International Journal of Contemporary Pediatrics
Sale A et al. Int J Contemp Pediatr. 2026 Dec;13(12):2479-2486
https://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20264314

Original Research Article

Outcomes and risk factors for mortality and morbidity of extramural neonates as compared to intramural neonates admitted in NICU in tertiary care teaching institute

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Received: 13 October 2026
Accepted: 13 November 2026

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ABSTRACT

Background: Neonatal morbidity and mortality are major global health concerns, with outcomes varying significantly between inborn (intramural) and outborn (extramural) neonates admitted to NICUs. Objectives: To compare outcomes, complications, and associated risk factors for morbidity and mortality between extramural and intramural neonates admitted to a tertiary care NICU.
Methods: A retrospective observational study was conducted on 648 neonates (456 inborn, 192 outborn) admitted to the NICU of a tertiary care teaching hospital. Data regarding gestational age, birth weight, mode of delivery, perinatal complications, resuscitation, ventilation, surfactant therapy, sepsis, and outcomes (discharge, death, DAMA) were collected from hospital records. Statistical analysis included chi-square, t-tests, and logistic regression to identify associations.
Results: Outborn neonates had significantly higher rates of early sepsis (52.2% vs 34.8%), need for phototherapy (34.8% vs 16.9%), resuscitation at birth (26.1% vs 13.5%), and complications at admission (13.0% vs 0.6%). Inborn neonates required more ventilation (28.1% vs 18.8%) and surfactant therapy (15.1% vs 8.9%), and developed more complications during NICU stay (41.6% vs 30.4%). Overall mortality was higher in inborn neonates (23.0% vs 13.0%). Key risk factors for mortality included prematurity, low birth weight, early sepsis, need for ventilation, and complications at admission.
Conclusions: Outborn neonates are more vulnerable to sepsis and perinatal complications at admission, while inborn neonates demonstrate higher mortality due to greater illness severity and intensive care needs. Targeted improvements in perinatal care, neonatal transport, and infection control are necessary to improve neonatal survival.

Keywords: Neonatal morbidity, Extramural neonates, Perinatal risk factors

INTRODUCTION

Neonatal morbidity and mortality are critical indicators of the quality of perinatal and neonatal healthcare in any country. Despite advances in obstetric and neonatal intensive care practices, neonatal mortality continues to account for a substantial proportion of under-five deaths globally. According to UNICEF and WHO estimates, approximately 2.3 million neonatal deaths occurred worldwide in 2021, with the majority concentrated in low and middle-income countries. India, with its large population and high birth rate, contributes significantly to this burden. Reduction in neonatal mortality remains a priority for achieving the Sustainable Development Goals (SDG-3) related to health and well-being.[1] A crucial determinant of neonatal outcomes is the place and quality

of perinatal care. The distinction between intramural and extramural neonates has important implications for morbidity, mortality, and risk factors because the circumstances surrounding birth, the availability of skilled personnel, the timeliness of resuscitation, and the safety of transport vary substantially between inborn and outborn neonates.[2]

India accounts for nearly one-fifth of global neonatal deaths. The neonatal mortality rate (NMR) has declined from 44 per 1000 live births in 2000 to 20 per 1000 live births in 2020, but progress is uneven across states and rural-urban settings. A major challenge lies in managing high-risk neonates, particularly those with prematurity, low birth weight, birth asphyxia, and infections. Inborn neonates delivered in well-equipped tertiary centers benefit from immediate specialized care, while outborn neonates often face delays in referral and suboptimal pre-referral stabilization, making them more vulnerable.[3]

The differences between extramural and intramural neonates extend beyond place of birth. Extramural neonates may be born in peripheral health facilities, private clinics or at home without skilled attendants. They often lack immediate access to life-saving interventions such as neonatal resuscitation, thermal care, breastfeeding initiation and infection prevention. Many arrive at tertiary NICUs late, in unstable conditions, and with complications such as hypothermia, hypoglycemia, or established sepsis. Conversely, intramural neonates benefit from immediate availability of neonatal resuscitation units, NICU support and obstetricians, but may also represent more complicated pregnancies requiring advanced obstetric intervention such as cesarean section.

