Determinants of Infant and Child Mortality in Rural Bangladesh

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Contents

Abstract

This paper examines the trends and covariates of infant and child mortality in rural areas of Bangladesh. Data on a cohort of 21,268 children born during 1983-1991 in three rural Project sites were obtained from the longitudinal Sample Registration System (SRS) of the MCH-FP Extension Project (Rural) of the International Centre for Diarrhoeal Disease Research, Bangladesh.

The analysis follows the model specified in the extended analysis of the Bangladesh Demographic and Health Survey 1993-94 and is divided into three components: neonatal mortality, post-neonatal mortality, and mortality between 12 and 23 months. Estimates of mortality differentials by socio-demographic characteristics were derived using a life-table technique. Multivariate logistic regression procedures were applied separately to include fixed and temporal characteristics of the cohort.

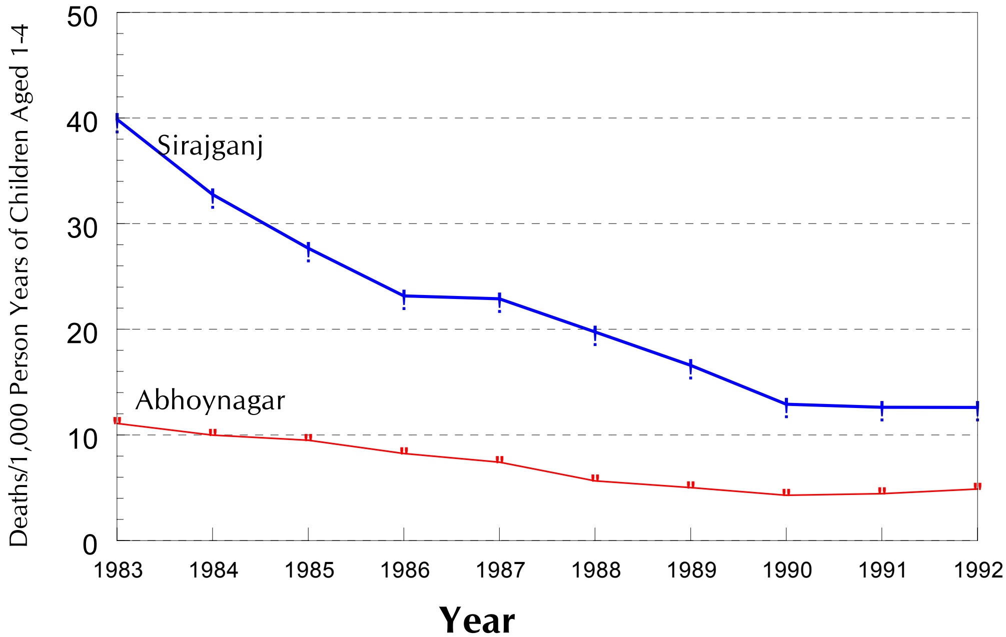
Mortality estimates were compared with those of the national-level extended analysis. Childhood mortality has been declining in the MCH-FP Extension Project areas since 1983, as it has been nationally. Reductions in the rates of mortality among infants and children aged less than five years were less pronounced at the Extension Project sites than it was in the national study.

The findings of the study confirm the findings of other research which show that longer preceding birth intervals play a significant role in reducing child mortality. Of course, provision of primary healthcare services is as well associated with reduced risk. The data from the SRS in the MCH-FP Extension Project sites suggest that there is a significant relationship between childhood immunization and reduced child mortality. Access to tubewell water was also associated with a reduced risk of mortality for young children. These findings have strong policy implications. Goals and objectives of the family planning programme and those of the EPI do not compete, rather they complement each other. Each of them plays a unique role in improving child survival.

Introduction

Data of the 1993-94 Bangladesh Demographic and Health Survey (BDHS) and data collected through demographic surveillance at Matlab, Abhoynagar, and Sirajganj of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) show that child mortality has recently declined significantly in Bangladesh. The Sample Registration System (SRS) of the MCH-FP Extension Project of the ICDDR,B recorded 172 and 142 infant deaths per 1,000 live-births in 1984 at its project sites in Sirajganj and Abhoynagar respectively [1]. By 1992, the infant mortality rate (IMR) had fallen to 135 and 100 at Sirajganj and Jessore respectively. In 1983, the age-specific mortality rate at Sirajgonj was 40 per 1,000 among children aged 1-4 years; this rate dropped to 18 by 1992. In 1983, the age-specific mortality rate for children aged 1-4 years was 11 at Abhoynagar, and dropped still further to five in 1992 (Fig. 1).

Fig.1. Three-year moving average of child mortality rate by area, 1983-1992



Note: Single-year rates are reported for the beginning and the ending years
Source: SRS, MCH-FP Extension Project (Rural)

The Demographic Surveillance System maintained by the ICDDR,B at Matlab has reported a decrease in infant mortality since the inception of its maternal and child health and family planning (MCH-FP) programme in 1977, when the IMR was 114 per 1,000 live-births. By 1992, the IMR had declined to 51 in the treatment area and to 79 in the comparison area. A sharp decline was also observed in the age-specific mortality rates for children aged 1-4 years at Matlab [2] from 23 in 1984 to 7 in 1995 in the treatment area, and from 39 in 1984 to 8 in 1995 in the comparison area. All data sources indicate that the reduction in child mortality has been greater than that in infant mortality.

