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Predictors of Infant Mortality in a Developing Country*

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Abstract: An attempt is made to investigate the predictors of neonatal and post-neonatal mortality in Bangladesh by utilizing the data of Bangladesh Demographic and Health Survey (BDHS) 1999-2000. In this study the Cross-tabulation analysis reveals that infant mortality varied significantly by several variables. Among these variables, parents education had significant negative effect on infant mortality, while occupation of parents had significant influence on post-neonatal mortality only. The infant mortality was found higher in small families, while low for the children whose mothers were currently breastfed and it decreased significantly with the increase of mothers standard of living index. Mother's age at birth of child and birth order had significant influence on infant mortality and it was lowest for the children having birth interval over 30 months. It is also found that timing of first antenatal check, Tetanus Toxoid (TT) during pregnancy and numbers of antenatal visit had significant influence for both mortality cohorts. Multiple logistic regression analysis, carried out by using the significant variables found in cross tabulation analysis, reveals that mother's education, family size, breastfeeding status, mother's age at birth, birth spacing, complication during birth, type of birth, timing of first antenatal check and TT during pregnancy had significant effect on neonatal mortality. Further, post-neonatal mortality varied significantly by education and occupation of father, family size, breastfeeding status, mother's age at birth, type of birth and TT during pregnancy. Thus further research is needed to assess the impact of several variables taken into consideration the above groups, so that the policy formulation will be easier for the people involved in planning purpose.

Key words: Neonatal, post-neonatal, tetanus toxoid, cross-tabulation, logistic regression, SLI

INTRODUCTION

The level of infant mortality is used as development indicator of a nation or a society. For infant and young children, the risk of dying is closely related to the environment in which they live. The environment depends on commitment of nation to provide proper nutrition and female education. The United Nations along with other organizations has been actively involved in reducing infant and under-five mortality in the world. As a result, globally there have been considerable improvements in the level of infant mortality in recent years. The introduction of immunization vaccines against some common life threatening diseases and prevention and controlled of diarrhoeal diseases through the use of ORS have significant contribution for reduction of these mortality rates.

Mosley and Chen (1984) identified the risk of childhood morbidity and mortality that directly influenced by education of mother, sanitation facilities, access to safe drinking water and maternal and child health care services. Cleland (1990) found that early childhood mortality is highly associated with

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the maternal education for all major developing regions. In rural Bangladesh, the most significant causes for infant mortality were tetanus, measles, fever, respiratory, diarrhoea and dysentery (Chen *et al*., 1980). Hossain (2000) studied the determinants of infant and child mortality and identified that the determinants were varying according to the age of the child. The study also identified that receiving of health care services, birth interval and education of mother were the major determinants of infant and child mortality.

Many studies identified that among socioeconomic variables, maternal education plays a crucial role in the child survival and observed an inverse relationship between education of mother and infant and child mortality (Bhuiya and Streatfield, 1991; Caldwell and Donald, 1982; Cleland, 1991; Gitter, 2003; Groose and Auffery, 1989; Hossain, 2000; Majumder and Islam, 1993; Pandey *et al*., 1998). In a study, Shaik and Rahman (1991) documented that mother's occupation has no impact on child mortality in rural areas of Bangladesh, but there is a volatile difference in infant mortality between children of employed and unemployed mother in urban areas. Baily (1989) shown that the child mortality rate is lower if mothers engaged in traditional sector jobs and higher if mothers engaged in farming or modern sector jobs. The place of residence is also regarded an important factor of child mortality, because the health care services including higher coverage of immunization, more safe delivery in urban areas than rural areas (Kabir *et al*., 1995). Dashtseren (2002) has identified that infant and child mortality were lower for the children whose mother read newspaper, watch TV, listen to radio compared with those children whose mother had no access of such medias. Pandey *et al*. (1998) concluded that mother exposure to mass media has no effect in neonatal mortality, but statistically significant effect for post-neonatal mortality and child mortality in India.

Several studies documented that demographic factors such as mother age at the birth of child, birth order, type of birth, birth spacing with previous child, sex of child, breastfeeding status were important factors of infant and child mortality (Bhandari *et al*., 1988; Chowdhury and Jayaswal, 1989; Hobcraft *et al*., 1985; Hossain, 2000; Roy and Jeyachandrann, 1996; Mozumder *et al*., 1998). Few studies had shown a classic U shaped relationship between age of mother at the birth of child and infant mortality (Alkabir, 1987; Mostafa *et al*., 1998; Tiwari, 1989). Many studies identified the negative relationship between birth interval and infant and child mortality (Boerma and Bicego, 1992; Hossain, 2000; Inayatullah, 1986; Pebley and Millman, 1986; Winikoff, 1983). A higher risk of infant and child mortality were indicated for four specific types of pregnancies such as before 18 years of age, after 35 years of age, after four deliveries, interval between births of less than 2 years (Inayatullah, 1986). The birth order of a child had strong effect on the survival in the first year of life but the effect diminished there after (Kabir *et al*., 1995). Investigations on the effect of breastfeeding on child survival have shown that infants who were exclusively breast-fed survive longer and healthier than artificially fed children (Habicht *et al*., 1986; Rosenberg, 1989).

The proper medical attention and hygienic conditions during pregnancy and delivery can reduce the risk of infections that can be caused death or various illnesses for the mother or the newborn child. The prenatal management, maternal nutrition, the process of child birth, treatment of obstetric emergencies played an important role in improving child survival (Rajaram, 1990). Studies identified that receiving of health care services during antenatal and post-natal period has very positive impact on the survival of the children (Ahmed *et al*., 2001; Gunasekaran, 1997; Hossain, 2000; Roy and Jeyachandrann, 1996). The maternal health care variables such as timing of first antenatal check, number of antenatal visit during pregnancy (TT) injection during pregnancy, taking iron and folic acid tablets, delivery assistance and place of delivery have profound importance in reducing the infant and child mortality. In Bangladesh, an inadequate health care service for mothers is an important reason for the high rates of infant and child mortality (Kabir and Amin, 1993).

