RESEARCH PAPER

Magnitude and determinants of immediate adverse neonatal outcomes among babies born by lower segment caesarean section

Dr. Mothe Siddharth Reddy[1], Dr. Bindu T Nair[2], Dr. Praneta Swarup[3]*, Dr. Shashi Bhushan[2]

[1]Assistant Professor, Department of Pediatrics, Pratima Relief Institute of Medical Sciences, Warangal, Telangana
[2]Professor, Department of Pediatrics, SMS&R, Sharda University
*[3]*Associate Professor, Department of Pediatrics, SMS&R (Corresponding Author)*

ABSTRACT

Background: Cesarean sections have risen worldwide, and elective cesarean deliveries (ECD) done without medical indication—especially before 39 weeks—are linked to higher neonatal respiratory morbidity, NICU admissions, and early neonatal mortality. This study examined the magnitude and determinants of immediate adverse neonatal outcomes among neonates born by LSCS at a tertiary center in North India.

Materials and Methods: In this cross-sectional study conducted from March 2021 to June 2022, 151 neonates delivered by LSCS were enrolled after excluding vaginal deliveries, intrauterine deaths, gestational age <28 weeks, birth weight <1000 g, and multifetal pregnancies. Data collected included APGAR scores, respiratory and cardiovascular status, neurological reflexes, birth trauma, time to first breastfeeding, and NICU admission and duration. Statistical analyses used Chi-square tests and Pearson's correlation; $p<0.05$ was considered significant.

Results: Immediate adverse outcomes occurred in 30% of neonates; no neonatal deaths were noted within 24 hours. NICU admission was required in 30% (n=45), predominantly for respiratory distress. Admission rates varied significantly by gestational age: <34 weeks 100%, 34–37 weeks 33.3%, >37 weeks 18.9% (p=0.000). Prolonged NICU stay (>24 hours) was significantly more common at lower gestational ages (p=0.000). Delayed initiation of breastfeeding beyond 1 hour occurred in 65% overall and was strongly associated with lower gestational age (p=0.000). Maternal conditions such as eclampsia, pre-eclampsia, and gestational diabetes showed higher NICU admissions but lacked statistical significance.

Conclusion: Prematurity, rather than mode of delivery alone, was the main driver of elevated NICU admissions and longer stays. Among neonates ≥34 weeks, many admissions were brief, suggesting transient respiratory issues. The high rate of delayed breastfeeding initiation after LSCS underscores the need for targeted supportive measures. Regional data can inform counseling, timing of elective procedures, and neonatal care planning.

Keywords: elective cesarean deliveries, NICU admissions, APGAR scores, neonatal morbidity, prematurity, transient tachypnea of the newborn, breastfeeding initiation

How to cite this article: Dr. Mothe Siddharth Reddy, Dr. Bindu T Nair, Dr. Praneta Swarup, Dr. Shashi Bhushan; Magnitude and determinants of immediate adverse neonatal outcomes among babies born by lower segment caesarean section: Int J Drug Deliv Technol. 2026; 16(5s): 937-942; DOI: 10.25258/ijddt.16.5s.115

Source of support: Nil.
Conflict of interest: Nil.

INTRODUCTION

Lower segment caesarean section (LSCS) is one of the most commonly performed obstetric surgical procedures worldwide. Over the past three decades, the global rate of caesarean delivery has increased substantially, exceeding the World Health Organization's recommended threshold of 10–15% in many countries.[1,2] While LSCS is a life-saving intervention when medically indicated, the rising trend of elective and repeat caesarean sections has raised concerns regarding neonatal outcomes.[3]

Neonates delivered by LSCS, particularly in the absence of labor or before 39 weeks of gestation, are at increased risk of immediate adverse outcomes such as respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), persistent pulmonary hypertension, hypoglycemia, poor Apgar scores, and increased need for neonatal intensive care unit (NICU) admission. [4–6] The absence of labor-associated catecholamine surge and thoracic compression may impair lung fluid clearance, predisposing these infants to respiratory morbidity.[7,8]

Several maternal and obstetric factors—including prematurity, meconium-stained liquor, maternal medical disorders, type of anesthesia, and emergency versus elective LSCS—have been identified as potential determinants of adverse neonatal outcomes.[9,10] Early identification of these determinants is essential to optimize perinatal care and reduce neonatal morbidity and healthcare burden.