Using a weighted least squares methodology and data from various sources at the national level, Hill [3] found that the probability of an infant dying by the age of one year appears to have fluctuated around 150 per 1,000 live-births in the mid-1970s [4], and then declined steadily to the early 1990s. By the early 1990s, the IMR had fallen to about 80 per 1,000 live- births [3]. The probability of dying by the age of five years fluctuated between 230 and 250 per 1,000 live-births from the late 1950s through the mid-1970s and stabilized around 120 in the early 1990s. Thus, the reduction in child mortality was similar to that in infant mortality from the mid-1970s to the early 1990s [5].

Rationale for the Study

The rapid decline occurring in infant and child mortality since the mid-1980s raise a number of interesting questions. These questions include: What were the specific health interventions instrumental in reducing child mortality? Were changes in social conditions, such as maternal education levels, of central importance? Was the reduction in child mortality largely driven by changes in fertility? The answers to these questions will be of obvious importance to the design and implementation of health programme in Bangladesh over the next decade [6-7].

The contraceptive prevalence rate (CPR) in Bangladesh rose from 19 percent in 1983 to 45 percent in 1993-1994. This may have contributed to an increased birth interval and the reduced average family size, thus improving the chance of survival of children aged less than five years [8].

Important social changes are also underway which may affect the survival status of young children. The percentage of ever-married women ever having attended school has increased over time. About 42 percent of the ever-married women had ever attended a school in 1993-1994. The corresponding figure in 1983 was 31 percent. Now, at least 17 percent of all rural households have access to electricity, and almost all households (92.3%) use tubewell or piped water for drinking purposes. Environmental factors have also improved. Use of sanitary facilities has increased. As of 1993-1994, 36 percent of the rural households were using either a modern toilet, slab, or pit latrine.

To identify the factors that contributed most to the decline in mortality of children aged less than five years, a broad-based study is required, involving two types of analyses: (i) a long-term analysis based on fixed characteristics, and (ii) a short-term analysis based on both temporal and fixed characteristics to assess the impact of immunization, family planning programme, and socioeconomic development on child health and survivorship. It should be pointed out, however, that some "fixed" characteristics do actually change over time.

Data from the surveillance system of the MCH-FP Extension Project, ICDDR,B have been used for the analysis. The national-level cross-sectional BDHS survey supplements these data, as a point of comparison for analyzing the effects of various factors on child health and survivorship.

Both analyses deal with the contemporary time period. However, the 1993-94 BDHS does not have data on immunization of children who died prior to the interview. This shortcoming in the Extended Analysis of BDHS 1993-1994 was handled by creating an instrumental variable. Whereas SRS data set contain information for children on DPT, irrespective of their survival status. So, the present study is expected to complement the national study.

The ICDDR,B's surveillance system provides information on the use of health services, including the contraceptive use and health-seeking behaviour of the parents, parental education, and exact dates of birth and death of children. Information on sources of drinking water and health services was obtained from the cross-sectional survey. Inclusion of this information permited us to compare the national-level BDHS findings with the longitudinal data obtained from the SRS of the MCH-FP Extension Project.

Although data from the MCH-FP Extension Project are generally regarded as high quality, they do not truly represent the nation, because of the strongly influential nature of the project over time. Despite this fact, it is worthwhile to undertake a study of child mortality, using data from both project and national levels. This approach will allow us to closely examine the similarities and differences between the findings based on these two data sets.

Objectives

The primary objective of the study is to examine the factors associated with changes in infant and child mortality and to investigate the role of family planning, the Expanded Programme on Immunization (EPI), environmental conditions and health service use on child mortality. The paper compared the findings of the study with those of the national study on infant and child mortality based on the 1993-94 BDHS data set.

Data and Settings

Data for this study include demographic and other relevant information about 14,100 children born between 1983 and 1991 at the three sites of the MCH-FP Extension Project of the ICDDR,B. The MCH-FP Extension Project (Rural) was responsible for the development of, and currently operates the SRS. This surveillance system consists of a longitudinal database which represents the responses of married women of reproductive age (MWRA) to interviews held at a 90-day interval, from a sample of approximately 10,000 rural households. The three project sites are: Abhoynagar in Khulna division (since 1983), Sirajganj in Rajshahi division (since 1983), and Mirsarai in Chittagong division (since 1994). Information collected during these interviews includes: (i) the respondent's background characteristics, (ii) childbearing history, (iii) sex, birth date, and survival status of the index child, (iv) date of death, prenatal care, and immunization status of children, (v) contraceptive use dynamics of mothers, and (iv) use of outreach health and family planning services. Data on possession of consumer durables and capital goods in the household, sources of safe water for drinking and distance from service-delivery points are available from cross-sectional surveys conducted in the project areas, which can be linked to the individuals in the longitudinal surveillance system.