Though the infant mortality rates declined significantly over the past few decades in Bangladesh, however, the level is still high. The determinants of infant mortality were also varying from time to

time due to the differences of facilities (Hossain, 2000). It is necessary to examine the predictors of infant morality that helps to identify the segment of population who are experiencing high rate of infant mortality.

The objectives of the study are: to examine the socio-economic, bio-demographic and maternal health care predictors of infant mortality and suggest feasible policies to increase health service and decrease infant mortality in Bangladesh.

MATERIALS AND METHODS

The data for this study were extracted from the Bangladesh Demographic and Health Survey (BDHS) 1999-2000, which is a nationality representative survey, collected the information on various issues including fertility, childhood mortality, family planning, breastfeeding, nutrition, maternal and child health from 10544 ever-married women.

This study considered the births and deaths that occurred during 5 years prior to the survey: the analysis was carried out using all births between November 1994 to October 1999 and all deaths occurred during November 1994 to September 1999. The sample children were then divided into two cohorts: neonatal (deaths within 0-28 days of age) and post neonatal (deaths between 1-11 months of age). The study considered the socio-economic variables-education of mother, education of father, occupation of mother, occupation of father, religion, family size, exposure to mass media, standard of living index and place of residence; bio-demographic variables-breastfeeding status, birth order, sex of child, birth spacing with previous child, mother age at birth of the child, complication during birth and type of birth and maternal health care service utilization variables-timing of first antenatal check during pregnancy, TT during pregnancy, number of antenatal visit during pregnancy and place of delivery.

The study adopted both univariate and multivariable techniques to investigate the predictors of infant mortality of Bangladesh. The association between mortality rate (neonatal and post-neonatal) and the selected variables was examined first by using cross-tabulation analysis. The percent of death was estimated for each of the categories of selected variables, which helps to understand the internal variation of mortality. Though cross tabulation analysis is an important first step in studying the relationship between infant mortality with several characteristics, however, it is difficult to interpret the internal mechanism of infant mortality by using these results only. In order to estimate the independent effects of each variable, while other variables are controlled, the multivariable approach needs to be adopted. The study considered multiple logistic regression model as a method of multivariable analysis, because the dependent variable is dichotomous.

RESULTS AND DISCUSSION

The predictors of infant mortality have been categorically discussed in two sections: Neonatal Morality and Post-neonatal Morality.

Neonatal Mortality

In BDHS 1999-2000, a total of 6686 children were found in neonatal cohort, of which 327 were dead during neonatal period. Among socio-economic variables under study, the variation of neonatal mortality was found significant for education of parents, family size and mother's standard of living index. The results indicate that the neonatal mortality was decreasing with the increasing of mother's education. The health care in the first month of life is very important for new-born child. The educated mother can utilize the existing health facilities and can take the adequate nutritious food among the available food baskets as she might have a significant role in family decision-making process. Therefore, mother's education is one of the most important factors for reducing neonatal mortality and increasing

child survival. A significant variation in neonatal mortality was also found according to education of father. The percent of death was decreasing (from 5.44 to 3.01%) with the increasing level of education of father. An educated father may be more conscious for taking proper care of the new-born baby and his wife during antenatal and post-natal period, which might be helpful for reducing infant mortality (Table 1).

The results indicate that the neonatal mortality was not varying significantly according to the occupation of parents. However, the neonatal mortality was found higher among the children whose mothers were involved in skilled manual work. Children of service-holder mothers have experienced comparatively lower neonatal mortality than others. Though the neonatal mortality was observed high for the children belonging to the non-Muslim religious community, however the variation of mortality was not statistically significant according to the religion. The children belonging to small family sizes (2-4 members) and it decreased to 3.79% for the children of large families (members 8 or more). The low neonatal mortality in large size families may be due to the availability of experienced persons in the family to take care of new born babies. The value of chi-square indicated significant variation on neonatal mortality for family size. The percent of neonatal death was found higher (5.08%) in rural areas than urban areas (4.34%). But the association between place of residence and neonatal mortality was found insignificant.

The variation of neonatal mortality was also examined according to the mother's exposure to mass-media. Mother's exposure to mass-media was measured if she listen radio, watched TV, read newspaper at least once a week. The neonatal mortality was not varying significantly according to the variation of exposure to mass-media. Pandey *et al*. (1998) also found similar result in their studies, however, Gunasekaran (1997) found that neonatal mortality declined considerably when the mother exposed to any mass media and argued that the effective uses of mass media propagate health and family welfare messages will help to reduce mortality. The variation of mortality also examined according to the mother's standard of living index (SLI), which was computed based on few background characteristics. The SLI may consider as an alternative measure of household's socio-economic

Table 1: Distribution of neonatal mortality according to selected variables[†]

