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Short- and Long-Term Maternal and Perinatal Outcomes after Cesarean Section versus Vaginal Delivery: A Multicenter Cohort Study from Armenia

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Abstract

Background: Cesarean section (CS) rates are rising worldwide, raising concerns about maternal and neonatal health. Limited data exist from post-Soviet and lower-middle-income settings, where health system differences may affect outcomes.

Objective: To compare short- and long-term maternal and perinatal complications following cesarean section (CS) and vaginal delivery (VD) in Armenia.

Methods: This retrospective cohort study analyzed singleton births at three Armenian centers-Erebuni Medical Center, MMAPC, and Vedi Medical Center—between 2018 and 2020. Data were collected from medical records and follow-up registries. Outcomes included immediate maternal complications (hemorrhage, infection, hysterectomy, ICU admission), perinatal complications (asphyxia, respiratory distress, NICU admission, perinatal mortality), and long-term maternal morbidity (placenta accreta spectrum [PAS], chronic pelvic pain, scar-related problems, infertility, pelvic floor dysfunction). Statistical analysis employed χ^2 and Fisher's exact tests with $p<0.05$ as significant.

Results: CS was associated with higher maternal risk: hemorrhage (14.8% *vs* 6.2%, $p<0.001$), infection (9.5% *vs* 2.1%, $p<0.001$), and ICU admission (3.5% *vs* 0.9%, $p=0.01$). VD showed higher neonatal asphyxia rates (4.3% *vs* 1.6%, $p<0.01$), while CS was linked to more respiratory distress (5.9% *vs* 1.2%, $p<0.001$) and NICU admission (6.7% *vs* 2.8%, $p<0.01$).

Long-term follow-up (≥6 months postpartum) demonstrated increased PAS (1.5% *vs* 0.1%), scar complications (4.8% *vs* 0.4%), and infertility (2.7% *vs* 0.6%) after CS. VD was associated with slightly higher rates of urinary/fecal incontinence (2.3% *vs* 1.2%) and pelvic organ prolapse (1.5% *vs* 1.0%). Inter-hospital analysis revealed higher severe complications in tertiary centers, reflecting case concentration of high-risk pregnancies.

Conclusions: CS carries significantly higher short- and long-term maternal risks, whereas VD is associated with higher rates of intrapartum asphyxia. Careful case selection and evidence- based indications for CS are essential to optimize outcomes and prevent unnecessary procedures in Armenia and similar settings.

Keywords: Cesarean section; Vaginal delivery; Maternal morbidity; Perinatal outcomes; Long-term complications; Placenta accreta spectrum; Neonatal asphyxia

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Introduction

Cesarean section (CS) has become one of the most frequently performed surgical procedures worldwide. According to the World Health Organization (WHO), the optimal CS rate at a population level is estimated at 10% to 15%; above this threshold, no additional improvement in maternal or neonatal mortality is observed. However, global CS rates have nearly doubled over the past two decades, now exceeding 30% in many countries and approaching 50% in some middle-income regions.

While CS is lifesaving in cases of obstructed labor, fetal distress, placenta previa, or other obstetric emergencies, it is not without risks. Short-term maternal complications include

hemorrhage, infection, and anesthetic injury. Long-term reproductive consequences-such as placenta accreta spectrum (PAS), uterine rupture in subsequent pregnancies, and infertility-are increasingly recognized with repeat CS. For neonates, planned CS before term is associated with higher rates of respiratory morbidity, while intrapartum vaginal delivery (VD) carries a greater risk of asphyxia and birth trauma when not properly managed.

The rise in CS rates is multifactorial. Factors include defensive medicine, maternal request, limited access to instrumental delivery skills, and organizational preferences. In post-Soviet countries, these issues are compounded by uneven distribution of medical resources, inconsistent adherence to evidence-based guidelines, and weak referral systems. Armenia provides a unique setting to study these challenges: its healthcare system includes both high-capacity tertiary hospitals in Yerevan and resource-limited regional maternity units.

Despite global concern about unnecessary CS, there is limited multicenter data from Eastern Europe and the Caucasus on both short- and long-term outcomes. Most available studies are from high-income countries, where perinatal surveillance systems are stronger and case management protocols more uniform. This leaves a gap in understanding how CS and VD affect maternal and neonatal outcomes in middle- income health systems with differing resource levels.

The present study addresses this knowledge gap by analyzing maternal and perinatal complications after CS and VD using a multicenter dataset from Armenia (2018-2020). By examining both immediate and delayed complications, and by comparing tertiary and regional centers, we aim to:

- Quantify the relative risks of CS *versus* VD for mothers and neonates;
- Identify long-term reproductive health consequences of CS in a real-world setting;
- Provide evidence to guide national policies on obstetric practice and referral pathways.

