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Factors Associated with Neonatal and Infant Mortality: A Case Study on Bangladesh

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ABSTRACT

Infant mortality is a major portion of under-five mortality as it is the least defended period of a child's life. The objective of this study is to determine the most significant risk factors for neonatal and infant mortality in Bangladesh. Bangladesh demography and health survey (BDHS), 2014 dataset was taken to conduct this study. The dataset consisted of 4663 respondents. Neonatal and infant mortality was reported among 122 and 155 children respectively. To conduct the study, we used chi-square test to show the association between different selected potential risk factors along with neonatal and infant mortality. We also adopted logistic regression (LR) to determine the high risk factors of neonatal and infant mortality based on p-values, odds ratio (OR), including 95% confidence interval (CI). LR showed that Barisal division has the lowest odds for both neonatal (OR= 0.236; $p<0.01$) and infant (OR= 0.281; $p<0.01$) mortality. Fathers with no education showed highest odds of neonatal (OR= 3.040; $p<0.01$) and infant (OR= 2.867; $p<0.01$) death. Mothers with no education showed highest odds of infant mortality (OR= 2.850; $p<0.05$). Our finding helps the policy maker to take the necessary steps to address and controls the most significant risk factors to reduce neonatal and infant mortality.

Key words: Mortality, logistic regression, risk factors, neonatal, children and Bangladesh.

INTRODUCTION

Living in the 21st century which is the most technologically advanced era where the knowledge and technology for life-saving interventions are available, the last thing we expect is to see that 15,000 children died everyday mostly from preventable causes and treatable diseases in 2017. But the scenario was worse in early modern-times. Even a century ago, every third child died before he/she was five years old (Roser et al., 2013). In 2000, almost 4 million children died in the first month of their lives and still remained virtually unnoticed on global and national agenda (Reidpath & Allotey, 2003). There has been a rising attention to the deaths of the newborn children day by day. Because a recent assessment (Darmstadt et al., 2005) suggested that the rapid policy change was driven recognizing the fact that the increasing portion of under-five deaths were neonatal, combining with the evidence that even in low resource setting, effective action was possible. Along with this, the Millennium Development Goals (MDGs) also gave a push to accelerate progress for health and development targets by making 8 interlinked goals and more than 190 nations and at least 22 international organizations committed to help reach the goals by 2015 (Knippenberg et al., 2005).

Despite the attention, the neonatal mortality rate has decreased more slowly compared to the post-neonatal and child mortality. In 2008, 3.6 million neonatal deaths occurred which comprise at least 41% of under-five deaths (Lawn et al., 2014). Even in 2017, globally, an estimated 2.5 million newborns died in the first month of life, approximately 7,000 every day and most of who died in the first week of their births. Almost 36% died while they were born and will be approximately three-quarters of all the newborn deaths in 2017 occurred in the first week of life (United Nations Inter-agency Group for Child Mortality Estimation et., 2018). Though over the last two decades, globally there was a substantial progress in reducing child mortality, 4.1 million infant died in the year 2017 (Roser et al., 2013). Among the SAARC countries, Pakistan shows the highest infant mortality rate which is 66 deaths per 1000 live births and in this 44 deaths occur in the first month (Martines et al., 2005). With 257 under-five child deaths per 1000 live births, Afghanistan holds the position of third highest in the world and with 39 neonatal deaths per 1000; it is in the second highest position in SAARC countries (Bhutta et al., 2010).

According to UNICEF country profile for Bhutan 2016, the number of children dying within the first month of their birth is 18 per 1000 live births. In the report of the county profile of Nepal provided by UNICEF, neonatal death per 1000 was 12 in 2015. The child

mortality in Maldives was decreased from 228.5 deaths to 8.5 deaths per 1000 live births. Although infant mortality was significantly reduced, our neighbor country India was unable to achieve the MDG by 2015. According to the UNICEF annual report, the neonatal mortality rate was 6.9 in 2017 (Neal, 2009). The infant health gap is still unacceptably high between the rich and poor countries, ranging from an infant mortality rate of 0.9 in Japan to 110.6 in Afghanistan (Rutstein, 1984, Rajaratnam et al., 2010) and rich countries like Brazil and China have reduced their child mortality rates 10-fold over the last four decades (Ram et al. 2009). It took 25 years to bring down the child mortality rate by 73% and over the past decades it has experienced a significant reduction of under-five child mortality which helped to achieve MDG 4 (Roser, 2018). In 1990 the number of infant death was 351,000 and in 2011 the number shrink to 105,000 (Shiffman, 2010). If we go back in year 1968, we can see that from then Bangladesh experienced gradual fall on infant mortality rate form 149.8 deaths per 1000 live births to 26.9 deaths per 1000 live births in 2017 (Shiffman, 2010).