Similarities and differences between the SRS and the 1993-94 BDHS are as follows:

Similarities

- Both SRS and BDHS samples consist of birth histories of about 10,000 married women of reproductive age (MWRA).

- Variables common to both the data sources include birth and death dates of children, and several socio-demographic variables, such as education and occupation of mothers and fathers, and birth attendant.

Differences

- SRS is a longitudinal database, whereas the 1993-94 BDHS is a cross-sectional database. Dates of birth and death are likely to be of higher quality in a longitudinal database.
- The SRS database contains information on the immunization status of children, irrespective of their survival status at the time of analysis, whereas the 1993-94 BDHS does not have any information on immunization status of the children who died prior to the interview.
- BDHS births date back 25 years from the time of the survey, whereas the SRS births cover a time span of about 14 years.

Methodology and analysis

The following were taken into consideration when constructing a workfile from the above-noted information to be used in analyzing the factors associated with changes in child mortality:

- The analysis followed the model of Ken Hill *et al*. for the extended analysis of the 1993-94 BDHS [3].

- Singleton live-birth is the unit of analysis (Index Child). Information on the use of health services was obtained from the cross-sectional surveys conducted at intervals during the study period. To reflect the current situation, births that occurred after 1989 have been included for the current factor analysis (multivariate analysis).

- Survival status of these children was followed up to the 59th month or December 1996, whichever came first.

- Life-table techniques and multivariate logistic regression procedures have been used for analyzing the levels of and trends in infant and child mortality and the factors associated with those levels and trends.

Data limitations

Serious analytical problems were associated with incorporating many of these types of variables into models of child survival. One such problem is contemporaneity, i.e. information on sources of drinking water refers to the time of the survey, but not necessarily to the exposure time of the children unless only recent information was used. A second problem is of endogeneity, e.g. health-seeking behaviour and health status may be causally linked to either direction, meaning that there may be a bias in the direction of the relationships observed. Third, information on immunization has only been available since 1990. Therefore, only births which have occurred since 1990 were considered in the short-term analysis.

Results

Differentials in child mortality

Table 1 shows the child mortality differentials. A life-table technique was used for calculating the mortality estimates for three subsequent landmarks for childhood: neonate (0-28 days); infant (birth-1 year); and under-five (birth-59 months). The study period was divided into segments (1983-1986 and 1988-1991), thus, separating the effect of time in the analysis. Children born in 1987 were dropped to avoid an overlap between the earlier and later periods. The figures in **bold** indicate a decline in any of the individual categories equal to or greater than the overall decline in the study cohort.

For the Extension Project as a whole, the neonatal mortality rate (NNMR) and the IMR fell by 15 and 20 percent respectively. The decline in the under-five mortality rate (U5MR) is more pronounced than that in the NNMR or the IMR (27 percent). Compared to the BDHS data, the estimates derived in this study show a less-pronounced decrease with regard to the NNMR and the IMR. The results were, however, similar in case of the U5MR.

Table 1. Differentials and trends in childhood mortality in the MCH-FP Extension Project (Rural): 1983-1986,1988-1991

Variable	Category	Neonatal mortality rate			Infant mortality rate			Under-5 mortality rate		
		1983-1986	1988-1991	% decline	1983-1986	1988-1991	% decline	1983-1986	1988-1991	% decline
Total	**MCH-FP Extn. Project**	**77.8**	**66.4**	**15**	**133.7**	**107.4**	**20**	**186.7**	**136.4**	**27**
Mothers' education	No schooling	80.3	67.3	**16**	141.2	111.0	**21**	202.0	142.5	**29**
	1-5 years	73.3	71.1	3	120.3	112.3	7	154.2	139.6	9
	6+ years	65.5	48.0	**27**	95.1	67.0	**30**	117.6	82.4	**30**
Fathers' education	No schooling	86.5	70.9	**18**	148.2	118.0	20	215.2	152.8	**29**
	1-5 years	66.0	64.8	2	127.2	101.0	**21**	175.6	125.2	**29**
	6+ years	62.9	53.9	14	97.7	78.2	20	124.6	95.6	23
Fathers' occupation*	Agriculture	75.4	67.5	10	129.1	103.7	20	173.3	133.2	23
	Unskilled labourer	87.5	64.3	**27**	149.4	106.6	**29**	219.0	135.5	**38**
	Semi-skilled	71.0	71.9	-1	128.7	118.6	8	193.4	150.2	22
	Professional	56.4	50.7	10	94.4	61.9	**34**	94.4	83.2	12
	Business	81.2	55.3	**32**	133.4	102.1	**23**	160.8	115.7	**28**
Birth order	First	103.9	97.5	6	173.1	148.6	14	219.4	170.0	23
	2-4	71.8	50.9	**29**	114.5	86.3	**25**	163.2	113.4	**31**
	5+	68.6	61.6	10	134.6	102.0	**24**	198.2	142.7	**28**
Preceding birth interval	<2 years	91.9	86.5	6	152.3	147.9	3	200.8	182.8	9
	2 years	58.8	42.8	**27**	110.3	77.3	**30**	169.7	112.8	**34**
	3 years	60.6	49.6	**18**	110.5	85.0	**23**	172.1	113.3	**34**
	4+ years	76.4	46.1	**40**	123.5	69.7	**44**	168.1	97.6	**42**
Mothers' age at time of birth	<20 years	109.0	97.7	10	182.4	149.3	18	232.6	166.0	**29**
	20-34 years	67.4	55.4	**18**	114.5	93.1	19	166.8	124.5	25
	35+ years	71.7	64.5	10	142.3	102.1	**28**	203.8	139.8	**31**

Continued..

