elective CS compared to vaginal delivery, these high rates of elective CS have become a global constant [6, 7]. However, after 39 weeks of gestation, this risk starts to decline [7]. Consequently, the impact of elective term CS timing on unfavorable neonatal outcomes has been the focus of recent research. A secondary analysis of the World Health Organization's Multicounty Survey on Maternal and Newborn Health, found that among singleton repeat term deliveries, delivery at 37 weeks compared to delivery after 37 weeks increased the odds of neonatal morbidity by two folds (95% CI 1.67–2.56) and intra-hospital early neonatal death by three folds (95% CI 1.72–-6.25) [8]. The incidence of uterine rupture significantly correlates with both the number of prior cesarean deliveries and the type of uterine incision. For women with one previous cesarean delivery, the rate of uterine rupture is around 1%, whereas it rises to 3.9% for those with more than one previous cesarean delivery [9].

The current study aimed to compare the rates of adverse maternal and neonatal outcomes between cesarean sections performed at 37 weeks to 38 weeks + 6 days and those delayed to 39 weeks and beyond in women with two or more previous C-sections. Also, to evaluate the risk of emergency cesarean sections and uterine rupture when elective cesarean sections are scheduled at different gestational ages in women with two or more previous C-sections.

Methods

The study was conducted at the Maternity and Children Hospital in Al-Ahsaa city, Eastern Province, Saudi Arabia. This hospital is a tertiary care facility and a regional referral center for obstetrics, gynecology, and pediatrics, providing an appropriate setting with access to the required patient population and resources for conducting maternal and child health research. It is a government-operated public healthcare institution specializing in medical and therapeutic services for maternity patients and children within the region.

The study focused on women with a history of two or more cesarean deliveries (CDs) who gave birth at the Maternity and Children Hospital between 2022 and 2024. These women were classified into two groups: Group 1 included women scheduled for cesarean delivery between 37 weeks and 38 weeks + 6 days of gestation, while Group 2 consisted of women scheduled for cesarean delivery at 39 weeks of gestation or later. Exclusion criteria included women with multifetal pregnancies or those undergoing cesarean sections for reasons other than repeated cesarean deliveries, such as diabetes, preeclampsia, placenta previa, or placental abruption.

Authors identified these patients through a search of hospital records for those with a history of two or more cesarean sections. Data were obtained from the hospital's maternal and children's records, focusing on women who had two or more cesarean sections and underwent either elective or emergency cesarean deliveries during the study period. Information was collected on the timing of the cesarean delivery,

whether the surgery was elective or emergency, and neonatal outcomes. Data were gathered from patient records, clinical documentation, and interviews with the patients. All data were entered into the hospital's electronic medical records system, which included maternal demographics, obstetric history, clinical data, and neonatal outcomes.

The sample size for the study was determined to be 385 patients, based on the hospital's database from 2022 to 2024. A non-probability, consecutive sampling technique was employed, where all women who met the inclusion criteria during the study period were included in the sample. This approach ensured that every eligible patient was accounted for, providing a comprehensive view of the population. Ethical approval for the study was obtained from the Maternity and Children's Hospital Review Board, ensuring that patient confidentiality and rights were protected throughout the research.

Data were analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic, obstetric, and clinical characteristics of the study participants. Continuous variables were presented as means and standard deviations (SD), while categorical variables were reported as frequencies and percentages. Associations between categorical variables were analyzed using the chi-square test (χ^2) or Fisher's exact test when expected cell counts were below five. Logistic regression analysis was conducted to determine potential predictors of adverse maternal and neonatal outcomes, adjusting for relevant covariates. Multivariate analysis was performed using binary logistic regression to assess factors influencing the timing of cesarean delivery. Variables found significant in univariate analysis ($p < 0.05$) were included in the multivariate models. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were reported. A p-value of less than 0.05 was considered statistically significant for all tests.

Result

A total of 1,827 cases were initially identified in the first phase (2023). After applying exclusion criteria, 278 cases were removed due to nationality (208 cases), preterm delivery before 37 weeks (65 cases), twin pregnancies (4 cases), and unclear previous cesarean section history (1 case). This resulted in 1,517 cases progressing to the first phase of 2024. During the screening process, 1,229 cases were excluded for not having a history of at least two previous cesarean sections (838 cases), nationality restrictions (259 cases), preterm delivery (119 cases), post-term delivery beyond 40 weeks and 6 days (4 cases), multifetal pregnancies (2 cases), and age-related exclusions (7 cases). This left 145 cases for further eligibility assessment in the second phase (2022 cohort). At this stage, an additional 46 cases were excluded due to missing neonatal files (18 cases), uncertain delivery dates (13 cases), and duplicate records from the same patient (15 cases). Ultimately, 390 cases met the inclusion criteria and were included in the final analysis for all screened cases at the different years (Figure 1).

