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The Effect of Child Mortality on Fertility Regulation in Rural Bangladesh

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Abstract: This study analyzes longitudinal data from Matlab, Bangladesh, to examine the impact of child mortality on subsequent contraceptive acceptance and continuation. The strong negative impact is found to attenuate with family size, indicating a "replacement effect." An 'insurance effect' is observed as contraceptive acceptance and continuation were negatively associated with the number of previous deaths of children. Couples seem to find contraceptive use acceptable if the child who dies is one of a large family. Potentially, contraception use could be acceptable for spacing after a child in a small family dies. Family planning programs can help to reduce fertility and maternal and child health risks substantially by supplying appropriate methods to those couples who have experienced a young child's death; to be most effective, methods should be supplied immediately after the child's death. (STUDIES IN FAMILY PLANNING 1998; 29,3: 268-281)

A high level of childhood mortality almost certainly keeps fertility at a high level through both biological and behavioral mechanisms. Although the biological effect of child mortality on fertility is well established (whereby the mother's infertile period following a birth is shortened because of truncated breastfeeding after the death of the child), the positive behavioral effect has not been shown clearly for developing countries. This article examines the patterns of contraceptive acceptance and discontinuation as measures of fertility-regulation behavior associated with child mortality in Matlab, a rural area of Bangladesh.

The research was conducted in the so-called 'treatment" area of Matlab, which has remained socio-economically poor and has relatively high child mortality. (1) Contraceptive prevalence in Matlab has risen to more than 65 percent, however, as a result of maternal and child health services and various family planning interventions (Koenig et al., 1992); (ICDDR,B, 1995). This study uses high-quality longitudinal data on reproductive behavior and childhood mortality that were gathered over a five-year period between 1982 and 1987. The data set provides a unique opportunity to assess systematically contraceptive use among couples who experience a child's death, as well as excess fertility that results from child mortality. The findings may be used to help the national family planning program develop strategies to improve child and maternal reproductive health and reduce excess fertility.

Effects of Child Mortality on Contraceptive Use

The impact of child mortality on contraceptive use is an important area of research of long-standing interest to demographers. During the 1970s, a large number of studies were conducted on the effect of child mortality on fertility {for empirical studies, see (Preston, 1978) }. Most of the studies attempted to measure both biological and behavioral effects. The biological effect occurs when the early death of a child exposes a mother to a high risk of subsequent conception because of the abrupt truncation of breast-feeding. As a result of this effect, in a population where voluntary control of fertility is absent, child mortality results in excess fertility (Chowdhury et al., 1976). Contraceptive use is the key proximate determinant of the behavioral effect that is likely to be negatively affected by child mortality and to keep fertility at a high level.

In developing hypotheses, demographers have identified a "replacement effect" and an "insurance effect" to explain the behavioral effect of child mortality on fertility. The replacement-effect hypothesis proposes that fertility control will be low among parents whose child dies, because they will continue childbearing to replace, the child they lost.

To illustrate a pure replacement effect, Figure 1 (left panel)(Figure 1 is missing) displays a hypothetical scenario of a parity fertility-control relationship for two cases--one in which the index child survives, the other in which the index child dies. The upper curve of the left panel (index child survives) shows that contraceptive use increases with the number of surviving children and plateaus when the number of children is large or, in other words, when couples have reached their desired family size. The lower curve (index child dies) follows a similar progression but maintains a constant distance at lower numbers of surviving children. Contraceptive use for couples with X surviving children whose last child dies equals that of (X-1) surviving children of the group whose index child survives. Death of the last child of couples with X children will leave them with X-1 surviving children. Therefore, these couples will follow the pattern of contraceptive use of those parents whose child survives, but with X-1 surviving children.

The right panel of Figure 1 (Figure 1 is missing) is similar to that of the left panel except that a larger gap occurs between the two curves. The larger gap represents both replacement and insurance effects. The insurance hypothesis proposes that, in an environment of high infant and child mortality, couples attempt to have more than the number of surviving children they want in order to compensate for the likelihood that some of their children will die. In this case, contraceptive use for couples with X surviving children whose last child dies is much lower than that for the couples with (X-1) surviving children whose last child survives as a result of both replacement and insurance effects.