Selected variables	No. of children			Percent of death	Chi-square (χ^2)
	Alive	Dead	Total		
Education of mother					
Illiterate	2937 (46.2)	176 (53.8)	3113 (46.6)	5.60	7.36**
Primary	1838 (29.0)	83 (25.4)	1921 (28.7)	4.30	
Secondary and above	1584 (25.0)	68 (20.8)	1652 (24.7)	4.10	
Education of father					
Illiterate	2766 (43.6)	159 (48.6)	2925 (43.8)	5.44	9.33**
Primary	1517 (23.9)	86 (26.3)	1603 (24.0)	5.36	
Secondary	1389 (21.9)	61 (18.7)	1450 (21.7)	4.21	
Higher 10[+]	675 (10.6)	21 (6.4)	696 (10.4)	3.01	
Occupation of mother					
Service	100 (1.6)	5 (1.5)	105 (1.6)	4.76	1.25
Laborer	589 (9.3)	30 (9.2)	619 (9.3)	4.85	
Skilled manual	387 (6.1)	25 (7.6)	412 (6.2)	6.07	
Household work	5252 (83.0)	267 (81.7)	5519 (82.9)	4.84	
Occupation of father					
Service	1803 (28.5)	80 (74.7)	1883 (28.3)	4.25	6.58
Agriculture	1263 (20.0)	59 (18.2)	1322 (19.9)	4.46	
Laborer	2088 (33.0)	128 (39.5)	2216 (33.4)	4.78	
Skilled manual	868 (13.7)	40 (12.3)	908 (13.7)	4.41	
Others	297 (4.7)	17 (5.2)	314 (4.7)	5.41	
Religion					
Muslim	5638 (88.7)	284 (86.9)	5922 (88.6)	4.79	1.08
Non Muslim	721 (11.3)	43 (13.1)	764 (11.4)	5.63	

Table 1: Continued

Selected variables	No. of children			Percent of death	Chi-square (χ^2)
	Alive	Dead	Total		
Family size					
Small 2-4	1578 (24.8)	126 (38.5)	1704 (25.5)	7.39	30.83**
Medium 5-7	2896 (45.5)	123 (37.6)	3019 (45.2)	4.07	
Large 8 and above	1885 (29.6)	78 (23.9)	1963 (29.4)	3.97	
Exposure to mass media					
No	3474 (54.7)	181 (54.4)	3655 (54.7)	4.95	0.06
Yes	2882 (45.3)	146 (44.6)	3028 (45.3)	4.82	
Standard of living index					
Low	2980 (46.9)	174 (53.2)	3154 (47.2)	5.52	10.40**
Medium	2383 (37.5)	122 (37.3)	2505 (37.5)	4.87	
High	996 (15.7)	31 (9.5)	1027 (15.4)	3.02	
Place of Residence					
Urban	1632 (25.7)	74 (22.6)	1706 (25.5)	4.34	1.51
Rural	7427 (74.3)	253 (77.4)	4980 (74.5)	5.08	
Currently working status of mother					
Yes	1126 (17.7)	64 (19.6)	1190 (17.8)	5.38	0.74
No	5231 (82.3)	263 (80.4)	5494 (82.2)	4.79	
Breastfeeding status					
Yes	4550 (71.6)	165 (50.5)	4715 (70.5)	3.50	66.56**
No	1809 (28.4)	162 (49.5)	1971 (29.5)	8.22	
Birth spacing with previous child					
≤15 month	211 (3.3)	26 (8.0)	237 (3.5)	10.97	87.63**
15-30	1270 (20.0)	59 (18.0)	1329 (19.9)	4.44	
30^+	3045 (47.9)	86 (26.3)	3131 (46.8)	2.75	
First birth	1833 (28.8)	156 (47.7)	156 (47.7)	7.84	
Mother age at birth of child					
≤15 years	385 (6.1)	48 (14.7)	433 (6.5)	11.09	55.47**
16-19 years	1553 (24.4)	105 (32.1)	1658 (24.8)	6.33	
20-29 years	3345 (52.6)	130 (39.8)	3475 (52.0)	3.74	
30-36 years	844 (13.3)	36 (11.0)	880 (132.2)	4.09	
37^+ years	232 (3.6)	8 (2.4)	240 (3.6)	3.33	
Birth order					
First	1825 (28.7)	154 (47.1)	1979 (29.6)	7.78	51.70**
2-3	2655 (41.8)	93 (28.4)	2748 (41.1)	3.38	
4^+	1879 (29.5)	80 (24.5)	1959 (29.3)	4.08	
Complication during birth					
No	4114 (69.6)	183 (61.4)	4297 (69.2)	4.26	8.81**
Yes	1801 (30.4)	115 (38.6)	1916 (30.8)	6.00	
Type of birth					
Single	6279 (98.7)	298 (91.1)	6577 (98.4)	4.53	112.3**
Multiple	80 (1.3)	29 (8.9)	109 (1.6)	26.60	
Sex of child					
Male	3261 (51.3)	180 (55.0)	3441 (51.5)	5.23	1.76
Female	3098 (48.8)	147 (45.0)	3245 (48.5)	4.53	
Timing of the first antenatal check					
1-4	810 (12.7)	13 (4.0)	823 (12.3)	1.58	35.02**
4^+	1006 (15.8)	33 (10.1)	1039 (15.5)	3.18	
None	4543 (71.4)	281 (85.9)	4824 (72.2)	5.83	
TT during pregnancy					
Yes	3694 (58.1)	96 (29.4)	3790 (56.7)	2.53	104.6**
No	2665 (41.9)	231 (70.6)	2896 (43.3)	7.89	
Antenatal visit during pregnancy					
1-2	934 (14.7)	32 (9.8)	966 (14.4)	3.31	35.49**
3-4	436 (6.9)	7 (2.1)	443 (6.6)	1.58	
5^+	445 (7.0)	7 (2.1)	452 (6.8)	1.54	
None	4544 (71.5)	281 (85.9)	4825 (72.2)	4.57	
Place of delivery					
Home	5363 (84.3)	269 (82.3)	5632 (84.2)	4.78	1.10
Hospital/clinic	414 (6.5)	23 (7.0)	437 (6.5)	5.26	
Other	582 (9.2)	35 (10.7)	617 (9.2)	5.67	

†: Values within the parenthesis indicate the percent of column, **: Significant at 5% level

condition and was used by some previous authors (Gunasekaran, 1997; Hossain *et al*., 2002) as determinants of infant and child mortality. The computation of SLI is given in Appendix-1. The distribution of neonatal mortality according to mother's SLI indicates that the percent of neonatal death was decreased significantly with increased of mother's SLI (Table 1). The neonatal mortality was found 5.52% for the children belonging to the mother's low SLI and it was found 3.02% for the children whose mothers SLI was high. The findings revealed that the socio-economic status of household had a strong effect of neonatal mortality. The children belongs to high SLI might get more advantage (nutrition and health care) than the children belongs to low SLI. A strong association has been observed between neonatal mortality and mother's standard of living index.