Figure 1. The Number of Previous Cesarean Sections among Women with a History of Multiple Cesarean Deliveries (N=390)

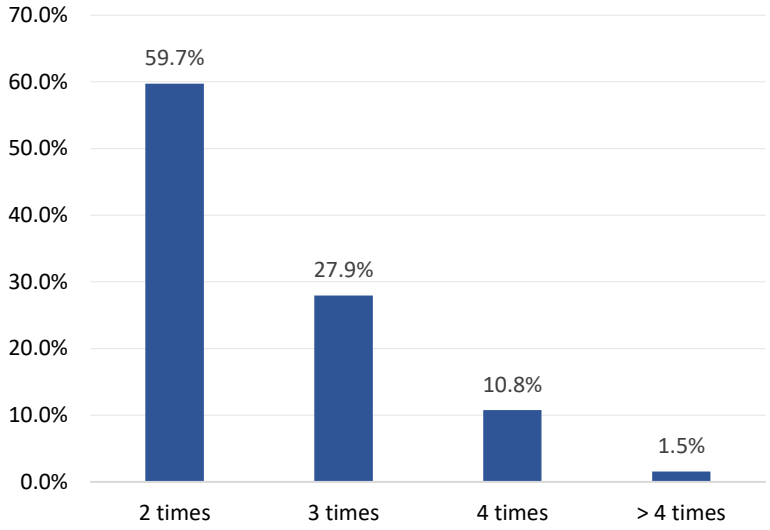


Table 1. Demographic and Obstetric Characteristics of the Study Women with a History of Multiple Cesarean Deliveries

Data	No	%
Age in years		
< 30	68	17.4%
30-35	125	32.1%
36-40	129	33.1%
> 40	68	17.4%
Mean ± SD	35.1± 5.4	
Body mass index		
Not reported	167	42.8%
Normal weight	23	5.9%
Overweight	72	18.5%
Obese grade I	101	25.9%
Obese grade II	27	6.9%
Number of pregnancies		
3-4	210	53.8%
5-6	115	29.5%
7+	65	16.7%
Mean ± SD	4.9± 1.8	
Number of deliveries		
2 times	146	37.4%
3 times	122	31.3%
4 times	70	17.9%
5 / more	52	13.3%
Mean ± SD	3.2± 1.4	
Number of full-term deliveries		

1-2	146	37.4%
3-4	179	45.9%
5+	41	10.5%
Not reported	24	6.2%
Mean ± SD	3.1±1.3	
Number of preterm deliveries		
Never	314	80.5%
1 time	11	2.8%
2 times	8	2.1%
3 / more	8	2.1%
Not reported	49	12.6%
Mean ± SD	0.2 ± 0.6	
Number of abortions		
Never	236	60.5%
1 time	93	23.8%
2 times	34	8.7%
3 times	14	3.6%
4 times	13	3.3%
Mean ± SD	1.0 ± 0.6	
Number of living neonates		
1-2	147	37.7%
3-4	191	49.0%
5+	52	13.3%
Mean ± SD	3.2± 1.4	

Table 1 presents the demographic and obstetric characteristics of the 390 study women with a history of multiple cesarean deliveries. Regarding age, the largest proportion of women was between 36-40 years old, representing 33.1% (n=129), closely followed by those aged 30-35 years, at 32.1% (n=125). The mean age was 35.1 ± 5.4 years. Body mass index (BMI) data was not reported for a significant portion, 42.8% (n=167) of the participants. Among those with reported BMI, the most common category was Obese Grade I, accounting for 25.9% (n=101), followed by overweight at 18.5% (n=72). Normal weight was observed in 5.9% (n=23). In terms of reproductive history, the majority of women had experienced 3-4 pregnancies, representing 53.8% (n=210), while 29.5% (n=115) had 5-6 pregnancies. The mean number of pregnancies was 4.9 ± 1.8. Concerning the number of deliveries, 37.4% (n=146) had two deliveries, 31.3% (n=122) had three, 17.9% (n=70) had four, with a mean of 3.2 ± 1.4 deliveries. For full-term deliveries, 45.9% (n=179) had 3-4, and 37.4% (n=146) had 1-2. The majority of women, 80.5% (n=314), reported no preterm deliveries. Regarding abortions, 60.5% (n=236) reported never having an abortion, while 23.8% (n=93) reported one abortion. Finally, concerning the number of living neonates, 49.0% (n=191) had 3-4, 37.7% (n=147) had 1-2, and 13.3% (n=52) had 5+ living neonates.