Table 1. *(Contd.)*

Variable	Category	Neonatal mortality rate			Infant mortality rate			Under-5 mortality rate		
		1983-1986	1988-1991	% decline	1983-1986	1988-1991	% decline	1983-1986	1988-1991	% decline
Usual source of drinking water	Tubewell	71.9	60.9	15	121.1	99.7	18	172.2	128.4	25
	Other**	89.9	79.5	12	140.8	98.2	**30**	210.4	163.7	22
Travel time to health servi-ces ***	1 (best)	80.4	61.6	**23**	130.2	100.0	**23**	169.6	122.9	**28**
	2	43.1	49.3	-14	121.7	88.3	**27**	149.3	106.0	**29**
	3	73.2	63.5	13	114.7	103.1	10	174.9	133.2	24
	4	68.5	55.6	**19**	122.6	91.4	**25**	164.8	122.9	25
	5	74.0	69.5	6	124.3	101.3	19	167.6	114.9	**31**
	6 (worst)	74.0	59.8	**19**	122.3	101.2	17	183.5	144.4	21
Project sites	Sirajganj (Rajshahi)	89.0	79.5	11	148.2	135.0	9	218.5	180.5	17
	Abhoynagar (Khulna)	60.1	55.3	8	110.9	84.2	**24**	137.1	101.8	26

*** Father's occupation:**

Agriculture = Farmer, absentee farmer

Unskilled labour = Agricultural daily labourer, non-agricultural daily labourer, boatman, fisherman, beggar, student, dependant, house worker, permanent servant, unemployed, disabled, other types of worker.

Semi-skilled = Mill worker, factory worker, skilled labourer, small trader.

Professional = Service person, professional.

Business = Business

**** Usual source of drinking water:**

Other = Well, pond, river, canal, ditch

***** Codes for travel time to health services:**

1. Travel time to H&FWC <16 minutes and to THC <61 minutes
2. Travel time to H&FWC <16 minutes and to THC >60 minutes
3. Travel time to H&FWC 16-30 minutes and to THC <61 minutes
4. Travel time to H&FWC 16-30 minutes and to THC >60 minutes
5. Travel time to H&FWC >30 minutes and to THC <61 minutes
6. Travel time to H&FWC >30 minutes and to THC >60 minutes

Education

Child mortality varied by parental educational level in all three age ranges. However, even among the non-educated mothers, the NNMR, IMR, and U5MR declined by 16, 21, and 29 percent respectively. The NNMR, IMR and U5MR among the children born to women with six or more years of schooling declined by 27, 30, and 30 percent respectively. The IMR was 141 in 1983-1986 if a woman had no education. This rate was 32 percent lower if the woman had six or more years of education.

Father's education showed a consistently negative relationship to the child mortality levels throughout the study period. The NNMR was 87 when the father had no education, and only 63 if the father had six or more years of education during the 1983-1986 period. In case of IMR, the differential was larger (148 vs. 98).

The IMR was 148 if a father had no education compared to 97 when a father had six or more years of schooling. The U5MR showed a similar pattern with regard to the level of paternal education. This was true during both 1983-1986 and 1988-1991 periods. However, all three measures of child mortality decreased by one-sixth to one-third from the earlier to the later period, even when a father had no schooling. This decline was less pronounced when a father had six or more years of education.

Father's occupation

Among the various occupations, children born to unskilled labourers had the highest NNMR, IMR, and U5MR during the earlier period. At the same time, this group had the highest decline in the U5MR and the second highest decline in the NNMR and IMR. All three measures of mortality dropped by one quarter to one-third in the business families. Also, the IMR declined by 34 percent among the children who lived in the households parented by one or more professionals.

Reproductive dynamics

During the neonatal and infant periods, first births had the highest mortality risk. Second to fourth births had the lowest mortality risk. The rate of mortality decline for both the time periods was more than one quarter for second to fourth births and lowest for birth order of one.

Mortality risk for all three age ranges was higher for an Index Child who was preceded by an older sibling with a birth interval of less than two years. However, the rate of mortality decline was over 40 percent for the Index Children preceded by a birth with an interval of four years or more. This was the highest decline among the four preceding birth-interval categories.

Children born to mothers aged less than 20 years had a higher mortality risk than those born to mothers aged 20-34 years. Also, in all three age ranges, the mortality rates of children born to mothers aged 35 years and over were higher than those born to mothers aged 20-39 years. The rate of the NNMR decline over the entire period was higher for children born to mothers aged 20-34 years. The decline in the U5MR was over 25 percent across the three maternal age groups.

