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Study of Risk Factors and Causes of Mortality in A Neonatal Intensive Care Unit (NICU) in A Tertiary Care Centre. A Hospital-Based Cross-Sectional Study

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ABSTRACT

Introduction: Neonatal mortality remains a major public health concern in India, particularly in tertiary care settings catering to rural and socioeconomically disadvantaged populations. Prematurity, low birth weight, birth asphyxia, and infections are recognized as leading contributors to neonatal deaths. Understanding the pattern of risk factors and causes of mortality is essential for planning targeted interventions.

Aim: To assess the risk factors and determine the causes of mortality among neonates admitted to the Neonatal Intensive Care Unit (NICU) of a tertiary care centre.

Materials and Methods: This hospital-based cross-sectional study was conducted in the NICU of Mahatma Gandhi Memorial Medical College & Hospital, Jamshedpur. A total of 317 neonates aged less than 28 days admitted during the study period were included using purposive sampling. Data were collected using a structured case record form after obtaining written informed consent from parents or guardians. Information regarding demographic profile, neonatal and maternal risk factors, clinical characteristics, and causes of death was recorded and analyzed descriptively.

Results: Among 317 neonates, 60.88% were males and 76.66% belonged to rural areas, with 56.47% from tribal communities. Preterm births accounted for 41.01% of admissions. Low birth weight (39.43%) and very low/extremely low birth weight (14.83%) constituted a significant proportion. Birth asphyxia (29.97%) and intrauterine growth restriction (29.02%) were common clinical findings. Intrauterine hypoxia (16.72%) was the leading cause of neonatal death, followed by respiratory distress syndrome (8.52%) and meconium aspiration (5.68%). A majority of deaths occurred during the late neonatal period (57.73%). Maternal risk factors such as preterm labour (18.93%) and hypertensive disorders (8.52%) were notable contributors.

Conclusion: Neonatal mortality in this tertiary care NICU is predominantly associated with prematurity, low birth weight, birth asphyxia, and maternal complications. Strengthening antenatal care, improving intrapartum management, and enhancing NICU-based supportive care are essential to reduce preventable

neonatal deaths, particularly among rural and socioeconomically vulnerable populations.

***Keywords**: Neonatal mortality; Prematurity; Low birth weight; Birth asphyxia; Intrauterine hypoxia; respiratory distress syndrome.*

INTRODUCTION

Neonatal morbidity and mortality remain major public health challenges worldwide, particularly in low- and middle-income countries. The neonatal period, defined as the first 28 days of life, is the most vulnerable phase of human survival and accounts for a substantial proportion of under-five mortality.[1] Globally, approximately 130 million neonates are born each year, and nearly 4 million deaths occur during the first month of life. A significant share of these deaths occurs in India, which continues to contribute substantially to the global neonatal mortality burden.[2]

Despite improvements in maternal and child health services, neonatal mortality remains a concern in India. According to national estimates, the neonatal mortality rate (NMR) has shown variations between urban and rural areas, with higher rates observed in rural populations. Neonatal deaths constitute a large proportion of total infant deaths, highlighting the need for focused interventions during the perinatal and early neonatal period. Prematurity, birth asphyxia, sepsis, and low birth weight are widely recognized as the leading causes of neonatal mortality in developing countries, while congenital anomalies and complications of prematurity predominate in developed nations.[3]

Low birth weight, birth asphyxia, intrauterine growth restriction, and infections contribute significantly to neonatal deaths in the community. Many of these causes are preventable or manageable with timely antenatal care, skilled intrapartum management, early neonatal resuscitation, and adequate neonatal intensive care support. However, socioeconomic factors, limited access to quality healthcare, delayed referrals, and inadequate awareness continue to adversely affect neonatal outcomes, particularly in rural and socioeconomically disadvantaged populations.[4]

The present study was conducted in a tertiary care government hospital catering predominantly to rural, semi-urban, and economically 0weaker sections of the population. As a major referral center for high-risk pregnancies and critically ill neonates, the hospital provides an opportunity to assess the prevailing pattern of neonatal morbidity and mortality. Understanding the risk factors and causes of neonatal death in this setting is essential for prioritizing resources, strengthening preventive strategies, and improving neonatal survival outcomes.

