

Factors Influencing Neonatal Mortality Rate in High-Risk Hospital Settings

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Abstract

Background: Neonatal mortality remains a significant public health concern in low-resource, hospital settings.

Objective: This study aimed to investigate factors influencing neonatal mortality in a tertiary care hospital in Bangladesh, focusing on demographic, maternal, and clinical characteristics associated with neonatal outcomes.

Methods: This retrospective study was conducted over one year (January to December 2022) at Bangladesh Shishu Hospital and Institute, involving 2,700 high-risk neonates admitted to the SCABU 1 and SCABU 2. Among these, 216 neonates (8%) died. Data on demographic information, clinical diagnoses, and maternal health factors were collected from hospital records, with statistical analyses performed to identify key mortality risk factors.

Results: The primary causes of neonatal mortality were prematurity with its complications (43.98%), sepsis (22.22%), and perinatal asphyxia (10.19%), with 25% of neonates classified as extremely low birth weight (ELBW) (< 1000g). Maternal factors included high rates of hypertension (37.04%) and inadequate antenatal care, with only 25% of mothers having regular ANC. Cesarean section was the predominant delivery method (62.96%), particularly in preterm births (74.07%).

Conclusions: High neonatal mortality in this cohort was strongly associated with respiratory distress syndrome (RDS), infections, and prematurity, exacerbated by maternal comorbidities and inadequate antenatal care. Improving prenatal and neonatal care resources, infection control, and support for high-risk pregnancies is crucial to reducing mortality rates in similar hospital settings.

Keywords: Neonatal Mortality, Respiratory Distress Syndrome, Prematurity, Sepsis, Antenatal Care, Maternal Comorbidities, High-Risk Neonates, Bangladesh.

DOI: <https://doi.org/10.3329/nimcj.v14i1.85091>

Northern International Medical College Journal Vol. 14 No. 1-2 July 2022-January 2023, Page 633-638

Introduction

Neonatal mortality remains a significant global public health concern, accounting for nearly half of all under-five deaths worldwide, with an alarming burden concentrated in low- and middle-income countries (LMIC).¹ Recent World Health Organization (WHO) and UNICEF reports emphasize the disparities in neonatal mortality rates across regions, with South Asia, particularly Bangladesh, facing disproportionately high rates compared to global averages.^{2,3} This region's neonatal mortality rates remain among the highest globally, driven by various complex, interrelated factors that affect neonatal outcomes in resource-limited, high-risk hospital environments. Despite advances in healthcare infrastructure and initiatives to establish Special Care Neonatal Units (SCANU) across Bangladesh, the country's neonatal mortality rate is still above the Sustainable Development Goal (SDG) target of 12 deaths per 1,000 live births, underscoring

the critical need for enhanced intervention strategies.^{4,5} High-risk hospital settings, such as neonatal intensive care units (NICU), emergency wards, and Special Care Baby Unit (SCABU), serve as essential care environments for neonates with severe health complications, including low birth weight, prematurity, respiratory distress, and infection. However, these settings in Bangladesh and similar LMIC are often fraught with significant operational challenges. Studies reveal that high-risk neonatal care facilities frequently suffer from equipment shortages, inadequate staffing, and logistical barriers that undermine effective neonatal care, particularly in rural or under-resourced hospitals.⁶⁻⁹ For example, Wichaidit et al. highlighted that only a fraction of Bangladeshi hospitals providing emergency obstetric and neonatal care met optimal care standards, with consistent availability of trained personnel being a core issue.¹⁰ The consequences of these limitations are profound, with timely and adequate neonatal