Usual source of drinking water

This variable was selected from the cross-sectional survey conducted in the project areas. In all age ranges, mortality risk was lower among the children living in the households supplied with drinking water from tubewells. The rates of decline were 15, 18 and 25 percent for the NNMR, IMR, and U5MR respectively.

Travel time to health services

Distance has been used as a proxy for access to health services. Households were categorized by the distance, measured in travel time, to a Health and Family Welfare Centre (H&FWC) and to a Thana Health Complex (THC). The H&FWCs and THCs used in the study existed throughout the study period, i.e. from 1983 to 1996. Mortality risk did not vary systematically at different levels of access to health services. Surprisingly, the best and the worst access categories showed the highest mortality risk during the neonate and infant stages of childhood. If the best category is ignored, mortality risks decline monotonically as access to health services improves. Children living 15 to 30 minutes away from an H&FWC, but within one hour's travel distance of a THC had the highest decline in the IMR and the second highest decline in the U5MR (27 and 29 percent, respectively) over the 1983-1996 period.

Project sites

The two project sites (Sirajganj and Abhoynagar) are located in two divisions of the country, Rajshahi and Khulna respectively. Information collected from these sites, each located in a separate division of the country, help depict the actual range of mortality which, in the aggregate, are not dissimilar to that of the nation as a whole. Sirajganj had the highest NNMR, IMR, and U5MR in both 1983-86 and 1990-91 periods, and has experienced only an 11 percent decline in the NNMR, while Abhoynagar had a 24 and 26 percent decline respectively, in the IMR and the U5MR. Both the project sites indeed showed an overall decline in all three child mortality indicators during the study period.

Multivariate analysis of child mortality

We carried out two types of analysis: one long-term analysis with fixed (permanent) characteristics, and the second one with both permanent and recent characteristics. Variables have been identified as two types: permanent characteristics of child, and characteristics that change over time. The permanent characteristic variables include the educational level of parents and reproductive factors, such as maternal age, birth order, and birth interval. Since these characteristics do not change over time, a multivariate analysis over a long time-frame was appropriate. Characteristics that change over time include access to and use of health services and environmental factors, such as access to safe drinking water.

Analysis with fixed (permanent) characteristics

The results of the multivariate logistic regression showed the effects of socio-demographic, temporal and programmatic factors on infant and child mortality (Table 2). Education of the mothers and fathers, reproductive dynamics, specifically mothers' age at birth, birth order of the Index Child and the log of the length of the birth interval preceding the child's birth are bracketed under permanent characteristics. In cases of first birth, preceding birth interval was set equal to the average length of birth intervals across the whole data set. Estimates were computed for the risk of dying during the six age ranges: (i) the first month of life, (ii) between 1 and 11 months, (iii) between 12 and 23 months, (iv) between 24 and 35 months, (v) between 36 and 47 months, and (vi) between 48 and 59 months. A time variable was determined by dividing the children into two groups: those born during 1983-1986 and those born during 1988-91.

In Model 1, only the time variable was included. In Model 2, the education variables (whether a mother had 1-5 years of schooling, or six or more years of schooling; and whether a husband had 1-5 years of schooling, or six or more years of schooling) were introduced, along with the time variable. In Model 3, the time variables were introduced with the reproductive dynamics variables. The time, education and reproductive dynamics variables were all included in Model 4. Table 2 presents each model's results for each of the 6-year age ranges of children.

Neonatal mortality risk

In each model, there was a significant decline in the NNMR over time from 1983 to 1991. Fathers' education was significantly associated with a reduced risk of neonatal mortality in Model 2 and to a lesser extent in Model 4. In Model 3, which includes the three reproductive dynamics variables along with the time variable, neonatal mortality risk was significantly higher for children born to mothers aged 20 years or younger. First births also demonstrated a significantly higher risk of neonatal mortality than birth orders of two to four. Longer preceding birth intervals were significantly associated with a reduced risk of neonatal mortality. In Model 4, the time variable, father's having six years of schooling, and the log of the preceding birth interval again showed a significant negative effect on neonatal mortality, while the first-born children and children born to mothers aged 20 years or younger again showed a significantly higher risk of neonatal death in the Extension Project sites.