Novelty: Since this is a hospital-based study and since most of the patients have a low socio-economic status, the results of this study may not reflect the actual burden that is prevalent in the community as a whole. This will show the cause of mortality and morbidity in our hospital which is the largest government hospital. Hospital in Kolhan area and hence will help us determine its cause in newborn babies.

Aim and Objectives of the Study

Aim

To assess the risk factors and determine the causes of mortality among neonates admitted to the Neonatal Intensive Care Unit (NICU) in a tertiary care centre.

Primary Objective

To identify and analyze the major causes of neonatal mortality among neonates admitted to the NICU.

Secondary Objectives

1. To evaluate the association between neonatal risk factors (such as prematurity, low birth weight, birth asphyxia, and IUGR) and neonatal mortality.
2. To assess the impact of maternal risk factors (including hypertensive disorders, preterm labour, infections, and diabetes) on neonatal outcomes.
3. To study the age-wise distribution (early and late neonatal period) of neonatal deaths.
4. To describe the demographic profile of neonates admitted to the NICU and its relation to mortality.

MATERIALS AND METHODS:

Study Design: Hospital based Cross sectional study.

Study Population: All admitted neonates in the NICU.

Setting & Places: Study was carried out in NICU at Mahatma Gandhi Memorial Medical College & Hospital, Jamshedpur.

Sample Size:
The sample size is determined by using a single population proportion formula considering the following assumptions; 95% confidence level, a margin of error of 5%, Z score: ±1.96 and a rate of preterm mortality of 24.9% in India according to the National Family Health Survey (NFHS)-5 data.[5] Sample size is calculated using formula N= P (1-p) Z2/E2. Sample size is estimated to be a total of 288 patients. The sample size after adding a 10% non-response rate is 316.8~317.

Sampling Process: Purposive sampling.

Inclusion Criteria

1. All neonates aged less than 28 completed days of life admitted to the Neonatal Intensive Care Unit (NICU) during the study period.
2. Both inborn (delivered in the study hospital) and outborn (referred from other hospitals or home deliveries) neonates admitted to the NICU.
3. Neonates whose parents or legal guardians provided written informed consent for participation in the study.

Exclusion Criteria

1. Neonates who left the hospital against medical advice (LAMA) before completion of treatment or before outcome assessment.
2. Neonates whose parents or legal guardians refused or did not provide consent to participate in the study.
3. Neonates with incomplete medical records that precluded proper assessment of risk factors or cause of death (if applicable to present protocol).

Data Collection
Data collection was carried out in the Neonatal Intensive Care Unit (NICU) of the tertiary care centre during the study period. All eligible neonates admitted to the NICU were screened for inclusion based on predefined inclusion and exclusion criteria. Prior to enrollment, the study purpose, procedures, potential benefits, and confidentiality aspects were explained in detail to the parents or legal guardians in their local language. Written informed consent was obtained from the parents or legal guardians for participation of their neonate in the study. Only those neonates whose guardians provided consent were included.

After obtaining consent, each neonate was assigned a unique identification number for study purposes. Relevant information was collected using a predesigned and pretested structured case record form. Data were obtained from multiple sources including maternal interview, hospital records, antenatal records, delivery notes, and NICU case sheets. Personal details of the neonate (age in days, gender, gestational age, birth weight, place of delivery, and clinical condition at admission) and maternal information (age, parity, antenatal history, obstetric complications, and medical conditions) were recorded systematically.

Clinical examination findings, laboratory investigations, and imaging reports performed during hospitalization were documented. Details regarding neonatal complications, treatment provided, duration of NICU stay, and final outcome (discharge or death) were also recorded. For neonates who expired, the probable cause of death was determined based on clinical diagnosis, laboratory findings, and treating physician documentation following standard definitions.

All collected data were checked for completeness and accuracy on a daily basis by the investigator to minimize information bias. Confidentiality of patient information was strictly maintained throughout the study by anonymizing identifiable details and restricting access to study records.

RESULTS

Category	Frequency	Percentage (%)
Male	193	60.88%
Female	124	39.12%
Urban	74	23.34%
Rural	243	76.66%
Tribal	179	56.47%
Non-Tribal	133	41.96%

Table 1 : Basic demography of the study subjects

Basic demography of study subjects is described in Table 1. The study population consisted predominantly of male neonates (60.88%), while females accounted for 39.12%, indicating a male preponderance among NICU admissions. A majority of the subjects belonged to rural areas (76.66%), reflecting the hospital's significant rural catchment population, whereas only 23.34% were from urban areas. Regarding community distribution, more than half of the neonates (56.47%)

belonged to the tribal population, with 41.96% from non-tribal communities. This demographic pattern suggests that neonatal morbidity and mortality in the study setting largely affect rural and tribal populations, highlighting the need for targeted maternal and neonatal healthcare interventions in these vulnerable groups.