Table 2. Antenatal Maternal Comorbidities and Intraoperative Complications in Multiple Cesarean Sections (N=390)

Complications		No	%
Antenatal maternal complications (Maternal medical disorders)	Free	303	77.7%
	Anemia	10	2.6%
	Gestational diabetes mellitus (GDM)	10	2.6%
	SCD	9	2.3%
	Thyroid disorder	9	2.3%
	Asthma	8	2.1%
	Hypertension	8	2.1%
	Diabetes mellitus	6	1.5%
	Preeclampsia	6	1.5%
	Fibroid	2	.5%
	Morbid obesity	2	.5%
	Others	2	.5%
	Depression	1	.3%
	Ectopic pregnancy	1	.3%
	G6PD trait	1	.3%
	Gestational thrombocytopenia	1	.3%
	Hypertension	1	.3%
	Hypothyroidism	1	.3%
	IBS	1	.3%
	IUFD	1	.3%
	Lab hole with blood transfusion, ICU admission	1	.3%
	Left salpingectomy	1	.3%
	Previous myomectomy	1	.3%
	PROM	1	.3%
	PT	1	.3%
	Reaction to drug	1	.3%
	Rheumatoid arthritis	1	.3%
Intra or post-operative surgical complications	Intact incision	293	75.1%
	Adhesion	22	5.6%
	Marked adhesion	16	4.1%
	Not reported	12	3.1%
	Mild adhesion	10	2.6%
	Scar dehiscence	10	2.6%
	Moderate adhesions	5	1.3%
	Post-partum hemorrhage	4	1.0%
	Post-partum blood transfusions	4	1.0%
	Marked adhesions	3	.8%
	Adhesions	2	.5%
	Bladder injury	2	.6%
	Embolization or ligation of pelvic vessels	1	.3%
	Myomectomy	1	.3%

Table 2 shows antenatal maternal complications and intra/post-operative surgical complications among women with a history of multiple cesarean deliveries. Looking at antenatal complications, the majority

of women (77.7%) were free of maternal medical disorders. Among those who did experience complications, the most frequent were anemia (2.6%, n=10), gestational diabetes mellitus (GDM) (2.6%, n=10), sickle cell disease (SCD) (2.3%, n=9). Regarding surgical complications, a substantial portion of women (75.1%) had an intact uterine incision. The most common intra/post-operative complications were: being free from complications (25.9%, n=101), adhesions (5.6%, n=22), marked adhesions (4.1%, n=16).

Figure 1 illustrates the frequency of previous cesarean sections (Cs) among the study population. The data demonstrate that the majority of women, 59.7% (n=233), had undergone two prior cesarean deliveries. A substantial proportion, 27.9% (n=109), had three previous Cs. The frequency decreases with an increasing number of prior Cs, with 10.8% (n=42) having four previous Cs and only 1.5% (n=6) having more than four.

Table 3. Current Cesarean Section: Indications, Gestational Age, and Procedure among Women with a History of Multiple Cesarean Deliveries (N=390)

Complications		No	%
Antenatal maternal complications (Maternal medical disorders)	Free	303	77.7%
	Anemia	10	2.6%
	Gestational diabetes mellitus (GDM)	10	2.6%
	SCD	9	2.3%
	Thyroid disorder	9	2.3%
	Asthma	8	2.1%
	Hypertension	8	2.1%
	Diabetes mellitus	6	1.5%
	Preeclampsia	6	1.5%
	Fibroid	2	.5%
	Morbid obesity	2	.5%
	Others	2	.5%
	Depression	1	.3%
	Ectopic pregnancy	1	.3%
	G6PD trait	1	.3%
	Gestational thrombocytopenia	1	.3%
	Hypertension	1	.3%
	Hypothyroidism	1	.3%
	IBS	1	.3%
	IUFD	1	.3%
	Lab hole with blood transfusion, ICU admission	1	.3%
	Left salpingectomy	1	.3%
	Previous myomectomy	1	.3%
	PROM	1	.3%
	PT	1	.3%
	Reaction to drug	1	.3%
	Rheumatoid arthritis	1	.3%
Intra or post-operative surgical complications	Intact incision	293	75.1%
	Adhesion	22	5.6%
	Marked adhesion	16	4.1%
	Not reported	12	3.1%
	Mild adhesion	10	2.6%
	Scar dehiscence	10	2.6%
	Moderate adhesions	5	1.3%

	Post-partum hemorrhage	4	1.0%
	Post-partum blood transfusions	4	1.0%
	Marked adhesions	3	.8%
	Adhesions	2	.5%
	Bladder injury	2	.6%
	Embolization or ligation of pelvic vessels	1	.3%
	Myomectomy	1	.3%

As for the current cesarean sections (CS) (Table 3), the vast majority of current CS were performed due to a history of previous CS, accounting for 88.2% (n=344) of cases. Other indications were less frequent, with tender scars with abdominal pain representing 2.1% (n=8), and several other indications each accounting for 1% or less. Regarding gestational age at the current CS, the largest proportion of deliveries occurred between 37+0 and 37+6 weeks, representing 53.6% (n=209) of cases, followed by 38+0 to 38+6 weeks at 33.3% (n=130). The majority of current CS were elective, classified as category 3 or 4, making up 83.1% (n=324) of the procedures. Emergency CS (category 1 or 2) represented 16.9% (n=66) of cases. Finally, spinal anesthesia was the most frequently used method, accounting for 85.4% (n=333) of cases.