Several studies in India and other developing countries have demonstrated higher morbidity among extramural neonates, particularly with regard to sepsis, jaundice, birth asphyxia and respiratory distress syndrome (RDS). Transport-related risks including hypothermia and hypoglycemia are additional burdens. However, paradoxically, mortality rates may sometimes be higher among inborn neonates, largely because tertiary centers serve as referral points for high-risk pregnancies (extreme prematurity, severe anomalies, severe preeclampsia, etc.), and such cases may not survive despite advanced neonatal support.[4]

Sepsis remains the leading cause of morbidity among outborn neonates. Early-onset neonatal sepsis is strongly associated with unhygienic delivery practices, lack of prophylactic antibiotic use in risk conditions, and delayed initiation of breastfeeding. Inborn neonates, although less prone to infections at admission, often develop nosocomial infections due to prolonged hospital stays and exposure to invasive devices. Similarly, respiratory morbidity differs: intramural neonates receive surfactant and ventilation more frequently, whereas extramural neonates often arrive late with established respiratory distress.[5]

The aim is to compare outcomes and risk factors for morbidity and mortality between extramural and intramural neonates admitted to the NICU of a tertiary care teaching hospital.

The objectives is to assess and compare the morbidity profile and complications between extramural and intramural neonates admitted to the NICU, evaluate and compare the risk factors influencing mortality in extramural versus intramural neonates, and analyze the association of maternal, perinatal, and neonatal factors with outcomes (discharge, death and DAMA) in both groups.

METHODS

Study design

The study was a retrospective observational study.

Study location

The research was conducted in the Neonatal Intensive Care Unit (NICU) of a tertiary care teaching institute.

Study duration

The study was carried out over a period of two years (January 2022 to December 2024), covering all NICU admissions during that timeframe.

Sample size

A total of 648 neonates admitted to the NICU formed the study sample.

Source of data

Data were obtained from hospital records of all neonates admitted to the NICU of a tertiary care teaching hospital during the study period. Permission from Institutional Ethics Committee was obtained for the study.

Inclusion criteria

The inclusion criteria include all neonates (both inborn and outborn) admitted to the NICU during the study period; Both term and preterm neonates; and neonates with complete available records.

Exclusion criteria

The exclusion criteria include neonates with incomplete medical records; Neonates discharged or transferred before adequate clinical evaluation.

Procedure and methodology

Hospital records of 648 neonates fulfilling the study criteria were reviewed. Neonates were categorized into two groups: Intramural (Inborn): delivered in the same hospital. Extramural (Outborn): born elsewhere and admitted after referral.

Early onset sepsis (EOS): EOS is defined as the onset of neonatal sepsis before 72 hours of life.

Late onset sepsis (LOS): LOS is defined as the occurring of neonatal sepsis from 72 hours to 90 days of life.[6]

Data extracted included: demographics: sex, gestational age and birth weight; Perinatal details: mode of delivery, maternal complications, antenatal history. Resuscitation and stabilization at birth.

Clinical presentation at admission (complications, sepsis, jaundice, asphyxia, respiratory distress). NICU interventions (ventilation, CPAP, surfactant and phototherapy).

Outcomes: survival, discharge, death, discharge against medical advice (DAMA).

Sample processing

Relevant laboratory investigations such as sepsis screen, blood cultures, serum bilirubin, and chest X-rays were reviewed from patient records. All data were entered into a structured proforma for analysis.

Statistical methods

Data were analyzed using SPSS (version 27.0). Categorical variables (e.g., type of delivery, complications, outcomes) were compared using Chi-square test/Fisher's exact test. Continuous variables (e.g., gestational age, birth weight) were analyzed with independent t-test or Mann- Whitney U test as appropriate. Logistic regression analysis was performed to identify independent risk factors for mortality. A p value <0.05 was considered statistically significant.

Data collection

Data collection was retrospective, relying on NICU admission registers, case files, discharge summaries, and laboratory reports. Quality checks were applied to ensure completeness and accuracy before statistical analysis.

RESULTS

As per distribution in Table 1, a greater proportion of preterm neonates were inborn (68.5%) compared to outborn (31.5%). Similarly, low birth weight and respiratory distress syndrome were more frequently observed among inborn admissions. Consequently, the majority of neonates requiring advanced respiratory interventions such as ventilation (78.0%) and surfactant therapy (80.2%) were inborn.

