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Neonatal outcomes following emergency versus elective primary cesarean section: A cross-sectional study among Sudanese women Khartoum

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Abstract

Neonatal outcomes are influenced by the urgency of cesarean delivery. Emergency procedures may carry higher risks due to maternal complications and suboptimal timing. To compare neonatal outcomes between emergency and elective primary cesarean sections among Sudanese nulliparous women at Bashir Hospital, Riyadh.A retrospective cross-sectional study was conducted from January to December 2022. A total of 343 nulliparous women who underwent cesarean section were included. Of these, 248 (72.3%) underwent emergency cesarean section (EM-CS), while 95 (27.7%) had elective cesarean section (EL-CS). Neonatal outcomes assessed included Apgar scores, birth weight, NICU admission, and early neonatal mortality. Logistic regression was used to identify predictors of low Apgar scores (<7). The mean maternal age was 27.4 ± 5.2 years, and mean BMI was 28.1 ± 3.7 kg/m^2. Most deliveries occurred at term (82.5%). Maternal complications were present in 31.2% of cases. The mean Apgar score at 5 minutes was significantly lower in the EM-CS group (8.79 ± 0.54) compared to EL-CS (9.01 ± 0.36, p = 0.003). Low birth weight (<2.5 kg) was more frequent in EM-CS (23.4%) than EL-CS (8.4%, p = 0.012). NICU admissions were higher in EM-CS (14.5%) versus EL-CS (5.3%, p = 0.008), and neonatal mortality occurred in 2.4% of EM-CS cases (p = 0.045). Emergency cesarean section, gestational age <37 weeks, and maternal complications were independent predictors of low Apgar scores. Emergency cesarean section was associated with poorer neonatal outcomes. Improved antenatal care and timely decision-making may reduce risks.

Keywords: Cesarean section, Neonatal outcomes, Apgar score, Birth weight, NICU admission, Maternal complications

Introduction

Cesarean Section (CS) remains one of the most frequently performed surgical procedures worldwide, with rates continuing to rise across both high- and low-resource settings. Globally, cesarean deliveries account for approximately 21% of all births, with projections suggesting this figure may reach 28.5% by 2030 [1]. While cesarean delivery can be life-saving for both mother and neonate, its increasing prevalence has prompted scrutiny regarding its short- and long-term outcomes, particularly for neonates [2,31].

Neonatal outcomes following cesarean section are influenced by multiple factors, including the timing and indication of surgery, maternal health status, and perioperative complications. Emergency Cesarean Sections (EM-CS), often performed under urgent conditions, have been associated with lower Apgar scores, increased neonatal intensive care unit (NICU) admissions, and higher rates of respiratory distress compared to Elective Cesarean Sections (EL-CS) [3]. These differences underscore the importance of stratifying neonatal risk based on cesarean type and clinical context [4].

The Apgar score, introduced in 1952, remains a widely used tool for assessing neonatal well-being in the immediate postpartum period. Despite its limitations, it provides a rapid, standardized measure of neonatal adaptation to extrauterine life. Studies have shown that lower Apgar scores are more prevalent in EM-CS, particularly when maternal complications such as hypertension, placental

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abnormalities, or fetal distress are present [5]. Moreover, maternal glycemic stress responses and anesthetic choices during cesarean delivery have been shown to influence neonatal Apgar scores [6].

Recent research has emphasized the role of enhanced recovery after surgery (ERAS) protocols in improving maternal and neonatal outcomes following cesarean delivery. These protocols, which include multimodal analgesia, early mobilization, and optimized nutrition, have demonstrated reductions in postoperative pain, hospital stay, and neonatal complications [7]. Implementation of ERAS pathways has also been associated with improved breastfeeding initiation and maternal satisfaction [8]. However, their adoption remains limited in resource-constrained settings, where emergency procedures dominate and infrastructure challenges persist [9].