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care compromised, thereby exacerbating the mortality risk in high-risk neonatal settings. The critical role of skilled personnel and access to essential resources in reducing mortality is further supported by research that shows improved outcomes in facilities with robust NICU infrastructures and high-volume delivery capacities.¹¹ Birth weight and prematurity emerge as two of the most impactful determinants of neonatal survival in high-risk settings, particularly in Bangladesh. The correlation between low birth weight (LBW), defined as less than 2,500 grams, and neonatal mortality is well-established, with studies from Bangladesh indicating that LBW nearly doubles the risk of neonatal death compared to normal-weight infants.^{11,12} Yasmin et al. (2001) found that LBW neonates had a mortality rate of 133 per 1,000 live births, especially in cases of extreme prematurity.¹¹ Prematurity compounds the risks associated with LBW, as preterm neonates face significant developmental challenges, including respiratory and immune system immaturity, which elevate their susceptibility to infections and respiratory complications.^{13,14} Sankar et al. reported that in a SCANU setting, prematurity accounted for more than half of all early neonatal deaths, especially within the first 24 hours of life, highlighting the urgency of addressing these risk factors in Bangladeshi hospitals.¹⁵ Beyond prematurity and LBW, additional factors like perinatal asphyxia, respiratory distress syndrome (RDS), and neonatal sepsis substantially elevate the mortality risk among neonates in high-risk settings. Perinatal asphyxia is a common complication, especially among neonates born in resource-limited settings without access to advanced resuscitation equipment and skilled neonatal resuscitators. Yadav and Damke (2017) underscore that maternal complications such as pregnancy-induced hypertension (PIH), oligohydramnios, and prolonged rupture of membranes (PROM) contribute significantly to the incidence of perinatal asphyxia, further complicating neonatal outcomes.¹⁶ Neonatal sepsis, another prevalent condition in NICUs in Bangladesh, has been linked to inadequate infection control measures and shortages of critical equipment, such as ventilators, that are essential for managing severe respiratory conditions in neonates.^{17,18} Antenatal care practices also play a pivotal role in mitigating the risks associated with high-risk pregnancies. However, in rural and underserved regions of Bangladesh, antenatal care remains suboptimal, with many women receiving inadequate prenatal monitoring and lacking access to preventive interventions like corticosteroid administration for fetal lung maturation. Roberts et al. have demonstrated that antenatal corticosteroid use can substantially reduce the risk of RDS and neonatal sepsis, especially in preterm neonates, by enhancing lung maturity before birth.¹⁹ Furthermore, maternal health complications such as hypertension and eclampsia are prevalent in Bangladesh and contribute to higher rates of preterm and LBW births, intensifying the vulnerability of neonates born in high-risk hospital environments.²⁰ Rahman and Rawli (2023) highlighted that hypertensive disorders among pregnant women were associated with higher perinatal complications, including preterm delivery and LBW, both of which increase the likelihood of neonatal ICU admissions and mortality.²¹ Given these complexities, it is evident that

neonatal mortality in high-risk settings is a multifaceted issue requiring a comprehensive approach.

Methods

This retrospective study was conducted at Bangladesh Shishu Hospital and Institute over a 1-year period from January to December 2022. The study aimed to investigate factors influencing neonatal mortality rates in high-risk settings, focusing on neonates admitted to the hospital's SCABU 1 and SCABU 2. A total of 2,700 high-risk neonates were included in the sample from two SCABU's (Special Care Baby Unit), among them, SCABU 1 contained more serious cases and SCABU 2 contained somewhat less severe cases. Among these, 2484 neonates were discharged, while 216 neonates succumbed to their conditions, resulting in a neonatal mortality rate of 8% within this population. For the purposes of this study, the final sample size was narrowed to include only the 216 neonates who experienced mortality, providing focused insights into the characteristics and risk factors associated with neonatal death in high-risk settings. Inclusion criteria comprised all neonates admitted to these units due to high-risk conditions, such as low birth weight, prematurity, respiratory distress, neonatal sepsis, and perinatal asphyxia. Data was collected from hospital records, including demographic information, clinical diagnoses, treatment interventions, and outcomes. The retrospective design allowed for the analysis of patient data to identify the factors most strongly associated with neonatal mortality within this high-risk hospital environment. Statistical analysis was conducted to determine correlations between risk factors and outcomes, providing insights into potential interventions that could improve neonatal survival rates in similar settings.

