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Covariates of Neonatal and Post-Neonatal Mortality in Bangladesh

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Abstract - This paper investigates covariates of neonatal and post-neonatal mortality in Bangladesh. The study uses the data extracted from the 2007 Bangladesh Demographic and Health Survey (BDHS). Multivariate proportional hazards models are employed to study the determinants of neonatal and post-neonatal mortality. The results show that father's education, place of residence, housing materials, number of children under five years of age, and previous death of sibling have significant influence on neonatal mortality. The findings also indicate that mother's education, toilet facility, number of children under five and breastfeeding have significant effect on post-neonatal mortality in Bangladesh.

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Covariates of Neonatal and Post-Neonatal Mortality in Bangladesh

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Abstract - This paper investigates covariates of neonatal and post-neonatal mortality in Bangladesh. The study uses the data extracted from the 2007 Bangladesh Demographic and Health Survey (BDHS). Multivariate proportional hazards models are employed to study the determinants of neonatal and post-neonatal mortality. The results show that father's education, place of residence, housing materials, number of children under five years of age, and previous death of sibling have significant influence on neonatal mortality. The findings also indicate that mother's education, toilet facility, number of children under five and breastfeeding have significant effect on post-neonatal mortality in Bangladesh.

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I. Introduction

Neonatal and post-neonatal mortality are important indicators of social and economic development of a nation. Like most developing countries, Bangladesh experienced a decline in neonatal and post-neonatal mortality rates. BDHS data indicate that neonatal mortality rate in Bangladesh has declined from 57 deaths per 1000 live births in 1993 to 37 births in 2007 and post-neonatal mortality rate has declined from 32 deaths per 1000 live births in 1993 to 15 births in 2007. Though neonatal and post-neonatal mortality rates have been decreased remarkably but they are still very high. It is well established by several studies that there is an inverse relationship between socioeconomic variables of the parents and neonatal and post-neonatal mortality (Muhuri, 1995; Forste, 1994; Doctor, 2004; Machado and Hill, 2005). The risk of deaths of infants is closely associated with their mother's characteristics as well as environment in which they live (Rajna et al., 1998). Father's education, mother's education and their work status each has independent significant influence on neonatal and post-neonatal mortality in developing countries (Sandiford et al., 1995 and Forste, 1994). Caldwell (1979) found that maternal education was the most important determinant of neonatal and post-neonatal mortality in Nigeria. Gaise (1980) found neonatal and post-neonatal mortality differentials among geographical and administrative units and subdivisions of population in tropical Africa.

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Maternal factors, which are biological attributes of birth, such as age of mother at child birth, birth order and the preceding birth interval of an index child have significant influence on neonatal and post-neonatal mortality (Forste, 1994). Past studies show a curvilinear relationship between in the maternal age at birth and neonatal and post-neonatal mortality, high risks having infant mortality at very young and old ages (Bhalotra and Van Soest, 2008; Maitra, 2004). Breastfeeding practices have at least three mechanisms by which breastfeeding contribute to infant health and survival. First, it is nutritious. Second, breast provides immunity to infections. Third, breast milk is clean and hygienic since the substances it includes prevent the growth of bacteria (Cabigon, 1997). The objective of this paper is to identify the factors (proximate determinants, such as demographic factors, environmental factors, nutritional factors and health seeking behavior) which influence neonatal and post-neonatal mortality in Bangladesh by using Mosley and Chen Framework (1984). This framework proposes that socioeconomic factors do not directly influence the outcome variable but rather must operate through proximate determinants to affect neonatal and post-neonatal mortality.

II. Data and Methods

The data analyzed in this study have been derived from the Bangladesh Demographic and Health Survey (BDHS) conducted from March to August 2007. The BDHS, 2007 data comprise a total of 6150 births that occurred 5 years preceding the survey. Multiple births are excluded because they experience a higher risk of death linked with their multiplicity, which could distort the results (Curtis et al., 1993). Births happening during the month of interview are also excluded because their disclosure to neonatal is censored. To avoid the violations of the independence assumption, only the last births are included in the analysis. Therefore, this analysis is limited to singleton births, born 1-59 months before the survey. To include the survival status of the older siblings of the analysis, only women who have at least two births are considered. Finally, we have considered 4003 births, which are about 65 percent of total sample for analyzing neonatal and post-neonatal mortality.