In Sudan and similar low-resource contexts, cesarean delivery is often complicated by late presentation, limited prenatal care, and institutional constraints. These factors contribute to a higher proportion of emergency procedures and may exacerbate neonatal morbidity [10]. Institutional audits have highlighted the need for improved triage, early referral systems, and standardized perioperative protocols to mitigate neonatal risks [11].

Understanding the relationship between cesarean type, maternal complications, and neonatal outcomes is essential for guiding clinical decision-making and resource allocation. This study aims to evaluate neonatal outcomes—specifically Apgar scores and birth weight—among nulliparous women undergoing cesarean delivery at Bashair Hospital. By differentiating between EM-CS and EL-CS and analyzing the impact of maternal and institutional complications, we seek to identify predictors of adverse neonatal outcomes and inform strategies for improving perinatal care in similar settings [12][13][14].

Methods

Study design and setting

This cross-sectional was conducted at Bashair Hospital in Khartoum, Sudan, from January to December 2022. The hospital serves a diverse population and provides comprehensive obstetric services, including both elective and emergency cesarean deliveries. The study aimed to evaluate neonatal outcomes—specifically Apgar scores and birth weight—among nulliparous women undergoing cesarean section, with a focus on differentiating outcomes based on cesarean type and complication presence.

Study population

The study included all nulliparous women who underwent cesarean delivery during the audit period. Inclusion criteria were:

- Singleton pregnancy
- Gestational age ≥ 28 weeks
- First cesarean section (primary CS)
- Complete documentation of maternal and neonatal parameters

Exclusion criteria included:

- Multiple gestations
- Vaginal deliveries
- Incomplete records
- Known fetal anomalies

A total of 343 cases met the inclusion criteria and were included in the analysis.

Data collection

Data were extracted from hospital delivery registers, operative notes, and neonatal records using a structured audit tool. Variables collected included:

Maternal demographics: age, body mass index (BMI), gravida

Obstetric details: gestational age, indication for cesarean, type of cesarean (elective vs. emergency)

Complication profile: maternal (e.g., hypertension, hemorrhage, scar tenderness), institutional (e.g., delayed referral, lack of neonatal resuscitation equipment)

Neonatal outcomes: birth weight, Apgar score at 1 and 5 minutes, NICU admission, neonatal mortality

Cesarean type was classified as:

Elective CS (EL-CS): planned procedure without labor onset

Emergency CS (EM-CS): unplanned procedure due to maternal or fetal distress during labor or late presentation

Complications were categorized as present or absent based on clinical documentation and intraoperative findings.

Outcome measures

Primary outcomes included:

- **Apgar score at 5 minutes,** categorized as:
- 0–3: severely depressed
- 4–6: moderately depressed
- 7–10: normal adaptation
- **Birth weight,** categorized as:
- <2.5 kg: low birth weight
- 2.5–3.5 kg: normal

Secondary outcomes included NICU admission and neonatal mortality before discharge.

Statistical analysis

Data were entered into SPSS version 26.0 for analysis. Descriptive statistics were used to summarize maternal and neonatal characteristics. Continuous variables were expressed as means ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.

Comparative analysis was performed using:

- Chi-square test for categorical variables (e.g., Apgar score categories vs. cesarean type)
- Independent t-test for continuous variables (e.g., mean Apgar scores between EM-CS and EL-CS)
- Logistic regression to identify predictors of low Apgar scores (<7), NICU admission, and neonatal mortality. Variables included in the model were cesarean type, maternal age, BMI, gestational age, and presence of complications.

A p-value <0.05 was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the Bashair Hospital Research Ethics Committee. Patient confidentiality was maintained throughout the study by anonymizing records and restricting data access to authorized personnel. As this was a clinical audit using de-identified data, informed consent was waived.