Category	Frequency	Percentage (%)
Term	187	58.99%
Preterm	130	41.01%
ELBW (<1 kg)	9	2.84%
VLBW (1.0–1.49 kg)	38	11.99%
LBW (1.5–2.49 kg)	125	39.43%
Normal Birth Weight (≥2.5 kg)	145	45.74%
Birth Asphyxia Present	95	29.97%
IUGR Present	92	29.02%
Jaundice within 24 hrs	12	3.79%
Inborn	192	60.57%
Outborn	118	37.22%
Home Delivery	6	1.89%
Hypertensive disorder (Pre-eclampsia/Eclampsia)	27	8.52%
Preterm Labour	60	18.93%
Maternal Infection	2	0.63%
Diabetes	5	1.58%
Severe Maternal Infection	4	1.26%
Table 2 : Clinical characteristics of the study subjects		

Clinical Characteristics of the Study Subjects is described in table 2. Among the 317 neonates included in the study, 58.99% were term and 41.01% were preterm, indicating a substantial proportion of premature births among NICU admissions. With respect to birth weight, 45.74% had normal birth weight (≥2.5 kg), while 39.43% were low birth weight (1.5–2.49 kg). Very low birth weight (11.99%) and extremely low birth weight (2.84%) together constituted nearly 15% of cases, reflecting a significant burden of vulnerable neonates. Clinically, 29.97% had birth asphyxia and 29.02% had intrauterine growth restriction (IUGR), both being important contributors to neonatal morbidity and mortality. Jaundice within the first 24 hours was observed in 3.79% of neonates. A majority of cases were inborn (60.57%), while 37.22% were outborn, and only 1.89% were home deliveries, indicating that most neonates received institutional care.

Regarding maternal conditions, 18.93% had preterm labour, and 8.52% had hypertensive disorders (pre-eclampsia/eclampsia), which are known risk factors for adverse neonatal outcomes. Maternal diabetes (1.58%), maternal infection (0.63%), and severe maternal infection (1.26%) were relatively less common but remain clinically relevant contributors. Overall, the findings highlight prematurity, low birth weight, birth asphyxia, IUGR, and maternal complications as key clinical determinants in this study population.

Cause of Death	Frequency	Percentage (%)
Intrauterine Hypoxia	53	16.72%
Respiratory Distress Syndrome	27	8.52%
Congenital Malformations	3	0.95%
Meconium Aspiration	18	5.68%
Necrotising Enterocolitis	7	2.21%
Intraventricular Hemorrhage	4	1.26%
Table 3: Distribution of study subjects as per cause of death		

The leading cause of neonatal death in the present study was intrauterine hypoxia (16.72%), indicating that perinatal asphyxia remains a major contributor to mortality. This was followed by respiratory distress syndrome (8.52%), reflecting the significant impact of prematurity and surfactant deficiency. Meconium aspiration syndrome accounted for 5.68% of deaths, further emphasizing the role of intrapartum complications.

Less frequent causes included necrotising enterocolitis (2.21%), intraventricular hemorrhage (1.26%), and congenital malformations (0.95%). Overall, the pattern suggests that most deaths were attributable to preventable or manageable perinatal and respiratory conditions, highlighting the importance of improved antenatal care, skilled intrapartum management, and advanced neonatal intensive care support to reduce mortality.