The neonatal mortality was found significantly high (8.22%) for the children whose mothers were not currently breastfeed to their child as compared to those who were currently breastfeed (3.50%). Birth order of the child also found to have significant effect on neonatal mortality. It was found that the neonatal mortality was 7.84% for first birth cohort. The high neonatal mortality for first born children may because such children are more likely to be born to a mother who is biologically, mentally, socially and economically unprepared to bear and bring up a child. In the case of children of higher birth orders, they are likely to be born to mothers who are physically weak and older and also they received very less care as there are more children in the family (Gunasekaran, 1997). Birth spacing with previous child is another demographic characteristics that taken into account in the present study. The neonatal mortality was found to decrease with the increase of birth spacing with previous child. The neonatal mortality rate was obtained highest (10.97%) when the birth spacing with previous child was ≤ 15 months and it was found lowest (2.75%) for birth spacing 30 months or more. Further, a strong association was found between neonatal mortality and birth spacing with previous child. Mother's age at the birth of child was found an influential factor for neonatal mortality in Bangladesh. The study found that mothers belonging to the ages ≤ 15 years had the highest (11.09%) neonatal mortality. The neonatal mortality was found lowest (3.74%) for the children whose mothers' ages were 20-29 years. The high rate of neonatal mortality for the children of youngest mothers may due to their physical immaturity and limited knowledge. On the other hand, high rate of neonatal mortality for the children of mother ages ≥ 30 years may because of the incidence of malnutrition and other complicacy during pregnancy and delivery.

Complication during birth plays dominant role on neonatal mortality. The association between neonatal mortality and complication during birth were found statistically significant. The neonatal mortality was found higher (6.0%) among the children whose mothers had complication during delivery than the children of mothers who had no complication during birth of the child (4.26%). The neonatal mortality was found extremely high (26.6%) for multiple births as compared to single birth (4.53%). It is well known that children of multiple births have much smaller chance of surviving because of low birth-weight and the greater likelihood of complications during delivery (Rutstein, 1983). It is common that male children have higher mortality than female children during neonatal period in south Asian countries (Hossain and Main, 2000; Hossain, 2000). The study found that the variation of mortality was not significant according to the sex of the child, may be because of changing attitude toward female children in recent time.

The distribution of neonatal mortality and timing of the first antenatal check during pregnancy showed that the neonatal mortality was highest (5.83%) among the children whose mother had not received antenatal check during pregnancy and it was lowest (1.58%) among the children whose mothers received first antenatal check during the 1-4 months of pregnancy (Table 1). The association between neonatal mortality and timing of first antenatal check was highly significant. The neonatal mortality was found to decrease significantly with the increase of number of antenatal visit during pregnancy. The neonatal death was decreased to 1.54% for the children of mothers who had more than

four antenatal visits during pregnancy. The distribution of neonatal mortality by TT during pregnancy indicated that the mortality was higher (7.89%) among the children whose mothers did not received TT than the children whose mothers received TT. In case of place of delivery, the variation of neonatal mortality was not found significant, though a slightly higher mortality was observed if the place of delivery is other than home.

Multiple Logistic Regression Analysis

The multivariable analysis considered the covariates that were found significant in cross-tabulation analysis. Inclusion of a large number of covariates in an analysis may create the multicollinarity problem. Keeping this view in mind, a few covariates were not considered in the multiple logistic regression analysis to avoid the problem of serious multicollinarity. These excluded variables were found strongly associated with similar type of other variables and assumed to have a little impact on mortality. In particular, occupation of mother and number of antenatal visit during pregnancy were excluded in multivariable analysis, because of the fact that occupation of father and timing of first antenatal check during pregnancy were included in the analysis.

The estimated coefficients, standard error and odds ratio for neonatal mortality obtained from the multiple logistic regression analysis. Among the variables under study, education of mother, family size, breastfeeding status, mother age at the birth of the child, birth spacing with previous child, complication during birth, type of birth, timing of first antenatal check and TT during pregnancy were found to have significant influence on neonatal mortality. However, education of father, mother's standard of living index and birth order had no significant effect on neonatal mortality (Table 2).

The findings indicate that education of mother had significant influence in reducing neonatal mortality. Children born to mothers having primary education was 27% lower risk of dying during neonatal period then those born to illiterate mothers and children born to mothers having secondary and above education was 32% lower risk of dying during neonatal period than those born to illiterate mothers. These result shows that the risk of neonatal mortality decreased with increased level of mother's education.

The risk of neonatal mortality was found 37 and 45% lower for the children who born in families with medium (5-7) or large (8+) size as compared to small family size (2-4). The children of mothers from medium or high standard of living index have low risk as compared to those of low standard of living. Breastfeeding status found to have significant impact on neonatal mortality. The risk of neonatal mortality was found 78% lower for the children who were currently breastfeeding than the children who were not currently breastfeeding. So, breastfeeding has played significant role in reducing neonatal mortality because proper nutrition of the baby can be maintained by mother's milk only during neonatal period.

Birth spacing with previous child was found to have a significant role in reducing neonatal mortality. The risk of neonatal mortality was found significantly low (79%) if the birth spacing was 30+ months as compared to children with birth spacing less than 15 months. Further 71% less risk of neonatal mortality was observed among children whose birth spacing was 15-30 months as compared to children whose birth spacing was less than 15 months. The risk of neonatal mortality was found 42% lower for the first birth as compared to the children with birth spacing less than 15 months. This may be due to the fact that short birth interval may retard foetal growth resulting in low birth weight and increased death risks due to endogenous causes. Aguirre (1995) investigated that the risk of dying for children born into short birth intervals (less than 2 years after the previous birth) was 1.9 times higher than the risk for children born in long birth intervals (more than 2 years after the previous birth). Hobcraft *et al.* (1985) also found similar result.

