Twenty-five years of Progress of Neonatal Deaths in Bangladesh: An Analysis of the Bangladesh Demographic and Health Surveys 1993-2018

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Abstract

Bangladesh has experienced a reduction in neonatal mortality from 52 deaths per 1,000 live births in 1994 to 30 deaths per 1,000 live births in 2018. While the country is expecting to attain sustainable development goals target 3.2 related to neonatal deaths by 2030; the slower reduction of neonatal mortality might appear as a key challenge. This study aims to analyze the trend of neonatal mortality for the last 25 years and identify underlying determinants of such unexpected deaths. To analyze the trend of neonatal mortality Bangladesh Demographic and Health Survey (BDHS) for the years of 1993-2018 data has been used. Both bivariate and multilevel regression analyses have been used focusing on the main objective of the study. The study demonstrates risk of neonatal death reduces with the mother's age and birth interval. Sex of the child and birth order were significantly associated with neonatal deaths for all survey years. Newborn mortalities are more common in rural areas than in urban areas. Despite a downward trend from 1993 to 2018, neonatal death reduction rate is substantially slower.

Keywords: Child mortality, Neonatal mortality, Sustainable Development Goals, Bangladesh

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DOI: https://doi.org/10.59146/pss.v18.7537

Introduction

One of the main contributing factors to overall child mortality is neonatal mortality, which is the total number of neonates that pass away before they turn 28 days old (NIPORT, ACPR, ICF, & Inc., 2020a). In 2020, 2.4 million newborns worldwide lost their lives within their first 28 days (WHO, 2022). A child's chance of dying is roughly 15 times higher in the first month of life than it is at any other point before their first birthday, which explains why a large number of baby deaths occur during this period (Requejo, Bryce, & Victora, 2012). The newborn period accounts for 47% of all under-five mortalities globally, and alarmingly, the rate of decline in neonatal morality is substantially slower than that of other under-five morality contributors as a whole (Rajia, Sabiruzzaman, Islam, Hossain, & Lestrel, 2019; WHO, 2022). Sub-Saharan Africa has the highest rate of neonatal death, followed by Central and Southern Asia. Around 52% of under-five mortality in the South-east Asia region is attributable to neonatal deaths. Around 241000 neonatal deaths are estimated yearly in the Association of Southeast Asian Nations (ASEAN) area, with estimates of the neonatal mortality rate varying from 2 to over 8 per 1,000 live births, depending on the geopolitical factors (see table I) (Hug, Alexander, You, & Alkema, 2019 & Alkema, 2019).

Table 1: Neonatal mortality rate by region in 1990, 2000, and 2017

Region/Country	1990	2000	2017
South East Asia	27.4	20.0	7.8
South Asia	58.6	46.6	26.9
Bangladesh	52.0	42.0	30.0

Source: Hug et.al., 2019

Over the last 25 years, Bangladesh has made some progress in reducing neonatal deaths, but the progress has been slow compared to other developing countries in the region. Between 1993 and 2018, Bangladesh's neonatal mortality rate decreased by 67% (Figure- 1), below the global average reduction of 51% and the average reduction of 72% for lower-middle-income countries (NIPORT et al., 2020a). Regarding meeting the SDG target, the target is to reduce the neonatal mortality rate to at least as low as 12 deaths per 1,000 live births by 2030 (Hug et al., 2019). This figure indicates the fact that in Bangladesh, the current rate of neonatal deaths is still higher than the SDG target. Bangladesh has experienced a reduction in neonatal mortality by degrees from 52 deaths per 1,000 live births in 1994 to 30 deaths per 1,000 live births in 2018 (NIPORT et al., 2020a) (Figure- 1). Nearly half of all deaths among children under the age of

five are caused by these infant deaths. Despite reductions in newborn and child mortality rates over the past two decades, Bangladesh's prenatal and neonatal mortality rates are still high. If the current rate of progress continues, it is unlikely that Bangladesh will meet the SDG target by 2030. Strong initiatives are needed to minimize newborn mortalities, which sadly account for 67% of all pediatric mortality, in order to meet the Sustainable Development Goals (SDG) objective of 12 per 1000 live births (Khan et al., 2021; NIPORT et al., 2020a; Organization, 2016).