Variable	Adjusted Odds Ratio (AOR)	95% CI	*P*-value	Interpretation
Preterm	0.36	0.13 – 1.00	0.050	Borderline significant
Birth Weight (continuous)	0.45	0.22 – 0.92	0.028	Significant protective effect
Birth Asphyxia	8.58	4.35 – 16.89	<0.001	Highly significant risk factor
IUGR	0.81	0.40 – 1.65	0.569	Not significant
Maternal Hypertension	0.51	0.18 – 1.48	0.215	Not significant
Preterm Labour	17.94	6.92 – 46.50	<0.001	Very strong predictor
Table 4 : Multivariable Logistic Regression for Predictors of Neonatal Mortality				

Multivariable logistic regression analysis identified birth asphyxia (AOR=8.58, p<0.001) and maternal preterm labour (AOR=17.94, p<0.001) as strong independent predictors of neonatal mortality. Low birth weight was significantly associated with increased mortality risk (AOR=0.45, p=0.028), indicating its protective gradient effect with increasing weight. Prematurity showed borderline statistical significance (p=0.050), while IUGR and maternal hypertensive disorders were not independently associated with mortality after adjustment.

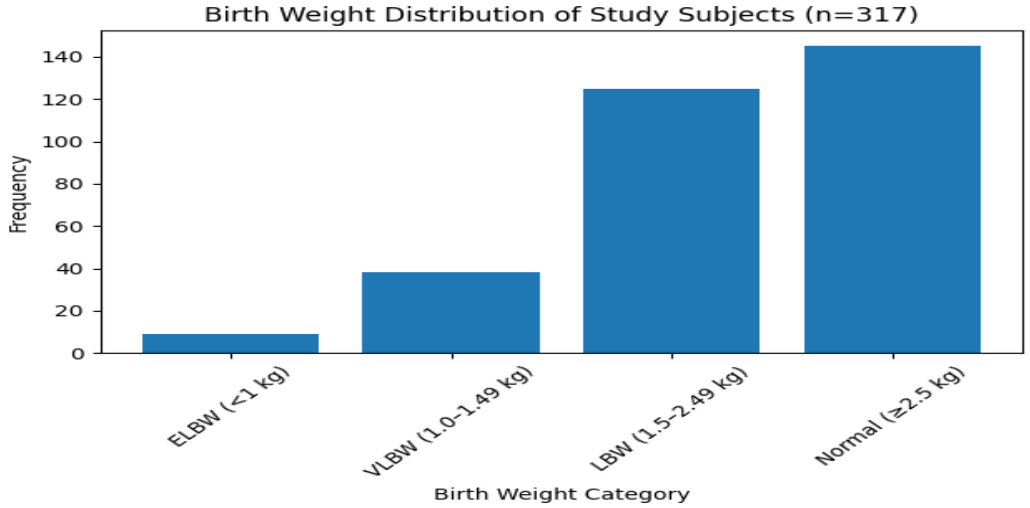

Figure 1: Distribution of study subjects as per Birth weight

The birth weight distribution shows that the majority of neonates had normal birth weight (≥2.5 kg), accounting for 45.74% of cases. A substantial proportion (39.43%) were classified as low birth weight (1.5–2.49 kg), indicating a significant burden of growth restriction and prematurity-related vulnerability. Very low birth weight (11.99%) and extremely low birth weight (2.84%) together constituted nearly 15% of the study population. Overall, while nearly half of the neonates had normal birth weight, a considerable proportion were underweight, highlighting low birth weight as an important clinical concern in this NICU population and a potential contributor to adverse neonatal outcomes.