Table 2. Logistic regression co-efficients of socio-demographic and fixed factors associated with child mortality levels in MCH-FP Extension Project (Rural) by infant and child age ranges: 1983-1986 to 1988-1991

	Neonatal mortality				Post-neonatal mortality			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Year 1988-1991 (RC^=1983-86)	-.1726**	-.1718**	-.1722**	-.1708**	-.3842***	-.3781***	-.3607***	-.3586***
Mothers' schooling (RC: none)								
1-5 years	-	.0912	-	.0274	-	-.0126	-	-.0424
6+ years	-	-.1287	-	-.2516	-	-.3680	-	-.4188
Fathers' schooling (RC: none)								
1-5 years	-	-.2147**	-	-.1863*	-	-.1225	-	-.1045
6+ years	-	-.3254**	-	-.2425*	-	-.5709***	-	-.5093***
Maternal age (years) (RC: 20-34)								
LE-20	-	-	.3331***	.3169**	-	-	.3129**	.2897*
35+	-	-	.2004	.1856	-	-	.1684	.1352
Birth order (RC: 2-4)								
First birth	-	-	.3973***	.4109***	-	-	.4226***	.4470***
Birth order 5+	-	-	.0559	.0394	-	-	.3551***	.3243**
Log (Preceding birth interval)	-	-	-.3724***	-.3562***	-	-	-.4365***	-.4119***
Constant	-2.4966	-2.3986	-1.4359	-1.3881	-2.7173	-2.5718	-1.5261	-1.4572
- 2 log L	6523	6506	6445	6430	4880	4845	4825	4794
Chi-square	6.17	23.2	83.8	98.8	21.2	55.8	76.5	107.4
Df	1	5	6	10	1	5	6	10
(No.)	(12762)	(12762)	(12762)	(12762)	(11807)	(11807)	(11807)	(11807)

^RC = Reference category

Contd...

* p≤ .05; **p≤ .01; ***p ≤ .001

Table 2. ***(contd.)***

	Mortality 12-23 months				Mortality 24-35 Months			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Year 1988-1991 (RC^=1983-86)	-.7115***	-.6943***	-.6514***	-.6449***	-.9658***	-.9409***	-.9140***	-.9021***
Mothers' schooling (RC: none)								
1-5 years	-	-.0743	-	-.0049	-	-.5963*	-	-.5488*
6+ years	-	-.5422	-	-.3878	-	-.5164	-	-.4070
Fathers' schooling (RC: none)								
1-5 years	-	-.6107***	-	-.6169***	-	-.1291	-	-.1320
6+ years	-	-.7457**	-	-.7573**	-	-.6313*	-	-.6309*
Maternal age (years) (RC: 20-34)								
LE-20	-	-	.1727	.1406	-	-	.0198	.0134
35+	-	-	-.0176	-.0448	-	-	.2248	.1742
Birth order (RC: 2-4)								
First birth	-	-	-.1838	-.1552	-	-	-.2750	-.2448
Birth order 5+	-	-	.5358**	.4977**	-	-	.1807	.1265
Log (Preceding birth interval)	-	-	-.1839	-.1483	-	-	-.2733	-.2373
Constant	-3.6728	-3.3910	-3.2400	-3.0793	-3.8612	-3.6130	-2.9657	-2.8314
- 2 log L	1996	1969	1981	1957	1540	1520	1533	1515
Chi-square	22.8	50.3	38.3	62.5	29.0	49.6	36.8	54.7
Df	1	5	6	10	1	5	6	10
(No.)	(10683)	(10683)	(10683)	(10683)	(10110)	(10110)	(10110)	(10110)

^RC = Reference category

Contd..

* p $\leq$ .05; ** p $\leq$ .01; *** p $\leq$ .001

Table 2. ***(contd,)***

	Mortality 36-47 months				Mortality 48-59 Months			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Year 1988-1991 (RC^=1983-86)	-.6059*	-.5846*	-.5640*	-.5541*	-.2359	-.2356	-.2529	-.2534
Mothers' schooling (RC: none)								
1-5 years	-	-.1175	-	-.1310	-	.1378	-	.1491
6+ years	-	-1.0677	-	-1.1237*	-	-.2599	-	-.2864
Fathers' schooling (RC: none)								
1-5 years	-	-.1335	-	-.1140	-	.1478	-	.1394
6+ years	-	-1.1320*	-	-.1237*	-	-.2500	-	-.2563
Maternal age (years) (RC: 20-34)								
LE-20	-	-	0.5304	.5170	-	-	-.4201	-.4376
35+	-	-	-.5261	-.5812	-	-	-.0081	-.0261
Birth order (RC: 2-4)								
First birth	-	-	-.4869	-.4664	-	-	-.4791	.4985
Birth order 5+	-	-	.3189	.2650	-	-	.1604	.1522
Log (Preceding birth interval)	-	-	-.0293	.0311	-	-	.0547	.0718
Constant	-4.6644	-4.4234	-4.6515	-4.6012	-5.2489	-5.2564	-5.5085	-5.5698
-2 log L	819	806	815	802	507	506	506	505
505	5.7	19.2	9.7	22.9	0.5	1.7	1.7	3.0
Df	1	5	6	10	1	5	6	10
(No.)	(9353)	(9353)	(9353)	(9353)	(8414)	(8414)	(8414)	(8414)

^RC = Reference category

* p ≤ .05; ** p ≤ .01; *** p ≤ .001

Post-neonatal mortality risk

Children born during the later period had a significantly lower risk of post-neonatal death those born during the earlier period. In Model 2, the variable mothers having six or more years of schooling and fathers having six or more years of schooling was associated with a reduced risk of post-neonatal death, but only a father having six or more years of schooling was highly significant. This is a clear demonstration of the effect of parental education on post-neonatal death. In Model 3, both first-order and fifth- or higher-order births faced a higher risk of death during the post-neonatal period. These were all statistically significant. The log of the preceding birth interval was significantly associated with a reduction in post-neonatal death. Model 4 suggests that the variables fathers having six or more years of schooling, first births and fifth- or higher-order births, and the log of the preceding birth interval were significant predictors of post-neonatal mortality during the overall study period. Children born to young mothers had a higher likelihood of death than children born to mothers aged 20-34 years.

