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Impact of Some Biosocial Variables on Infant and Child Mortality

Introduction

THE infant and child mortality in Bangladesh is one of the highest in developing world. Under five mortality rate in Bangladesh is 13 3 per 1000 and infant mortality rate is 87 per 1000 live birth in the early 1990's. Variations in infant and child mortality rates of developing countries have been attributed both to reproductive characteristics of the mother and to environmental risk factors. Changes in reproductive patterns can influences child health and survival through a number of different factors, notably, through changes in maternal age at birth, birth interval and breast-feeding, and survival status of previous child. Very few studies have taken these factors into account. Most studies, although varying extensively in geographical settings, analytical approach and data quality—have reported a positive and consistent relationship of breast-feeding and child survival, but determination of the magnitude of the effects of breast-feeding is complex (Cleland and Sathar, 1984; Hobcraft *etal*., 1985; Palloni and Millman, 1986; Majumder, 1991). Child spacing and breast-feeding are closely related;
breast-feeding delays the next conception by delaying the return of ovulation. Thus improvement of child health may partly depend on breast feeding through its contribution to longer birth spacing. The duration of breast feeding may be truncated by an early death and thus, in the absence of contraception, the next conception is likely to occur more rapidly than if breast feeding had continued. Early cessation of breast feeding may also occur due to short pregnancy interval and result in an inadequate care of youngest child.

Koenig *et al*. (1990) studied the relationship between birth intervals and childhood mortality using data from Matlab, a rural area of Bangladesh where the impact of short birth intervals on mortality is substantially less than that found in some previous studies and discussed in terms of the potential for family planning programs to contribute to improved child survival. Majumder (1991) using 1975 Bangladesh Fertility Survey data found that preceding birth

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interval, subsequent pregnancy and breast-feeding duration each have an independent influence on early mortality risk. Alam (1995) using data from Matlab, a rural area of Bangladesh examined the effects of birth interval on childhood mortality and found that the high mortality risks of closely spaced children are due to sibling competition for parental resources. Both breast feeding and mortality are influenced by mother's education level and social factors at the community level (Akisit and Akisit, 1989).

In this article, further evidence is presented on the effects ofbio-social variables on infant and child mortality based on the analysis of a new data set of Bangladesh Demographic and Health Survey 1993-94 and compare the infant, second year of life and childhood mortality to ascertain similarities and differences between them employing Cox's proportional hazard model.

Materials and Methods

Data from 1993-94 Bangladesh Demographic and Health Survey were used in this analysis. The 1993-94 BDHS employed a nationally representative two-stage sample. The sample was selected from the frame of the Integrated Multipurpose Master Sample, newly created by the Bangladesh Bureau of Statistics on the basis of 1991 census data. The BDHS has two basic questionnaires, i.e., a household questionnaire which recorded information on all household members, and an individual questionnaire which recorded detailed information on eligible women who were identified from the household questionnaire. The individual questionnaire collected information on the respondent's background characteristics, reproductive history, knowledge and practice of family planning, breast feeding practices, marriage, fertility preferences, as well as husband's background characteristics. A total of 9,681 households were selected from which 9,640 eligible women of age 10-49 were successfully interviewed during November 17, 1993 to March 12,1994.
This study is based on the data extracted from 9640 individual respondent's background characteristics and birth history data where each child is the unit of analysis. In this file a total of 32,590 births and 6043 deaths has been observed. The index birth considered in the present study is any birth that occurred during the period 1989-93 and there are 7045 births and 723 deaths during this period. There are 96 infant death, 89 death in the age group 12-23 and 583 death in the age group 24-59.
The conceptual framework ofMosley and Chen (1984) has an important influence in the study of infant and child survival. It identifies five groups of proximate determinants of child health, such as, factors related to mother (age, parity, birth interval); environmental contamination; nutrient deficiency; injury and personal illness control. It is posited that all these are influenced by socio-economic determinants. This framework crystallises the implicit assumption in the literature that variation in mortality between households within a given community is explained by differential in socio-economic factors such as education, occupation, income and wealth. The operational framework include a wide range of bio-social determinants of infant and child mortality, such as, maternal age at birth of the index child, maternal education, birth order, sex of the child, previous birth interval, next pregnancy interval, breast

feeding and residence etc., which appeared to have influenced the mortality at 5% level and even at the 10% level of chi-square distribution.