Results

In this study we found that among the 1592 cases of SCABU 1, mortality rate was 9.23%, while in SCABU 2, among the 1108 cases, the mortality rate was 6.23%. This slight difference was understandable, as SCABU 1 generally contained the more severe cases. (Table 1)

Table I: Incidence of mortality among the participants (N=2700)

Criteria	SCABU 1 (n=1592)		SCABU 2 (n=1108)	
	Frequency	Percentage	Frequency	Percentage
Discharge	1445	90.77%	1039	93.77%
Death	147	9.23%	69	6.23%

In the monthly distribution of admissions and mortality across the two Special Care Baby Units (SCABU), SCABU 1 recorded a total of 1,592 admissions, with monthly admissions ranging from 113 in November to 147 in December. Mortality in SCABU 1 varied monthly, with the highest mortality observed in January and April (16 each) and the lowest in November (7). SCABU 2, with a total of 1108 admissions, showed monthly admissions ranging from 70 in February to 117 in August. Mortality in SCABU 2 ranged from 3 (February) to 9 (August). SCABU 1 generally reported higher monthly mortality figures compared to SCABU 2, indicating variations in mortality outcomes between the two units across the

year. This data reflects monthly and seasonal trends in admissions and mortality in high-risk neonatal care. (Figure1)

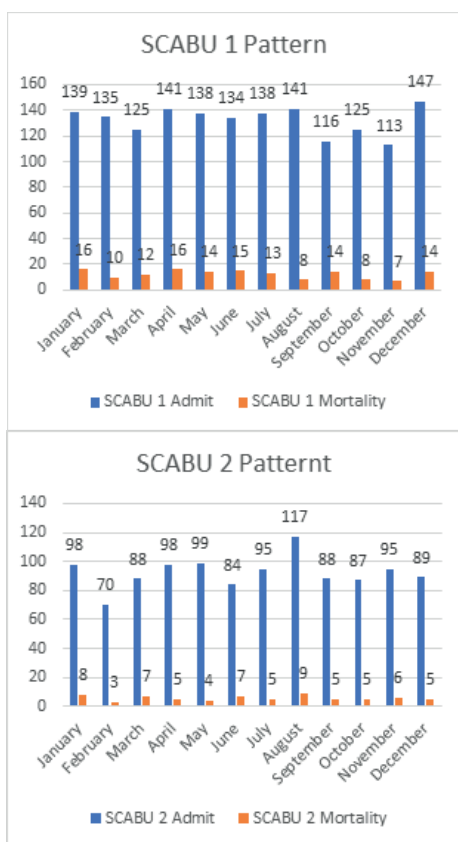


Figure 1: Distribution of participants by monthly admission and mortality pattern among the participants (N=2700)

The baseline characteristics of the 216 neonatal mortalities reveal a mean age of 3.5 days (± 2.4) at the time of death, with an average weight at admission of 1480 grams (± 427). These values indicate that the neonates who did not survive were generally very young and of very low birth weight, highlighting the vulnerability of this population in high-risk settings.

Table II: Baseline characteristics of the participants (n=216)

Characteristic	Mean $\pm$ SD
Age (days) on Death	3.5 $\pm$ 2.4
Weight at Admission (g)	1480 $\pm$ 427

The maternal characteristics of the neonates who did not survive indicate that most mothers were aged 21-30 years (55.56%). A majority of pregnancies were preterm (74.07%), and nearly three-quarters of mothers had irregular or no antenatal checkups (75.00%). Common maternal comorbidities included hypertension (37.04%) and preeclampsia/eclampsia (19.44%), with cesarean section being the predominant mode of delivery (62.96%). These factors underline the prevalence of high-risk maternal profiles associated with neonatal mortality in this cohort.