Table 4. Neonatal Outcomes Among Women with a History of Multiple Cesarean Deliveries (N=390)

Neonatal outcome	**No**	**%**
Neonate APGAR score		
4-6	12	3.1%
7-10	378	96.9%
Neonatal ICU admission		
Yes	43	11.0%
No	347	89.0%
Length of NICU stay		
< 5 days	21	48.8%
> 5 days	22	51.2%
Birth weight		
Very low birth weight	9	2.3%
Low birth weight	42	10.8%
Normal weight	157	40.3%
High birth weight	21	5.4%
Not reported	161	41.3%
Neonatal outcome		

Free	330	84.6%
Neonatal respiratory morbidity	47	12.1%
Neonatal ICU (NICU) admission of >24 hours	11	2.8%
Sepsis	10	2.6%
Hypoxic-ischemic encephalopathy	2	0.5%

Table 4 presents neonatal outcomes among the study women. Most of the neonates had an APGAR score between 7-10 (96.9%, 378 neonates), but a small percentage (3.1%, 12 neonates) had an APGAR score of 4-6. Neonatal ICU admissions were relatively low, with 43 neonates (11.0%) requiring admission, and the majority (89.0%, 347 neonates) did not. Among those admitted to the NICU, 21 neonates (48.8%) stayed for less than 5 days, while 22 neonates (51.2%) had stays longer than 5 days. Regarding birth weight, the distribution shows 9 neonates (2.3%) categorized as having very low birth weight, 42 neonates (10.8%) as having low birth weight, 157 neonates (40.3%) as having normal weight, and 21 neonates (5.4%) as having high birth weight. Notably, birth weight data was not reported for 161 neonates (41.3%). In terms of neonatal outcomes, a majority of neonates (84.6%, 330 neonates) were reported to be free of complications. However, 47 neonates (12.1%) experienced neonatal respiratory morbidity, 11 neonates (2.8%) had NICU admissions lasting more than 24 hours, 10 neonates (2.6%) experienced sepsis.

Table 5. Factors associated with timing of cesarean delivery in women with Multiple Cesarean Deliveries (N=390)

Factors	**Gestational age of current CS**										**p-value**
	36+0 to 36+6 wk		**37+0 to 37+6 wk**		**38+0 to 38+6 wk**		**39+0 to 39+6 wk**		**40+0 wk**		
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	
Age in years											.674
< 30	4	5.9%	35	51.5%	21	30.9%	5	7.4%	3	4.4%	
30-35	5	4.0%	62	49.6%	47	37.6%	5	4.0%	6	4.8%	
36-40	7	5.4%	68	52.7%	46	35.7%	6	4.7%	2	1.6%	
> 40	2	2.9%	44	64.7%	16	23.5%	4	5.9%	2	2.9%	
Body mass index											.012*
Not reported	6	3.6%	82	49.1%	55	32.9%	12	7.2%	12	7.2%	
Normal weight	4	17.4%	9	39.1%	9	39.1%	0	0.0%	1	4.3%	
Overweight	3	4.2%	45	62.5%	21	29.2%	3	4.2%	0	0.0%	
Obese grade I	3	3.0%	59	58.4%	36	35.6%	3	3.0%	0	0.0%	
Obese grade II	2	7.4%	14	51.9%	9	33.3%	2	7.4%	0	0.0%	
Number of pregnancies											.049*
3-4	8	3.8%	101	48.1%	83	39.5%	10	4.8%	8	3.8%	
5-6	6	5.2%	72	62.6%	30	26.1%	3	2.6%	4	3.5%	
7+	4	6.2%	36	55.4%	17	26.2%	7	10.8%	1	1.5%	
Number of deliveries											.005*
2 times	6	4.1%	60	41.1%	68	46.6%	6	4.1%	6	4.1%	

3 times	4	3.3%	75	61.5%	34	27.9%	5	4.1%	4	3.3%	
4 times	5	7.1%	40	57.1%	20	28.6%	3	4.3%	2	2.9%	
5 / more	3	5.8%	34	65.4%	8	15.4%	6	11.5%	1	1.9%	
History of preterm											.487
Yes	2	7.4%	17	63.0%	6	22.2%	2	7.4%	0	0.0%	
No	12	3.8%	166	52.9%	109	34.7%	17	5.4%	10	3.2%	
History of abortions											.352
Yes	7	4.5%	90	58.4%	42	27.3%	9	5.8%	6	3.9%	
No	11	4.7%	119	50.4%	88	37.3%	11	4.7%	7	3.0%	
Chronic health problem											.714
Yes	3	3.4%	42	48.3%	34	39.1%	5	5.7%	3	3.4%	
No	15	5.0%	167	55.1%	96	31.7%	15	5.0%	10	3.3%	
Number of previous Cs											.049*
2 times	10	4.3%	111	47.6%	90	38.6%	14	6.0%	8	3.4%	
3 times	3	2.8%	66	60.6%	32	29.4%	4	3.7%	4	3.7%	
4 times	5	11.9%	27	64.3%	8	19.0%	1	2.4%	1	2.4%	
> 4 times	0	0.0%	5	83.3%	0	0.0%	1	16.7%	0	0.0%	