Table 1: Distribution of neonatal characteristics and interventions among inborn and outborn neonates.

Parameter	Total with parameter (N)	Inborn, N (%)	Outborn, N (%)
Preterm (<37 weeks)	359	246 (68.5%)	113 (31.5%)
Low birth weight (<2.5 kg)	414	283 (68.4%)	131 (31.6%)
Male sex	378	262 (69.3%)	116 (30.7%)
Cesarean delivery	310	277 (89.4%)	33 (10.6%)
Resuscitation at birth	112	62 (55.4%)	50 (44.6%)
Ventilation required	164	128 (78.0%)	36 (22.0%)
Surfactant therapy	86	69 (80.2%)	17 (19.8%)
Phototherapy required	144	77 (53.5%)	67 (46.5%)
Early-onset sepsis	259	159 (61.4%)	100 (38.6%)
Complications at admission	28	3 (10.7%)	25 (89.3%)
Complications during NICU stay	248	190 (76.6%)	58 (23.4%)
Respiratory distress syndrome (RDS)	194	142 (73.2%)	52 (26.8%)
Birth asphyxia	70	41 (58.6%)	29 (41.4%)
Hypothermia at admission	59	18 (30.5%)	41 (69.5%)
Hypoglycemia at admission	66	27 (40.9%)	39 (59.1%)
Nosocomial (LOS) sepsis	163	121 (74.2%)	42 (25.8%)
NEC (≥ Stage II)	33	24 (72.7%)	9 (27.3%)
Patent ductus arteriosus (PDA)	44	33 (75.0%)	11 (25.0%)
IVH (≥ Grade II)	29	21 (72.4%)	8 (27.6%)
Apnea of prematurity	105	79 (75.2%)	26 (24.8%)
Meconium aspiration syndrome	29	16 (55.2%)	13 (44.8%)
Deaths	130	105 (80.8%)	25 (19.2%)

Table 2: Baseline characteristics, interventions, and outcomes by group (n=648).

Variable	Inborn=456	Outborn=192	Test	95% CI (Inborn-Outborn)	P value
Admissions, N	456 (100%)	192 (100%)	-	-	-
Gestational age (weeks)	36.10±2.80	35.40±3.00	Welch t(363.4) = 2.79; Δ = 0.70	0.21 to 1.19	0.005
Birth weight (kg)	2.39±0.58	2.22±0.62	Welch t(360.7) = 3.21; Δ = 0.17	0.07 to 0.28	0.001
Male sex	262 (57.5%)	116 (60.4%)	z = -0.72; Δ% =-2.9	-11.3% to 5.6%	0.471
Preterm (<37w)	246 (53.9%)	113 (58.9%)	z = -1.14; Δ% =-5.0	-13.7% to 3.6%	0.255
LBW (<2.5kg)	283 (62.1%)	131 (68.2%)	z = -1.45; Δ% =-6.1	-15.0% to 2.8%	0.147
Cesarean delivery	277 (60.7%)	33 (17.4%)	z = 10.86; Δ% = 43.3	35.5% to 51.0%	<0.001
Resuscitation at birth	62 (13.5%)	50 (26.1%)	z = -3.79; Δ% =-12.6	-19.2% to -6.0%	<0.001
Ventilation	128 (28.1%)	36 (18.8%)	z = 2.54; Δ% =9.3	2.0% to 16.6%	0.011
Surfactant	69 (15.1%)	17 (8.9%)	z = 2.01; Δ% = 6.2	0.1% to 12.2%	0.045
Phototherapy	77 (16.9%)	67 (34.8%)	z = -4.94; Δ% =-17.9	-25.0% to -10.7%	<0.001
Early sepsis	159 (34.8%)	100 (52.2%)	z = -4.29; Δ% =-17.4	-25.5% to -9.3%	<0.001
Complications at admission	3 (0.6%)	25 (13.0%)	z = -5.20; Δ% =-12.3	-16.9% to -7.7%	<0.001
Complications during stay	190 (41.6%)	58 (30.4%)	z = 2.72; Δ% = 11.2	3.0% to 19.3%	0.007
Mortality	105 (23.0%)	25 (13.0%)	z = 2.90; Δ% =10.0	3.2% to 16.8%	0.004

The mean gestational age was significantly higher in the inborn group (36.1±2.8 weeks) compared to outborns (35.4±3.0 weeks; p=0.005). Similarly, the mean birth weight was greater among inborn neonates (2.39±0.58 kg) than outborns (2.22±0.62 kg; p=0.001). The distribution of sex, prematurity, and low birth weight did not differ significantly between groups. Cesarean section deliveries were markedly higher among inborn neonates (60.7% vs 17.4%, p<0.001).