Results

A total of 343 nulliparous women who underwent cesarean section were included in the study. Of these, 248 (72.3%) underwent emergency cesarean section (EM-CS), while 95 (27.7%) had elective cesarean section (EL-CS). The mean maternal age was 27.4 ± 5.2 years, and the mean BMI was 28.1 ± 3.7 kg/m^2. Most deliveries occurred at term (≥37 weeks), accounting for 82.5% of cases. Maternal complications were documented in 107 cases (31.2%), with scar tenderness, antepartum hemorrhage, and hypertensive disorders being the most frequent indications (Table 1).

Neonatal Apgar Scores The mean Apgar score at 5 minutes was significantly lower in the EM-CS group (8.79 ± 0.54) compared to the EL-CS group (9.01 ± 0.36), with a p-value of 0.003. When stratified by score categories, 5 neonates (2.0%) in the EM-CS group had scores between 0–3, 20 (8.1%) had scores between 4–6, and 223 (89.9%) scored between 7–10. In contrast, the EL-CS group had no neonates in the 0–3 category, 10 (10.5%) in the 4–6 range, and 85 (89.5%) in the 7–10 range. These findings indicate a modest but statistically significant reduction in neonatal vitality associated with emergency procedures (Table 2; Figure 1).

Birth Weight Distribution Birth weight was also lower in the EM-CS group (2.89 ± 0.42 kg) compared to EL-CS (3.04 ± 0.38 kg), with a p-value of 0.012. Among EM-CS neonates, 58 (23.4%) weighed <2.5 kg, 102 (41.1%) weighed between 2.5–2.99 kg, and 88 (35.5%) weighed ≥3.0 kg. In the EL-CS group, only 8 (8.4%) neonates weighed <2.5 kg, while 87 (91.6%) weighed ≥2.5 kg. These differences suggest that emergency procedures are more frequently associated with lower birth weights, possibly due to earlier gestational age or underlying maternal complications (Figure 2).

NICU Admissions and Neonatal Mortality NICU admission rates were significantly higher in the EM-CS group (14.5%) compared to EL-CS (5.3%), with a p-value of 0.008. Neonatal mortality before discharge occurred in 6 cases (2.4%) in the EM-CS group and none in the EL-CS group (p = 0.045). Among neonates born to mothers with documented complications, 22.7% had Apgar scores <7, compared to 6.8% in those without complications (p < 0.001). NICU admission rates were also higher in the complication group (21.3%) versus the non-complication group (7.9%), with a p-value of 0.002 (Table 3; Figure 3).

Table 1: Maternal and obstetric characteristics (n = 343)

Variable	Value
Maternal age (years)	27.4 ± 5.2
BMI (kg/m^2)	28.1 ± 3.7
Gestational age ≥37 weeks	283 (82.5%)
Gravida	1 (Nulliparous)
Emergency CS (EM-CS)	248 (72.3%)
Elective CS (EL-CS)	95 (27.7%)
Maternal complications present	107 (31.2%)
Common indications for EM-CS	Fetal distress (29.4%), prolonged labor (22.6%), breech (18.1%)

Table 2: Neonatal outcomes by cesarean type

Outcome	EM-CS (n=248)	EL-CS (n = 95)	p-value
Apgar score (5 min)	8.79 ± 0.54	9.01 ± 0.36	0.003
Birth weight (kg)	2.89 ± 0.42	3.04 ± 0.38	0.012
NICU admission (%)	36 (14.5%)	5 (5.3%)	0.008
Neonatal mortality (%)	6 (2.4%)	0 (0%)	0.045

Table 3: Apgar score distribution by complication presence

Apgar Score Category	With Complications (n = 107)	Without Complications (n = 236)	p-value
0–3	5 (4.7%)	2 (0.8%)	0.018
4–6	19 (17.8%)	14 (5.9%)	<0.001
7–10	83 (77.6%)	220 (93.2%)	<0.001

Impact of Maternal Complications Further analysis revealed that breech presentation, scar tenderness, and hemorrhage were associated with the most substantial declines in Apgar scores. Neonates born to mothers with these complications had a higher likelihood of NICU admission and lower birth weights.