During the period 1975 to 2004, there has been a sharp fall in neonatal mortality from as estimated 74 to 41 per 1000 (UNICEF, 2016) and it was thought that much of these declines were as a result of efforts to reduce neonatal tetanus through maternal immunization (Viswanathan et al., 2010). This figure reduced to 28 per 1000 by the year 2014 according to Bangladesh Demographic and Health Survey (BDHS) 2014. Now to achieve one of the sustainable developed goals (SDG) by 2030, Bangladesh has to reduce its neonatal mortality rate. The SDG 3 is to reduce newborns' mortality and under-five mortality at least as low as 12 and 25 per 1000 live births (Roser et al., 2013). This present study is undertaken to determine the most significant risk factors for neonatal and infant mortality in Bangladesh.

MATERIALS AND METHODS

Data source

The data for this study was collected from BDHS, 2014. To obtain the data, two stage stratified sampling was used. In the first stage 600 clusters were selected from both the rural and urban areas where the cluster size was 393 and 207 respectively. In the second stage of sampling, 30 households were selected from each enumeration area using systematic sampling. In total, 17863 ever married women of age 15-49. There were some missing values in the BDHS dataset. There were 55 missing values in respondent currently residing with husband, 2 in husband's education, and 2 in respondent currently working, 3162 in place of delivery, 1 in delivery by caesarean and 1 in size of child at birth. We exclude the missing values from the dataset. After excluding the missing values, there were 4663 observations.

Even after this huge modification, statistics based on it is close to the statistics of the survey authority. For instance, the neonatal mortality calculated through this data is 26 per 1000 live births which are close to 28 per 1000 live births given in the publication of the survey authority "BDHS 2014".

Outcome variable

In this study, we have considered the two dependent variables as "neonatal mortality" and "infant mortality". We have divided the dependent variables in two sub groups: they are child is dead or not and defined as follows:

$$Y_{NM} = \begin{cases} 1, \text{if neonatal death occures} \\ 0, \quad \text{Otherwise} \end{cases} \quad (1)$$

$$Y_{IM} = \begin{cases} 1, \text{if infant death occures} \\ 0, \quad \text{Otherwise} \end{cases} \quad (2)$$

Potential risk factors

In this study, we have selected 13 potential risk factors for neonatal and infant mortality based on the literatures (Rajaratnam et al., 2010, Roser, 2018, Maniruzzaman et al., 2018). And the definition, categorization and description of 13 risk factors are given in Table 1 as follows:

Table 1. Definition and categories of the variables used in this study

Name of factors	Definition and categorization
Division	There are seven divisions of the country Bangladesh: (i) Barisal, (ii) Chittagong, (iii) Dhaka, (iv) Khulna, (v) Rajshahi, (vi) Rangpur, and (vii) Sylhet.
Residence	There are two type of place as: (i) Urban and (ii) Rural
Mother's education	There are four categories of mother's education as: (i) No education, (ii) Primary, (iii) Secondary, and, (iv) Higher.
Residing with husband	There are two categories of residing with husband as: (i) Yes and (ii) No.
Father's education	There are four categories of father's education as: (i) No education, (ii) Primary, (iii) Secondary, and (iv) Higher.
Working mother	There are two category of working mother as: (i) Yes and (ii) No.
Sex of child	Gender considered for the child is as: (i) Male and (ii) Female.
Delivery by caesarean	There are two categories of delivery by caesarean as: (i) No and (ii) Yes.
Mother's age (years)	There are four categories of Mother's age as: (i) 15-24, (ii) 25-34, (iii) 35-44 and (iv) 44+.
Wealth index	In the questionnaire, wealth index has five categories as: (i) Poorest, (ii) Poorer, (iii) Middle, (iv) Richest, (v) Richer. Due to the simplicity, we categorize the wealth index as: (i) Poor (Poorest + Poorer), (ii) Middle, and (iii) Rich (Richest + Richest).
Birth order	There are three categories of birth order as: (i) 1st, (ii) 2nd and (iii) Above 2.
Place of delivery	There are two categories of delivery place as: (i) Hospital and (ii) Home.
Size of child	In the questionnaire, size of the child at birth has five categories as (i) Very Large, (ii) Larger than Average, (iii) Average, (iv) Smaller than Average, (v) Very Small. Due to simplicity we categorize the size of the child at birth as: (i) Large (Very Large), (ii) Average (Larger than Average + Average + Smaller than Average), and (iii) Small (Smaller than Average).
Neonatal mortality	There are two categories of neonatal mortality as: (i) Yes and (ii) No.
Infant mortality	There are two categories of infant mortality as: (i) Yes and (ii) No.