The study uses the framework of Mosley and Chen (1984) with modification based on the limitations and structure of the DHS data. Like the Mosley and

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Chen (1984) framework, the socio-economic variables affect the outcome (Survival Status) through the four proximate determinants namely, demographic factors, environmental factors, nutritional factors and health seeking behavior factors. The variables included in the framework under five broad heads are as follows:

Socioeconomic Variables : Parental education; socioeconomic status; place of residence; region of residence and religion of respondents.

Demographic Factors : Age of the mother at the time of birth; birth order; birth interval; sex of the child; previous sibling death; and number of children under five years of age.

Environmental Contamination : Source of drinking water; toilet facilities; and housing construction material.

Nutritional Factor : Breastfeeding and body mass index.

Health-seeking Behavior : Prenatal care; place of birth; tetanus injection before birth; and contraceptive use.

The present study has employed Cox's proportional hazards model to assess the effects of selected variables on mortality rates. In this study, neonatal and post-neonatal survival time are considered as dependent variables. Age of dead children is calculated by subtracting date of birth of children from the date of death whereas; age of survived children is computed by subtracting date of birth from date of interview. Numbers of children who are surviving at the time of interview are considered as censored cases because their true duration of surviving could not be followed till death as the survey is retrospective. To evaluate the impact of covariates on different rates of mortality, proportional hazard models are employed to the data separately.

III. Results and Discussion

a) Covariates of Neonatal Mortality

Chi-square is used to study the association of independent variables under different broad heads with neonatal mortality. Except religion of the respondents, sex of child, parity, body mass index of mothers, drinking water, toilet facility, and prenatal care, all other variables have shown significant association with neonatal mortality. To examine the effect of explanatory variables on neonatal deaths, five models are fitted to the data considering all the explanatory variables found significant in bivariate analysis. Model-1 is employed to evaluate the effects of socioeconomic variables. After including environmental factors with socioeconomic variables, model-2 is fitted. Again with environmental and socioeconomic factors adding demographic variables, model-3 has been fitted. Finally, including all factors considered in the study framework, model-4 is fitted to the data. As revealed by log likelihood ratios and the associated chi-squares, all the models are found to be statistically significant.

Table 1 presents the proportional hazard estimates of relative risk of selected factors on neonatal mortality of model-1 through model-4. The results of model-1, which includes all socioeconomic variables show that father's education with secondary and above level has an inverse significant effect on neonatal mortality. The hazard of neonatal mortality of babies whose fathers have secondary and higher levels of education is about 60 percent lower as compared to babies whose fathers have no education.

Rural-urban differentials of vital events are pronounced in Bangladesh due to marked variations of opportunities and resources among the citizens. The findings of the hazard analysis of this study show higher neonatal mortality for babies born to the residents of rural areas as compared to those born to residents of urban areas. It shows that relative risk of neonatal mortality for children in rural area is almost 53 percent higher than those in urban areas. It is observed from the results of model-2 that father's education with secondary background and place of residence are still maintaining its significance. Housing material, as an environmental factor has been found to be a significant covariate in influencing neonatal mortality. Improved household environmental conditions play a major role in the decline of childhood mortality. Table 1 shows that babies born to mothers living in houses constructed with tin have 4 folds more likelihood of neonatal mortality than babies born to mothers living in cement constructed houses. It also shows that the risk of neonatal mortality is 3.07 times higher among children whose mothers are living in other low quality materials built houses compared to babies of mothers who are living in houses constructed with cement.

It has been observed from model-3 that fathers with secondary and above level of education, place of residence, and housing materials have their dominance in affecting neonatal mortality. Babies born to mothers within the interval of 25-48 months have 64 percent lower risk of neonatal mortality than those born within 24 months of a previous child.

The results also show that the hazard of neonatal mortality of babies born within the interval of 49 months and above is 40 percent lower as compared to babies born within 2 years. The findings are consistent with those of previous studies. Short preceding birth intervals are associated with an increased risk of dying in the neonatal period and at 1-6 months of age, and to a much lesser extent at 7-23 months of age (Boerma and Bicego, 1992).