The replacement strategy of parents leaves them with their desired family size but leads to excess fertility, which keeps fertility at a high level. Apparently, the replacement-fertility mechanism does not affect population growth but high fertility is a risk factor for both child and maternal mortality. Similarly, the insurance effect keeps desired fertility and, thus, actual fertility at a high level, resulting in high population growth and child and maternal mortality.

A few studies conducted in Bangladesh observed no or a negligible behavioral effect of child mortality on fertility. For example, two studies did not find any statistically significant effects of the mortality of a previous child on the duration of the subsequent birth interval (Chowdhury et al., 1976); (Sufian and Johnson, 1989). One probable reason for this finding may be that contraceptive use was very low (5 percent or below) during the period of study in the late 1960s and early 1970s. A relatively recent descriptive study conducted in the Matlab treatment area, when contraceptive prevalence was between 20 and 35 percent during 1977-79, found no significant impact of child mortality on contraceptive acceptance but a significant impact on discontinuation of contraception (Chowdhury et al., 1992). However, the study did not consider the effect of confounding variables on contraceptive acceptance and discontinuation.

Testing of Hypotheses

The impact of child mortality on contraceptive use is examined here by testing the replacement-effect hypothesis, which will help assess which of those couples whose child dies are more likely to use contraceptives. To do this, another piece of information is needed-desired family size (the desired number of surviving children), because couples seek to replace a child who died only if the death leaves them with fewer surviving children than they want. If, after the death of the last child, the number of surviving children is still equal to or higher than their desired family size, couples will not try to replace the child who died. Unfortunately, information on desired family size at the individual level is lacking in the data set used in this study.

In the Matlab treatment area, the average desired family size was 4.4 children in 1975 and 3.1 children in 1990 (Koenig et al., 1992). According to a fertility survey conducted in 1984, 7 percent and 1 percent of women who had five and six or more surviving children, respectively, expressed their desire to have additional children.

According to the replacement-effect hypothesis, the death of the index child is expected to have a stronger adverse impact on contraceptive acceptance or continuation among couples who have fewer children than among those with a large number of children, because the former will try to replace the child who died to achieve their desired family size. In contrast, little or no difference in contraceptive acceptance or continuation is expected to be found between those couples whose last child dies and those whose last child survives in large families, because even after the death of the last child, these couples will have achieved their desired family size.

The replacement-effect hypothesis is tested by examining the effect of the death of the child in question (the index child) and that of the interaction between the death of the index child and the number of surviving children. According to the hypothesis, the interaction will have a statistically significant effect on contraceptive acceptance and continuation.

As noted above, because of the lack of adequate information in the data set, the insurance-effect hypothesis cannot be tested in an ideal situation. However, the results of the effect of one variable-'number of previous deaths of children"-is used, which may explain partially the insurance effect. This variable is likely to capture some of the effect of the insurance strategy of fertility behavior. If a mother has already experienced one or more child deaths, she may perceive that more of her children may die and, consequently, be encouraged to have more than her desired number of children.

Contraceptive acceptance is expected to be negatively associated with the number of previous deaths of children, and contraceptive discontinuation is expected to be positively associated with the number of previous deaths of children.

The test of the insurance hypothesis is incomplete because a woman may not only consider her own experience of a child's death but also the child-mortality experience of other women in the community. Ideally, an analysis of the insurance effect would include information about community variation in terms of child mortality. However, such information is not available from the data set used here. A woman's personal experience of child mortality may more strongly influence her insurance strategy for fertility behavior than may the community experience of mortality.

Population, Data, and Methods

Matlab is a rural, riverain sub-district located about 35 miles south of Dhaka, the capital of Bangladesh. The area is isolated and largely inaccessible except by river transportation. Subsistence rice agriculture and fishing dominate the economy. Literacy is still low, particularly among women, and social institutions are predominantly traditional despite the steadily increasing modernizing influence of radio and personal commercial contact with urban areas.