P: Exact probability test *^: Pearson X^2 test* ** P < 0.05 (significant)*

Table 5 examines factors associated with the gestational age of current cesarean section (CS) in women with multiple prior CS. BMI showed a significant association (p = 0.012). Women with normal weight had a higher percentage of deliveries at 36+0 to 36+6 weeks (17.4%) and 38+0 to 38+6 weeks (39.1%). Whereas obese grade II had a higher percentage of deliveries at 36+0 to 36+6 weeks (7.4%). The number of pregnancies also significantly affected gestational age at delivery (p = 0.049). Women with 5-6 pregnancies had a higher percentage of deliveries at 37+0 to 37+6 weeks (62.6%) compared to those with 3-4 pregnancies (48.1%). Furthermore, those with 7+ pregnancies had a higher percentage of deliveries at 39+0 to 39+6 weeks (10.8%). Similarly, the number of deliveries was significantly associated with gestational age (p = 0.005). Women with 5 or more deliveries showed a higher percentage of deliveries at 37+0 to 37+6 weeks (65.4%) and 39+0 to 39+6 weeks (11.5%). Women with 2 deliveries had a higher percentage of deliveries at 38+0 to 38+6 weeks (46.6%).

Table 6. Relation between neonatal outcome and with type of caesarean section at different gestational ages

Neonatal outcome	Gestational age of the current CS														
	36+0 to 36+6 wk		p-value	37+0 to 37+6 wk		p-value	38+0 to 38+6 wk		p-value	39+0 to 39+6 wk		p-value	40+0 wk		p-value
	Elective CS	Emergency CS		Elective CS	Emergency CS		Elective CS	Emergency CS		Elective CS	Emergency CS		Elective CS	Emergency CS	
Neonate APGAR score			.021*			.049*			.019*			.257			.057
4-6	0.0%	33.3%		2.8%	10.3%		0.0%	5.0%		11.1%	0.0%		0.0%	33.3%	
7-10	100.0%	66.7%		97.2%	89.7%		100.0%	95.0%		88.9%	100.0%		100.0%	66.7%	
Neonatal ICU admission			.002*			.204			.008*			.099			.400
Yes	13.3%	100.0%		9.4%	17.2%		6.4%	25.0%		22.2%	0.0%		20.0%	0.0%	
No	86.7%	0.0%		90.6%	82.8%		93.6%	75.0%		77.8%	100.0%		80.0%	100.0%	
Length of NICU stay			.136			.611			.079			-			-
< 5 days	0.0%	66.7%		47.1%	60.0%		28.6%	80.0%		100.0%	0.0%		0.0%	0.0%	
> 5 days	100.0%	33.3%		52.9%	40.0%		71.4%	20.0%		0.0%	0.0%		100.0%	0.0%	
Neonatal complications			.002*			.216			.060			.413			.400
No	86.7%	0.0%		85.0%	75.9%		90.0%	75.0%		77.8%	90.9%		80.0%	100.0%	
Yes	13.3%	100.0%		15.0%	24.1%		10.0%	25.0%		22.2%	9.1%		20.0%	0.0%	
Birth weight			.145			.412			.127			.935			.800
Very low birth weight	6.7%	0.0%		3.3%	3.4%		0.0%	5.0%		0.0%	0.0%		0.0%	0.0%	
Low birth weight	13.3%	66.7%		7.8%	17.2%		13.6%	20.0%		0.0%	0.0%		0.0%	0.0%	
Normal weight	60.0%	0.0%		42.2%	27.6%		40.0%	35.0%		33.3%	27.3%		50.0%	66.7%	
High birth weight	0.0%	0.0%		5.6%	6.9%		5.5%	0.0%		11.1%	9.1%		10.0%	0.0%	
Not reported	20.0%	33.3%		41.1%	44.8%		40.9%	40.0%		55.6%	63.6%		40.0%	33.3%	
Neonatal outcome			.001*			.023*			.041*			.392			.492
Neonatal respiratory morbidity	6.7%	100.0%		12.2%	17.2%		7.3%	25.0%		11.1%	0.0%		20.0%	0.0%	
Neonatal ICU (NICU) admission of >24 hours	6.7%	33.3%		2.8%	10.3%		.9%	0.0%		0.0%	0.0%		0.0%	0.0%	
Sepsis	6.7%	33.3%		2.8%	0.0%		1.8%	0.0%		0.0%	9.1%		0.0%	0.0%	
Hypoxic-ischemic encephalopathy	0.0%	0.0%		0.0%	3.4%		0.0%	0.0%		11.1%	0.0%		0.0%	0.0%	
Free	86.7%	0.0%		85.0%	75.9%		90.0%	75.0%		77.8%	90.9%		80.0%	100.0%	