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Table 1 : Cox's proportional hazard estimates of relative risk of selected factors on neonatal mortality, BDHS, 2007

Factors	Independent variables	Model-1	Model-2	Model-3	Model-4
Socioeconomic	**Maternal Education**				
	No education	1.000	1.000	1.000	1.000
	Primary	0.892	0.835	0.877	0.782
	Secondary and above	0.814	0.769	0.774	0.772
	Father's Education				
	No education	1.000	1.000	1.000	1.000
	Primary	0.903	0.894	0.882	0.901
	Secondary and above	0.391***	0.370***	0.406***	0.378**
	Socioeconomic Status				
	Lower	1.000	1.000	1.000	1.000
	Medium	0.976	0.987	1.041	1.064
	Higher	0.872	0.892	0.992	0.996
	Place of Residence				
	Urban	1.000	1.000	1.000	1.000
	Rural	1.526*	1.688*	1.679**	1.609*
	Region of Residence				
	Barisal	1.000	1.000	1.000	1.000
	Chittagong	0.909	0.902	0.763	0.676
	Dhaka	0.795	0.747	0.731	0.692
	Khulna	0.559	0.636	0.728	0.701
	Rajshahi	1.341	1.366	1.396	1.324
	Sylhet	1.590	1.747	1.290	1.036
Environmental	**Housing material**				
	Cement		1.000	1.000	1.000
	Tin		4.000***	3.575***	3.566***
	Others		3.071**	2.802**	2.763**
Demographic	**Preceding birth Interval (in months)**				
	≤24			1.000	1.000
	25-48			0.363***	0.345***
	49 & above			0.600**	0.596**
	Children under five				
	1			1.000	1.000
	2 and above			1.429***	2.430***
	Mother's age (in years)				
	15-19			1.000	1.000
	20-34			0.713	0.717
	35-49			0.689	0.699
	Previous death of sibling				
	No				
	Yes			1.000	1.000
				1.348**	1.697**

Table 1 : contd.

Factors	Independent variables	Model-1	Model-2	Model-3	Model-4
Health care	**Contraceptive Use**				
	0=No				1.000
	1=Yes				0.608**
	Place of Delivery				
	1=Home				1.000
	2=Hospital /other places				0.874
	Tetanus injection before birth				
	0=No				1.000
	1=Yes				0.781
	-2 log likelihood	1694.47	1684.22	1622.30	1613.44

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	Chi-square	28.875	37.18	114.80	127.29
	DF	12	14	20	23
	Significance	0.004	0.003	0.000	0.003

Note: *** p ‹0.01; ** p ‹0.05; * p ‹0.10.

In a longitudinal study in Bangladesh, Koenig et al. (1990) showed that the effects of short preceding birth intervals were limited to the neonatal period. Retherford et al. (1989) observed an association between short birth intervals (less than 2 years) and increased mortality, even after controlling for other demographic and socioeconomic variables.

More number of children under five years of age of a mother is significantly associated with short birth intervals among children. Hobcraft et al. (1985) showed that short birth intervals increase mortality risks among children. The odds ratios of this study show that babies born to mothers who have more than one children under five years of age have 1.43 times higher risk of neonatal mortality as compared to babies whose mothers have only index child.

Findings of model-3 in Table 1 show that babies born to mothers who experienced previous child death have about 35 percent higher risk as compared to babies of mothers who never experienced a child death earlier. The influence of the survival status of the preceding child on the mortality risk of the index child has been explained in terms of the existence or lack of sibling competition for maternal attention and household resources (Koenig et al., 1990). Das Gupta (1990) found that the probability of a child's death was significantly increased if the child has siblings who died in childhood. She argued that the women who had experienced multiple child deaths were also often less resourceful and differed in use of basic child health care. However, Guo (1993) argued that a family's environment is likely to remain same throughout the time when all children are born and raised.

Model-4 is fitted to investigate the effect of all variables including broad heads of health care, socioeconomic, demographic and environmental factors. It is observed from the results of model-4 of the Table 1 that father's education with secondary and higher background, rural residence, preceding birth interval, number of children under five years of age, previous death of siblings and housing materials still hold their significant role accordingly in the variations of neonatal mortality in Bangladesh.