The Matlab treatment area has received a series of carefully designed and closely supervised health and family planning interventions (Bhatia et al., 1980); (Phillips et al., 1982, 1984, and 1988). Briefly, family planning services have been provided on an intensive basis since 1977 through house-to-house delivery of contraceptives and information by trained village women, known as community health workers. The service program has been given credit for a marked increase in the use of contraceptives and a correspondingly pronounced decline in fertility (Phillips et al., 1988). The contraceptive prevalence rate rose from about 5 percent in 1977 to about 45 percent in 1985, increasing to 65 percent in 1994. The total fertility rate (TFR) has declined from 6.8 children per woman in the late 1970s to 2.9 in 1993. In the neighboring comparison area, where family planning services are provided by the government program, the contraceptive prevalence rate was 16 percent in 1984 and 27 percent in 1990 (Koenig et al., 1987 and 1992). The TFR in the comparison area was 3.8 in 1993.

Infant and child mortality have declined over the last decade in Matlab (see Appendix Table Al), but are still high in the comparison area and moderate in the treatment area. Neonatal mortality remains high at 43 and 65 deaths per 1,000 live births, respectively, in the treatment and comparison areas. The Bangladesh Demographic and Health Survey conducted in 1993-94 documents that, in the rural areas of the country, the probabilities of dying by one month, one year, and five years were 65, 103, and 153 per 1,000 live births, respectively (Mitra et al., 1994). These estimates reflect the average mortality level during the decade prior to the surveying

Data

For this study, information on vital events was taken from the Matlab Demographic Surveillance System (DSS) that has been registering births, deaths, and migrations since 1966 and marital events since 1974. Information on the dynamics of contraceptive use was taken from the Record Keeping System (RKS), a service-statistics system that has been maintaining reproductive histories married women aged 15-49 since late 1977. The dates of contraceptive acceptance and discontinuation and method switching are available from, the RKS for the treatment area only. This information was linked to the DSS data on births, deaths, and migrations. Data on socioeconomic conditions, household environment, and other background characteristics are compiled in cross-sectional, house-to-house censuses in the DSS area. The last such census for which data were available at the time this study was conducted in mid-1982. Each individual in the DSS area has a unique and permanent identification number, permitting cross-referencing and linking of information over time.

For this study, the data were linked to provide a cohort of 3,435 women who had singleton live births (hereafter referred to as the index births or children) in the Matlab treatment area during the 1982 calendar year. A longitudinal record was created for each mother to include the RKS and DSS information for five years after the index birth. Background information on maternal education, household socio-economic status, and the mother's preceding births and deaths of children in the five years prior to the index birth was included in the data. A sample of 3,147 treatment-area women is used in the study. (2)

Analysis

Dependent Variables

Two components of the dynamics of contraceptive use, were used as the dependent variables in the analysis: (i) the acceptance of contraception as measured by the waiting time until acceptance after the index birth, and (ii) the discontinuation of contraception by duration of use. Use of any type of contraceptive method-whether modem or traditional-was considered as the event of acceptance. Among the segments of contraceptive use, more than 41 percent involved injectables, about 30 percent were IUDs, 12 percent were oral contraceptives, 6 percent were tubectomies, 4 percent were condoms, 7 percent were other traditional methods, and 0.1 percent were vasectomies.

Contraceptive acceptance and discontinuation were defined in the study according to the conventions accepted internationally in demographic research. Acceptance refers to the timing of the first segment of contraceptive practice in the post-delivery period. The definition of continuation complies with the standard definition widely used studying the "all-method continuation rate" of contraceptive use (Tietze and Lewit, 1968). If an acceptor discontinued and then reaccepted contraception after a gap in use, the second segment of use was not considered in the duration of contraceptive use. If method switching without discontinuation occurred, the total duration of use of all methods was considered.

Discontinuation refers to termination of the use of a method, whether it was voluntary or due to contraceptive failure. A distinction between purposeful discontinuation and method failure cannot be made from the data available. Pills, condoms, and traditional methods, which comprise 23 percent of the methods used, are prone to use-failure. In the Matlab treatment area during the early 1980s, (Bairagi and Rahman 1996) found that the 12-month use-failure rates of these methods is high (about 15 percent). If a conception occurred while a method was being used, the case was treated as a discontinuation. The date of discontinuation was estimated by subtracting one month from the date of conception. Contraceptive failure may be associated with certain behavioral characteristics: For example, a pill or condom user whose child died may be less careful in using a method to avoid subsequent pregnancy and hence have a higher probability of contraceptive failure-than a user whose last child survived. The inability to distinguish the failure cases from those who discontinue use for other reasons is not likely to bias the results, because the relationships between discontinuation and contraceptive failure and the death of the index child are expected to be in the same direction.