A question may arise about the accuracy of information in terms of reporting of birth history and thus birth intervals, particularly in the distant past. But primary and secondary report of 1993-94 DHS data show that genuine fertility fluctuations related to the liberation war and famine, that occurred 20-25 years ago are reflected in the data. This indicates that the quality of birth history data is good. Since death truncates breast feeding an artificial association between breast feeding duration and mortality will always exist. The data on breast-feeding were collected only for the last three births which reduces the sample size to 4991 for multivariate analysis. This information is likely to improve the overall accuracy of the reported duration of breast-feeding because there is less likelihood of recall bias. Even so there is a slight evidence of number preference with peaks at 12,24 and 36 months, otherwise it is good.

The previous birth refers to the birth immediately preceding the index birth. Survival status of the immediately preceding child has been coded as' 1' if the child alive and '0' if the child died. Preceding birth interval was used as a continuous variable. The subsequent pregnancy interval was grouped into < 9 and 9+ months to include whether or not the mother conceived before the index child reached 9 months of age and whether the mother's early conception is detrimental to the child's survival at age 12-23, 24-59 months. This interval (the interval between the index child's birth and pregnancy following the index birth) was obtained by subtracting 9 months from the date of birth of the immediately following birth of the index child. The analysis included mother's age at birth in two categories: (20-29) years and otherwise, birth order of the child was coded as less than 5 and 5+, maternal education as no-education, primary education and secondary and above. All these variables are likely to be related to mortality. Unadjusted rates of infant, second year and early childhood mortality were first examined to determine trends within the categories of each of the explanatory variables.

The dependent variable is the survival times of the children during infancy, second year of life and early childhood. Since many children have not completed the event at the date of survey these observations were considered as censored. Cox's proportional hazard model is appropriate for the analysis of data that includes censored observations. The model is given by

$$h(t,z)=h_{0,}(t)e^{bz}$$

where $h_0\{t\}$ is the base line hazard function and $\beta/ = (\beta_1,\beta_2,\ldots\beta_p)$. Method of Partial likelihood for estimation of parameter and generalizedWilcoxontes^generally used for test of goodness of fit. In this context we had used a proportional hazarcfmodel withfixed covariates. The hazards function enables one to estimate the relative risks of each variable by exponentiatmg the regression coefficients $\exp(\beta)$. For the variable which was coded as dummy, each exponent of the coefficients $\exp(\beta)$ represents the effect of the covariate on the hazard function for the reference group. The category with the relative risk 1.00 represents the reference category for the categorical variables. Value greater than one indicates that the relative risk of dying is greater for this group compared with the reference group while value less than one indicates a decrease in risk of dying the child.

Results

Table 1 presents number of exposed children and mortality rates for infant, age groups 12-23 month and early childhood (24-59 months) according to the selected explanatory variables for the last five years period of the survey. Children breast-fed for less than 11 months had