Despite increasing LSCS rates in India, there is limited local data quantifying the magnitude and determinants of immediate adverse neonatal outcomes. Therefore, this study aims to assess the magnitude and identify

**Author for Correspondence:* Dr. Praneta Swarup

determinants of immediate adverse neonatal outcomes among babies born by LSCS.

MATERIAL AND METHODS

This was a cross-sectional study conducted from March 1, 2021 to June 30, 2022 in the Department of Pediatrics of a tertiary care teaching hospital. Ethical clearance was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed consent was secured from parents of enrollment of neonates.

The study included neonates delivered by lower segment cesarean section (LSCS) during the study period. Neonates delivered vaginally or those with intrauterine fetal demise were excluded. Additional exclusion criteria included gestational age less than 28 weeks, birth weight below 1000 grams, and multifetal pregnancies.

The sample size was calculated using the formula N=(z2pq)/l2N = (z²pq)/l²N=(z2pq)/l2, assuming a 95% confidence level (z = 1.96), an expected prevalence (p) of 0.5, and precision (l) of 10% and was found to be 151 neonates. A total of 151 neonates met the eligibility criteria and were enrolled in the study.

Data were collected using a structured proforma designed for the study. Maternal variables recorded included maternal age, obstetric history, number of antenatal visits, associated maternal illnesses, and indication and type of cesarean section (elective or emergency).

Neonatal details were documented immediately after birth. Clinical assessment included APGAR scores at 1 and 5 minutes, respiratory rate, heart rate, capillary refill time (with more than 3 seconds considered delayed), muscle tone, posture, and primitive reflexes including Moro, sucking, Babinski, and grasp reflexes. Birth trauma, if present, was categorized as soft tissue, bony, or visceral injury.

The time to initiation of breastfeeding was recorded. Based on clinical evaluation, neonates were either shifted to the mother for routine care or admitted to the Neonatal Intensive Care Unit (NICU) for indications such as respiratory distress, prematurity, birth asphyxia, or meconium aspiration. Duration of NICU stay was categorized as less than 24 hours or 24 hours and above. A follow-up assessment at 24 hours was performed to evaluate the neonate's clinical status and determine ongoing care requirements

Statistical analysis:

Patient details and investigations were collected on case record sheets and entered in Microsoft Excel Version 2017 (Microsoft Corporation, New York, USA). Results were analysed and statistically evaluated using Microsoft Excel and Statistical Package for Social Sciences (SPSS statistics for Windows, Version 26, Armonk, NY: IBM Corp). Normality of each variable was assessed by using the Kolmogorov-Simirnov test. Quantitative data was expressed by mean and standard deviation or median with interquartile range depending on normal distribution. Qualitative data was expressed in percentage and difference between the proportions was tested by Chi square test or Fisher's exact test. Karl Pearson's correlation coefficient was used to find associations between maternal and neonatal variables used Chi-square tests and. A 'P' value of less than or equal to 0.05 was considered statistically significant.

RESULTS

The study comprised of 151 neonates as per the inclusion and exclusion criteria. Table 1 presents the comprehensive maternal and neonatal profile of the 151 LSCS deliveries included in the study. The mean maternal age was 26.41 ± 4.03 years (range: 20–36 years).

Table 1. Baseline Maternal and Neonatal Characteristics of the Study Population (n = 151)

Variable	Category	Frequency (n)	Percentage (%)
Mode of Delivery	Elective LSCS	117	77.5
	Emergency LSCS	34	22.5
Maternal Illness	None	131	86.8
	Preeclampsia	5	3.3
	Eclampsia	3	2.0
	GDM	3	2.0
	Hypothyroidism	3	2.0
	Low-lying placenta	2	1.3
	Hepatitis B	1	0.7
	Hypothyroidism + Preeclampsia	1	0.7
	IHCP	1	0.7
	Systemic lupus erythematosus	1	0.7
Gestational Age Of Neonates	<34 weeks	15	9.9
	34–37 weeks	30	19.9
	>37 weeks	106	70.2
Sex of Neonate	Male	84	55.6
	Female	67	44.4

Figure 1 summarizes the indications for NICU admission and the association between gestational age and duration of NICU stay. Among the 45 neonates admitted to NICU, respiratory causes collectively constituted the most common indication (TTN 28.9%, RDS 15.6%, and MAS 8.9%), accounting for over half of all admissions. Prematurity was the next most frequent primary indication (33.3%), particularly among neonates born before 34 weeks of gestation. Birth asphyxia, early-onset neonatal sepsis, and Congenital pneumonia each accounted for 4.4% of

admissions. Lower gestational age was significantly associated with prolonged NICU stay ($p < 0.001$).