Contraceptive use may play an important role in reducing neonatal mortality by lengthening duration of birth intervals. The hazard analysis of this study shows that children born to mothers who have ever used contraceptives have lower chances of neonatal mortality compared to babies of mothers who never used any contraceptive methods. The hazard of neonatal mortality of babies of mothers of ever users is about 39 percent lower relative to babies of mothers who are never users.

b) Covariates of Post-Neonatal Mortality

Attempts have been made to investigate the effects of covariates on post-neonatal mortality by employing five proportional hazards models. Table 2 presents proportional hazard estimates of relative risk of selected factors on post-neonatal mortality of model-1 through model-5. Educated mothers are expected to experience lower post-neonatal mortality than illiterate mothers. Education improves the ability to deal with new ideas, and to accept the concepts that appear contrary to common sense. Schooling may lessen reliance on the opinions of elders, giving educated family members the freedom to follow a more independent course in efforts to improve their well-being. Table 2 reveals that secondary and above educated mother have 61 percent lower likelihood of post-neonatal mortality compared to their illiterate counterparts. It is observed from the results of model-2 that mothers with at least secondary level of education play a vital role in bringing down the post-neonatal mortality.

Toilet facility as one of the important environmental factors shows significant effect on post-neonatal mortality. To avoid intestinal infectious diseases and parasitosis, hygienic removal of faeces is important for good health of mothers and child survival (Sixl et al., 1988). Children whose families have no toilet facilities have 4.44 times more likelihood of post-neonatal mortality relative to children residing in houses with flush system.

Proportional hazard model-3 is constructed to investigate the effect of demographic, socioeconomic and environmental factors on post-neonatalmortality in Bangladesh. It can be noted from the Table 2 that the influence of previous birth interval on post-neonatal mortality is significant and follows the same pattern as observed in the case of neonatal mortality.

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Table 2 : Cox's proportional hazard estimates of relative risk of selected factors on post-neonatal mortality, BDHS, 2007

Factors	Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5
Socioeconomic	**Maternal Education**					
	No education	1.000	1.000	1.000	1.000	1.000
	Primary	0.672	0.839	0.846	0.857	0.816
	Secondary & above	0.391**	0.547*	0.537*	0.522*	0.519*
	Father's Education					
	No education	1.000	1.000	1.000	1.000	1.000
	Primary	0.972	0.960	0.978	0.982	0.989
	Secondary & above	0.820	0.849	0.942	0.945	0.941
	Place of Residence					
	Urban	1.000	1.000	1.000	1.000	1.000
	Rural	1.353	1.137	1.019	1.125	1.125
	Region of Residence					
	Barisal	1.000	1.000	1.000	1.000	1.000
	Chittagong	0.688	0.592	0.539	0.466	0.464
	Dhaka	0.644	0.607	0.627	0.598	0.615
	Khulna	0.735	0.701	0.830	0.821	0.819
	Rajshahi	0.465	0.412	0.461	0.480	0.465
	Sylhet	1.812*	1.911*	1.709	1.297	1.288
Environmental	**Drinking Water**					
	River/Pond/Unprotected		1.000	1.000	1.000	1.000
	Tubewell/Pipe		0.510	0.503	0.568	0.561
	Toilet Facility					
	Flush		1.000	1.000	1.000	1.000
	Pit/Hanging toilet		1.637	1.758	1.796	1.805
	No facility		4.441**	4.598**	4.414***	4.365**
	Housing Material					
	Cement		1.000	1.000	1.000	1.000
	Tin		1.023	1.038	1.045	1.027
	Others		1.057	1.066	1.087	1.059
Demographic	**Preceding Birth Interval (in months)**					
	≤24			1.000	1.000	1.000
	25-48			0.391***	0.361***	0.365***
	49 & above			0.503**	0.465**	0.471**
	Children Under Five					
	1			1.000	1.000	1.000
	2 & above			1.815**	1.715*	1.615*
	Previous Death Of Sibling					
	No					
	Yes			1.000	1.000	1.000
				1.606**	1.585	1.506
	Mother's Age (in years)					
	15-19			1.000	1.000	1.000
	20-34			0.908	0.947	0.969
	35-49			1.223	1.298	1.258

Table 2 : contd.