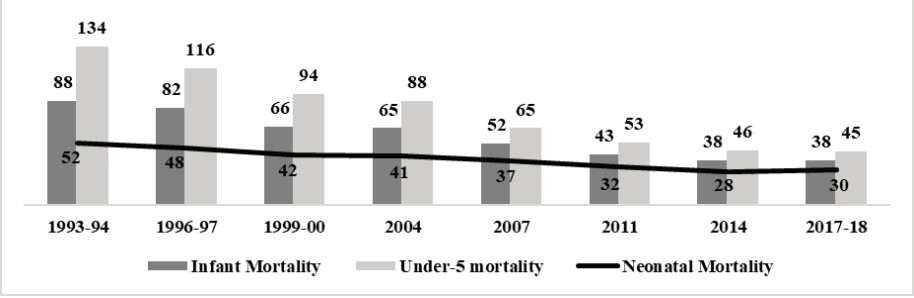

Figure 1: Trends of Childhood Mortality (1993-2018)

Source: NIPORT et al., 1993, 1998, 2000, 2004, 2008, 2009, 2012, 2015, 2020

According to the BDHS, Bangladesh's neonatal mortality rate (NMR) has declined from 52 deaths per 1,000 live births in 1994 to 30 deaths per 1,000 live births in 2018 (NIPORT et al., 2020a). While this represents a significant reduction, it is slower than the progress made by some other lower-middle-income countries in the region. For example, Nepal's NMR has dropped from 76 deaths per 1,000 live births in 1996 to 21 deaths per 1,000 live births in 2022 (NDHS). India's NMR has declined from 78 deaths per 1,000 live births in 1993 to 25 deaths per 1,000 live births in 2021[9] (NAFH). Bangladesh's progress in reducing neonatal deaths has been slower, although still significant, compared to these countries.

In order to ensure the best possible level of child health while focusing on lowering neonatal mortality, it is essential to determine the causes of neonatal survival problems. In this situation, the Mosley-Chen framework, a paragon model of child survival that is appropriate for developing nations like Bangladesh, is used (Figure- 2). This analytical model deftly incorporates numerous issues, such as socioeconomic and near-term factors affecting neonatal survival (ICF, 2021; Ministry of Health and Population, 2022). Neonatal mortality in underdeveloped nations is influenced by a number of causes, including maternal characteristics (age, parity, and birth interval),

environmental factors, nutritional inadequacy, injury, individual preventive actions, and medical care (Mekonnen, Tensou, Telake, Degefie, & Bekele, 2013; Ronsmans, Chowdhury, Alam, Koblinsky, & Arifeen, 2008). Early childhood mortality was linked to both biomedical (gestational period, child's sex) and non-medical (location, mother's age, wealth, education, and maternal healthcare-seeking behavior) variables, according to literature from sub-Saharan Africa (Mosley & Chen, 1984; Ronsmans et al., 2008). According to studies conducted in southern and central Asia, the high neonatal mortality rates were caused by a lack of well-equipped neonatal intensive care facilities and a shortage of medical experts (Abir et al., 2017; Ghimire et al., 2018). Additionally, the World Health Organization (WHO) found that the primary underlying causes of global neonatal mortality were infections, birth abnormalities, and birth asphyxia (WHO, 2022). Bangladesh has recorded the same causes.