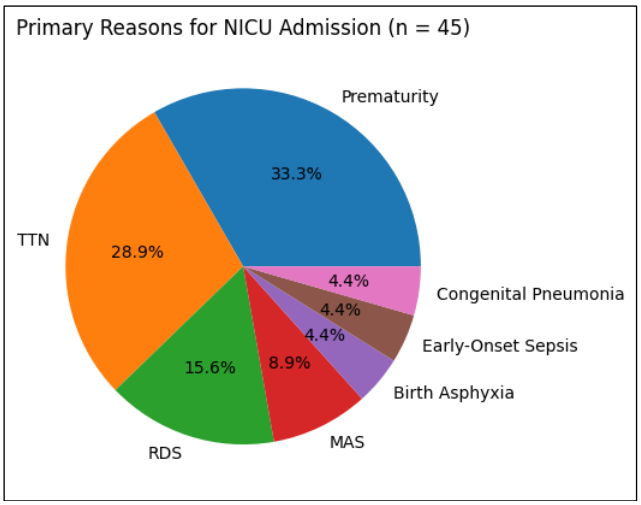

Figure 1: Indications for NICU admissions

Table 2. NICU Admission Characteristics and Duration of Stay According to Gestational Age

Variable	Category	n (%)	<34 Weeks (n=15)	34–37 Weeks (n=10)	>37 Weeks (n=20)	P-value
NICU Stay Duration	< 24 hours	15 (33.3 %)	0 (0.0 %)	3 (30 %)	12 (60 %)	
	≥ 24 hours	30 (66.7 %)	15 (100 %)	7 (70 %)	8 (40 %)	**0.000***

Table 2 shows the association of duration of NICU stay with gestational age of the neonates. This association was found to be statistically significant.

Table 3. Association of variables with Initiation of First Feed Among Neonates (n = 151)

Variable	Category	≤ 1 Hour (n=53) n (%)	> 1 Hour (n=98) n (%)	P-value
Gestational Age	< 34 weeks	0 (0.0)	15 (100.0)	**0.000***
	34–37 weeks	9 (30.0)	21 (70.0)	
	> 37 weeks	44 (41.5)	62 (58.4)	
Maternal Age (years)	≤ 25	24 (45.2)	43 (43.8)	0.630
	26–30	16 (30.1)	37 (37.7)	
	> 30	13 (24.5)	18 (18.3)	
Socio-Economic Status	Lower class	13 (24.5)	20 (20.4)	0.857
	Lower middle class	11 (20.7)	28 (28.5)	
	Upper lower class	9 (16.9)	17 (17.3)	
	Upper middle class	18 (33.9)	26 (26.5)	
	Upper class	2 (3.7)	7 (7.1)	
ANC Visits	≤ 3 visits	26 (53.1)	47 (47.9)	0.705
	> 3 visits	23 (46.9)	51 (52.0)	

Table 3 summarizes the factors associated with initiation of the first feed among neonates delivered via LSCS. A statistically significant association was observed between gestational age and timing of first feed ($p = 0.000$), with preterm neonates (<34 weeks) showing universal delay (100% initiated ≥2 hours). In contrast, term neonates (>37 weeks) had a higher proportion of early initiation (41.5%). However, maternal age ($p = 0.630$), socio-economic status ($p = 0.857$), and number of ANC visits ($p = 0.705$) did not demonstrate statistically significant associations with early breastfeeding initiation. Additionally, maternal illnesses were not found to significantly influence early initiation of breastfeeding in the present study.