Table 2: Multiple logistic regression analysis of neonatal mortality

Variables	β	SE	Odds ratio	95% confidence interval LCI	UCI
Education of mother					
Illiterate[Rc]	-	-	1.00		
Primary	-0.321	0.163	0.73**	0.998481	1.897391
Secondary and above	-0.146	0.221	0.68	1.332637	1.784539
Education of father					
Illiterate[Rc]	-	-	1.00		
Primary	0.009	0.161	1.00	1.383422	1.358743
Secondary	-0.016	0.197	0.98	1.447908	1.494991
Higher 10^{+}	-0.328	0.341	0.72	1.405453	2.708405
Family size					
Small (2-4)[Rc]	-	-	1.00		
Medium (5-7)	-0.469	0.156	0.63**	0.849387	2.170071
Large 8 and above	-0.590	0.179	0.55**	0.787289	2.562133
Standard of living index					
Low[Rc]	-	-	1.00		
Medium	-0.046	0.146	0.96	1.271453	1.393976
High	-0.202	0.265	0.82	1.373552	2.057311
Breastfeeding status					
No[Rc]	-	-	1.00		
Yes	-1.537	0.134	0.22**	0.279610	6.047470
Birth spacing with previous child					
≤15[Rc] months	-	-	1.00		
15-30	-1.224	0.278	0.29**	0.507063	5.864282
30^{+}	-1.583	0.265	0.21**	0.345211	8.185792
First birth	-0.545	0.924	0.58	3.546779	10.549090
Mother age at the birth of child					
≤15[Rc]	-	-	1.00		
16-19	-0.277	0.213	0.76	1.150826	2.002667
20-29	-0.430	0.243	0.65*	1.047368	2.475098
30-35	-0.023	0.323	0.98	1.840579	1.927223
35^{+}	-0.286	0.469	0.75	1.883704	3.337560
Birth order					
First birth[Rc]	-	-	1.00		
2-3	-0.141	0.894	0.87	5.009019	6.640850
4^{+}	-0.157	0.921	0.86	5.197408	7.114678
Type of birth					
Single[Rc]	-	-	1.00	0.181758	16.296010
Multiple	2.248	0.277	9.45**		
Complication during birth					
No[Rc]	-	-	1.00		
Yes	0.368	0.131	1.44**	0.849387	1.867798
Timing of first antenatal check					
None[Rc]	-	-	1.00		
1-4	-0.853	0.331	0.43**	0.815267	4.489584
4^{+}	-0.052	0.220	0.95	1.461115	1.621254
TT during pregnancy					
No[Rc]	-	-	1.00		
Yes	-1.356	0.153	0.26**	0.347803	5.237687

[Rc]: Reference category, **: Significant at 5% level, *: Significant at 10% level

Mother age at birth is regarded as an important bio-demographic characteristic for neonatal mortality. The risk of neonatal mortality was significantly lower among mothers who had given birth at ages 16-19 years as compared to below 15 years. Further, the neonatal mortality risk was found lowest among the children whose mother's age was 20-29 years than children born to mothers aged ≤ 15 years. This result confirms the findings of some other studies where it has been reported that children born to young mothers had a significantly higher risk of neonatal mortality than children born to mothers aged 20-34 years (Hill *et al*., 1996; Mozumder *et al*., 1998). A higher infant death among

children born to young mothers may be due to biological complications, immaturity and babies born under weight. Further a higher risk of infant deaths among old age mothers may be that such mothers usually belong to high order parity and repeated births might weakened them and as a result they became anaemic. Consequently their babies may have lower birth weight and more likely to succumb to infections and illness (Gunasekaran, 1997).

Type of births was found to have highly significant effect on neonatal mortality. Multiple births have 9.45 times more risk of death than those of single birth during neonatal period. The risk of neonatal mortality was significantly higher (1.44 times) for those children who born with complication during birth as compared to children who born without complication.

Timing of first antenatal check during the pregnancy has significant effect on neonatal mortality. About 57% less risk of neonatal mortality was found among the children whose mothers received first antenatal check during 1-4 months of their pregnancy as compared to mothers who had not received any antenatal check. This result confirms the findings of some other studies where it has been reported that birth to mother who did not take antenatal care during the pregnancy had a lower chance of survival as compared to those who took antenatal care during pregnancy (Roy and Jeyachandrann, 1996). The vaccination in terms of TT injection during pregnancy played a significant role in reducing neonatal mortality. The risk of neonatal mortality was found 74% lower for the children whose mother's had received tetanus toxoid vaccination as compared to the children whose mother had not received TT during pregnancy. Similar result was reported by Hossain (2000), Gunasekaran (1997) and Stephenson and Matthews (1998).

Post-Neonatal Mortality

Here, discusses variation of post-neonatal mortality according to the selected variables. The results show that parents' education has a consistent negative relationship with the post-neonatal mortality. The post-neonatal mortality was found to vary significantly according to both father's and mother's education and it was decreasing sharply with the increasing of educational level of mother and father. The distribution of post-neonatal mortality by occupation indicated that parents' occupation had significantly influence on post-neonatal mortality. The post-neonatal mortality was found surprisingly high (6.38%) for the children whose mothers were engaged in service, may be the fact that service-holder mother have not enough time to take care of her child due to her busy work schedule at outside the home. The post-neonatal mortality was found relatively high for the children whose parents were engaged as labourer. The variation of post-neonatal mortality was not significant according to the religion, however, the mortality was observed high for the children belonging to the non-Muslim religious community than Muslims. The impact of family size on post-neonatal mortality was found significant. The post-neonatal mortality was found highest (3.55%) in small (2-4 members) families. The post-neonatal mortality was found to vary significantly according to the mother's SLI. It was observed that the mortality was decreased remarkably with the increase of the living index. Mother exposure to mass media had no significant effect on post-neonatal mortality too. However, the mortality was comparatively low for the children whose mothers had exposure to mass media than for the children whose mothers had no exposure to mass media. The effect of place of residence and currently working status of mother on post-neonatal mortality was found insignificant (Table 3).