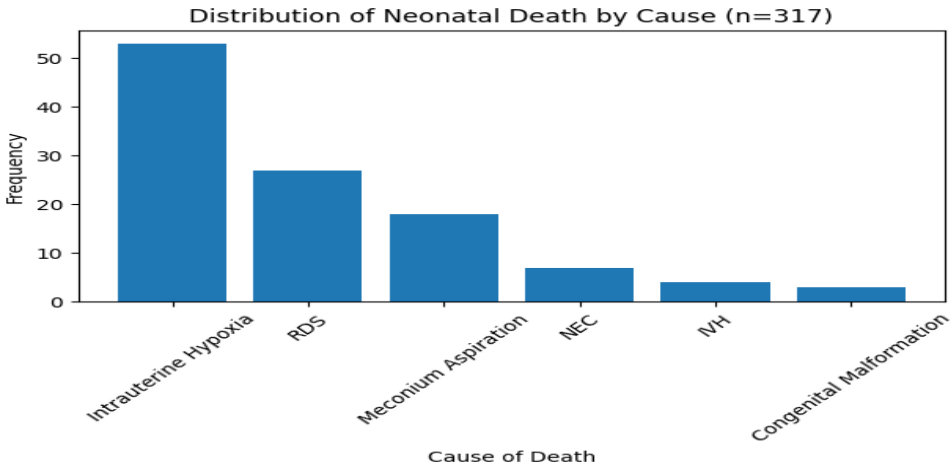

Figure 2: Distribution of study subjects as per neonatal death by cause

Figure 2 illustrates that the largest proportion of neonates belonged to the normal birth weight category (≥2.5 kg), accounting for 45.74% of cases. However, a considerable percentage (39.43%) were low birth weight (1.5–2.49 kg), indicating a substantial burden of neonates at increased risk of morbidity. Additionally, 11.99% were very low birth weight (1.0–1.49 kg) and 2.84% were extremely low birth weight (<1 kg).

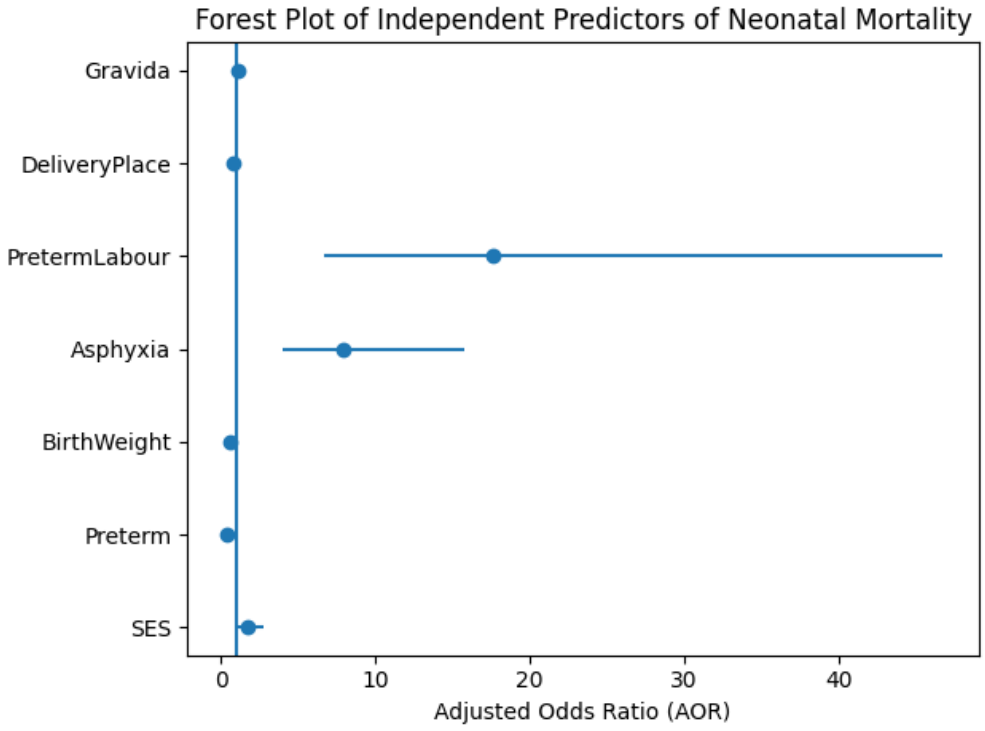

Figure 3: Forest plot of independent predictors of Neonatal mortality

The forest plot confirms that maternal preterm labour and birth asphyxia are the strongest independent predictors of neonatal mortality in this study population, while socioeconomic disadvantage significantly contributes to adverse outcomes. These findings underscore the importance of integrated maternal–neonatal care strategies to reduce preventable neonatal deaths.

DISCUSSION

The demographic patterns in the present study show a male predominance (60.88%), which is consistent with published neonatal care data demonstrating higher male admission proportions. For example, Kshirsagar et al. (2022)6 reported that 55.5% of neonates admitted to Special Newborn Care Units (SNCUs) in India were males, reflecting a similar male skew in NICU/SNCU usage . Studies from large neonatal admission registries also observed that male infants tend to dominate

neonatal care admissions, a trend often attributed to biological vulnerabilities such as prematurity and respiratory complications.

The high rural representation (76.66%) in present cohort aligns with broader evidence that rural areas contribute disproportionately to neonatal morbidity due to limited access to quality perinatal and newborn services. While national overviews emphasize the rural burden of neonatal mortality, Upadhyay et al. (2012)7 highlighted that rural Indian communities consistently exhibit higher neonatal mortality and morbidity indicators compared to urban settings, underscoring persistent healthcare access disparities .