Table 4. Association Between Maternal Illness and Initiation of First Feed (n = 151)

Maternal Illness	≤ 1 Hour (n=53) n (%)	> 1 Hour (n=98) n (%)	P-value
Eclampsia	0 (0.0)	3 (3.0)	
Gestational Diabetes Mellitus (GDM)	0 (0.0)	3 (3.0)	
Hepatitis B	2 (3.7)	0 (0.0)	
Hypothyroidism	2 (3.7)	1 (1.0)	
Hypothyroidism with Preeclampsia	1 (1.8)	0 (0.0)	
IHCP with Preeclampsia	2 (3.7)	0 (0.0)	
Low-Lying Placenta (LPV)	2 (3.7)	1 (1.1)	
Preeclampsia	1 (1.8)	1 (1.0)	

Systemic Lupus Erythematosus	0 (0.0)	1 (1.0)	
None	43 (81.1)	88 (89.7)	
Total	**53 (100.0)**	**98 (100.0)**	**0.621**

Table 4 presents the association between maternal illnesses and initiation of breastfeeding within one hour of birth. The majority of mothers in both groups had no documented medical illness (81.1% in the ≤1 hour group vs 89.7% in the >1 hour group). No statistically significant association was observed between maternal illness and early initiation of breastfeeding (p = 0.621). These findings suggest that maternal comorbidities did not significantly influence the timing of first feed in the present study.

DISCUSSION

The present study evaluated immediate adverse neonatal outcomes after LSCS in 151 neonates at a tertiary care center in North India. Overall, 30% of neonates required NICU admission, and immediate adverse outcomes were observed in the same proportion, though no neonatal deaths occurred within the first 24 hours. These findings underscore the clinical significance of prematurity and related factors in determining early neonatal morbidity, even when mode of delivery is surgical and carefully managed. These findings are consistent with existing literature.[11,12]

Gestational age as a principal determinant

Gestational age emerged as the strongest predictor of NICU admission and prolonged hospitalization. All neonates born before 34 weeks required NICU admission, and 100% had stays exceeding 24 hours. Those born between 34–37 weeks had significantly lower admission rates, and term neonates (>37 weeks) lower still. The pattern aligns with well-documented increased susceptibility of preterm infants to respiratory distress, thermoregulatory difficulties, feeding challenges, and other complications necessitating specialized care. Lower gestational age was also significantly associated with delayed initiation of breastfeeding; neonates born before 34 weeks showed the highest proportion of feed initiation beyond one hour. This may reflect clinical instability, need for respiratory support, or NICU protocols—factors directly tied to prematurity rather than LSCS per se.

The significantly higher incidence of brief NICU stays among term neonates—suggestive of transient issues such as transient tachypnea of the newborn (TTNB)—supports the notion that timing of delivery and lung maturity are essential considerations. Among neonates ≥34 weeks admitted to NICU, half had stays less than 24 hours, implying primarily transient respiratory adaptation issues rather than severe morbidity.

Maternal illnesses

Although NICU admissions were more frequent among neonates born to mothers with eclampsia, pre-eclampsia, or gestational diabetes, statistical significance was not achieved. Nonetheless, these conditions may influence neonatal outcomes through mechanisms such as placental insufficiency, hypertensive stress, or metabolic disturbances.

Breastfeeding initiation

Delayed initiation of breastfeeding occurred in 65% of neonates, with strong association to lower gestational age. For very preterm infants, clinical stability often dictates postponement of feeding; however, for late preterm or term infants, delay beyond one hour may reflect systemic or procedural gaps, including surgical or staffing constraints, maternal pain or immobilization, or lack of immediate support for breastfeeding post-CS.The high rate of delay among term infants suggests an opportunity for improving post-operative protocols—such as encouraging skin-to-skin contact and supporting early latching when clinically feasible.

The magnitude of immediate adverse neonatal outcomes observed in the present study was 30%, with NICU admissions also accounting for 30% of neonates delivered by LSCS. This rate is higher than the 22% immediate adverse neonatal outcome rate reported by Abdullahi et al. in Eastern Ethiopia, where neonatal mortality was documented at 45.52 per 1000 live births following cesarean delivery.[13] In contrast, no neonatal mortality was observed within the first 24 hours in our cohort, which may reflect differences in referral patterns, case mix, availability of tertiary neonatal care, and institutional protocols.