P: Exact probability test

** P < 0.05 (significant)*

Table 6 demonstrates several significant differences in neonatal outcomes based on the type of cesarean section (CS) at different gestational ages. Neonate APGAR scores were significantly lower in emergency CS compared to elective CS at 36+0 to 38+6 weeks (p-values: .021, .049, .019), with a higher percentage of neonates scoring 4-6 in emergency CS cases. Neonatal ICU admission was significantly more frequent in emergency CS at 36+0 to 36+6 weeks (p = .002) and 38+0 to 38+6 weeks (p = .008), indicating a higher need for critical care in these cases. Additionally, neonatal complications were significantly more common in emergency CS at 36+0 to 36+6 weeks (p = .002), suggesting that early emergency deliveries pose higher risks. Neonatal respiratory morbidity and adverse outcomes, including sepsis and prolonged NICU stay, were significantly associated with emergency CS at 36+0 to 38+6 weeks (p-values: .001, .023, .041). However, at 39+0 weeks and beyond, no significant differences were observed between elective and emergency CS.

Table 7. Crude and adjusted odds ratio for Impact of Timing of Cesarean Delivery on Maternal and Neonatal Outcomes in Women with a History of Multiple Cesarean Deliveries

CI: Confidence interval Adjusted for pre-gestational body mass index, maternal age, abortions, preterm, co-morbidities, and previous CS

* P < 0.05 (significant)

Excluded cases reasons during study phases by study years

Phase	Year	Total	Excluded	Reasons	No
First phase	2023	1827	278	Nationality	208
				Women who delivered before 37+0	65
				Twins	4
				PS ? PREV ?	1
	2024	1517	1229	No history of 2 previous CS	838
				Nationality	259
				Multifetal pregnancy	2
				Delivery before 37+0 weeks	119
				Age	7
				After 40+6 weeks	4
Second phase	2022	145	46	Neonat's file is not found	18
				uncertain date no	13
				complete data same ID	3
				patient No.21	1
				Patient has SCD with complications	1
				She delivered in 2023 neonate	1
				delivery on 36 weeks	1
				Neonate born with congenital anomaly	1
				mother have muliple co-morbidities	1

			deliver at 36 week	2
			clinical notes before cs is not found	3
			uncertain gestational age of the current pregnancy	1
2024	289	153	Invalid data(mother's or neonat's file is not foun	150
			Nationality	1
			No history of 2 previous CS	2

Table 7 assesses the impact of the timing of cesarean delivery on maternal and neonatal outcomes. Regarding maternal outcomes, a significant association was observed for deliveries occurring at 38+0 to 38+6 weeks (p = 0.046). The crude odds ratio (OR) was 2.06 (95% CI: 1.01-7.64), indicating a slightly increased risk of maternal complications at this gestational age. After adjusting for pre-gestational BMI, maternal age, abortions, preterm births, comorbidities, and previous CS, the adjusted OR was 1.63 (95% CI: 1.02-4.69), still showing a significant association. This suggests that delivering at 38+0 to 38+6 weeks in women with multiple prior CS is associated with a significantly higher risk of maternal complications. For neonatal complications, a significant association was found for deliveries at 39+0 to 39+6 weeks (p = 0.049). The crude OR was 0.44 (95% CI: 0.08-0.97), suggesting a decreased risk of neonatal complications at this gestational age. However, after adjusting for confounding factors, the adjusted OR was 0.91 (95% CI: 0.09-0.99), which, while still showing a trend toward decreased risk, has a confidence interval that includes 1.0, and therefore the significance becomes less clear. This indicates that while there might be a lower risk of neonatal complications at 39+0 to 39+6 weeks, this association needs further investigation to confirm its clinical significance.

Discussion

The study population primarily consisted of women with advanced age distributions, reflecting the increased likelihood of multiple cesarean deliveries with advancing maternal age. The high proportion of obesity, particularly in the Obese Grade I category, suggests a possible association between elevated BMI and the necessity for repeat cesarean sections, possibly due to obstetric complications or physician preference. Reproductive history indicates that most women had three to four pregnancies, and deliveries reveal a strong association between a higher number of pregnancies and subsequent cesarean deliveries. The low incidence of preterm deliveries suggests effective prenatal management in this sample. The high frequency of full-term deliveries supports the safety of repeat cesarean sections in achieving term pregnancies. Additionally, the limited number of abortions means relatively stable reproductive health among these women.