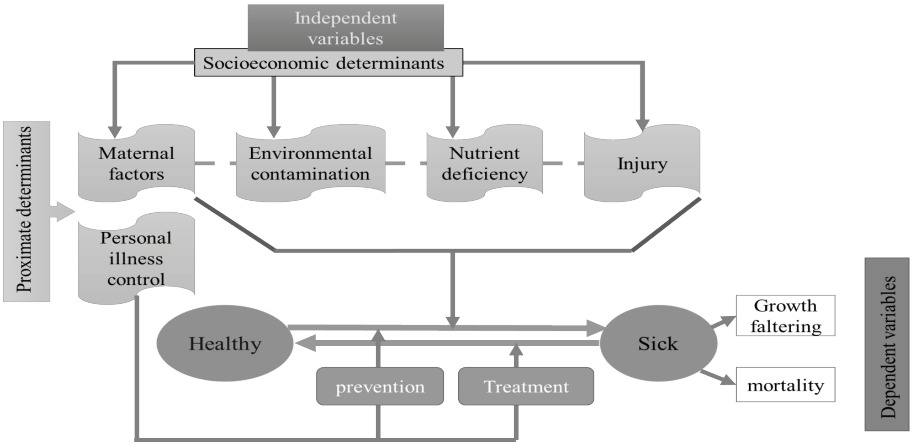

Figure 2: Analytical framework of child survival

Source: Modified analytical framework of child survival adopted from Mosely and Chen (Mosley & Chen, 1984)

However, there is not much research that examines this issue (Haider, Qureshi, & Khan, 2017; Mosley & Chen, 1984). Thus, the purpose of this study is to examine neonatal mortality trends in Bangladesh and identify the factors that are related to neonatal mortality.

Materials and Methods

Source of Data

This analytical study is based on the data of a nationally representative survey,

BDHS ranging from 1993-94 to 2017-18. The NIPORT (The Ministry of Health and Family Welfare) is in charge of conducting the BDHS surveys.

Dependent Variable

The dependent variable for this study is neonatal mortality, which is a dichotomous variable with a value of 'no' or 'yes'. Neonatal mortality means deaths during 0-28 days of life.

Independent Variables

The independent variables of this study have been classified into four groups'- such as **individual level** [age (15-24, 25-34 or 35-49), education (no education, primary, or secondary above), working status (employed or not employed), age at first cohabitation (Less than 14 or more than 14), birth interval (less than 2 years or more than 2 years,)]; **household level** [wealth (Poor, middle or rich) and media exposure (Yes or No)], **spatial level** [place of residence (urban or rural) and administrative divisions) and **child level** [sex of child (male or female), birth order (less than 3 or more than 3), ANC received (No ANC visit or ANC visits), delivery (Home or healthcare facilities) and PNC received (Same day or first days or One week or more)].

Statistical Analysis

All the analyses are carried out by adjusting the survey weight (provided in the dataset) that accounts for the complex survey design of BDHSs. Bivariate analyses are conducted to test the significant association between the independent and dependent variables. Then the model's binary logistic regression has been estimated to confirm the relationships of the independent variables to the dependent variable, shown as adjusted odds ratios (AOR with 95% confidence interval). In the logistic regression model, only those variables are considered that are statistically associated at the bivariate level. The whole analysis of the study is carried out in STATA (version 21).

Ethical Considerations

Ethical approval is not required for this study since the BDHSs data are openly available from the Demographic Health Survey (DHS) site and the reports are already published.

Results

For the past years, neonatal mortality patterns based on background variables are shown in Table 1. The mothers' age has a substantial impact on neonatal

mortalities across the study period (1993–2018); the younger the mothers, the higher the risk of neonatal mortality. Neonatal mortality is also correlated with mothers' employment level. Compared to neonates whose mothers are not working, those whose mothers are working have a lower mortality rate. According to the study's findings, mothers who have children more than two years apart from each other have lower neonatal mortality rates than their counterparts. It has been observed that education has a strong correlation with neonatal mortality during the course of the survey years. Neonatal mortality rate and wealth are not significantly correlated when looking at household-level variables. The neonatal death rates between children whose mothers are media-exposed and those whose mothers are not, however, differ significantly.