TABLE 1: MORTALITY RATES PER 1000 EXPOSED CHILDREN BY SELECTED CHARACTERISTICS FOR BANGLADESH 1989-93

Variables	*Population* n (%)	*No. of deaths (and mortality rate)*		
		Infant	*12-23*	*24-59*
Breast Feeding				
duration* (months)				
<11	1426(28.6)	32(22)	45(32)	169(119)
11+	3565(71.4)	27(8)	17(5)	105(29)
Preceding Child				
at age 1 year**				
Alive	4446(83.7)	49(11)	42(9)	296(67)
Dead	867(16.3)	14(16)	11(13)	109(126)
Preceding birth interval				
(months)**				
<24	1129(21.3)	12(11)	15(13)	177(157)
24-35	1734(31.6)	19(11)	20(12)	140(81)
36+	2450(46.1)	32(13)	18(7)	88(36)
Next Pregnancy interval				
(months)				
<9	2660(37.8)	96(36)	77(3)	146(55)
9+	4385(62.2)	0	12(3)	392(89)
Maternal age at birth				
(years)				
< 19 years	1944(27.6)	35(18)	34(17)	177(91)
20 - 29 *{Ret)*	3860(54.8)	53(14)	37(10)	257(67)
30 +	1241(17.6)	8(6)	18(15)	104(84)
Maternal Education				
None	4057(57.6)	63(16)	56(14)	361(89)
Primary	1976(28.0)	23(12)	23(12)	131(66)
Secondary +	1012(14.4)	10(10)	10(10)	46(45)
Birth order				
1	1732(24.6)	33(19)	36(21)	133(77)
2-4	3555(50.9)	47(13)	31(9)	242(68)
5+	1758(25.0)	16(9)	22(13)	163(93)
Sex of the child				
Male	3588(50.9)	50(14)	46(13)	284(79)
Female	3457(49.1)	46(13)	43(12)	254(73)
PI ace of Residence				
Urban	932(13.2)	8(9)	12(13)	51(55)
Rural	6113(86.8)	88(14)	77(13)	48(80)

Note: *For the last child. **0mits first order births.

considerably higher mortality rates than those breast-fed at least 11 months. Children whose immediately preceding sibling was alive at exact age 1 year had lower mortality rates than when the preceding sibling died in infancy. Children born with longer preceding birth interval had a lower mortality rate than those born with a shorter birth interval. Children bom with short next pregnancy interval had higher mortality rates than the longer interval. Children whose mothers had no formal education, and those bom to mothers aged below 19 and above age 30 had the higher mortality rate, this is reversed in case of infants whose mother's were of ages above 30. Mortality rate was higher among males compared to female children. Children in birth order one and above four, those who were bom in rural area had the highest rate of mortality, however, this survival advantage is reversed in case of infant with birth order 2-4. The rates of mortality was higher in rural area compared to urban area during infancy and early childhood, however, found to be equal during second year of life.

Multivariate Analysis

For the multivariate analysis, four different main effects models have been fitted successively. Model-1 considers breast-feeding duration and maternal factors (such as, maternal age at birth, maternal education, birth order, sex of child, and the place of residence). Model-IV considers survival status of preceding child at age one year, in addition to the variables in model-I. Model-11 includes next pregnancy interval and excludes breast-feeding duration in model-I. Finally model-Ill includes all the variables under consideration. The logic behind taking four models is to assess the relative importance of each of the biological variables on infant and child mortality in the presence of social variables. Three age ranges of child were used: the risk of dying in the first year of life, second year of life and early childhood. The modeling strategy used for each age range to identity the significant changes in trend due to the inclusion of birth interval and breast feeding, moreover, first bom children are at higher risk of dying because of younger maternal age and they are unlikely to compete with older siblings. The result for each model and each age range are shown in Tables 2, 3,4.

Infant Mortality

Table 2 presents results for mortality risk of infants. In model-I (included first birth), duration of breast feeding was associated with a significantly lower risk of mortality. Mother's secondary education was associated with reduced risk of mortality but not significantly so, while primary education was significant at 5% level, but not have the expected sign. Although birth order, mother's age at birth, next pregnancy interval, sex of the child and place residence all generally had negative coefficients but not significant. In model II, only previous birth interval was significant and decline risk of mortality with a unit increase in previous birth interval. None of the other variables are significant predictor of mortality, although, had expected sign, only exception was maternal education which was neither significant nor had expected sign. In model III (all the variables), being a mother under 20 and above 30 having 5th and higher order birth and having short preceding interval less than 9 month who had shorter duration of breast feeding was associated with higher risk of mortality. In model IV, here also breast feeding was the only significant factor associated with reduced risk of mortality. Secondary education of mother showed decline in infant mortality. All the four models showed that a male child who had a preceding sibling died before age one year, bom in the rural area was associated with higher risk of mortality. Maternal age at birth and birth order for model I and IV neither significant nor had expected sign.