Mortality during the second year of life

Time continued to be a predictor of reduced mortality risk in children aged 12-23 months. Any level of father's schooling was significantly more important than the extent of a mother's education. Any degree of paternal schooling (1-5, 6 or more years) was associated with a reduced risk of mortality in the second year of life. Model 2 and Model 4 illustrate this point. In Model 3 and Model 4, it is evident that higher-order birth was more closely associated with high risk than lower birth order. The log of the preceding birth interval was associated with a reduced risk of death, but not significantly. When all variables are included under Model 4, a father having any level of education was significantly associated with a reduced risk of mortality. Model 4 furthermore suggests that higher-order births had higher risks of death during the second year of life.

Mortality during the third year of life

Children born during the later period had a significantly lower risk of death during their third year of life than children born during the earlier period in each of the four models. In Model 1, it is also evident that the rate of reduction in risk was much higher for this time period. Model 2 and Model 4 pick up the education variables, *mothers having one to five* and *fathers having six or more years of schooling* as predicators of reduced risk during the child's third year of life. None of the reproductive variables (Model 3 or Model 4) had any significant association with the mortality risk of children aged 24-35 months.

Mortality during the fourth year of life

For this age range, mortality risk decreased significantly during the earlier period in each of the four models. All of the education variables were associated with a reduced risk in Model 2, but only the education category of *fathers having six or more years of schooling* was statistically significant. None of the reproductive variables were significant in Model 3. When all variables were combined in Model 4, the time variable and *fathers having six or more years of schooling* were associated with a reduced risk of death during the fourth year of life. Thus, socioeconomic status, represented by the father's education and temporal trends in mortality, emerged as the only two significant factors in the model reducing the risk of children aged 36-47 months.

Mortality during the fifth year of life

Neither time, education, nor reproductive variables had any significant effect on the risk of death during the fifth year. Thus, the other positive determinants of mortality for this age group need to be examined.

Analysis with recent characteristics

Three age ranges: neonatal, post-neonatal (29 days - 1 year), and 12-23 months were considered for a combined analysis with recent and permanent characteristics. The results are reported in Table 3. A logistic regression procedure was applied to analyze the data.

Neonatal mortality

Among the education variables, only *mothers having six or more years of schooling* had statistically significant negative co-efficients with the neonatal mortality levels. Among the reproductive variables, children having a mother younger than 20 years and being first-born were associated with a higher risk of neonatal death than children born to mothers aged 20-34 years and children of higher birth order.

Table 3. Logistic regression co-efficients of socio-demographic and health service exposure factors associated with neonatal, post-neonatal and child (age 12-23 months) mortality levels:1990-1996

Variable	Neonatal mortality	Post-neonatal mortality	Age 12-23 months
Education (RC^: none)			
Mother's 1-5 years of schooling	.0447	.0059	-
Mother's 6+ years of schooling	-.6111***	-.3967	-
Father's 1-5 years of schooling	.0133	.1378	-
Father's 6+years of schooling	.2263	-.6041*	-
Reproductive dynamics (RC: Age 20-34)			
Mother's age <20 at birth	.5970***	.0968	-
Mother's age 35+ at birth	.0132	.3081	-
Birth order (RC: Age 2-4)			
First birth	.4091**	.5599**	-
5th or higher birth	.2038	-.0685	-
Log (Preceding birth interval)	-.1545	-.6530***	-.7251*
Source of drinking water (RC: other)			
Tubewell	-.4761	.5922	-1.0295*
Immunization:			
TT	-.0793	-	-
DPT	-	-3.4434***	-2.3644**
Birth attendant (reference categories: others)			
TBA	.0004	.3634	-
Physician/paramedics	.6661**	-.8463	-
Health service access (RC: best-code)			
Code 2	-.1884	-.2522	.4259
Code 3	-.0421	.3010	-.6999
Code 4	.0846	.0414	-.0498
Code 5	.0133	-.1131	-.8628
Code 6	-.0129	.2317	-.6058
Constant	-2.1548	-.9287	.2559
-2 log L	2996	1534	483
Chi-square	73.0	364.0	68.7
Df	18	18	8
(No.)	(6912)	(6443)	(5038)

^RC= Reference category; *$p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

Births attended by the traditional birth attendants or physicians and paramedics had a higher risk of mortality than births attended by the relatives or neighbours. This was somewhat an unexpected finding. One plausible explanation could be that high-risk mothers or mothers experiencing pregnancy complications seek the assistance of physicians and paramedics. Thus, selectivity could explain this unusual finding.