Both urban and rural areas have had almost the same trend in neonatal mortality over the past few years. Results of the study show that Sylhet Division has been recognized as the riskiest area with a higher rate of neonatal mortalities over the past years. However, it is discovered that, at the child level, male neonates tend to have a substantially greater mortality rate than female neonates. Additionally, as neonatal mortality rates and access to medical services have been linked, the general trend indicates that neonatal mortality rates are much higher among mothers who have not received ANC, delivery care, or PNC (Table II). ANC services throughout pregnancy may improve a child's chances of surviving, as demonstrated in Table II. When compared to mothers who did not get any ANC, those mothers have the highest newborn death rates. In Bangladesh, home births are the norm, and there are a lot of children who pass away from unsafe deliveries. Table II makes it very evident that children born in healthcare facilities had higher survival rates than those born at home. Similar patterns were also seen with PNC services.

Table 2: Trends of Neonatal Deaths by Background Characteristics in Percentage

		BDHS 1993-94	BDHS 1996-97	BDHS 1999-00	BDHS 2004	BDHS 2007	BDHS 2011	BDHS 2014	BDHS 2017-18
Individual level	**Age**	***	***	***	***	***	***	***	***
	15-24	93.7	95.1	96.5	96.9	97.5	97.0	97.0	97.2
	25-34	84.4	87.0	87.6	87.2	91.9	90.1	90.2	91.1
	35-49	77.8	78.1	79.4	80.6	78.7	80.8	80.7	86.3
	Education	***	***	***	***	***	***	***	***
	No education	80.4	80.9	81.2	82.4	80.9	81.6	81.6	82.6
	Primary	84.0	85.4	85.7	84.5	86.6	85.8	85.7	87.2
	Secondary or more	87.0	92.3	90.7	89.2	87.8	89.8	89.8	90.2
	Working Status				***				**
	Not Working	81.1	80.3	84.7	83.4	80.3	81.8	81.8	88.0
	Working	79.9	79.9	85.5	83.8	80.3	81.0	81.0	85.1
	Age at First Cohabitation			*			*	*	**
	Less than 14	81.7	83.0	83.0	82.0	83.4	84.2	84.1	86.1
	More than 14	86.3	87.0	90.9	81.7	90.9	93.2	93.2	95.0
	Birth Interval	***	***	***	***	***			
	Less than 2 years	84.1	86.0	85.1	85.6	85.4	84.5	84.5	86.2
	More than 2 years	77.6	77.6	78.3	79.1	78.7	82.0	82.0	83.4
Household Level	**Wealth**								
	Poorer	NA	NA	NA	81.5	82.1	83.7	83.7	85.8
	Middle	NA	NA	NA	82.7	84.0	83.7	83.6	85.7
	Richer	NA	NA	NA	82.2	85.2	85.7	85.6	87.5
	Media Exposer			***		***	***	***	
	No	81.0	81.3	82.0	82.7	81.3	82.2	82.2	85.7
	Yes	82.8	85.3	85.4	84.5	85.8	86.5	86.4	86.3
Spatial Level	**Place of Residence**								
	Urban	81.1	85.0	84.5	82.7	84.4	84.8	84.7	86.5
	Rural	81.7	82.4	82.9	84.1	83.1	84.2	84.1	86.3
	Division	***	***	***	***	***	***	***	***
	Barisal	82.4	80.8	79.7	80.0	80.8	81.1	81.1	80.6
	Chittagong	78.2	77.7	79.4	80.1	79.1	79.7	79.7	85.4
	Dhaka	81.0	82.8	83.3	85.0	83.1	85.0	84.9	87.4
	Khulna	85.3	86.6	86.4	85.3	85.9	86.9	86.9	87.9
	Rajshahi	84.0	85.0	84.0	84.4	85.9	87.8	87.7	85.4
	Sylhet	NA	83.5	86.6	87.3	86.2	87.6	87.6	88.7
	Rangpur	NA	NA	NA	NA	NA	82.9	82.8	86.7
	Mymensingh	NA	NA	NA	NA	NA	NA	NA	88.0