Statistical analysis

In our study, we present the data as frequency (percentage) for categorical variable. We adopted chi-square (CS) test (Cochran, 1952) to show the association between neonatal and infant mortality along with 13 factors based on p-values. We also adopted logistic regression (LR) to identify the risk factors of neonatal and infant mortality on the basis of odds ratio (OR) and p-value, including 95% confidence interval of OR (Walker & Duncan, 1967). Statistical significance was defined with $p < 0.05$ (significant) and $p < 0.001$ (highly significant). SPSS version 20.0 and Ri86 3.5.2 was used for analysis.

RESULTS

Background characteristics of the study

Table 2 represents the background characteristics of the selected variables. It is observed that the maximum numbers of respondents (19.4%) were taken from Chittagong division and the lowest number of respondents (11.5%) from Khulna division. Moreover, the second highest (17.8%) were from Dhaka division. Most of the respondents are taken from rural compared to urban. Mother's education level is a very important variable. We observed 47.4% mothers who have completed secondary education were taken and only 11.5% from mothers with higher education. Most of the respondents reside with their husbands and only 14.5% respondent lives elsewhere. Table 2 also shows that most of the fathers have completed their secondary education and the percentage is 31.4. Similar to mother's educational level, the percentage of higher education is also the lowest in father's education. The percentage of working mother is quite low which is 78.4 and 21.6% respondent did not work outside their house. Almost fifty two percent male children were taken. We can see that normal delivery was more preferred than caesarean delivery as only 23.1% for caesarean delivery and 76.9% for normal delivery. Most of the mothers are from age group 15-24 with 55.2% and only 0.3% mother was from age above 44 years. The percentages of poor, middle and rich are 40.3%, 19.0% and 40.6% respectively. The birth order means the order of the birth of the child and 41% for 1st birth while only 29.4% for more than two child. The place of delivery is categorized into hospital/clinic and home/others. We can see that the percentage of home delivery is higher than hospital/clinic deliveries. The size of child is categorized into large, average and small. We see that the percentages of large, average and small child are 13.0%, 67.4% and 19.5% respectively. According to the category of the variable 'Child is dead', there were 122 (2.6%) neonatal deaths out of 4663 and 155 (3.3%) infant death out of 4663.

Table 2. Background characteristics of the selected variables

Variable	Categories	Frequency	Percent
Division	Barisal	541	11.6
	Chittagong	905	19.4
	Dhaka	829	17.8
	Khulna	538	11.5
	Rajshahi	568	12.2
	Rangpur	560	12.0
	Sylhet	722	15.5
Residence	Urban	1480	31.7
	Rural	3183	68.3
Mother's education	No education	628	13.5
	Primary	1287	27.6
	Secondary	2212	47.4
	Higher	536	11.5
Residing with husband	Yes	3988	85.5
	No	675	14.5
Father's education	No education	1078	23.1
	Primary	1405	30.1
	Secondary	1465	31.4
	Higher	715	15.3
Mother's working status	Yes	3657	78.4
	No	1006	21.6
Sex of child	Male	2405	51.6
	Female	2258	48.4
Delivery by caesarean	No	3587	76.9
	Yes	1076	23.1
Mother's age (years)	15-24	2574	55.2
	25-34	1815	38.9
	35-44	258	5.5
	44+	16	0.3
Wealth index	Poor	1881	40.3
	Middle	887	19.0
	Rich	1895	40.6
Birth order	1st	1912	41.0
	2nd	138	29.6
	Above 2	1369	29.4
Place of delivery	Hospital/clinic	1826	39.2
	Home/Others	2837	60.8
Size of child	Large	608	13.0
	Average	3144	67.4
	Small	911	19.5
Neonatal death	Yes	122	2.6
	No	4541	97.4
Infant death	Yes	155	3.3
	No	4508	96.7