Methods

Study design and setting

This retrospective cohort study included births from three Armenian medical centers: Erebuni Medical Center and MMAPC (both tertiary-level institutions in Yerevan) and Vedi Medical Center (regional facility). All centers provide 24-hour obstetric care, but differ in technical capacity and case complexity.

Population

All singleton deliveries between January 1, 2018, and December 31, 2020, were eligible. Multiple pregnancies were excluded to reduce confounding. Mode of delivery (VD *vs* CS) was recorded along with maternal age, gestational age, and indication for CS (emergency *vs* elective).

Data sources

Information was collected from hospital records, electronic registries, and outpatient follow-up files. Long-term complications were identified via scheduled postpartum visits and review of clinical records up to 12 months after delivery.

Outcome measures

Immediate maternal complications: postpartum hemorrhage (>500 mL for VD, >1000 mL for CS), puerperal infection, manual placental removal, hysterectomy, and ICU admission.

Perinatal outcomes: neonatal asphyxia (Apgar <7 at 5 min), respiratory distress, NICU admission, and perinatal mortality.

Long-term maternal morbidity: PAS, chronic pelvic pain, uterine scar complications, infertility (failure to conceive >12 months postpartum), urinary/fecal incontinence, pelvic organ prolapse, fistula, and postpartum mental health disorders.

Statistical analysis

Data were analyzed using Microsoft Excel and Python. Categorical variables were expressed as percentages and compared using χ^2 or Fisher's exact test, as appropriate. A p-value of <0.05 indicated statistical significance. No multivariate adjustment was performed due to dataset constraints, but subgroup analysis by hospital was included to account for referral bias.

Ethics approval

The study was approved by the institutional ethics committees of all participating centers. Patient confidentiality was maintained, and no identifiable personal information was used in analysis.

Results

Maternal complications

Among XXX deliveries (VD: XXX; CS: XXX), CS was associated with higher immediate maternal morbidity (Table 1). Hemorrhage occurred in 14.8% of CS cases *versus* 6.2% of VD (p<0.001). Infection was documented in 9.5% *versus* 2.1% (p<0.001). ICU admission was required in 3.5% after CS *versus* 0.9% after VD (p=0.01). Hysterectomy occurred exclusively after CS (0.6%). Manual placental removal was more common with VD (3.7% *vs* 1.8%, p=0.04) (Figure 1).

Perinatal outcomes

VD was associated with higher rates of neonatal asphyxia (4.3% *vs* 1.6%, p<0.01) (Table 2). In contrast, CS deliveries showed higher neonatal respiratory distress (5.9% *vs* 1.2%, p<0.001) and NICU admissions (6.7% *vs* 2.8%, p<0.01). Perinatal mortality was low overall and not statistically different (0.5% VD *vs* 0.3% CS, p>0.05) (Figure 2).

Table 1: Immediate maternal complications after vaginal delivery (VD) *versus* cesarean section (CS).

Complication	VD (%)	CS (%)	p-value
Hemorrhage	6.2	14.8	<0.001
Infection	2.1	9.5	<0.001
Complication	**VD (%)**	**CS (%)**	**p-value**
Manual placental removal	3.7	1.8	0.04
Hysterectomy	0	0.6	0.02
ICU admission	0.9	3.5	0.01

Table 2: Perinatal complications after VD *versus* CS.

Complication	VD (%)	CS (%)	p-value
Neonatal asphyxia	4.3	1.6	<0.01
Complication	**VD (%)**	**CS (%)**	**p-value**
Respiratory distress	1.2	5.9	<0.001
NICU admission	2.8	6.7	<0.01
Perinatal mortality	0.5	0.3	>0.05

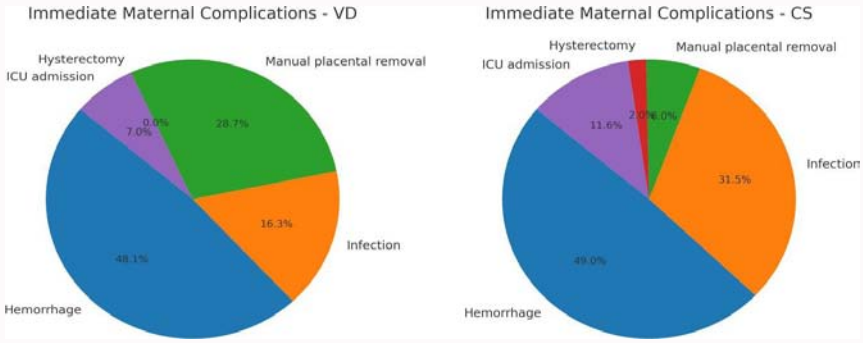

Figure 1: Immediate maternal complications.