Our study revealed that the low prevalence of antenatal medical disorders is consistent with previous findings that uncomplicated pregnancies are common unless pre-existing conditions exist [1]. However, complications such as anemia, gestational diabetes mellitus (GDM), and sickle cell disease (SCD) reflect known risks associated with prior uterine scarring [2, 3]. The lower GDM prevalence compared to other studies may be influenced by screening variations and other factors [4]. Surgical outcomes indicate that nearly half of the women had an intact uterine incision, with adhesions being the most common complication, consistent with previous studies [5]. The absence of complications in one-fourth of cases is reassuring, but the presence of undocumented complications highlights the need for standardized surgical reporting [6]. The distribution of prior CDs follows global trends, with most women having two or three previous CDs, while higher-order CDs remain uncommon due to increased risks and clinical guidelines discouraging excessive repeat surgeries [7, 8]. Most CDs were performed electively due to prior uterine scars, highlighting the preference for scheduled repeat procedures over trial of labor after cesarean (TOLAC) [9]. The peak gestational age at delivery (37–38 weeks) aligns with recommendations for reducing rupture risks in scarred uteri [10]. The high rate of elective (category 3/4) CDs over emergency

procedures is in line with global obstetric practice favoring planned deliveries in high-risk women [11]. Also, our findings, along with those of Shinar et al. (2022) [12], suggest that elective CDs at 37–38 weeks in women with multiple prior CDs are safe, with low rates of severe complications. However, the higher adhesion risk in our cohort underlines the need for individualized decision-making. While early-term delivery appears favorable, delaying until 39 weeks—as suggested by Shinar et al. (2022)—may be reasonable in select cases.

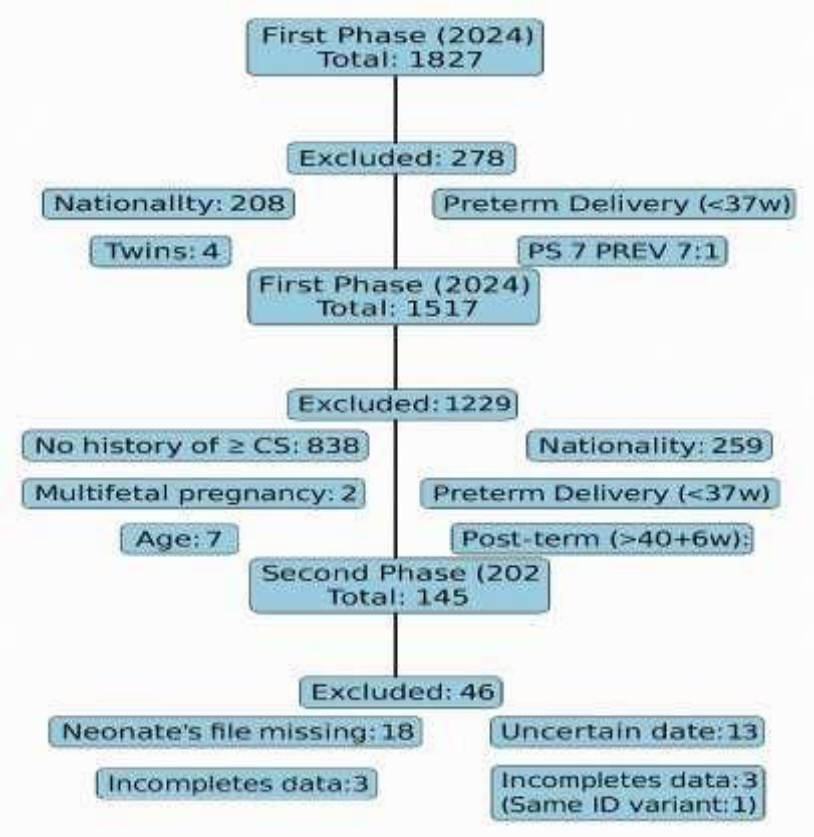
The neonatal outcomes in this study were favorable, with most of the infants having APGAR scores between 7-10, consistent with findings from recent studies on elective repeat cesarean deliveries [13, 14]. However, our results showed significantly worse outcomes in emergency procedures, particularly at 36-38 weeks' gestation, where we observed lower APGAR scores and higher NICU admission rates. These findings are similar to whar reported by Tita et al. [10], who established increased neonatal risks associated with unplanned deliveries before 39 weeks. The respiratory morbidity rate in our cohort, higher than in some comparable studies, likely reflecting our population's earlier delivery timing, supporting Clark et al.'s [15] observations about increased respiratory risks with early-term delivery. Our findings regarding maternal BMI's influence on delivery timing corroborate Marchi et al.'s [16] systematic review showing obesity's association with earlier deliveries. The contrast between our emergency delivery outcomes and Shinar et al.'s [12] findings of optimal outcomes at 39 weeks suggests that while timing matters, the planned nature of delivery may be equally crucial. This keeps in line with current ACOG guidelines (2019) recommending individualized timing decisions for women with multiple prior cesareans [17]. The high rate of complication-free neonates in our elective delivery group supports the relative safety of planned early-term delivery in this population.