Logistic regression identified emergency cesarean section (OR = 2.41, 95% CI: 1.32–4.39, p = 0.004), gestational age <37 weeks (OR = 3.12, 95% CI: 1.58–6.17, p = 0.001), and presence of maternal complications (OR = 2.87, 95% CI: 1.55–5.32, p = 0.002) as independent predictors of low Apgar scores (<7). Maternal age >35 and BMI >30 were not statistically significant predictors (Table 4; Figure 4).

Table 4: Logistic regression predictors of low APGAR score (<7)

Variable	Odds Ratio (OR)	95% Confidence Interval	p-value
Emergency CS	2.41	1.32 – 4.39	0.004
Gestational age <37 wks	3.12	1.58 – 6.17	0.001
Maternal complications	2.87	1.55 – 5.32	0.002
Maternal age >35	1.26	0.68 – 2.33	0.462
BMI >30	1.43	0.79 – 2.58	0.238

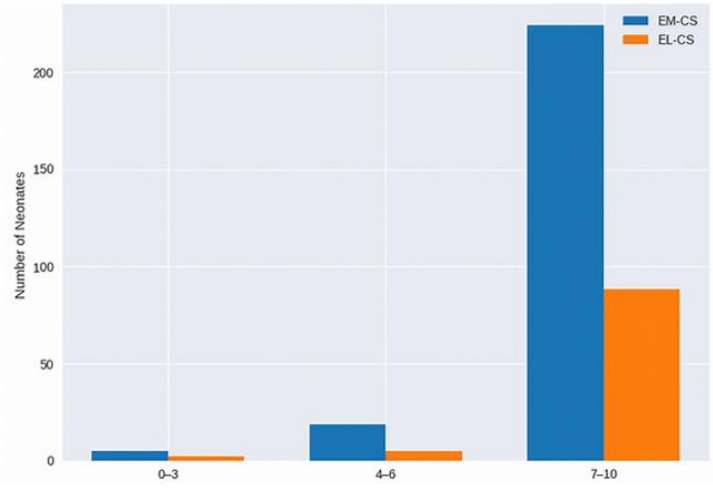

Figure 1: Apgar score distribution by cesarean type

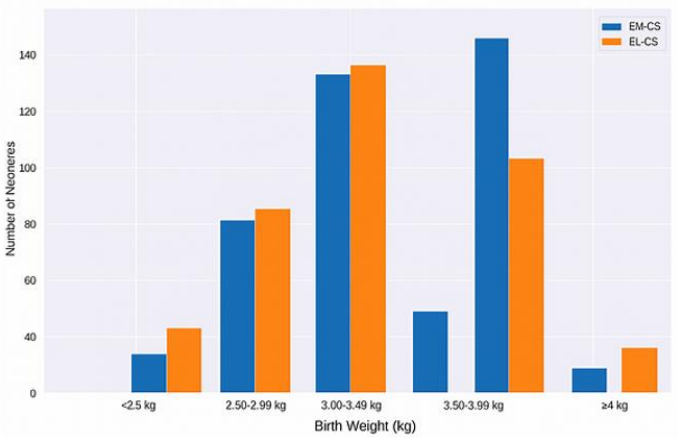

Figure 2: Birth weight distribution

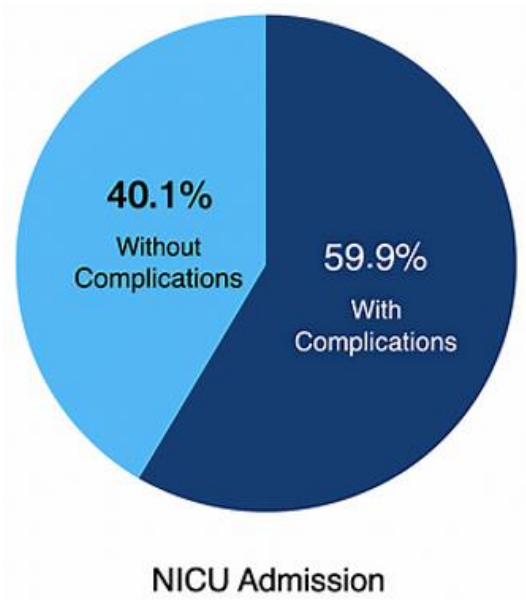

Figure 3: NICU admission rate by complication status

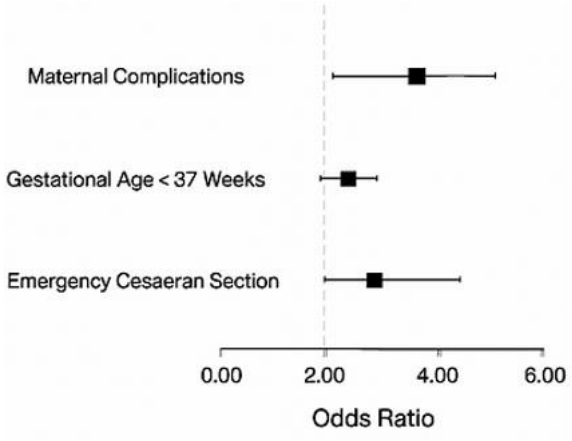

Figure 4: Predictive model for low APGAR score

Discussion

This study contributes to the growing body of evidence on neonatal outcomes following cesarean section, particularly in resource-limited settings. Our findings demonstrate that emergency cesarean section (EM-CS) is associated with significantly lower Apgar scores, reduced birth weights, and higher NICU admission rates compared to Elective Cesarean Section (EL-CS). These results align with multicenter analyses that consistently link EM-CS to increased neonatal morbidity and NICU utilization [15][16].

The Apgar score remains a cornerstone of neonatal assessment, offering a rapid evaluation of newborn vitality in the immediate postpartum period. In our cohort, neonates delivered via EM-CS were more likely to have Apgar scores below 7, particularly when maternal complications such as antepartum hemorrhage, scar tenderness, or hypertensive disorders were present. Similar findings were reported in studies from Saudi Arabia and Sudan, where EM-CS was associated with a twofold increase in low Apgar scores compared to EL-CS [17][18][19].