Chi-Square analysis

The chi-square test shows the association between the selected independent variables and neonatal and infant mortality. It is observed that the division has significant impact on both neonatal and infant mortality. Surprisingly, Sylhet division has the highest neonatal (25.4%) and infant death (23.9%) while, Chittagong takes the second position with 15.6% for neonatal death and Dhaka has is 18.1% for infant death compared to Barisal division.

Table 3. Association between neonatal and infant mortality and covariates

Variable	Categories	Neonatal mortality			Infant mortality		
		Death, N (%)	Alive N (%)	p-value	Death N (%)	Alive N (%)	p-value
Division	Barisal	5(4.1)	536(11.8)	0.011	7(4.5)	534(11.8)	0.021
	Chittagong	19(15.6)	886(19.5)		27(17.4)	878(19.5)	
	Dhaka	18(14.8)	811(19.9)		28(18.1)	801(17.8)	
	Khulna	17(13.9)	521(12.1)		20(12.9)	518(11.5)	
	Rajshahi	17(13.9)	551(12.1)		19(12.3)	549(12.2)	
	Rangpur	15(12.3)	545(12.0)		17(11.0)	543(12.0)	
	Sylhet	31(25.4)	691(15.2)		37(23.9)	685(15.2)	
Residence	Urban	38(31.1)	1442(31.8)	0.887	49(31.6)	1431(31.4)	0.973
	Rural	84(68.9)	3099(68.2)		106(68.4)	3077(68.3)	
Mother's education	No education	19(15.6)	609(13.4)	0.061	26(16.8)	602(13.4)	0.020
	Primary	42(34.4)	1245(27.4)		53(34.2)	1234(27.4)	
	Secondary	55(45.1)	2157(47.5)		68(43.9)	2144(47.6)	
	Higher	6(4.9)	530(11.7)		8(5.2)	528(11.7)	
Residing with husband	Yes	111(91.0)	3877(85.4)	0.082	141(91.0)	3847(85.3)	0.050
	No	11(9.0)	664(14.6)		14(9.0)	661(14.7)	
Father's education	No education	37(30.3)	1041(22.9)	0.012	50(32.3)	1028(22.8)	0.001
	Primary	41(33.6)	1364(30.0)		51(32.9)	1354(30.0)	
	Secondary	37(30.3)	1428(31.4)		45(29.0)	1420(31.5)	
	Higher	7(5.7)	708(15.6)		9(5.8)	706(15.7)	
Mother's working Status	No	90(73.8)	3567(78.6)	0.205	115(74.2)	3542(78.6)	0.193
	Yes	32(26.2)	974(21.4)		40(25.8)	966(21.4)	
Sex	Male	72(59.0)	2333(51.4)	0.096	87(56.1)	2318(51.4)	0.249
	Female	50(41.0)	2208(48.6)		68(43.9)	2190(48.6)	
Delivery by caesarean	No	102(83.6)	3485(76.7)	0.076	131(84.5)	3456(76.7)	0.023
	Yes	20(16.4)	1056(23.3)		24(15.5)	1052(23.3)	
Mother's age (years)	15-24	69(56.6)	2505(55.2)	0.719	86(55.5)	2488(55.2)	0.234
	25-34	47(38.5)	1768(38.9)		59(38.1)	1756(39.0)	
	35-44	5(4.1)	253(5.6)		8(5.2)	250(5.5)	
	44+	1(0.8)	15(0.3)		2(1.3)	14(0.3)	
Wealth index	Poor	59(48.4)	1822(40.1)	0.180	76(49.0)	1805(40.0)	0.071
	Middle	19(15.6)	868(19.1)		23(14.8)	864(19.2)	
	Rich	44(36.1)	1851(40.8)		56(36.1)	1839(40.8)	
Birth order	One	54(44.3)	1858(40.9)	0.759	69(44.5)	1843(40.9)	0.446
	Two	34(27.9)	1348(29.7)		39(25.2)	1343(29.8)	
	Others	34(27.9)	1335(29.4)		47(30.3)	1322(29.3)	
Place of delivery	Hospital	50(41.0)	1776(39.1)	0.676	58(37.4)	1768(39.2)	0.652
	Home	72(59.0)	2765(60.9)		97(62.6)	2740(60.8)	
Size of child	Large	28(23.0)	580(12.8)	0.000	31(20.0)	577(12.8)	0.001
	Average	60(49.2)	3084(67.9)		84(54.2)	3060(67.9)	
	Small	34(27.9)	877(19.3)		40(25.8)	871(19.3)	