Regarding tribal status, the present finding that 56.47% of neonates belonged to tribal communities parallels results from Lusk et al. (2024)8, Vaishnav K et al 9who reported that 69.1% of SNCU admissions in a rural Gujarat centre were tribal neonates, with corresponding implications for birth weight and prematurity patterns that differ from non-tribal groups . This supports the view that tribal neonates form a substantial portion of NICU/SNCU admissions in regions with significant Scheduled Tribe populations, likely due to a combination of socioeconomic, nutritional, and healthcare access challenges. The present study observed that 41.01% of neonates were preterm, representing a substantial burden of prematurity among NICU admissions. This finding is consistent with the multicountry prospective cohort study by Dhaded et al. (2022)10 published in The Lancet Global Health (PURPOSe study), which identified prematurity as one of the leading causes of neonatal mortality in India and Pakistan and emphasized that complications of preterm birth remain a dominant contributor to neonatal deaths in low- and middle-income countries. Similarly, Sankar et al. (2016)11, in a systematic review and meta-analysis published in The Lancet, reported that preterm birth complications account for a major proportion of neonatal mortality in India, reinforcing the urgent need for improved antenatal surveillance and perinatal care to reduce preterm-related morbidity and mortality.

Regarding birth weight, the current study found that 39.43% were low birth weight (LBW) and nearly 15% were VLBW/ELBW, indicating a high proportion of vulnerable neonates. These findings are comparable to the National Neonatal-Perinatal Database (NNPD) India reports and align with large hospital-based analyses such as Kumar et al. (2021)12 in the Journal of Family Medicine and Primary Care, which documented a high prevalence of LBW among SNCU admissions and demonstrated its strong association with neonatal mortality. Globally, Blencowe et al. (2013)13 in The Lancet estimated that LBW remains a major underlying determinant of neonatal deaths, particularly when associated with prematurity and intrauterine growth restriction (IUGR). Low birth weight has consistently been identified as an independent predictor of adverse neonatal outcomes, especially in resource-limited settings.

The proportions of birth asphyxia (29.97%) and IUGR (29.02%) in the present study further highlight the role of intrapartum and intrauterine factors in neonatal morbidity. The global cause-of-death estimates by Liu et al. (2015)14 published in The Lancet identified intrapartum-related events (including birth asphyxia) as one of the leading causes of neonatal mortality worldwide, with a particularly high burden in South Asia. Likewise, Indian tertiary-care-based analyses such as Soni H et al. (2014)15 and other large facility-based datasets have consistently reported significant proportions of asphyxia-related NICU admissions, emphasizing the importance of skilled birth attendance and timely neonatal resuscitation to prevent hypoxic injury.

Maternal risk factors identified in the present study — particularly preterm labour (18.93%) and hypertensive disorders (8.52%) — are well-established contributors to neonatal morbidity. The PURPOSe study by Dhaded et al. (2022)10 demonstrated strong associations between maternal complications, including hypertensive disorders of pregnancy, and increased risks of preterm birth and early neonatal death. Additionally, large epidemiological analyses such as Chawanpaiboon et al. (2019)16 in The Lancet Global Health have confirmed the global burden of preterm birth and its strong linkage with maternal obstetric complications, underscoring the importance of comprehensive antenatal care and early identification of high-risk pregnancies.

In the present study, intrauterine hypoxia (16.72%) emerged as the leading cause of neonatal death, indicating that perinatal asphyxia continues to be a major contributor to mortality. This observation is consistent with the global mortality analysis by Liu et al. (2015)14 in The Lancet, which identified intrapartum-related hypoxic events as one of the principal causes of neonatal mortality in South Asia. Similarly, Dhaded et al. (2022)10 reported that hypoxia-related conditions remain a significant cause of early neonatal deaths in India and Pakistan, particularly in resource-constrained settings.