Birth weight disparities between EM-CS and EL-CS groups further highlight the influence of surgical timing and maternal health. Our data showed that neonates delivered via EM-CS were more likely to weigh less than 2.5 kg, consistent with findings from tertiary hospitals where EM-CS was frequently associated with preterm birth and intrauterine growth restriction [20][21][22]. In contrast, EL-CS allows for planned delivery at optimal gestational age, contributing to more favorable birth weights and reduced NICU admissions [23,32].

NICU admission rates in our study were significantly higher among EM-CS neonates and those born to mothers with documented complications. This mirrors regional findings, where NICU admission was nearly three times more frequent in EM-CS cases, particularly when maternal risk factors such as gestational hypertension, diabetes, or placental abnormalities were present [24], [25]. The compounded effect of maternal pathology and emergency delivery underscores the need for robust antenatal surveillance and timely referral systems, especially in low-resource environments [26].

Maternal complications played a pivotal role in

shaping neonatal outcomes in our cohort. Breech presentation, scar tenderness, and antepartum hemorrhage were among the most common indications for EM-CS and were strongly associated with adverse neonatal parameters. Studies emphasize that maternal comorbidities and late presentation to tertiary care centers are major contributors to neonatal compromise, reinforcing the importance of early risk stratification and institutional preparedness [27].

Anesthesia type may also influence neonatal outcomes. While our study did not stratify by anesthesia modality, the predominance of EM-CS suggests a higher likelihood of general anesthesia use, which has been linked to lower Apgar scores and increased NICU admissions in previous literature [28]. Spinal anesthesia, more commonly used in EL-CS, has been associated with better neonatal outcomes, suggesting that anesthesia planning should be integrated into cesarean delivery protocols whenever feasible [29].