Contrary to the findings of the national study using the BDHS data, indicators of poor access to health services were not systematically associated with an increased risk of neonatal death.

Post-neonatal mortality

Fathers having six or more years of schooling had a significant negative effect on post-neonatal mortality. The effect of *mothers* and *fathers having 1-5 years of schooling* was not significantly different from no parental education. First birth was positively associated with post-neonatal death. Also, the length of the preceding birth interval was negatively related with post-neonatal death. Having received DPT, immunization was significantly related to reduced death during the post-neonatal period. No other variables in the model exerted any significant positive or negative influence.

Mortality during the second year of life

The significant variables in this model, such as the log of the length of the preceding birth interval, drinking tubewell water, and having received DPT immunization, were negatively associated with a risk of mortality of children aged 12-23 months. The health service access variables were neither associated in the expected direction nor were they significant.

Discussion and Conclusions

Child mortality differentials obtained from the Project's SRS data sets are higher than those obtained from the 1993-94 BDHS. The neonatal, infant and under-five mortality estimates by parental education and reproductive dynamics obtained from the longitudinal database were higher than the estimates derived from the national survey. Moreover, the rate of decline was smaller for the NNMR and IMR. The reduction in the U5MR was similar between the two studies. In the Extension Project areas, neonatal mortality fell by about 29 percent during the overall study period for children who were second to fourth births, and by 40 percent if children were preceded by a birth interval of four years or more. About 30 percent reduction in mortality occurred in case of infants who were born to mothers with six or more years of schooling and whose fathers were professionals. A 44-percent reduction in mortality occurred in infants who were preceded by a birth interval of four years or more, and whose residence was within 15-30 minutes travel distance of the H&FWC, but within one hour of the THC. The U5MR decreased by more than 27 percent even with no paternal education or where fathers were unskilled labourers or businessmen. Maternal education did not matter with regard to the U5MR. Mothers with no education or six years of schooling had a similar decline in the U5MR. Children who were second or higher birth order or were preceded by a birth interval of two years or more had a larger than average U5MR decline. A rather large decline also occurred in the U5MR whose mothers were younger (15-20 years) or aged 35 years and above, and lived close to a health facility. The lowest (21%) decline in mortality occurred in the children aged less than five years whose mothers lived far away from a health centre.

The results of the multivariate analysis are mixed. When logistic regression procedures were used for exploring the effect of fixed characteristics on the study cohort, children born to young mothers and first-borns had a significantly higher risk of neonatal mortality than children born to mothers aged 20-34 years and children with birth orders between two and four. *Fathers with at least some* (one year or more) *schooling,* and the length of the preceding birth interval were negatively associated with neonatal death. These were all highly significant.

In the national study based on the 1993-94 BDHS data [3], being born to youngest mothers or the oldest mothers (compared to the middle reproductive age group) and being first born or being of fifth- or higher-order birth carried a higher risk of neonatal death. Moreover, any parental education and a longer preceding birth interval reduced the risk of neonatal death.

With regard to post-neonatal mortality, *father with six years of schooling,* a young mother, being first-born or of fifth or higher birth order, and having a shorter preceding birth interval had significant relationships with post-neonatal death. Mothers', rather than fathers', higher education was more important in the national study.

When fixed and temporal characteristics were combined in the Extension Project data set, the logistic regression coefficients pick up *mother with six or more years of schooling, mother under age 20 years* and first birth as significant predictors of neonatal mortality. Associations are in the expected directions. Contrary to our expectations, however, births attended by a physician or a paramedic experienced a higher risk of mortality than births attended by the relatives or neighbours. Selectively, due to high-risk women and women with complications seeking qualified health care providers, may have caused this unusual finding. In the 1993-94 BDHS study, birth order (being first-born) and having more limited access to health services were significant positive predicators of neonatal mortality. Also in the national study, the more difficult the access to health services, the higher the risk of death for the first month of life.

During the post-neonatal period, DPT appeared to have a highly protective role in reducing mortality in the Extension Project, whereas BCG had the opposite effect in the Extended Analysis using BDHS 1993-1994 data. DPT may be serving as a proxy for other health intervention exposures and use. Fathers' education was found to be more important than mothers' education in the Extension Project data set, whereas mother's education was found to be more significant in reducing risks of post-neonatal death in the national study. Fathers' education may also indicate a higher socioeconomic status, enabling the family members to seek health services. Also, males are the major decision-makers in the family. The length of the previous birth interval was found to be associated with the reduced risk of post-neonatal death in the both studies.

During the second year of life, the length of preceding birth interval, drinking tubewell water, and immunization were significantly associated with reduced mortality in the 12-23-month age group in the Extension Project data set. Conversely, only the length of preceding birth interval was significantly associated with lower mortality for this age group in the national study.

Increased birth spacing through family planning or breast-feeding as well as EPI certainly contributed to the rapid improvement of childhood survival. These findings have strong policy implications. Goals and objectives of the family planning programme and those of the EPI do not compete, rather they complement each other. Each of them plays a unique role in improving child survival.

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