Like neonatal mortality, breastfeeding also plays a significant role on post-neonatal mortality. It was found that the post-neonatal mortality was low among the children whose mothers were currently breastfed than the children whose mothers were not currently breastfeeding to their child. The effect of birth spacing with previous child on post-neonatal mortality was found statistically significant and mortality rate was found remarkably high for the children whose birth interval was 15 months or less. A significant variation was observed in post-neonatal mortality according to the mother's age at the

birth of the child. Birth order played a significant role on post-neonatal mortality. The results show that the post-neonatal mortality was high for the children belonged to higher birth order and first birth cohorts. Children of higher birth order are more likely to be born to older mothers and these children may face competition for resource such as food and medical care (Howlader and Bhuiyan, 1999; Rutstein, 1984). It was found that the complication during birth didn't have any affect on post-neonatal mortality; however type of birth had significant influence on post-neonatal mortality like neonatal mortality. The post-neonatal mortality was found abruptly high (15.73%) for multiple births as compared to single birth (2.21%). The difference of post-neonatal mortality by sex of child was not found statistically significant.

In Bangladesh, one of the important reasons for high rate of infant mortality may be due to limited use of maternal health care services. The post-neonatal mortality was found significantly high (2.95%) among the children whose mother did not receive any antenatal care during pregnancy in comparison to the children whose mother received such services (0.98%). The post-neonatal mortality was found almost triple for the children whose mothers didn't receive TT during pregnancy in comparison to those who received it. The association between post-neonatal mortality and number of antenatal visits was found significant and mortality rate was decrease significantly with the increase of number of antenatal visits during pregnancy. The distribution of post-neonatal mortality by place of delivery indicates that the effect of place of delivery was not significant on post-neonatal mortality.

Multiple Logistic Regression Analysis

The result of multiple logistic regression analysis indicates that education of father, family size, occupation of father, breastfeeding status, mother age at the birth of child, type of birth, TT during pregnancy have significant effect on post-neonatal mortality (1-11 months). However, education of mother, standard of living index, birth spacing with previous child, birth order and timing of first antenatal check were found to have insignificant effect on post-neonatal mortality (Table 4).

Table 3: Distribution of post-neonatal mortality according to selected variables†

Selected variables	No. of children			Percent of death	Chi-square (χ^2)
	Alive	Dead	Total		
Education of mother					
Illiterate	2515 (47.0)	78 (58.6)	2593 (47.3)	3.00	14.03**
Primary	1541 (28.8)	41 (30.8)	1582 (28.9)	2.59	
Secondary and above	1293 (24.2)	14 (10.5)	1307 (23.8)	1.07	
Education of father					
Illiterate	2343 (43.9)	81 (60.9)	2424 (44.3)	3.34	21.08**
Primary	1281 (24.0)	31 (23.3)	1312 (24.0)	2.36	
Secondary	1149 (21.5)	18 (13.5)	1167 (21.3)	1.54	
Higher 10^+	566 (10.6)	3 (2.3)	569 (10.4)	0.53	
Occupation of mother					
Service	88 (1.7)	6 (4.5)	94 (1.7)	6.38	8.64**
Laborer	513 (9.6)	17 (12.9)	530 (9.7)	3.21	
Skilled manual	342 (6.4)	6 (4.5)	348 (6.4)	1.72	
Household work	4380 (82.3)	103 (78.0)	4483 (82.2)	2.30	
Occupation of father					
Service	1544 (29.1)	22 (16.5)	1566 (28.7)	1.40	18.89**
Agriculture	1060 (19.9)	23 (17.3)	1083 (19.9)	2.12	
Laborer	1737 (32.7)	63 (47.4)	1800 (33.0)	3.50	
Skilled manual	728 (13.7)	15 (11.3)	743 (13.6)	2.02	
Others	245 (4.6)	10 (7.5)	255 (4.7)	3.92	
Religion					
Muslim	4731 (88.4)	112 (84.2)	4843 (88.3)	2.31	2.26
Non Muslim	618 (11.6)	21 (15.8)	639 (11.7)	3.27	