Women who out migrated during the study period and those who conceived before using any method are excluded from the analysis. The date of conception is estimated by subtracting nine months from the date of the subsequent birth. The focus here is solely on the intervals between live births; other sorts of conceptions are disregarded because the data do not permit an estimation of the date of those conceptions. Each record was censored after the subsequent birth and, therefore, any births or use of contraceptives after the first subsequent birth in the five-year follow-up period were not considered in this analysis.

Bivariate Analysis

Proportions accepting and discontinuing contraception are compared for couples whose index child survived and for those whose index child died. Migrants are excluded from such calculations, but contraceptive use was almost equal for the nonmigrants and outmigrants. The maximum-likelihood estimates of the waiting time to accept contraception, the birth-to-conception interval, and the duration of use were calculated using the Kaplan-Meier method (Kaplan and Meier, 1958); (Lawless, 1982). The time unit in calculating the Kaplan-Meier estimate was the completed month after the birth of the index child in cases of acceptance and the completed month after acceptance in cases of discontinuation. The censored cases were included in the analysis until just before the month of the censoring event.

Multivariate Analysis

Child mortality and contraceptive use may be related for reasons other than a causal effect of the former on the latter. A number of explanatory variables are controlled for in the analysis. Such variables have been found to be correlated with both child mortality and contraceptive use in previous studies. In this case a multivariate analysis is necessary, because the bivariate relationship between child mortality and contraceptive use is highly likely to be confounded by such demographic and socio-economic variables. The analysis was conducted by means of hazards models in which these variables were included. In the acceptance analysis, the interval begins with the birth of the index child. In the discontinuation analysis, the reference period begins with the time of acceptance. A generalized hazards model was used for analyzing the acceptance data, because maternal age was found to have a nonproportional (that is, time-dependent) effect on the acceptance of contraception. The effects of all of the other explanatory variables on contraceptive discontinuation were found to be proportional, and, therefore, (Cox's 1972) proportional hazards model was used for studying the discontinuation of contraception. A discrete-time hazards model was used for estimating the hazards-regression coefficients (Allison, 1982). A three-month interval was used for acceptance to simplify computing.

Variable Specifications

The survival status of the index child was entered in the hazards model as a time-varying covariate. At each monthly time interval, the variable "index child died (ICD)" took the value of zero if the index child was still alive and the value of one if he or she had died before the acceptance (or discontinuation) of contraception.

For the variable "number of previous deaths of children," all deaths of children prior to the birth of the index child were included in the mother's acceptance analysis. In the contraceptive-discontinuation analysis, all deaths of children prior to contraceptive acceptance were considered. Death(s) of the older siblings of the index child may have occurred during the study period. Such deaths were not recorded. Because the median previous birth interval was greater than four years and most older siblings who had survived till the birth of the index child had passed the highest mortality risk by the time the index child was born, this variable likely captures the actual number of previous deaths of children.

The effects of the number of children ever born (CEB) is considered in the analysis as a control variable. The interaction between CEB and ICD (ICD x CEB) was included in the models to examine if the effect of a child's death varies over the number of surveying children in the family. This variable tested the replacement-effect hypothesis. The effects of gender of the index child and gender composition of surviving children are also controlled in the analysis. The variable 'son' is coded as one if the index child was male and zero otherwise. The effect of the death of a son or a daughter was examined by including the interaction term (ICD x son).

Three gender-composition variables are included:

{1} a dummy variable "no surviving son," which took the value of one if the couples did not have a surviving son and the value of zero otherwise; {2} the number of surviving sons; and {3} a dummy variable "no surviving daughter," which took the value of one if there was no surviving daughter in the family, and the value of zero otherwise.

Maternal and household head's education, and household space, a proxy for household income, were included as the socio-economic variables. The variable "Hindu," which captures religious affiliation, was coded as one for Hindus and zero for Muslims.

Descriptive statistics for the explanatory variables are shown separately for the acceptors and non-acceptors in Table 1. The proportion of couples whose index child died was lower among the acceptors than among the non-acceptors (in the interval in question). The average of the number of previous deaths of children was also lower among the acceptors than among the non-acceptors. These differences suggest that contraceptive use in this population is influenced by child mortality. The table also shows that averages of all independent variables, except maternal age, are different for contraceptive acceptors than for non-acceptors. Also, averages of the independent variables are different for contraceptive continuers and discontinuers. These findings suggest that the effects of these variables must be controlled in a multivariate analysis.