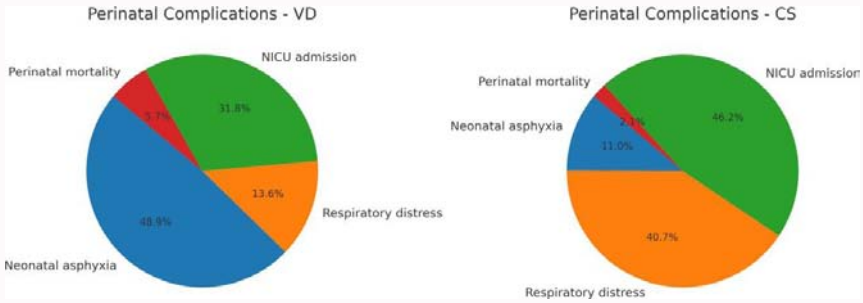

Figure 2: Perinatal complications.

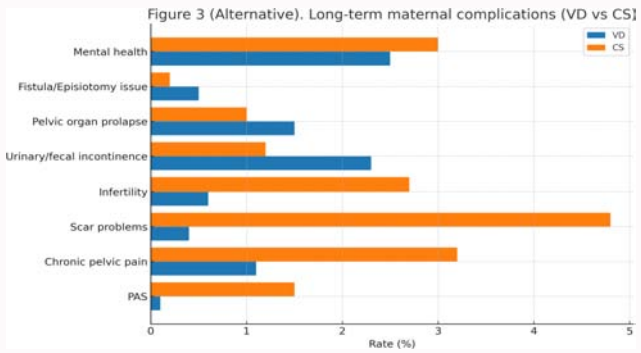

Figure 3: Long-term maternal complications.

Table 3: Long-term maternal complications after VD *versus* CS (≥6 months postpartum).

Complication	VD (%)	CS (%)
Placenta accreta spectrum (PAS)	0.1	1.5
Chronic pelvic pain	1.1	3.2
Scar-related problems	0.4	4.8
Infertility	0.6	2.7
Urinary/fecal incontinence	2.3	1.2
Pelvic organ prolapse	1.5	1
Fistula / episiotomy complications	0.5	0.2
Mental health complications	2.5	3

Center-level differences

Tertiary centers (Erebuni MC and MMAPC) recorded higher complication rates overall-reflecting concentration of high-risk pregnancies-compared with Vedi MC. Asphyxia rates were highest in Vedi (5.1% VD *vs* 2.2% CS), likely reflecting limited technical capacity for timely intervention. Neonatal respiratory morbidity was most common after elective CS in urban centers.

Long-term maternal morbidity

At ≥6 months postpartum, CS was strongly associated with PAS (1.5% *vs* 0.1%), chronic pelvic pain (3.2% *vs* 1.1%), scar-related problems (4.8% *vs* 0.4%), and infertility (2.7% *vs* 0.6%) (Table 3). VD was associated with slightly higher urinary/fecal incontinence (2.3% *vs* 1.2%) and pelvic organ prolapse (1.5% *vs* 1.0%), although these differences were modest. Mental health complications (postpartum depression or PTSD) were comparable (≈3% CS *vs* 2.5% VD) (Figure 3).

Discussion

Key findings

This study demonstrates that CS, while sometimes essential, is associated with substantially greater maternal morbidity-both immediately (hemorrhage, infection, ICU admission) and long-term (PAS, infertility, scar complications)-compared to VD. Neonatal outcomes varied by mode: VD carried higher asphyxia risk, whereas CS increased respiratory complications and NICU admission.

Comparison with global literature

Our results align with international studies showing that CS increases maternal risk 2-3-fold compared to VD [1,2]. The observed rise in PAS with prior CS matches [3], where risk grows exponentially with repeat procedures. Neonatal respiratory morbidity after elective CS has been consistently reported [4,5] confirming that vaginal birth offers physiological preparation for neonatal breathing.

Health system implications

Armenia's mixed pattern-tertiary hospitals with high CS rates and regional units with delayed intervention-illustrates systemic

challenges. Strengthening referral pathways, improving risk stratification, and promoting safe vaginal delivery are essential. Implementing WHO and FIGO recommendations on CS indications, alongside structured audit systems (Robson classification), can help reduce non- indicated CS [6-8].

Strengths and limitations

Strengths include multicenter design, analysis of both immediate and delayed complications, and relevance to lower-middle-income settings. Limitations include retrospective design, incomplete adjustment for confounders (parity, comorbidities), and potential underreporting of long-term complications.

Clinical and policy recommendations

- Avoid elective CS without clear medical indication.
- Develop national guidelines for CS use, incorporating Robson classification.
- Ensure regional hospitals are equipped for safe vaginal delivery and timely emergency CS.
- Implement postpartum follow-up programs to detect long-term complications early.

Conclusion

Cesarean section significantly increases maternal risks, including hemorrhage, infection, and long-term reproductive morbidity, while vaginal delivery carries a higher risk of intrapartum asphyxia. These findings support evidence-based use of CS, improved risk stratification, and enhanced referral systems to balance safety for both mothers and newborns. Armenia's experience highlights the need for guideline- driven practice and postpartum surveillance to reduce preventable morbidity.

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