TABLE 2: ESTIMATED REGRESSION COEFFICIENTS AND STANDARD ERROR OF INFANT MORTALITY FOR PROPORTIONAL HAZARD MODEL ANALYSIS ON SOME SELECTED CHARACTERISTICS (DHS 93-94)

(N=4920)

Variables	*Model I*	*Model II*	*Model 111*	*Model IV*
Breast Feeding duration (months)	-.0987*** (.0148)		-.0147*** (.0166)	-.0725*** (.0142)
Preceding Child at age 1 year				
Alive (Ref)				
Dead		-.1259 (.1923)	-.1437 (.1925)	-.1102 (.1920)
Preceding birth interval (months)		-.0156* (.0093)	-.0149 (.0094)	-.0101 (.0090)
Next Pregnancy interval (months)				
<9 (Ref)				
9+ .		-6.3683 (26.6217)	-6.2456 (35.6062)	
Maternal age at birth				
(20-29)years(Ref)				
Otherwise	-.0719 (.1480)	.0362 (.1908)	.0153 (.1909)	-.0414 (.1903)
Maternal Education				
None (Ref)	-	-	-	-
Primary	. 4480** (.2250)	.3396 (.2554)	.3613 (.2556)	.2920 (.2561)
Secondary+	-.0683 (.2681)	.0211 (.3040)	.0208 (.3028)	-.0185 (.3023)
Birth order				
<5 (Ref	-	-	-	-
5+	-.0168 (.1575)	.0147 (.1652)	.0134 (.1649)	-.0234 (.1658)
Sex of the child				
Male (Ref)	-	-	-	-
Female	-.1111 (.1371)	-.0874 (.1548)	-.0874 (.1546)	-.0562 (.1546)
Place of Residence				
Urban (Ref)	-	-	-	-
Rural	.2478 (.2617)	.1566 (.2652)	.1533 (.2644)	.1191 (.1546)
-2LogL	830.474	567.212	596.618	641.649

Note: *p < .10; ** P < .05; ***p <.0001. SE in the parenthesis.

Table 3 presents results for mortality risk of child of age 12-23 months. In model-I (include first birth) breast feeding was the only significant variable that affects mortality. In model II, III and IV(includes second and higher birth) next pregnancy interval and duration of breast feeding were found to be significant predictor of mortality. Unlike infant, mortality of female

TABLE 3: ESTIMATED REGRESSION COEFFICIENTS AND STANDARD ERROR OF CHILD (12-23 MONTHS) MORTALITY FOR PROPORTIONAL HAZARD MODEL ANALYSIS ON SOME SELECTED CHARACTERISTICS

DHS 93-94. *(N=3752)*

Variables	*Model I*	*Model II*	*Model III*	*Model IV*
Breast Feeding duration	-.1484***		-.1080***	-.1244***
(months)	(.0133)		(.0177)	(.0145)
Preceding Child at age 1 year				
Alive (Ref)		-	-	-
Dead		.1382	.2319	.2152
		(.2265)	(.2264)	(.2255)
Preceding birth interval		-.0086	-.0053	-.0015
(months)		(.0094)	(.0093)	(.0089)
Next Pregnancy interval (months)				
< 9 (Ref)		-	-	
9 +		-1.799***	-1.323***	
		(.2417)	(.2459)	
Maternal age at birth				
(20-29) years (Ref)	-	-	-	-
Otherwise	-.0018	.1862	.1180	.0128
	(.1314)	(.1763)	(.1768)	(.1750)
Maternal Education				
None (Ref)	-	-	-	-
Primary	-.0702	.0096	.1122	-.1114
	(.1900)	(.2265)	(.2292)	(.2290)
Secondary +	-.0688	-.1237	-.2251	-.1772
	(.2091)	(.2690)	(.2708)	(.2790)
Birth order				
<5 (Ref)	-	-	-	-
5+	.0024	.2198	.1157	.1303
	(.1442)	(.1587)	(.1620)	(.1614)
Sex of the child				
Male (Ref)	-	-	-	-
Female	-.0198	.0928	.0059	.0868
	(.1284)	(.1558)	(.1587)	(.1557)
Place of Residence				
Urban (Ref)	-	-	-	-
Rural	-.0348	-.0939	-.1371	-.1483
	(.1915)	(.2226)	(.2228)	(.2242)
-2LogL	737.616	550.661	497.084	543.661