Similarly, the NICU admission rate in our study (30%) exceeded the 19.77% reported by Abdullahi et al.[13] The discrepancy may be attributable to differences in gestational age distribution and clinical thresholds for NICU admission. Socio-economic status also showed differing associations across studies. **Abdullahi et al**. reported increased neonatal morbidity among infants born to mothers of low socio-economic status.[13] In contrast, our study did not demonstrate a statistically significant association between socio-economic class and NICU admission or delayed initiation of breastfeeding.

Prematurity consistently emerged as the most important determinant of neonatal morbidity across studies. In our cohort, NICU admission rates were 100% in neonates <34 weeks, 33.3% in 34–37 weeks, and 18.9% in >37 weeks (p=0.000). These findings align with those of **Abdullahi et al**., who similarly reported significantly higher morbidity among preterm neonates.[13]

Khasawneh et al. analyzed 2595 cesarean deliveries in Jordan and reported a NICU admission rate of approximately 30%, comparable to our findings.[14] However, they observed higher NICU admission rates following emergency LSCS compared to elective procedures. In our study, emergency LSCS was also significantly associated with increased NICU admission

(p=0.000), reinforcing the impact of intrapartum complications and fetal distress on neonatal outcomes.

Thomas et al. demonstrated that early-term cesarean section (37–38 weeks) was associated with increased NICU admissions, with rates of 8% in preterms compared to 4.4% among full-term neonates.[15] In our study, NICU admission among neonates >37 weeks was 18.9%, which is higher than that reported in Thomas et al. This may be explained by inclusion of late preterm neonates (34–37 weeks) in our broader gestational categories and potential institutional differences in admission policies.

Breastfeeding initiation patterns in our study were also consistent with international data. We observed delayed initiation (>1 hour) in 65% of neonates delivered by LSCS. A demographic survey conducted by **Gedefaw et al**. in Ethiopia reported delayed breastfeeding initiation in 61.2% of neonates born via cesarean section.[16] These findings collectively emphasize that cesarean delivery, irrespective of region, is associated with challenges in early breastfeeding, likely due to maternal postoperative pain, delayed mother–infant contact, and neonatal observation requirements.

Respiratory morbidity was the most common indication for NICU admission in our study, accounting for 66.7% of admissions, with transient tachypnea of the newborn (TTN), respiratory distress syndrome (RDS), and meconium aspiration syndrome (MAS) being predominant. This observation is consistent with the meta-analysis by Tefera et al., which demonstrated significantly higher respiratory morbidity among neonates delivered by elective cesarean section compared to vaginal delivery.[11] **Ramachandrappa et al.** also highlighted the role of absent labor-associated catecholamine surge and delayed lung fluid clearance in neonates delivered via elective CS.[12]

Overall, comparison with existing literature suggests that while LSCS is associated with increased neonatal respiratory morbidity and delayed breastfeeding initiation, gestational age remains the most influential determinant of adverse outcomes.17 Our findings reinforce global evidence advocating avoidance of elective cesarean delivery before 39 weeks unless medically indicated.

Strengths and limitations

Key strengths include execution in a tertiary care center with clearly defined inclusion and exclusion criteria and use of structured assessments shortly after birth. The sample size was adequate for primary outcomes, allowing detection of significant associations, notably with gestational age.

Limitations include the fact that being a cross-sectional study, causal inferences are limited; prematurity and related factors likely drive outcomes, but the design does not directly compare LSCS with other delivery modes. Inclusion of neonates born before 34 weeks introduces a confounding element, as prematurity might overshadow effects potentially attributable to elective timing or surgical delivery. Variability in clinical management, staffing, or local protocols might also influence outcomes such as breastfeeding initiation time.

Implications for practice

Findings reinforce the importance of cautious decision-making regarding timing of LSCS, particularly in elective contexts. In resource-limited or high-volume settings, reducing prematurity, even modestly, could meaningfully decrease NICU burden. Strengthening early breastfeeding support after LSCS—through protocols for early skin-to-skin contact, breastfeeding counseling, or dedicated staff—could improve early feeding indicators, especially for term infants where delay is more avoidable.

Future research

Longitudinal follow-up could elucidate whether early respiratory issues or delayed feeding translate into longer-term morbidity or developmental differences. Research on interventions to promote earlier breastfeeding initiation post-CS and their impact on neonatal outcomes would also be valuable.