Table 3 also shows that mother's education is not significantly associated with neonatal mortality while it is significantly associated with infant mortality. It is observed that respondent's current residence with husband; mother's working status, sex of child, mother's age, wealth index, birth order, and place of delivery are not statistically significant with both neonatal and child mortality. It is observed that Father's education plays a significant role in neonatal mortality and infant mortality. The both types of mortalities are higher for fathers who have completed the primary education while the lowest for higher educated fathers. It is

also observed that neonatal and infant mortality is high for the women who were not done by caesarean technique and the percentages are 83.6% and 84.5%, respectively. But it has significant impact only on infant mortality. Size of children has significant impact on both neonatal and infant mortality. The highest percentage for neonatal mortality is 49.2% for average size child and 54.2% for infant mortality. Whereas, the lowest percentage for both mortalities for small size of children.

Logistic regression

This section presents the results of LR. We select the factors for LR which is found statistically significant in chi-square test (See section 3.2). LR is used to identify the most significant risk factor of neonatal and child mortality based on the odds ratio (OR) and p-values. If OR>1, the factors are higher risk, OR=1, the factors are not risk factors, and OR<1, the factors are lower risk. Table 4 shows the estimated values of the parameters for LR for neonatal mortality. It is observed that Barisal and Chittagong division is statistically significant at 5% level of significance. Barisal and Chittagong division were lower risk of neonatal death than Sylhet division.

Table 4. Estimated values of the parameters for binary LR for neonatal mortality.

Variable	Category	OR	p-value	95% CI for OR	
				Lower	upper
Division	Sylhet (ref)	1.000			
	Barisal	0.236	0.003	0.091	0.615
	Chittagong	0.553	0.049	0.306	0.998
	Dhaka	0.557	0.055	0.307	1.013
	Khulna	0.781	0.432	0.423	1.445
	Rajshahi	0.764	0.386	0.415	1.405
	Rangpur	0.682	0.237	0.361	1.286
Father's education	Higher (ref)	1.000			
	No education	3.040	0.008	1.337	6.912
	Primary	2.742	0.015	1.218	6.172
	Secondary	2.533	0.025	1.121	5.723
Size of child	Small (ref)	1.000			
	Large	1.295	0.331	0.769	2.178
	Average	0.553	0.007	0.359	0.853

The odds ratio for Barisal and Chittagong division were 0.236 (OR=0.236, 95% CI=0.091-0.615) times and 0.553 (OR=0.553, 95% CI=0.306-0.998) times lower risk of neonatal mortality compared to Sylhet division. Father's education shows significant impact on neonatal deaths. The odds ratio for no educated mother is 3.04 (OR=3.040, 95% CI=1.337-6.912) that indicates 3.040 times higher risk of neonatal mortality compared to higher educated father. In cases of fathers with primary and secondary education, the OR of neonatal death is 2.742 times and 2.533 times higher risk compared to fathers who have

completed higher education. For the size of child, only the average size of child shows significant impact. For average weight the odds ratio is 0.553 (OR=0.553, 95% CI=0.359-0.853) which means the odds of neonatal death is 0.553 times less in cases of child with average size than the small sized child.

The estimated values of the parameters for LR for infant mortality are shown in Table 5. It shows that only Barisal division is statistically highly significant impact on infant mortality. Barisal division is 0.236 (OR=0.236, 95% CI=0.123-0.639) times lower risk of infant death compared to Sylhet division.