Table 1: Average of the explanatory variables, by acceptance and discontinuation of contraception, Matlab, Bangladesh, 1982-87

Variable	**Non-acceptors**	**Acceptors[a]**		
		Continuers[b]	**Discountinuers**	**All**
Index child died	0.22	0.04	0.08	0.07
Number of children ever born	3.43	4.71	3.18	3.64
Number of previous death of children	0.86	0.48	0.76	0.53
No surviving son	0.31	0.05	0.23	0.17
No surviving daughter	0.29	0.13	0.27	0.22
Number of surviving son	1.26	2.21	1.37	1.62
Matemal age (years)	25.6	28.8	25.5	25.8
Matemal education (years of schooling)	1.36	2.02	1.93	1.90
Household head's education	2.32	3.25	2.80	2.86

(years of schooling)				
Household space (square feet)	281.7	406.8	412.4	411.2
Hindu	0.17	0.21	0.17	0.19
Observations (N)	(1,531)	(335)	(1,180)	(1,.515)

[a] Acceptors exclude permanent-method acceptors. [b] Continuers who used a contraceptive through the end of the five-year period are included.

Bivariate Results

On average, the women in the sample were about 26 years old and had ever had about 3.5 children. The level of child mortality for the sample was high: About 35 percent of women reported that they had experienced the death of at least one child. In Matlab, child mortality has declined remarkably since 1982, but even in 1995, it remained at a high level: About 20 percent of respondents reported that they had lost at least one child.

Contraceptive Acceptance

Table 2 shows the numerical distribution of women by the survival status of their index child and status of contraceptive acceptance in a five-year follow-up period between 1982 and 1987 in the Matlab treatment area. Of the 3,147 mothers in the sample, about 16 percent (N = 485) experienced the death of their index child within five years of its birth. This finding implies a probability of 159 deaths per 1,000 children by age five (see Table 3). Overall, 1,616 couples (51 percent) accepted contraception within five years after the birth of the index child and before the birth of the subsequent child (if any) (not shown). Among the couples whose index child died, 57 accepted contraception after the death of the index child, 85 children died after the acceptance of contraception, and 343 couples did not accept contraception. The number of acceptors whose contraceptive decision was likely to be influenced by child mortality was 57 and, therefore, the contraceptive acceptance rate among the couples whose index child died was {57/(485 - 85)} or 14 percent. In contrast, the contraceptive acceptance rate among couples whose child survived was {(85 + 1,334) / (85 + 1,334 + 1,048)) or 58 percent. Therefore, contraceptive acceptance among the couples whose index child died was only one-fourth (14.2/57.5) that of those whose index child survived.

Table 2: Numerical distribution of parents, by the survival status of the index child and the acceptance of contraception during the five-year period of observation, Matlab, Bangladesh, 1982-87

Survival status of the index child and mothers' acceptance of contraception	Number
Parents (Total)	3,147
Parents whose index child died	485
Child died before acceptance	57
Child died after acceptance	85
Child died and mother did not accept contraception	343
Parents whose index child survived	2,382
Child survived and mother accepted contraception	1,334
Child survived and mother did not accept contraception	1,048
Mothers who migrated out of the study	280
Mother migrated out acceptance of contraception	140
Mother migrated out but did not accept contraction before migration	140

Table 3: Distribution and probability of childhood deaths, by age, Matlab, Bangladesh, 1982-87

Age at death (month)	Number of deaths	Cumulative percent	Cumulative probability of dying/1,000
0	162	33	52
1-5	84	50	8
6-11	37	58	90
12-17	45	67	105
18-23	64	80	26
24-35	56	92	145
36-47	29	98	155
48-59	8	100	159