CONCLUSION

Immediate adverse neonatal outcomes after LSCS are predominantly driven by prematurity, with lower gestational age associated with higher NICU admissions, prolonged stays, and delayed breastfeeding. Term neonates may still experience transient respiratory issues, but many require only brief NICU care. Enhancing decision-making around timing of elective CS and improving early feeding support represent actionable strategies to optimize neonatal outcomes.

REFERENCE

1. World Health Organization. WHO statement on caesarean section rates. Geneva: WHO; 2015.
2. Betrán AP, Ye J, Moller AB, Zhang J, Gülmezoglu AM, Torloni MR. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. PLoS One. 2016;11(2):e0148343. doi: 10.1371/journal.pone.0148343.
3. Meikle SF, Steiner CA, Zhang J, Lawrence WL. A national estimate of the elective primary cesarean delivery rate. Obstet Gynecol. 2005;105:751–6.
4. Kamath BD, Todd JK, Glazner JE, Lezotte D, Lynch AM. Neonatal outcomes after elective cesarean delivery. Obstet Gynecol. 2009;113(6):1231-18. doi: 10.1097/AOG.0b013e3181a66d57.
5. Tita AT, Landon MB, Spong CY, Lai Y, Leveno KJ, Varner MW et al. NICHD Maternal-Fetal Medicine Units Network. Timing of elective repeat cesarean delivery at term and neonatal outcomes. N Engl J Med. 2009;360(2):111-20. doi: 10.1056/NEJMoa0803267.

6. Hansen AK, Wisborg K, Uldbjerg N, Henriksen TB. Risk of respiratory morbidity in term infants delivered by elective caesarean section: cohort study. BMJ. 2008;336(7635):85-7. doi: 10.1136/bmj.39405.539282.BE.
7. Zanardo V, Simbi AK, Franzoi M, Soldà G, Salvadori A, Trevisanuto D. Neonatal respiratory morbidity risk and mode of delivery at term: influence of timing of elective cesarean delivery. Acta Paediatr. 2004;93:643-7.
8. Levine EM, Ghai V, Barton JJ, Strom CM. Mode of delivery and risk of respiratory diseases in newborns. Obstet Gynecol. 2001;97:439-42.
9. Hook B, Kiwi R, Amini SB, Fanaroff A, Hack M. Neonatal morbidity after elective repeat cesarean section and trial of labor. Pediatrics. 1997;100:348-53.
10. Landon MB, Hauth JC, Leveno KJ, et al. Maternal and perinatal outcomes associated with a trial of labor after prior cesarean delivery. N Engl J Med. 2004;351:2581–9.
11. Tefera M, Assefa N, Mengistie B, Abrham A, Teji K, Worku T. Elective cesarean section on term pregnancies has a high risk for neonatal respiratory morbidity: a systematic review and meta-analysis. Front Pediatr. 2020;8:286.
12. Ramachandrappa A, Jain L. Elective cesarean section: its impact on neonatal respiratory outcome. Clin Perinatol. 2008;35(2):373-93.
13. Abdullahi YY, Assefa N, Roba HS. Magnitude and determinants of immediate adverse neonatal outcomes among babies born by cesarean section in public hospitals in Eastern Ethiopia. Res Rep Neonatol. 2021;11:1-12. .
14. Khasawneh W, Obeidat N, Yusef D, Alsulaiman JW. Neonatal outcomes and cesarean section rate in a tertiary teaching hospital in Jordan. BMC Pregnancy Childbirth. 2019;19:1-7.
15. Thomas J, Paranjothy S, James D. Effect of early-term elective cesarean section on neonatal respiratory morbidity. Arch Dis Child Fetal Neonatal Ed. 2007;92:F343-7.
16. Gedefaw G, Demis A, Alemnew B, Wubetu M. Prevalence and associated factors of delayed initiation of breastfeeding among mothers who gave birth by cesarean section in Ethiopia. Int Breastfeed J. 2020;15:1-9.
17. Sandall J, Tribe RM, Avery L, Mola G, Visser GH, Homer CS et al. Short-term and long-term effects of caesarean section on the health of women and children. Lancet. 2018;392(10155):1349-1357. doi: 10.1016/S0140-6736(18)31930-5.