Outborns required significantly more resuscitation at birth (26.1% vs 13.5%, p<0.001), whereas inborns more often received assisted ventilation (28.1% vs 18.8%, p=0.011) and surfactant therapy (15.1% vs 8.9%, p=0.045). Morbidity indicators showed that outborns had a higher burden of phototherapy requirement (34.8% vs 16.9%, p<0.001), early sepsis (52.2% vs 34.8%, p<0.001), and complications at admission (13% vs 0.6%, p<0.001). In contrast, complications developing during the NICU stay were more frequent in inborns (41.6% vs 30.4%, p=0.007). Mortality was significantly higher among inborn neonates (23% vs 13%, p=0.004).

Complications at admission included early-onset sepsis, hypothermia, hypoglycemia, and birth asphyxia. These were significantly higher in outborn neonates: Early sepsis: 52.2% vs 34.8% (p<0.001). Hypothermia: 21.4% vs 3.9% (p<0.001). Hypoglycemia: 20.3% vs 5.9% (p<0.001). Birth asphyxia: 15.1% vs 9.0% (p=0.034). Overall complications at admission: 13% in outborns vs 0.6% in inborns (p<0.001).

Table 3: Morbidity profile and complications by group (n=648).

Morbidity/complications	Inborn (n=456)	Outborn (n=192)	Test	95% CI (Inborn-Outborn)	P value
Early sepsis	159 (34.8%)	100 (52.2%)	z = -4.29; Δ% = - 17.4	-25.5% to -9.3%	<0.001
Phototherapy	77 (16.9%)	67 (34.8%)	z = -4.94; Δ% = - 17.9	-25.0% to -10.7%	<0.001
Complications at admission	3 (0.6%)	25 (13.0%)	z = -5.20; Δ% = - 12.3	-16.9% to -7.7%	<0.001
Complications during stay	190 (41.6%)	58 (30.4%)	z = 2.72; Δ% =11.2	3.0% to 19.3%	0.007
RDS	142 (31.1%)	52 (27.1%)	z = 1.01; Δ% = 4.0	-3.9% to 11.9%	0.314
Birth asphyxia	41 (9.0%)	29 (15.1%)	z = -2.12; Δ% = -6.1	-11.7% to -0.5%	0.034

Continued.

Morbidity/complications	Inborn (n=456)	Outborn (n=192)	Test	95% CI (Inborn-Outborn)	P value
Hypothermia at admission	18 (3.9%)	41 (21.4%)	z = -7.05; Δ% = - 17.5	-22.3% to -12.6%	<0.001
Hypoglycemia at admission	27 (5.9%)	39 (20.3%)	z = -5.64; Δ% = - 14.4	-19.4% to -9.4%	<0.001
LOS/Nosocomial sepsis	121 (26.5%)	42 (21.9%)	z = 1.11; Δ% = 4.6	-2.9% to 12.1%	0.267
NEC (≥Stage II)	24 (5.3%)	9 (4.7%)	z = 0.30; Δ% = 0.6	-3.4% to 4.6%	0.765
PDA	33 (7.2%)	11 (5.7%)	z = 0.57; Δ% = 1.5	-2.8% to 5.9%	0.568
IVH (≥Grade II)	21 (4.6%)	8 (4.2%)	z = 0.14; Δ% = 0.4	-3.2% to 4.0%	0.890
Apnea of prematurity	79 (17.3%)	26 (13.5%)	z = 1.15; Δ% = 3.8	-2.4% to 10.0%	0.251
Meconium aspiration	16 (3.5%)	13 (6.8%)	z = -1.60; Δ% = -3.3	-7.3% to 0.7%	0.109