Note: * p <. 10; ** p < .05; ***p <.0001. SE in the parenthesis.

child is higher than the male child at ages 12-23, although in model I which includes first birth showed female child had lower mortality than male child. Children born in the rural area had lower mortality than the children bom in the urban area. Children born to the mother's age under 20 and over 30 and of birth order above four had higher risk of dying compared to the other child. Maternal education although not significant had expected sign except the primary education in model II and III.

Early Childhood

In Table 4, model II (second and higher order birth) fifth and higher order birth showed significantly higher risk of mortality than the lower order index child. None of the other variables were found to be significant. In model IV breast feeding, survival status of the immediately preceding child and sex of the index child were significantly associated with reduced risk of early childhood mortality. Model III (all variables) showed no significant improvement than model IV. Like children of ages 12-23, early childhood mortality of female child was higher than the male child. Rural children were generally associated with higher risk of mortality than the urban children, except in model I. Maternal secondary and higher education was associated with reduced risk of mortality in model I, III and IV and primary education in model III and IV were associated with lower risk of mortality. Birth order did not had expected sign except in model II. Breast feeding was the highly significant variable and associated with reduced risk of mortality in all models.
Breast-feeding is likely to interact on mortality with several socio-economic and environmental factors. The positive influence of breast-feeding was found to be more pronounced among children of mothers with no education than children of educated mothers in Peru (Palloni and Tienda, 1986). In Malaysia breast-feeding was more strongly related to infant survival in families without adequate facilities of drinking water and toilet sanitation. The negative influence of early cessation of breast-feeding was found to be more severe among infants of mothers with less or no education than infants of mother with higher education in Egypt (Janowitz *et al.*, 1981). But this study did not consider interaction effects.

Discussion and Conclusion

The estimates for all the age groups show that the risk of dying decreases with increasing duration of breast feeding. The early cessation of breast feeding results in a considerably higher risk of dying for child even when the influences of a number of factors on mortality including birth intervals are controlled statistically. Breast feeding appeared to be a prime factor influencing infant, second year and early childhood. It was such a crucial determinant that its influence override the next pregnancy interval and preceding birth interval, the two repeatedly discussed factors explaining infant and child mortality differentials to a large extent This analysis suggests that the effect of preceding interval on mortality is not significant in the presence of breast feeding and next pregnancy interval although have expected sign. The effect of next pregnancy interval appeared to be one of the prime factor influencing mortality at ages 12-23 months. During infancy and early childhood this variable is not significant although it maintains the decreasing trend of mortality when pregnancy interval is greater than 9 months.

TABLE 4: ESTIMATED REGRESSION COEFFICIENTS AND STANDARD ERROR OF CHILD (24-59 MONTHS) MORTALITY FOR PROPORTIONAL HAZARD MODEL ANALYSIS ON SOME SELECTED CHARACTERISTICS

BDHS 93-94. (N=2606)