Child Level	**Sex of Child**	***	***	***	***	***	***	***	***
	Male	83.6	85.6	85.4	85.8	85.0	86.0	85.9	87.2
	Female	79.4	79.5	81.0	81.4	81,8	82.5	82.5	85.2
	Birth Order	***	***	***	*	***	***		***
	Less than 3	82.2	83.6	84.6	84.8	85.3	85.0	84.9	86.5
	3 or more	81.0	81.7	81.6	82.3	80.8	83.2	83.2	86.0
	ANC Received	***	*	***	***	***	***	***	
	No	100.0	97.3	98.2	99.2	98.6	100.0	100.0	100.0
	Yes	81.6	95.9	82.7	83.3	83.2	84.0	84.0	86.3
	Delivery	***	***	***	***	***	***	***	***
	Home	100.0	97.3	98.0	98.4	98.7	98.6	98.6	100.0
	Healthcare Facilities	80.6	80.9	81.8	82.2	82.1	83.4	84.3	86.0
	PNC Received								
	Within 7 Days	NA	NA	NA	100.0	100.0	100.0	100.0	86.1
	More than 1 Week	NA	NA	NA	100.0	97.6	97.5	97.5	100.0

Source: [2, 13-20] (***p < 0.001; **p < 0.01; *p < 0.05)

Using a logistic regression line, the factors influencing newborn death were determined. The outcomes are displayed in Table 3. After adjusting for all other risk factors in the model, the odds ratio is the individual effect of each risk factor that independently predicts newborn mortality. A higher odds ratio of more than 1 denotes a higher risk for that factor. For all of the survey years 1993–18, Table III shows the results of independent factors such as person level, spatial level, child level, and household level on neonatal mortality. After correcting for all covariates at the individual level, it is clear from the table that mothers' age and birth interval had a significant impact on neonatal death in all surveys (NIPORT, 2016; NIPORT et al., 2020a; NIPORT, ACPR, ICF, & Inc., 2020b; NIPORT, icddr'b, & Evaluation, 2017). According to the study, younger mothers have a significantly higher risk of newborn deaths than their more experienced peers (OR 6.87 and 1.65 respectively for the year 1993). The finding also reveals that larger birth intervals are associated with a lower risk of neonatal mortality (the odds ratio for the birth interval in 1993 was 0.66, and the odds ratio was 0.73 for the year 2018). However, the outcome is not constant over time. For example, in 2004 (OR = 0.57), the odd ratio decreased from the year before, but in 2011 and 2018, it climbed (OR 0.81 and OR 0.73).

Child-level factors, such as the child's sex and birth order, are significantly and consistently correlated with neonatal mortalities at the individual level throughout all survey years. Women who have three or more children are substantially more likely than their counterparts to have neonatal mortalities

(OR 1.34 in 1993 to OR 1.48 in 2018, for third or higher order birth). However, when compared between male and female neonates, female neonatal mortalities are substantially lower. In 1993, the odds ratio for the child's sex was 0.71, and in 2018, it was 0.91. Additional findings show that, during the survey years 1993 to 2018, there was no significant relationship between household media exposure and the prevalence of neonatal mortality. According to additional research, there was no change in the pattern over time and media exposure at the household level did not significantly increase the incidence of newborn deaths from the survey years 1993 to 2018.

Divisions and places of residency have no discernible impact on neonatal mortalities when spatial-level variables are taken into account. Neonatal deaths are greater in rural than in urban areas, according to the study's findings, and the trend has persisted over time. There are large disparities in neonatal mortality between the administrative divisions, and none of the administrative divisions are strongly linked to neonatal deaths. Neonatal deaths are less likely to occur in the Barisal and Chittagong divisions than in the other divisions. From 1993 to 2018, this neonatal death pattern remained constant. However, the probabilities of neonatal mortality were greater in Khulna, Rajshahi, Sylhet, Rangpur, and Mymensingh throughout all survey years. Overall, the study shows that the trend of neonatal mortality has gradually decreased from 1993 to 2018 (Table 3).