Outborn neonates had a disproportionately higher incidence of early sepsis (52.2% vs 34.8%, p<0.001), requirement of phototherapy (34.8% vs 16.9%, p<0.001), and complications at admission (13% vs 0.6%, p<0.001). They also presented with significantly higher rates of hypothermia (21.4% vs 3.9%, p<0.001) and hypoglycemia (20.3% vs 5.9%, p<0.001), suggesting inadequate stabilization during referral. Birth asphyxia was also more common among outborns (15.1% vs 9.0%, p=0.034). In contrast, inborn neonates were more prone to develop complications during NICU stay (41.6% vs 30.4%, p=0.007), possibly reflecting longer hospital stays and invasive procedures. Respiratory distress syndrome, apnea of prematurity, nosocomial sepsis, necrotizing enterocolitis, PDA, IVH, and meconium aspiration did not differ significantly between the groups, though the absolute burden was numerically higher in inborns for RDS and apnea. Additional complications during hospitalization like ventilator associated pneumonia, pulmonary hemorrhage, pneumothorax, thrombocytopenia, anemia and persistent pulmonary hypertension in newborn were analyzed to provide a comprehensive assessment of in-hospital mortality.

Table 4. Risk factors influencing mortality (univariate analysis (n=648).

Risk factor (Exposure)	Deaths / Total (Exposure=risk factor present)	Deaths / Total (Unexposed=risk factor not present)	RR (95% CI)	RD% (95% CI)	Chi-square	P value
Outborn (vs Inborn)	25/192 (13.0%)	105/456 (23.0%)	0.56 (0.37-0.85)	-10.0% (-16.8%- -3.2%)	8.44	0.004
Preterm (<37 weeks)	102/359 (28.4%)	28/289 (9.7%)	2.92 (1.95-4.37)	18.7% (12.7%-24.8%)	43.25	<0.001
LBW (<2.5kg)	104/41 (25.1%)	26/234 (11.1%)	2.26 (1.49-3.43)	14.0% (7.8%-20.2%)	21.86	<0.001
Early sepsis	68/259 (26.3%)	62/389 (15.9%)	1.66 (1.22-2.26)	10.4% (4.7%-16.1%)	10.61	0.001
Ventilation	79/164 (48.2%)	51/484 (10.5%)	4.58 (3.35-6.27)	37.7% (29.8%-45.6%)	138.27	<0.001
Resuscitation at birth	33/112 (29.5%)	97/536 (18.1%)	1.63 (1.13-2.35)	11.4% (3.7%-19.1%)	7.43	0.006
Complications at admission	17/28 (60.7%)	113/620 (18.2%)	3.33 (2.25-4.92)	42.5% (25.7%-59.4%)	52.12	<0.001

Continued.

Risk factor (Exposure)	Deaths / Total (Exposure=risk factor present)	Deaths / Total (Unexposed=risk factor not present)	RR (95% CI)	RD% (95% CI)	Chi-square	P value
Cesarean delivery	66/310 (21.3%)	64/338 (18.9%)	1.13 (0.82-1.56)	2.4% (-3.9%-8.7%)	0.57	0.451

Mortality risk was significantly influenced by several neonatal risk factors. Outborn status itself was associated with lower mortality compared to inborns (13% vs 23%, RR 0.56, 95% CI 0.37-0.85, p=0.004), likely due to referral bias where the sickest pregnancies delivered intramurally. Preterm birth conferred a nearly threefold increased risk of death (28.4% vs 9.7%, RR 2.92, 95% CI 1.95-4.37, p<0.001). Low birth weight similarly raised mortality risk more than twofold (25.1% vs 11.1%, RR 2.26, p<0.001). Early sepsis significantly increased mortality (26.3% vs 15.9%, RR 1.66, p=0.001), while need for ventilation showed the strongest association (48.2% vs 10.5%, RR 4.58, p<0.001). Neonates requiring resuscitation at birth also had higher mortality (29.5% vs 18.1%, RR 1.63, p=0.006), and those with complications at admission had the highest risk (60.7% vs 18.2%, RR 3.33, p<0.001). Cesarean delivery did not significantly influence mortality.

Although outborn neonates had higher sepsis and resuscitation rates, mortality was higher in inborn neonates (23% vs 13%). This is explained by the case-mix paradox: Inborn deliveries at tertiary centers often include high- risk pregnancies (extreme prematurity, PIH, severe anomalies) transferred in utero. These neonates have greater illness severity, require ventilation (28.1%) and surfactant (15.1%), and thus have higher mortality. Outborns include a mix of moderate-risk neonates who survived transport, causing apparent lower mortality. Hence, higher inborn mortality reflects concentration of critically ill births at tertiary centers rather than quality of care issues

Table 5: Association of maternal, perinatal, and neonatal factors with outcomes (Discharge/Death/DAMA) (n=648).