Table III: Maternal Characteristics of Neonates (N=216)

Characteristic	no	%
Maternal Age Distribution		
≤ 20 years	45	20.83%
21-30 years	120	55.56%
> 30 years	51	23.61%
Type of Pregnancy		
Term	40	18.52%
Preterm	160	74.07%
Post-term	16	7.41%
ANC Checkup Regularity		
Regular	54	25.00%
Irregular	126	58.33%
None	36	16.67%
Maternal Comorbidities		
Hypertension	80	37.04%
Diabetes	30	13.89%
Preeclampsia/Eclampsia	42	19.44%
None	64	29.63%
Mode of Delivery		
Vaginal	80	37.04%
Cesarean Section	136	62.96%

* Multiple response in maternal comorbidities

The weight distribution of the 216 neonatal mortalities shows that nearly half (48.15%) were classified as low birth weight (1000-2499g), while 25% were categorized as extreme low birth weight (<1000 g). Neonates with normal birth weight (2500-3999g) constituted 25%, and only 1.85% were overweight (≥ 4000 g). (Table -IV)

Table IV: Weight distribution of the participants (N=216)

Weight Category	n	%
Extreme Low Birth Weight (<1000 g)	54	25.00%
Low Birth Weight (1000-2499g)	104	48.15%
Normal Birth Weight (2500-3999g)	54	25.00%
Overweight (≥ 4000 g)	4	1.85%

Regarding the primary causes of death, prematurity-related complications were the leading cause, contributing to 43.98% (95) of deaths, followed by neonatal sepsis at 22.22% (48). Perinatal asphyxia accounted for 10.19% (22) of deaths, while congenital anomalies were responsible for 5.09% (11). Other causes of death constituted 18.52% (40), reflecting the multifactorial nature of neonatal mortality in critical care settings.

Table V: Primary Cause of Death (n=216)

Cause of Death	no	%
Neonatal Sepsis	48	22.22%
Prematurity-related Complications	95	43.98%
Perinatal Asphyxia with different HIE	22	10.19%
Congenital Anomalies	11	5.09%
Others	40	18.52%

Discussion

The findings of this study demonstrate an 8% mortality rate among high-risk neonates admitted to a tertiary hospital (BSH&I) in Bangladesh, underscoring the substantial challenges faced by neonates in critical care settings in low-resource environments. This rate aligns with Lafta & Habeeb's study in Iraq, where respiratory distress syndrome (RDS), congenital anomalies, and infections were among the primary causes of neonatal death, emphasizing the role of resource limitations and high disease burden in mortality rates within similar contexts.²² Comparatively, in a study from India, This consistent pattern across studies highlights the pervasive impact of respiratory and infectious complications on neonatal survival in developing regions, where access to advanced neonatal respiratory support and infection control is often limited. The baseline characteristics of our cohort also indicate that young, low birth weight neonates (mean weight of 1480 grams) face disproportionately high mortality risks. Studies across various South Asian and Middle Eastern settings have confirmed that low birth weight, particularly extreme low birth weight (<1000g), and prematurity significantly elevate neonatal mortality. In a study conducted by Gebreheat et al., low birth weight and RDS were identified as leading factors in neonatal mortality, reinforcing our finding that the majority of participants of our study had low birth weight.²⁴ Nayeri et al. also noted that extremely low birth weight neonates had high mortality rates.²⁵ Maternal factors, particularly inadequate antenatal care (ANC) and comorbidities, further compound neonatal risk. In our study, only 25% of mothers had regular ANC, with irregular or absent ANC observed in 75% of cases, a concerning finding that parallels Almarri et al.'s study, which reported that irregular ANC was associated with adverse neonatal outcomes due to missed opportunities for preventive interventions.²⁶ Additionally, hypertensive disorders in pregnancy were prevalent among mothers in our cohort, with 37.04% affected, aligning with findings by Gupta et al., who reported high cesarean section rates and neonatal complications among hypertensive mothers.²⁷ This combination of poor maternal health and limited ANC likely exacerbates neonatal vulnerability, particularly in settings lacking sufficient prenatal and intrapartum support. Cesarean section was the predominant mode of delivery among neonates who died (62.96%), with Lafta & Habeeb observing similar trends in Iraq, where surgical deliveries were frequently associated with high-risk pregnancies and adverse neonatal outcomes.²² Studies indicate that high cesarean rates in cases with maternal or neonatal complications may correlate with poor neonatal survival, as cesarean deliveries are often performed in response to high-risk conditions, including fetal distress and prematurity. Indeed, the high rate of preterm births in our study (74.07%) aligns with similar studies by Aljawadi et al. and Debere et al., who both found prematurity to be a leading factor contributing to neonatal mortality in high-risk NICU populations.^{28,29} Our study's findings on primary causes of neonatal death align with global and regional data, where prematurity-related complications (43.98%) were the leading cause of death, followed by neonatal sepsis (22.22%) and other causes (18.52%), with perinatal asphyxia (10.19%)