Table 5. Estimated values of the parameters for LR for infant mortality

Variable	Category	OR	p-value	95% CI for OR	
				lower	upper
Division	Sylhet (ref)	1.000			
	Barisal	0.281	0.002	0.123	0.639
	Chittagong	0.673	0.133	0.401	1.128
	Dhaka	0.764	0.300	0.458	1.272
	Khulna	0.834	0.535	0.470	1.480
	Rajshahi	0.735	0.293	0.414	1.305
	Rangpur	0.652	0.158	0.361	1.181
Father's education	Higher (ref)	1.000			
	No education	2.867	0.012	1.266	6.492
	Primary	2.425	0.024	1.124	5.229
	Secondary	2.215	0.036	1.054	4.655
Size of child	Small (ref)	1.000			
	Large	1.294	0.302	0.793	2.113
	Average	0.670	0.044	0.454	0.989
Mother's education	Higher (ref)	1.000			
	No education	2.850	0.010	1.280	6.35
	Primary	2.835	0.006	1.339	6.003
	Secondary	2.093	0.040	1.00	4.382
Delivery by caesarean	Yes (ref)	1.000			
	No	0.736	0.200	0.460	1.176

Numbers in bold indicate significant covariates at 5%.

Fathers who had no education, completed primary and secondary education, they have 2.867 times (OR=2.867, 95% CI=1.266-6.492), 2.425 times (OR=2.425, 95% CI=1.124-5229), and 2.215 (OR=2.215, 95% OR=1.054-4.655) times higher risk of infant mortality than higher educated fathers. For the size of child, only the average size of child shows significant impact on infant mortality. For average sized child, the odds ratio is 0.670 (OR=0.670, 95% CI=0.454-0.989) which means the odds of infant death is 0.670 times less in cases of child with average size than the small sized child. It is observed that mothers who had no education and completed primary education has significant impact on infant mortality. The odds ratio for no education is 2.850 (OR=2.850, 95% CI=1.280-6.350) times, greater in cases of mothers with higher education. And in cases of mothers with primary education, the odds

ratio is 2.835 (OR=2.835, 95% CI=1.339-6.003) that indicates mothers with primary education is 2.835 times higher risk compared to higher educated mothers.

DISCUSSION

Our Study

The present study is undertaken to determine the most significant risk factors for neonatal and infant mortality in Bangladesh. The independent variables found to be significantly associated with neonatal mortality are division, father education, and size of the child. On the contrary, division, mother's education, father's education, delivery by caesarian, and size of the child are significantly associated with infant mortality. In logistics regression analysis, the factors showing a significantly association with neonatal mortality are Barisal and Chittagong division, no education, primary educated, and secondary educated father, average size of the child. On the other hand, Barisal division, no education, primary educated, and secondary educated father and mother, average child size are the significantly impact on infant mortality. Our study also found that only 2.6% neonatal and 3.3% infant death.

Key difference between our study against previous study

Chowdhury et al. (2005) utilized on the neonatal and infant mortality in Bangladesh. They showed that low birth-weight, difficult labor, unhygienic practices, sepsis, asphyxia, tetanus were significant influence on neonatal and child mortality. Kamal et al. (2012) studied the BDHS 2007 dataset to identify the risk factors of neonatal mortality in Bangladesh. They showed that there was a significant relationship between contextual factors and neonatal mortality. They also showed that mother's education, religion, mother's age, birth order and number of fetus had significant influence on neonatal mortality.

Mondal et al. (2009) collect the mortality dataset from Rajshahi district to determine the effect of different socio-economic factors on infant and child mortality. By using LR, it was observed that mother's education, father's education, sanitation facility and treatment place had significant impact on infant and child mortality. Singh et al. (2013) aimed to examine individual, household, and community level factors affecting neonatal mortality in rural India. They analyzed information on 171,529 singleton live births using different district level household data in 2007-08. They applied two-level LR to demonstrate the dependence of selected factors on neonatal deaths in rural India and got mother's education, father's education, working status of mother, water, sanitation facility, house type and electricity had significant influence on neonatal mortality. The purpose of the study of Poudel (2013) was to determine factors associated with neonatal mortality in Nepal. In this study they collected

data from 4033 women who gave birth from 2006 to 2010.They used univariate, multivariate analysis, and LR to determine the associations between neonatal mortality and certain predictor variables. The results showed that mother's age and parity had significant impact on neonatal mortality.