Our study revealed a significantly increased risk of maternal complications at 38+0–38+6 weeks (adjusted OR 1.63, 95% CI: 1.02–4.69, p=0.046), contrasting with Shinar et al.'s [12] finding of comparable maternal risks at 37–38 weeks. This inconsistency is mostly due to differences in study populations—while their cohort included women with ≥1 prior cesarean, our focus on women with multiple (≥2) cesareans likely reflects a higher-risk subgroup where uterine scarring and adhesion-related complications increase with each subsequent surgery [2]. For neonatal outcomes, we observed a non-significant trend toward reduced complications at 39+0–39+6 weeks (adjusted OR 0.91, 95% CI: 0.09–0.99), which make even directionally with Shinar et al.'s [12] report of significantly lower adverse neonatal outcomes at 39 weeks (adjusted RR 0.51, 95% CI: 0.29–0.91). Shinar et al.'s [12] found increased neonatal risks at 37 weeks (adjusted RR 1.68, 95% CI: 1.39– 2.01), whereas our study lacked sufficient 37-week deliveries to assess this association robustly. Both studies concur that 38–39 weeks may offer a balance of risks, though our data highlight that for women with multiple cesareans, even this window may carry elevated maternal hazards. The rising risk of unplanned cesareans with advancing gestation (6.5% at <38 weeks vs. 32.6% at <40 weeks in Shinar et al.'s [12]) further complicates decision-making, suggesting that while 39 weeks may be ideal neonatally, maternal risks and labor unpredictability may necessitate earlier delivery in high-risk cases.

Existing literature presents conflicting evidence regarding optimal delivery timing for women with multiple prior cesareans. While Glavind et al. [18] and Kadour-Peero et al. [19] found no significant difference in maternal complications between 38- and 39-week deliveries, Melamed et al. [20] reported higher maternal risks at later gestational ages—a contrast to our finding of significantly increased maternal complications at 38 weeks (adjusted OR 1.63, 95% CI: 1.02–4.69). Neonatal outcomes show greater consensus: multiple studies [10, 21, 22] associate early-term delivery (<39 weeks) with adverse outcomes like respiratory morbidity and NICU admissions, aligning with our observed trend toward reduced neonatal complications at 39 weeks (adjusted OR 0.91, 95% CI: 0.09–0.99). Chiossi et al. [23] the only prior study comparing elective delivery to expectant management—proposed 39 weeks as ideal for balancing risks, but their cohort primarily included women with only one prior cesarean, unlike our high-risk population with ≥2 cesareans. This difference may explain why our study detected elevated maternal risks earlier (38 weeks), suggesting that uterine integrity and adhesion risks escalate with each repeat surgery. Methodological differences further complicate comparisons: most prior studies evaluated

elective deliveries in isolation, whereas our design accounted for real-world obstetrical scenarios (e.g., unplanned CDs, spontaneous labor), paralleling the clinical dilemma of timing delivery against unpredictable complications.

Figure 2: The Graph is the PRISMA for cases inclusion in the study



Conclusions and recommendations

This study revealed that in women with ≥2 prior cesarean deliveries (CDs), the timing of delivery significantly impacts both maternal and neonatal outcomes. Maternal complications were more frequent at 38 weeks, while neonatal outcomes showed a trend toward improvement at 39 weeks, though statistical significance was marginal. These findings contrast with some previous studies but align with others highlighting that women with multiple prior CDs represent a different high-risk population where uterine scarring and adhesion risks may shift the risk-benefit balance toward earlier delivery. Emergency CDs, particularly before 39 weeks, were associated with worse neonatal outcomes, reinforcing the importance of planned delivery when possible. Individualized Delivery Timing: For women with ≥2 prior CDs, delivery planning should weigh maternal risks (higher at 38 weeks) against neonatal benefits (optimal at 39 weeks). Shared decision-making should consider prior surgical history, BMI, and comorbidities. Avoid Non-Urgent Deliveries Before 39 Weeks: While maternal risks may increase with expectant management, elective delivery before 39 weeks should be reserved for clear indications.

Limitations

This study has some limitations that should be considered when interpreting the findings. Although a consecutive sampling technique was used to reduce selection bias, the use of a non-probability design

may still limit the broader generalizability of the results. In addition, some variables—such as body mass index and neonatal birth weight—had a relatively high rate of missing data, which may have affected the precision of the analysis. The distribution of participants across gestational age groups was not fully balanced, with fewer cases in the 39-week group, which may have reduced the ability to detect significant differences in neonatal outcomes at that gestational age. As with all observational studies, causality cannot be definitively established, and unmeasured factors such as provider decision-making, institutional policies, or undocumented clinical details may have influenced outcomes. Lastly, the study was conducted in a single tertiary hospital, which may limit the applicability of the findings to other settings.

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