Table 3: Continued

Selected variables	No. of children			Percent of death	Chi-square (χ^2)
	Alive	Dead	Total		
Family size					
Small 2-4	1359 (25.4)	50 (37.6)	1409 (25.7)	3.55	10.11**
Medium 5-7	2437 (45.6)	50 (37.6)	2487 (45.4)	2.01	
Large 8 and above	1553 (29.0)	33 (24.8)	1586 (28.9)	2.08	
Exposure to mass media					
No	2916 (54.5)	88 (66.2)	3004 (54.8)	2.93	7.08
Yes	2431 (45.5)	45 (33.8)	2476 (45.2)	1.82	
Standard of living index					
Low	2490 (46.6)	80 (60.2)	2570 (46.9)	3.11	12.46**
Medium	2026 (37.9)	44 (33.1)	2070 (37.8)	2.13	
High	833 (15.6)	9 (6.8)	842 (15.4)	1.07	
Place of residence					
Urban	1396 (26.1)	34 (25.6)	1430 (26.1)	2.38	0.019
Rural	3953 (73.9)	99 (74.4)	4052 (73.9)	2.44	
Currently working status of mother					
Yes	990 (18.5)	31 (23.3)	1021 (18.6)	3.04	1.97
No	4357 (81.5)	102 (76.7)	4459 (81.4)	2.29	
Breastfeeding status					
Yes	3537 (66.1)	65 (48.9)	3602 (65.7)	1.80	17.24**
No	1812 (33.9)	68 (51.1)	1880 (34.3)	3.62	
Birth spacing with previous child					
≤15 month	191 (3.6)	8 (6.0)	199 (3.6)	4.02	18.01**
15-30	1077 (20.1)	30 (22.6)	1107 (20.2)	2.71	
30^{+}	2490 (46.6)	53 (39.8)	2543 (46.4)	2.08	
First birth	1591 (29.7)	42 (31.6)	1633 (29.8)	2.57	
Mother age at birth of child					
≤15	347 (6.5)	18 (13.5)	365 (6.7)	4.93	13.24**
16-19	1328 (24.8)	24 (18.0)	1352 (24.7)	1.78	
20-29	2780 (52.0)	68 (51.1)	2848 (52.0)	2.39	
30-36	702 (13.1)	16 (12.0)	718 (13.7)	2.23	
37^{+}	192 (3.6)	7 (5.3)	199 (3.6)	3.52	
Birth order					
First	1583 (29.6)	42 (31.6)	1625 (29.6)	2.58	4.74**
2-3	2163 (40.4)	42 (31.6)	2205 (40.2)	1.90	
4^{+}	1603 (30.0)	49 (36.8)	1652 (30.1)	2.97	
Complication during birth					
No	3415 (69.7)	83 (69.7)	3498 (69.7)	2.37	0.0002
Yes	1485 (30.3)	36 (30.3)	1521 (30.3)	2.37	
Type of birth					
Single	5274 (98.6)	119 (89.5)	5393 (98.4)	2.21	67.6400**
Multiple	75 (1.4)	14 (10.5)	89 (1.6)	15.73	
Sex of child					
Male	2730 (51.0)	71 (53.4)	2801 (51.1)	2.53	0.286
Female	2619 (49.0)	62 (46.6)	2681 (48.9)	2.31	
Timing of the first antenatal check					
1-4	608 (11.4)	6 (4.5)	614 (11.2)	0.98	20.67**
4^{+}	723 (13.5)	5 (3.8)	728 (13.3)	0.69	
None	4018 (75.1)	122 (91.7)	4140 (75.5)	2.95	
TT during pregnancy					
Yes	2798 (52.3)	33 (24.8)	2831 (51.6)	1.17	39.29**
No	2551 (44.7)	100 (75.2)	2651 (48.4)	3.77	
Antenatal visit during pregnancy					
1-2	673 (12.56)	8 (6.0)	681 (12.4)	1.17	20.14**
3-4	322 (6.0)	1 (0.8)	323 (5.9)	0.31	
5^{+}	336 (6.3)	2 (1.5)	338 (6.2)	0.59	
None	418 (75.1)	122 (91.7)	4140 (75.5)	2.95	
Place of delivery					
Home	4462 (83.4)	108 (81.2)	4570 (83.4)	2.36	0.963
Hospital/clinic	332 (6.2)	11 (8.3)	343 (6.3)	3.21	
Other	555 (10.4)	14 (10.5)	569 (10.4)	2.46	

†: Values within the parenthesis indicate the percent of column, **: Significant at 5% level

Table 4: Multiple logistic regression analysis of post-neonatal mortality

Variables	β	SE	Odds ratio	95% confidence interval LCI	95% confidence interval UCI
Education of mother					
Illiterate[Rc]	-	-	1.00		
Primary	0.133	0.217	1.10	1.747734	1.339532
Secondary and above	-0.195	0.379	0.82	1.729513	2.554458
Education of father					
Illiterate[Rc]	-	-	1.00		
Primary	-0.326	0.231	0.72	1.135145	2.178769
Secondary	-0.465	0.311	0.63	1.155531	2.928704
Higher 10^{+}	-1.398	0.696	0.25**	0.966726	15.834010
Family size					
Small (2-4)[Rc]	-	-	1.00		
Medium (5-7)	-0.841	0.234	0.43**	0.682249	3.667976
Large 8 and above	-0.513	0.258	0.60**	0.992707	2.769537
Occupation of father					
Service[Rc]	-	-	1.00		
Agriculture	0.162	0.318	1.18	1.586103	2.193021
Laborer	0.458	0.276	1.58*	1.086498	2.715456
Skilled manual	0.358	0.348	1.43	1.382758	2.829443
Others	0.970	0.405	2.64**	0.838450	5.834567
Standard of living index					
Low[Rc]	-	-	1.00		
Medium	-0.101	0.210	0.90	1.364243	1.669627
High	-0.154	0.418	0.85	1.945035	2.646611
Breastfeeding status					
No[Rc]	-	-	1.00		
Yes	-0.966	0.190	0.38**	0.552335	3.812938
Birth spacing with previous child					
≤15[Rc] months	-	-	1.00		
15-30	-0.399	0.428	0.67	1.552521	3.448295
30^{+}	-0.597	0.410	0.55	1.229491	4.057634
First birth	-6.194	21.367	0.002	3.15E+15	7.55E+20
Mother age at the birth of child					
≤15[Rc]	-	-	1.00		
16-19	-0.974	0.335	0.38**	0.728039	5.106938
20-29	-0.506	0.359	0.60	1.218524	3.352278
30-35	-0.630	0.469	0.53	1.335412	4.707891
35^{+}	-0.135	0.561	0.87	2.623633	3.436866
Birth order					
First birth[Rc]	-	-	1.00		
2-3	-5.963	21.363	0.003	3.93E+15	5.95E+20
4^{+}	-5.812	21.365	0.003	4.59E+15	5.13E+20
Type of birth					
Single[RC]	-	-	1.00		
Multiple	2.308	0.339	10.05**	0.193291	19.539540
Timing of first antenatal check during pregnancy					
None[Rc]	-	-	1.00		
1-4	-0.140	0.461	0.90	2.145902	2.839307
4^{+}	-0.753	0.484	0.47	1.216089	5.482932
TT during pregnancy					
No[Rc]	-	-	1.00		
Yes	-1.079	0.226	0.34**	0.529385	4.581196

[Rc]: Reference category, **: Significant at 5% level, *: Significant at 10% level

Father's educational status is regarded as an important determinant of post-neonatal mortality. The risk of post-neonatal mortality were found 28, 37 and 75% lower for the children whose father's education were primary, secondary and higher 10^{+} (HSC and above), respectively in comparison to the children whose father's had no education. It is clear that the post-neonatal mortality was decreasing remarkably with the increasing of the level of father's education.