Table 3: Odds Ratios of Selected Explanatory Variables to Predict Neonatal Deaths

		BDHS 1993-94	BDHS 1996-97	BDHS 1999-00	BDHS 2004	BDHS 2007	BDHS 2011	BDHS 2014	BDHS 2017-18
		AOR	AOR	AOR	AOR	AOR	AOR	AOR	AOR
Individual Level	**AGE**								
	15-24	6.87***	5.32***	4.34***	5.38*	13.43***	12.80***	5.07***	3.87***
	25-34	1.65***	1.92***	1.83***	1.29	2.71***	2.23***	2.78***	0.63*
	35-49	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Education								
	No education	0.77	0.44***	0.64*	0.28***	0.91	0.84	0.84	0.63**
	Primary	0.82	0.59*	0.87	0.36**	1.19	1.10	0.88	0.91
	Secondary or more	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Age at First Cohabitation								
	Less than 14	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	More than 14	1.69	2.82	1.21	1.19	2.77	3.84	0.79	3.52
	Birth Interval								
	Less than 2 years	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	More than 2 years	0.66***	0.62***	0.65***	0.57***	0.65***	0.81*	0.63***	0.73**

Spatial Level	**Divisions**								
	Barisal	1.21	0.93	0.76	0.81	0.85	0.71	0.85	0.74
	Chittagong	0.83	0.74**	0.85	0.96	0.80	0.69*	0.79	0.95
	Dhaka	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Khulna	1.29	1.14	1.32	1.02	1.37	1.25	0.76	1.41
	Rajshani	1.21	1.16	1.11	0.96	1.44	1.11	1.16	1.11
	Sylhet	NA	1.07	1.45*	1.21	1.40*	1.05	1.19	1.12
	Rangpur	NA	NA	NA	NA	NA	0.92	1.09	1.13
	Mymensingh	NA	NA	NA	NA	NA	NA	NA	1.17
	Place of Residence								
	Urban	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Rural	1.14	1.12	0.97	1.10	1.06	0.95	1.08	0.91
Child Level	**Sex of Child**								
	Male	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	Female	0.71***	0.69***	0.78***	0.67***	0.78*	0.78**	0.87	0.91
	Birth Order								
	less than 3	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	3 or more	1.34***	1.38***	1.27**	1.36	1.06*	1.23*	1.41	1.48***
Household Level	**Media Exposure**								
	Yes	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
	NO	0.95	0.94	0.86	0.91	0.84	0.76**	0.92	0.97

Source: [2,13-20] (***p < 0.001; **p < 0.01; *p < 0.05)

Discussion

This study's trend analysis reveals that Bangladesh must quickly reduce neonatal mortality in order to increase overall child survival and meet SDG target 3.2, which is connected to the neonatal mortality rate, by 2030. This analysis illustrates that although neonatal mortality has decreased in Bangladesh, the rate is still high when compared to other factors that contribute to child mortality as a whole. According to earlier studies, this pattern may be explained by the fact that there is a lesser reduction in neonatal mortalities when access to prenatal care, institutional birth, and postnatal care is restricted and maternal healthcare services are of poor quality (Dana & Afroz, 2021; Kishowar Hossain, 2010; Mosley & Chen, 1984; Ronsmans et al., 2008; WHO, 2022). These factors are similar to the policy involved in ASEAN countries. Moreover, socioeconomic advancement, a consistent policy focus on maternal and child health, a stable health workforce, supportive financial mechanisms, and a coordinated health-system in ASEAN countries appear to be responsible for the improvements

in neonatal health situation. Thailand has applied a favorable health system that is consistent with economic development. In Indonesia, it is found that using comparable actions in a situation with distinct system capabilities and focusing on regional factors might produce better results for the improvement of neonatal health (Acuin et al., 2011).