Variables	*Model I*	*Model II*	*Model III*	*Model IV*
Breast Feeding duration	-.1076***		-.1052***	-.1046
(months)	(.0042)		(.0047)	(.0047)
Preceding Child at age 1 year				
Alive (Ref)				
Dead		-.0861	-.2367***	-.2335***
		(.0830)	(.0831)	(.0830)
Preceding birth interval		-.0229	-.0082	.0012
(months)		(.0058)	(.0055)	(.0055)
Next Pregnancy interval (months)				
< 9 (Ref)				
9+		-.5434	-.0589	
		(.0758)	(.0791)	
Matemal age at birth	.			
(20-29) years (Ref)				
Otherwise	.0120	-.0241	-.0227	-.0185
	(.0039)	(.0776)	(.0809)	(.0806)
Maternal Education				
None(Ref)				
Primary	.0643	.0258	-.0537	-.0405
	(.0992)	(.1212)	(.1252)	(.1240)
Secondary +	-.1085	.0917	-.1815	-.1863
	(.1092)	(.1339)	(.1409)	(.1407)
Birth order				
<5 (Ref)				
5+	-.1109	.1689**	-.0590	-.0569
	(.0678)	(.0714)	(.0735)	(.0735)
Sex of the child				
Male (Ret)				
Female	.1106*	.0850	.1345*	.1293**
	(.0633)	(.0695)	(.0734)	(.0731)
Place of Residence				
Urban (Ref)				.0663
Rural	-.0165	.0708	.0641	
	(.1048)	(.1185)	(.1243)	(.1244)
-2LogL 2757.371		2730.166	2330.245	2030.896

*Note:*p<AO;**p<.05;***p<.OOOl.* SE in the parenthesis.

Both preceding and subsequent pregnancy intervals are likely to effect breast feeding. The birth of the index child within a short period of the preceding sibling may have an adverse influence on mother's health and this in turn is likely to lead to a shorter duration of breast feeding for the index child than if the index child were bom after a long interval. A pregnancy close to the birth of the index child may also lead to a shorter duration of breast feeding for the index child is likely to be affected more by subsequent interval than the preceding birth interval. A child whose mother conceives shortly after its birth may be subject to cessation of breast feeding or erratic breast feeding due to the mother becoming pregnant again. The adverse effects associated with the early cessation of breast feeding during the early months of life are higher in some early stage of child (Majumder, 1991). The earlier cessation of breast feeding may increase the child's susceptibility to illness and death in a particular age interval. This analysis suggests that preceding birth interval, next pregnancy interval and breast feeding each has its own influence on early age mortality risk.

Another additional finding of interest from Table 2, Table 3 and Table 4 concerns the effect of the fate of the previous child. The death of the preceding sibling appeared to confer a insignificantly positive effect on mortality during second year of life, however, insignificantly negative impact on the survival chances of the index child during infancy and significantly negative impact on early childhood. Plausible explanations first center on the absence of a competitor for scarce familial resource and/or a means for the cross-transmission of infection, second, the errors in reported age at death might have produced such a result. Although a similar result was found by Koenig *et al*. (1990).

This study found that during infancy and early childhood (24-59 months) mortality in rural area is higher but during second year of life urban child mortality is higher, compared to the rural area. The higher infant mortality rates in the rural compared to urban areas of developing countries have been attributed to the greater availability of health care services, higher income and educational levels in urban areas. Nevertheless, in urban areas of some developing countries where there is over-crowding and poverty through migration into cities from rural areas, infant mortality rates are excessively high (Aksit and Aksit, 1989; Bagenholm and Nasher, 1989;Thavere/o/., 1990).

Children born to women under the age of 20 have higher mortality risk than those bom to women aged 35 and over in general have higher mortality risks than those bom to women aged 20-34. The differences by mother's age are not very large, though mortality decline was uniformly fastest for the women aged 20-34.

Differential effect of education variable gives puzzling result. The probable reason for the inconsistent effect of maternal education on infant and child mortality is first because of methodological, second there is a possibility ofsocioeconomic differential of recall lapse of birth reporting. It may be such that uneducated women who experience higher infant and child mortality are more likely to under report these children in the birth history. This possibility can only be single-out by doing a diagnostic study of birth history reporting.

Finally, breast feeding the child more than one year, spacing pregnancies more than 2 years and averting births over birth order three to four appear to have greatest potential for reducing infant and childhood mortality.

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