Factor (Present vs Absent)	Present: Discharge/Death/ DAMA (n)	Absent: Discharge/Death/ DAMA (n)	Mortality % in Present (95% CI)	Chi- square	P value
Maternal anemia	144/37/18 (199)	423/93/33 (549)	18.6% (13.9%-24.4%)	5.12 (df=2)	0.077
PROM ≥18h	69/27/10 (106)	498/103/41 (642)	25.5% (18.1%-34.6%)	7.98 (df=2)	0.018
PIH	94/35/12 (141)	473/95/39 (607)	24.8% (18.3%-32.6%)	6.31 (df=2)	0.043
Antenatal steroids (yes, preterm)	136/44/16 (196)	431/86/35 (552)	22.4% (17.1%-28.7%)	4.92 (df=2)	0.085
Transport time >2h (outborn only)	57/21/10 (88)	68/4/32 (104)	23.9% (15.8%-34.5%)	9.41 (df=2)	0.009
Pre-referral antibiotics (outborn only)	54/14/8 (76)	71/11/34 (116)	18.4% (11.2%-28.8%)	4.11 (df=2)	0.128

Maternal, perinatal, and systemic factors showed variable associations with neonatal outcomes. Maternal anemia was prevalent in 199 cases, with a mortality of 18.6%, but the difference from non-anemic mothers was not statistically significant (p=0.077). Premature rupture of membranes ≥18 hours was strongly associated with higher mortality (25.5% vs lower in non-PROM, p=0.018), as was maternal PIH (24.8% mortality, p=0.043). Use of antenatal steroids among preterm mothers showed a protective trend, with mortality of 22.4% compared to higher rates without steroids, though not statistically significant (p=0.085). Among outborn neonates, prolonged transport time >2 hours significantly increased mortality (23.9%, p=0.009), highlighting the need for better neonatal transport systems. Pre-referral antibiotic administration in outborns reduced mortality to 18.4%, though this was not statistically significant (p=0.128).

DISCUSSION

In cohort, inborn neonates had slightly higher gestational age and birth weight than outborns, yet they received more invasive respiratory support (ventilation 28.1% vs 18.8%; surfactant 15.1% vs 8.9%). This pattern is consistent with tertiary centers acting as delivery hubs for

high-risk pregnancies-extreme prematurity, severe PIH, or anticipated respiratory morbidity-leading to early escalation to CPAP/IMV and surfactant even at modest mean GA/BW differences. Kermani F et al.[7]

Multi-center series from India and LMICs similarly report greater use of advanced respiratory support among inborn babies delivered at tertiary hubs, despite small GA/BW gaps, because of immediate access to NICU teams and protocols for early rescue surfactant/ventilation. In some datasets, overall mortality is higher in outborns; however, several hospital-based series (including recent Indian NICUs) have noted higher inborn mortality when tertiary units concentrate the sickest antenatal referrals (a "case-mix paradox"), mirroring higher inborn mortality (23% vs 13%). A 2023 NICU study found outborn mortality higher overall but highlighted prematurity and illness severity as dominant drivers across both streams, underscoring how center-specific case-mix can invert crude inborn/outborn gaps. Kundu TK et al.[8]

Outborn neonates required resuscitation more frequently and had significantly higher rates of hypothermia and hypoglycemia at admission, highlighting vulnerabilities associated with interfacility transport and pre-referral stabilization. Similar findings have been reported by Diggikar et al who demonstrated a high baseline burden of admission hypothermia among transported neonates and showed that structured transport interventions significantly improved thermal stability.[9]