The findings of this study show that a variety of factors, including those at the individual, spatial, child, and household levels, such as the mother's age, education level, employment status, age at first marriage, birth interval, religion, wealth, media exposure, place of residence, family structure, division of household responsibilities, child's sex, birth order, and receipt of prenatal, perinatal, and postnatal care, are linked to the risk of neonatal mortality in Bangladesh. Results show that neonatal mortality is strongly correlated with mothers' ages; the younger the mothers, the more likely it is that their newborns will die, which is consistent with other research of a similar kind (Dana & Roy, 2020; Mengesha & Sahle, 2017; Shah & Dwivedi, 2011; Wall et al., 2010). Additionally, the findings show that male neonates have much higher neonatal mortality rates than female neonates, which is consistent with the genetic susceptibility of male neonates to infections, intrauterine growth reactions, and preterm death (Pongou, 2013). Pragmatic approaches such as ensuring institutional delivery and efficient use of neonatal intensive care units can reduce the deaths of male neonates. Additionally, the results reveal that neonatal mortality rates are greater in shorter inter-pregnancy intervals than they are in longer birth intervals, which is consistent with the results of another study that indicated longer birth intervals can reduce the likelihood of an unfavorable pregnancy (Abir et al., 2017; H. R. Chowdhury et al., 2010; Nisha, Alam, Islam, Huda, & Raynes-Greenow, 2019). Furthermore, neonatal mortality is higher in rural than in urban settings, which may be related to the lack of neonatal-specific healthcare facilities in rural areas as well as the distance of the location (H. R. Chowdhury et al., 2010; Nisha et al., 2019). Contrary to earlier studies (Best et al., 2019; Das & Chakraborty, 2021; Fottrell et al., 2015), this one demonstrates that mothers with no formal education and little media exposure have reduced neonatal mortality rates.

This result is consistent with the Bangladesh paradox theory, which explains Bangladesh's success in the health sector in the absence of economic growth (Rahman et al., 2021). The Mother and Child Benefit Programme (MCBP), which is primarily intended for poor, vulnerable, and underprivileged women, is one argument that could be put down to its intense implementation (A. M. R. Chowdhury et al., 2013). Another aspect of Bangladesh's success story is the adoption of door-to-door counseling services for illiterate, impoverished

pregnant women. These services are provided by family welfare visits and family welfare assistants (Ministry of Women and Children Affairs. (2022). Additionally, research shows that moms with more birth orders continue to have higher rates of neonatal mortality than their counterparts because mothers with more birth orders are more likely to experience obstetric problems (Best et al., 2019; Das & Chakraborty, 2021; Mengesha & Sahle, 2017).

Conclusion

In this study, neonatal mortality trends in Bangladesh are summarized, and associations between several variables and neonatal mortality are found. The study's results show that although Bangladesh's neonatal death rate has decreased over the last 25 years, it is still fairly high. Interventions to reduce teenage pregnancy and increase birth spacing are necessary to achieve a significant drop in neonatal mortalities. To boost newborn survival rates in Bangladesh, the government must increase maternal education levels, postpone marriage until women are more mature, and empower women through a variety of means. In order to improve neonatal mortalities and attain SDG 3.2, which is connected to newborn mortality, the government should prioritize taking more practical action. This includes implementing the Maternal Neonatal and Child Survival (MNCS) program universally. The current study has certain limitations, such as the recall bias problems with the BDHS, which includes mothers' reporting of newborn mortality. Prior to 2004, there were neither wealth index nor postpartum care (PNC)-related factors available in the BDHS. To reduce neonatal mortalities and accomplish the SDGs, future research must concentrate on adolescent pregnancy, which is connected to adolescent marriage.

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