Factors	Independent Variables	Model-1	Model-2	Model-3	Model-4	Model-5
Health care	**Contraceptive Use**					
	0=No				1.000	1.000
	1=Yes				0.438***	0.426***
	Tetanus Injection before Birth					
	0=No				1.000	1.000
	1=Yes				0.962	0.973

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Nutritional	**Body Mass Index**					
	≤18.5					1.000
	18.51-24.99					0.923
	25 and above					1.018
	Breastfeeding					
	0=No					1.000
	1=Yes					0.227**
	-2 log likelihood	952.02	937.59	909.78	901.86	899.17
	Chi-square	37.06	55.60	91.24	105.90	111.66
	DF	10	15	21	23	26
	Significance	.000	.000	.000	.000	.000

Note: *** p ‹0.01; ** p ‹0.05; * p ‹0.10.

The hazard of post-neonatal mortality of children born within the birth interval of 25-48 months is 64 percent lower mortality as compared to the babies born within 24 months. Babies born within 4 or more years have about 53 percent lower chances of post-neonatal mortality than children born within 2 years. The U-shaped pattern of previous birth interval and post-neonatal mortality is observed in developing countries. It has been observed that children born within an interval of less than 2 years experienced higher mortality risks during infancy than those born in an interval of two or more years (Winikoff, 1983).

More number of children under five years of age of a mother may increase risk of post-neonatal mortality. The proportional hazard co-efficients show that babies born to mothers who have more than one child under five years of age have about 82 percent higher risk of post-neonatal mortality as compared to children whose mothers have only index child.

The chance of post-neonatal mortality is 1.61 times higher of mothers who have experienced a preceding child death compared to babies of mothers who did not experience a sibling death earlier. The index children whose next older siblings died when they were born have significantly higher risk of post-neonatal mortality than those whose next older siblings survived, because of genetic characteristics, environmental conditions, family behavior and child care practices that affect both children (Zenger, 1993).

Like neonatal mortality, the effect of contraceptive use is found significant in reducing post-neonatal mortality. The results of model-4 indicate that babies born to mothers who have ever used contraceptives have lower likelihood of post-neonatal mortality as compared to babies of mothers who never used contraceptives. The risk of post-neonatal mortality of babies of contraceptive ever users is 56 percent lower relative to their non-user counterparts.

Hazards model-5 is fitted to the data to investigate the effect of all factors considered in the analysis including breastfeeding and body mass index on post-neonatal mortality. The hazard analysis shows a significant negative effect of breastfeeding on post-neonatal mortality. Breastfed children have lower likelihood of post-neonatal mortality compared to children who are not breastfed. The hazard of post-neonatal mortality is found 77 percent lower among the babies who are breastfed than their counterparts. Earlier studies have also documented positive effects of breastfeeding on infants' health (Da Vanzo et al., 1983; Goldberg et al., 1984; Millman, 1985). Van Ginneken (1974) showed that prolonged lactation induced longer postpartum amenorrhea, increasing the likelihood of longer intervals between births. Early cessation of breastfeeding may expose the child to greater risks of illness from contaminated water and food in conditions where proper substitutes of food are scarce (Manda, 1999).

IV. Conclusion

The multivariate proportional hazards models employed in this study show that father's education, place of residence, housing materials, number of children under-five years of age, and previous death of sibling have significant influence on neonatal mortality. The findings also reveal that mother's education, toilet facility, number of children under five, and breastfeeding have significant effect on post-neonatal mortality. Furthermore, contraceptive use and preceding birth interval have highly significant influence on neonatal and post-neonatal mortality. The findings of this analysis do not fully support the hypothesis that socioeconomic factors affect neonatal and post-neonatal mortality only through the proximate determinants as proposed in the framework. However, it has been observed that socioeconomic factors have both their independent and indirect effect in reducing neonatal and post-neonatal mortality in Bangladesh. Moreover, the findings reveal that the proximate determinants have stronger impact on neonatal and post-neonatal mortality than that of the socioeconomic factors.

Hence, on the basis of the results, it can be suggested that the rise in parental education, ensure more civic facilities in vast rural areas, persuasion of mothers for full breastfeeding practices and improvements in the quality of water supply may be important steps to be taken to reduce infant mortality in Bangladesh. The findings also show that neonatal and post-neonatal mortality can significantly be reduced if the interval between births be expanded more than two

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years. Thus, neonatal and post-neonatal mortality in Bangladesh can be reduced by motivating couples to use modern effective contraceptive methods for spacing purpose.

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