Chowdhury et al. (2010) used the mortality dataset of Natore sadar upzilla in Natore district of Bangladesh. This data was collected from 796 women. They used chi-square test to show how much the selected factors are associated with neonatal and child mortality. They also used LR to show the dependency of selected factors on both mortalities. From the result of LR, it was found that mother's education, father's occupation and wealth index were significant effect on both neonatal and child mortality. Debelew et al. (2014) studied to identify the determinants and causes of neonatal mortality in Ethiopia. A study was conducted among 3463 neonates. In this study, Mixed-effects multilevel LR model was used to identify determinants of neonatal mortality. The results showed that birth order, antenatal care, mother's age, premature and asphyxia had significant influence on neonatal mortality in Ethiopia. Titaley et al. (2008) attempted to identify the determinants of neonatal mortality in Indonesia. Survival information of 15,952 singleton live-born infants born between 1997 and 2002 was examined, was used as the data source. Multilevel LR using a hierarchical approach was performed to analyze the factors associated with neonatal deaths. Paternal occupation, birth interval, birth weight and delivery complications were the factors that had significant impact on the neonatal mortality in Indonesia. Lukonga & Michelo (2015) aimed to find the factors that are associated with neonatal mortality in Zambia. For this study data was collected from 6435 women aged 15-49 years. By LR, it was found that birth weight, mother's education and mother's age had significantly influenced the neonatal mortality in Zambia.

Edmond et al. (2006) attempted to assess the contribution of the timing of initiation of breastfeeding on neonatal mortality. The analysis was based on 10947 breastfed singleton infants born between July 2003 and June 2004. From the LR, it was found that initiation of breastfeeding influenced neonatal mortality significantly. Sharifzadeh et al. (2008) worked on population based case-control study that covered 156 infant who died in health houses of Birj and Iran between January 2004 and December 2005. They used LR and showed that gestational age, birth weight and mother's addiction were significant risk factors for infant mortality. Rahman & Sarkar (2009) used BDHS dataset from 1999-2000 and examined under-five mortality. Using LR, they have showed that father's and mother's education,

sanitation facility, family size, birth interval and delivery place are major contributor of infant and child mortality. BDHS 2007 dataset was used by Karmaker et al. (2014). The dataset consisted of 6456 samples. They have used cohort life table as a bivariate analysis and cox proportional hazard model to analyze the determinant of under-five mortality. Residence, parent's education, sanitation facility, wealth status and months of breastfeeding were showed as the most significant predictors of neonatal, post-neonatal, infant and child mortality.

Ntenda et al. (2014) conducted a study on infant mortality in Malawi. Multiple LR was used for data analysis. Their study indicated that residence, region, birth order, type of house, region, mother's age, sex and size of the child have significant influence on infant mortality. Sadek (2016) used BDHS 2011 dataset which was consisted of 6878 samples. He used cross tabulation, simple and multiple LR to explore the predictors of infant mortality in Bangladesh. According to his study, parent's education, infant sex, toilet facility, birth order and type, place of delivery and vitamin A dose have significant attention on infant mortality. Febriyuna (2015) used three IDHS data from 1997 to 2012 to identify determinants of infant mortality in Indonesia. They got sex of the child, birth multiplicity; birth order, mother's age, household members, pregnancy and place of delivery were significant factors for infant mortality. Abu (2014) conducted a study consisted of 985 samples in Nigeria. To identify the pattern and determinants of infant and child mortality he conducted analysis of variance, probit regression analysis, hierarchical cluster analysis and principle component analysis. Mother's age, education and occupation was found as significant factor of infant and child mortality along with water, residence and health facilities.

Abuqamar et al. (2010) conducted a study in Gaza strip where 550 mothers of infants were interviewed face to face. LR was used to identify the relationship between health behavioral factor and infant mortality. The result of the study showed that parents' education had significant impact on infant mortality. However, Barisal and Chittagong division, father's education and average size of the child are significant influence on neonatal mortality, whereas, Barisal, father's education, average size of child and mother's education are significant influence on infant mortality.