Like the neonatal mortality, the risk of post-neonatal mortality was lower (57%) for the households consisting of members (5-7) as compared to households of small family size (2-4 members) and the risk of post-neonatal mortality was found 40% lower for the children of large (8^+ members) families. Occupation of father was found to have significant impact on post-neonatal mortality. The risk of post-neonatal mortality ware found 1.18, 1.58, 1.43 and 2.64 times higher for the children whose father engaged agriculture, labourer, skilled manual and others job respectively as compared to the children whose father engaged in service. This may due to the fact that service-holder father may be educated and may be more aware to the child's health (food, nutrition and immunization). The risk of post-neonatal mortality was 62% lower for the children whose mothers were currently breastfeeding to their children as compared to the children whose mothers were not currently breastfeeding to their children. Aguirre (1995) had found that the length of breastfeeding is one of the most important factors affecting infant mortality. Longer duration of lactation reduces the risk of dying.

Among bio-demographic variables, mother's age at the birth of the child is one of the important characteristics of post-neonatal mortality. The post-neonatal mortality were found 62, 40, 47 and 13% lower for children who were born to mothers aged 16-19, 20-29, 30-35 and 35+, respectively as compared to mother aged ≤15 years. The effect of mother age on post-neonatal mortality was found statistically significant. Type of birth was found to have highly significant effect on post-neonatal mortality. The odds ratio of multiple births was obtained as 10.05, which indicate that children of multiple births was 10.05 times more likely to died during post-neonatal period as compared to single birth. D'Souza (1985) investigated that about 50% of all twin births are died within the first year of life.

TT during pregnancy was found significant effect on post-neonatal mortality. The risk of post-neonatal mortality was 66% lower for the children whose mothers had taken TT injection during the pregnancy. Hossain *et al.* (2002) also found similar result.

CONCLUSIONS

Neonatal and post-neonatal mortality were found moderately high in Bangladesh, varying significantly by a number of characteristics related to socio-economic, bio-demographic and health care facilities. The results suggest that education of parents had been identified the most important socio-economic characteristics - for which infant mortality were varied significantly. Fathers' education played dominant role in reducing the risk of post-neonatal mortality and mothers' education played significant role in reducing the risk of neonatal mortality. Mothers' occupation was found to have significant influence on post-neonatal mortality only; however, fathers' occupation has played significant role in reducing the risk of post-neonatal mortality. The neonatal and post-neonatal mortality was found significantly low for the children who born in medium (5-7 members) and large (8^+ members) sizes family. Though negative relationship had been observed between mother's SLI and infant mortality, however it was found insignificant in multiple logistic regression analysis. There were no significant variation in mortality for the socio-economic variables - religion, mother's exposure to mass media, place of residence and working status of mother.

Among bio-demographic variables, breast-feeding status was found to have significant influence on neonatal and post-neonatal mortality. Further, mother's age at the birth of child and type of birth had significant influence on neonatal and post-neonatal mortality. Birth spacing was found significant for neonatal mortality only and the risk of neonatal mortality was very low if the birth spacing was more than 30 months. There was no significant variation in infant mortality according to sex of the child. The study found that infant mortality were varied significantly by all the variables related to health care facilities except place of delivery. The maternal health care variables like TT during pregnancy was affected the neonatal and post-neonatal mortality; and timing of first antenatal check

during pregnancy was found significant for neonatal mortality. So attention should be given to parent education, birth spacing, mother age and maternal health care factors in order to reduce the risk of infant mortality in a society like Bangladesh.

The findings of the study might be useful for researchers and policy makers to take appropriate strategies to reduce infant mortality as it identified the segment of population where the mortality was high. The existing health care facilities need to be extending and strengthening as the study identified that the infant mortality reduced significantly after availing such facilities. Appropriate measures should be under-taken to ensure that health personnel would be available at health care centers. People should aware about the demerits of treatments by traditional healer using local herb, which is purely unscientific. Mass-media campaign is required for strengthening the awareness of the people about the demerits of early age pregnancy, demerits of consecutive births with short interval, advantages of antenatal cares during pregnancy, advantages of immunization vaccines for mothers and children, beneficial effects of breastfeeding and also maintaining hygienic environments.

Appendix 1: Computation of mother's standard of living index (SLI). In computation of mother's standard of living index (SLI), following variables along with the scores were considered

Variables	Scores
Types of toilet used by mother	Hanging/open = 1
	Septic latrine = 2
	Other (no facility) = 3
Types of wall of the house	Brick/tin = 3
	Rudimentary (wood) = 2
	Natural = 1
	Other = 0
Source of water for the household work	Pipe water = 3
	Tube well/surface = 2
	Pond/river = 1
	Other = 0
Ownership of household goods	Motorcycle/telephone+ TV + bicycle + radio = 4
	TV+bicycle+radio = 3
	Bicycle = 2
	Radio = 1
	None = 0
Standard of Living Index (SLI)	Score Range: 00-13
Categories of SLI	Range
Low SLI	0-5
Medium SLI	6-9
High SLI	10-13

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