The present study identified intrauterine hypoxia (perinatal asphyxia) as the leading cause of neonatal death (16.72%). This finding is consistent with global cause-of-death analyses. Liu et al. (2016)14 in The Lancet reported that intrapartum-related events remain one of the three leading causes of neonatal mortality globally, particularly in South Asia. Similarly, the multicountry PURPOSe study by Dhaded et al. (2022)10 in The Lancet Global Health demonstrated that hypoxia-related conditions contribute substantially to early neonatal deaths in India and Pakistan. In addition, Lee et al. (2013)17, in a systematic review published in The Lancet, emphasized that timely intrapartum care and neonatal resuscitation could

prevent a large proportion of asphyxia-related deaths in low-resource settings. These findings support the strong independent association observed in the present study between birth asphyxia and mortality (AOR = 8.58, $p < 0.001$).

Respiratory distress syndrome (RDS) accounted for 8.52% of deaths, reflecting the contribution of prematurity and surfactant deficiency. Global epidemiological estimates by Chawanpaiboon et al. (2019)16 in The Lancet Global Health confirmed that preterm birth complications remain the leading direct cause of neonatal mortality worldwide. Likewise, Blencowe et al. (2013)13 in PLOS Medicine demonstrated that prematurity-related respiratory complications significantly increase mortality risk in low- and middle-income countries. Facility-based data from India, including Sankar et al. (2016)11, further emphasize that preterm-related complications are a dominant cause of neonatal deaths, reinforcing the borderline significance of prematurity ($p = 0.050$) observed in the present regression model.

Meconium aspiration syndrome (MAS) contributed to 5.68% of deaths in the present study, highlighting the impact of intrapartum complications. Lee et al. (2013)17 estimated that improved obstetric and immediate neonatal care can significantly reduce mortality from intrapartum-related conditions including MAS. Additionally, hospital-based analyses from South Asia show that MAS remains a significant contributor to NICU mortality in settings with limited intrapartum monitoring.

Less frequent causes such as necrotising enterocolitis (NEC) (2.21%) and intraventricular hemorrhage (IVH) (1.26%) are well-recognized complications of prematurity. Patel et al. (2020)18 in JAMA Pediatrics reported that extremely low birth weight infants are at substantially increased risk of NEC and IVH, both independently associated with mortality. Similarly, Stoll et al. (2015)19 in JAMA demonstrated that VLBW infants face high mortality from complications such as NEC and severe IVH. The low but present proportion of congenital malformations (0.95%) is consistent with global data from Liu et al. (2016)14, which estimate congenital anomalies account for approximately 9–11% of neonatal deaths worldwide.

Regarding the multivariable logistic regression findings, birth asphyxia emerged as a strong independent predictor of mortality (AOR = 8.58). This aligns with findings by Lawn et al. (2014)20 in The Lancet, who demonstrated that intrapartum-related hypoxic events significantly increase early neonatal mortality risk. The very strong association between maternal preterm labour (AOR = 17.94, $p < 0.001$) and neonatal death is supported by Chawanpaiboon et al. (2019)16 and Dhaded et al. (2022)10, both of whom identified preterm birth as the single largest driver of neonatal mortality globally and in South Asia.

Low birth weight showed a significant gradient effect (AOR = 0.45, $p = 0.028$), indicating increasing birth weight reduces mortality risk. This protective relationship has been consistently documented. Blencowe et al. (2019)13 demonstrated that mortality risk declines substantially with increasing birth weight categories. Similarly, Katz et al. (2013)21 in Bulletin of the World Health Organization showed that LBW infants have several-fold higher mortality risk compared to normal birth weight neonates.

In contrast, IUGR and maternal hypertensive disorders were not independently significant in the adjusted model. Although hypertensive disorders are known risk factors for prematurity and fetal growth restriction, multivariable analyses in large cohort studies (e.g., Dhaded et al., 2022)10 demonstrate that their effects on mortality are often mediated through prematurity and low birth weight rather than acting as direct independent predictors.

CONCLUSION

This hospital-based cross-sectional study highlights that neonatal mortality in a tertiary care NICU is predominantly associated with prematurity, low birth weight, birth asphyxia, IUGR, and maternal complications. A substantial proportion of neonates were preterm and low birth weight, indicating a high burden of vulnerable newborns requiring intensive care. Intrauterine hypoxia emerged as the leading cause of death, followed by respiratory distress syndrome and meconium aspiration, underscoring the major role of preventable perinatal and respiratory conditions. The predominance of deaths during the late neonatal period suggests the contribution of infections and complications of prematurity beyond the immediate perinatal phase. Additionally, the higher proportion of neonates from rural and tribal communities reflects underlying socioeconomic and healthcare access disparities.

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