and congenital anomalies (5.09%) contributing less frequently. For instance, Abebaw et al. highlighted respiratory distress syndrome, asphyxia, and congenital anomalies as leading causes of neonatal death in Ethiopia, mirroring the significant contributions of prematurity-related complications (43.98%), neonatal sepsis (22.22%), and perinatal asphyxia (10.19%) in our cohort. Additionally, the 'Other Causes' category accounted for 18.52%, reflecting the multifactorial nature of neonatal mortality.³⁰ The high incidence of prematurity-related complications in our study (43.98%) is consistent with findings by Verma et al., who reported that prematurity and low birth weight were associated with the highest case fatality rates in a tertiary hospital in India.³¹ This further underscores the need for enhanced care strategies targeting premature neonates, including the use of antenatal steroids and advanced respiratory support, as demonstrated by Roberts et al., who found antenatal corticosteroids beneficial in reducing respiratory complications among preterm infants.¹⁹ Sepsis accounted for 22.22% of neonatal deaths in our study, emphasizing the role of infection in neonatal mortality. This is consistent with Kumar et al., who reported high mortality rates due to sepsis, with multidrug-resistant organisms compounding the treatment challenges in neonatal sepsis.³² The persistence of neonatal sepsis as a major cause of death in various studies reflects the urgent need for improved infection control practices, particularly in NICUs where neonates are highly susceptible to nosocomial infections. Furthermore, Nayeri et al. observed that infection and congenital anomalies contributed significantly to neonatal mortality in NICUs, echoing our finding of congenital anomalies in 5.09% of cases and reinforcing the importance of early diagnosis and specialized care for neonates with congenital conditions.²⁵ In summary, our study highlights a profile of neonatal mortality in high-risk hospital settings consistent with regional and international trends. Respiratory distress, sepsis, and prematurity-related complications emerge as critical causes of death, influenced by factors such as low birth weight, poor maternal health and limited access to comprehensive ANC. Comparative data from studies in South Asia and the Middle East underscore these findings, illustrating the challenges faced by neonates in low-resource settings where advanced neonatal interventions are limited. These findings underscore the need for targeted improvements in neonatal and maternal care, particularly in enhancing ANC, infection control, and specialized NICU resources, to reduce neonatal mortality rates and improve outcomes in similar settings.

Limitations of The Study

This study was limited by its retrospective, single-center design, which may affect the generalizability of the findings. Data completeness varied across hospital records, potentially impacting the accuracy of certain variables. Additionally, the observational nature limits causal inferences between identified risk factors and neonatal mortality. Future multicenter studies are recommended for broader insights.

Conclusion

This study highlights the significant burden of neonatal mortality

in high-risk hospital settings, with prematurity-related complications (43.98%), neonatal sepsis (22.22%), and low birth weight (73.15%) emerging as major contributors. Extreme low birth weight (<1000g) and inadequate antenatal care were strongly associated with poor outcomes, alongside high rates of cesarean sections (62.96%) among high-risk pregnancies. These findings underscore the urgent need for targeted interventions to improve maternal care, neonatal intensive care resources, and infection control practices. Addressing these factors could significantly reduce neonatal mortality and improve outcomes in similar low-resource settings.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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