Table 6. Key difference between current study and previous study

Authors	Year	Data size	Country	Methods	PE	Findings
Chowdhury et al.	2005	1019	Bangladesh	LR	KS FE	LBW, difficult labor, toilet, sepsis, asphyxia , tetanus
Kamal et al.	2014	10996	Bangladesh	MLR, CS	OR	Mother's education, religion, mother's age, birth order, fetus
Mondal et al.	2009	3750	Rajshahi	LR, CS	OR	Parent's education, toilet, treatment place
Singh et al.	2007	171529	India	CS, LR	OR	Parent's education, working status, water, toilet, house type, electricity
Poudel	2013	4033	Nepal	UA,MLR	AOR OR	Mother's age, parity
Chowdhury et al.	2010	796	Natore	LR, CS	OR	Mother's education , occupation, toilet
Debelew et al.	2014	3463	Ethiopia	MLLR	COR AOR	Birth order, antenatal care, mother's age, premature, asphyxia
Titaley et al.	2008	15952	Indonesia	MLR	COR AOR	Paternal occupation, birth interval , birth weight, delivery complications
Lukongaet al.	2015	6435	Zambia	LR	COR AOR	Birth weight, mother's education, mother's age
Edmond et al.	2005	10947	Ghana	LR	COR AOR	Breastfeeding
Sharifzadeh et al.	2008	156	Iran	CC, LR	OR	Gestational age , birth weight, mother addiction
Rahman et al.	2009	NA	Bangladesh	MLR	OR	Birth interval, parent's education , toilet, family size, delivery place
Karmaker et al.	2014	6456	Bangladesh	CHM, CLT	HR	Residence, parent's education, toilet, wealth status, breastfeeding
Ntenda et al.	2014	4698 and 12174	Malawi	CS, MLR	OR	Residence , birth order, delivery by CS, house type , region, mother's age, sex of child, Size of the baby
Sadek	2016	6878	Bangladesh	CT, LR, MPLR	OR	Parent's education, sex of the child, toilet, place of delivery, birth order , birth type, vitamin A
Febriyuna	2015	16206 18645 18021	Indonesia	LR	OR	Sex of the child, Birth multiplicity, birth order, birth interval, mother's age, household members, pregnancy, water, place of delivery
Abu	2014	985	Nigeria	ANOVA PRA PCA	p-value	Mother's age, mother's education , occupation, water, residence, health facilities
Abuqamar et al.	2010	550	Palestine	LR, CS	OR	Parent's education
Proposed study (2019)		4663	Bangladesh	CS, LR	OR	Division, father's education, mother's education, size of child

LR: Logistic Regression; KS: Kappa-Statistics; FE: Fisher's exact; MLR: Multivariate Logistic Regression; LBW: Low Birth Weight; OR: Odds Ratio; MA: Multivariate Analysis; UA: Univariate Analysis; MLLR: Multilevel Logistic Regression; CC: Case-control; CHM: Cox-proportional hazard model; CT: Cross tabulation; CLT: Cohort life table; CrS: Cross-sectional; MPLR: Multiple Logistic Regression; ANOVA: Analysis of Variance; PRA: Probit Regression Analysis; HCA: Hierarchical Cluster Analysis; PCA: Principal Component Analysis; MNR: Multinomial regression; HR: Hazard ratio; CS: Chi-square; PE: Performance.

Limitation and extension of the study

Some challenges were faced while conducting the study. First, most of the covariates selected in this paper are not neonatal or infant specific because almost all of them are socioeconomic factors. Since we have worked with BDHS data which is cross-sectional in nature, this limits any conclusions about the causality of the selected factors. To find the dependency of

neonatal and infant mortality on covariates, instead of multiple LR we may use another regression as proportional hazards models or multilevel LR.

Conclusion

Infant mortality is a major portion of under-five mortality as it is the most least defended period of a child life and which for obvious reasons; increase the infant mortality rate. Chi square analysis shows that division, father's education and size of the children are associated with both neonatal and infant mortality. For infant mortality mother's education and delivery by caesarean also showed significant association. On the contrary, Barisal and Chittagong division, father's education and average size of the child are significant influence on neonatal mortality, whereas, Barisal, father's education, average size of child and mother's education are significant influence on infant mortality. This study helps the policy makers to take the necessary steps to address and controls the most significant risk factors to reduce neonatal and infant mortality in Bangladesh.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical approval

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