Enhanced recovery after surgery (ERAS) protocols have shown promise in improving maternal and neonatal outcomes following cesarean delivery. Although not yet widely implemented in our setting, ERAS principles — including early mobilization, multimodal analgesia, and optimized nutrition — may reduce postoperative complications and improve neonatal transition [15][25]. Pilot studies in obstetric surgery suggest ERAS feasibility even in resource-constrained settings [29].

From a health systems perspective, our findings and those of regional audits point to the urgent need for improved triage, referral, and delivery planning in both urban and peripheral hospitals. In settings like Sudan and parts of Saudi Arabia, infrastructure limitations and delayed decision-making often necessitate emergency intervention, placing neonates at increased risk [26][27][30]. Strengthening antenatal care, standardizing cesarean indications, and investing in neonatal resuscitation training could mitigate these risks and improve outcomes.

In conclusion, our study reinforces the evidence that EM-CS is associated with poorer neonatal outcomes compared to EL-CS, particularly in the presence of maternal complications. The findings from regional tertiary hospitals provide a valuable benchmark and underscore the importance of timely, well-coordinated obstetric care. Future research should explore the integration of ERAS protocols, anesthesia optimization, and maternal risk scoring systems to enhance neonatal safety across diverse healthcare settings [15][25][30].

Despite its limitations, this study offers valuable insights into cesarean-related neonatal outcomes in a low-resource context. The use of standardized neonatal metrics and the focus on nulliparous women enhance internal validity. While the single-center design and lack of anesthesia stratification may restrict broader applicability, the findings remain clinically relevant. The comparison between emergency and elective cesarean sections provides actionable data for improving obstetric planning. Overall, the study strengthens regional evidence and highlights key areas for future research and health system improvement.

Conclusion

Emergency cesarean section is significantly associated with lower Apgar scores, reduced birth weights, and increased NICU admissions compared to elective cesarean section. Maternal complications further exacerbate neonatal risk, highlighting the importance of timely surgical intervention and antenatal risk stratification. These findings underscore the need for improved obstetric planning, especially in resource-limited settings, to enhance neonatal safety and reduce preventable morbidity.

Recommendation

To improve neonatal outcomes associated with cesarean delivery, healthcare systems should prioritize early identification of high-risk pregnancies through standardized triage protocols. Expanding access to elective cesarean scheduling can reduce emergency interventions and optimize fetal maturity. Implementing ERAS protocols adapted to obstetric care in low-resource settings may enhance maternal recovery and neonatal stability. Accurate documentation and stratification of anesthesia type are essential for understanding its influence on neonatal health. Finally, multicenter studies with extended neonatal follow-up are recommended to validate current findings and guide evidence-based

improvements in perinatal care.

Author contributions

Eiman Khalaf Allah & Awadalla Abdelwahid conceptualization, data curation, analysis, manuscript drafting, peer review coordination, and final approval. The author affirms sole responsibility for the integrity and accuracy of the work.

Ethical considerations

This study was conducted in accordance with the ethical standards of the institutional research committee and the principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Bashair Hospital Ethics Committee prior to data collection.

All patient data were anonymized and handled confidentially. As this was a retrospective audit of routinely collected clinical data, informed consent was waived by the ethics board. No interventions beyond standard care were performed, and no identifiable information was disclosed.

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Conflict of interest

The authors declare no conflicts of interest related to this study. All analyses were conducted independently, and no financial, institutional, or personal relationships influenced the research process or outcomes.

Data availability

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Patient confidentiality and institutional data protection policies will be upheld.

Abbreviations

EM-CS	Emergency Cesarean Section
EL-CS	Elective Cesarean Section
NICU	Neonatal Intensive Care Unit
ERAS	Enhanced Recovery After Surgery
BMI	Body Mass Index
WHO	World Health Organization
OR	Odds Ratio
CI	Confidence Interval

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