Outborns had substantially higher early-onset sepsis (EOS) (52.2% vs 34.8%), phototherapy needs (34.8% vs 16.9%), and admission hypothermia/hypoglycemia-classic signatures of suboptimal intrapartum hygiene, late referral, and inadequate stabilization. Large Indian and LMIC analyses consistently identify outborn status as a sepsis amplifier, with recent national program data also flagging higher culture-positive sepsis incidence and case-fatality among outborns in public newborn care units. PROM ≥18 h is a major EOS antecedent; data (Table 5) show worse outcomes with prolonged latency, concordant with meta-analytic and cohort evidence that risk climbs sharply after 16-18 h-even with IAP-due to ascending infection and chorioamnionitis. Pradhan D et al.[10] By contrast, "complications during stay" were higher in inborns (41.6% vs 30.4%), cohering with their greater exposure to invasive respiratory care (ventilation, surfactant) and longer NICU LOS- two conditions that raise nosocomial risk (e.g., VAP and LOS), even when EOS at arrival is lower. Indian and regional reports associate ventilation/central lines with higher in-NICU infection and mortality, which mirrors univariate signal for ventilation (RR ≈4.6). Mabbul S et al.[11]

Prematurity and low birth weight retained the strongest biological association with death (RR ≈2.9 and 2.3, respectively), in line with global and Indian estimates where preterm/LBW complications dominate neonatal deaths. UNICEF's latest data reiterate the disproportionate contribution of preterm complications to neonatal mortality, reinforcing effect sizes. Early sepsis doubled mortality risk in cohort-again matched by national reviews noting India's high sepsis burden and its decisive role in fatality. Ventilation requirement was the most powerful marker (RR ≈4.6), which is expected: the need for IMV captures illness severity (RDS, severe sepsis, neurological depression) and exposes infants to device-related risks. Prior NICU studies from India and neighboring settings link ventilator dependence and VAP with sharply higher mortality, supporting findings. Singh R et al.[12]

Interestingly, crude data show lower mortality in outborns (RR 0.56 vs inborns). As noted above, center-level case-mix can invert inborn/outborn mortality contrasts; several series still show higher outborn mortality overall, but the direction varies with referral patterns and triage (e.g., tertiary hospitals doing in-utero transfers of the highest-risk pregnancies-PIH, severe growth restriction and anticipated extreme prematurity can concentrate risk among inborns). This underscores the need for adjusted models (multivariable logistic regression) before drawing causal inferences by birth setting. Das G et al.[13]

Antenatal corticosteroid exposure showed a protective trend in our cohort, although statistical significance was not reached. This direction of effect is consistent with findings from the WHO ACTION-I trial, which demonstrated reduced neonatal mortality, severe respiratory distress, and need for neonatal resuscitation among appropriately selected women at risk of early preterm birth who received antenatal corticosteroids. De Costa A et al.[14]

Limitations

The study was retrospective and relied on hospital records, which may be subject to incomplete documentation and reporting bias. Data on severity scoring systems (e.g., SNAP-II and CRIB) were not available, limiting objective assessment of baseline illness severity. Outborn neonates admitted represented only those who survived referral; severely ill neonates dying before transfer were not captured, potentially underestimating the true burden. The study was conducted at a single tertiary care center, which may limit generalizability to other regions with different referral patterns and healthcare resources. Long-term neurodevelopmental outcomes after NICU discharge were not assessed, restricting interpretation of morbidity to the immediate hospital course.

CONCLUSION

This study highlights important differences in morbidity and mortality between extramural (outborn) and intramural (inborn) neonates admitted to the NICU of a

tertiary care teaching institute. Outborn neonates were more likely to present with early-onset sepsis, hypothermia, hypoglycemia, and complications at admission, largely attributable to inadequate perinatal care and delays in referral or transport. Inborn neonates, though having slightly higher gestational age and birth weight, demonstrated greater need for advanced respiratory interventions and developed more complications during hospital stay, reflecting a higher concentration of high-risk deliveries and prolonged intensive care exposure.

Mortality was significantly higher among inborn neonates, predominantly due to prematurity, low birth weight, and critical illness severity. Across both groups, prematurity, low birth weight, early sepsis, need for ventilation, and complications at admission emerged as dominant predictors of mortality. Strengthening antenatal care, infection prevention, neonatal transport systems, and standardized NICU practices are essential to reduce avoidable neonatal deaths and morbidity.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Sale A, Arsiwala R, Kulkarni R. Outcomes and risk factors for mortality and morbidity of extramural neonates as compared to intramural neonates admitted in NICU in tertiary care teaching institute. Int J Contemp Pediatr 2026;13:2479-86.