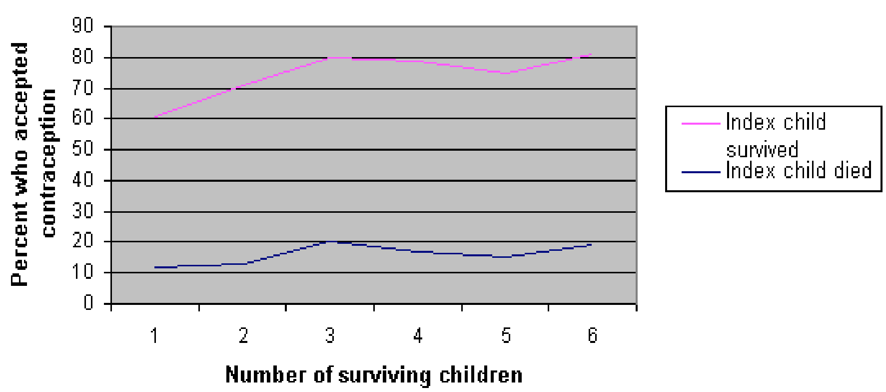
Women whose index child died not only had a lower level of contraceptive acceptance than did those whose index child survived, but they also tended to choose short-term and temporary methods of contraception. Table 4 shows that none of the 57 couples who accepted contraception after the death of the index child chose a permanent method. In contrast, of those couples who accepted a method before their child died, 9 percent adopted permanent methods. Similarly, the proportion of IUD acceptors was two times greater among acceptors whose index child survived compared with those whose index child died. Proportions using the pill and injectables were almost one and a half to nearly two times greater among the acceptors whose index child died than among those whose index child survived.

Table 4: Percentage distribution of acceptors, by survival status of the index child, according to contraceptive method, Matlab, Bangalesh, 1982-87

Survival status	Pills	Injectables	IUD	Permanent methods	Other methods	Total	(N)
Method accepted after child's death	23	60	14	0	3	100	(57)
Method accepted before child's death	9	34	29	9	19	100	(85)
Child survived for at least years	13	43	8	7	9	100	(1,334)

Figure 2 shows contraceptive acceptance by the survival status of the index child and the number of surviving children. Contraceptive acceptance varied from 50 percent to 60 percent for those couples whose index child survived, but was 20 percent or below for those couples whose index child died. Large differences in contraceptive acceptance between the two groups were observed almost equally for all numbers of surviving children, indicating that child mortality affects contraceptive acceptance negatively and strongly. These results, however, do not support the hypothesis regarding the pattern of the replacement effect. According to this hypothesis, contraceptive acceptance for the two groups would be nearly equal for couples who already had five or more surviving children (probably a family size larger than desired). Apparently, couples postpone the decision to adopt any method of contraception when the index child dies, regardless of the number of surviving children they have.

Figure 2: Percentage of women who accepted contraception, by survival status of the index child and number of surviving children, Matlab, Bangladesh, 1982-87



Contraceptive Discontinuation

A total of 142 couples were exposed to the risk of method discontinuation because of the death of the index child. (Those couples who adopted permanent methods were excluded from the analysis.) Table 5 shows the proportion of couples who had discontinued contraception by the end of the study period or before having a subsequent conception within the five-year period. In Matlab, temporary contraceptive methods are often used for spacing rather than for limiting births (DeGraff, 1991); (Koenig et al., 1987). Therefore, the finding, shown in the table, that couples will discontinue contraceptive use When the last index child has reached the age of five or more is not unexpected.

Contraceptive discontinuation was significantly higher ($p \leq 0.01$) among couples whose index child died than among those whose index child survived. Contraceptive discontinuation was lower among the couples whose index child died before acceptance than among those whose child died after acceptance. One probable reason is that the couples who accepted a method after the death of the index child already had a number of surviving children that was larger than their desired number of children even after the child died. In contrast, the couples whose index child died after they began practicing contraception found themselves in changed circumstances and were more likely to want to replace the lost child. Those couples who accepted contraception after the death of the index child might have done so to limit rather than to space births and, thus, were highly motivated to continue contraceptive use.

Table 5: Percentage of couples who discontinued temporary methods by the end of the five-years study period, by survival status of their index child, Matlab, Bangladesh, 1982-87

Survival status	**(N)**	**Discontinuers**	**Percent**
Index child died before acceptance	(57)	(50)	88
Index child died after acceptance	(77)	(72)	(94)
Index child survived	(1,247)	(979)	79

Notes: The difference in discontinuation between couples whose index child died and those whose index child survived is significant at p£ 0.01. Chi-square (2df) = 12.4.

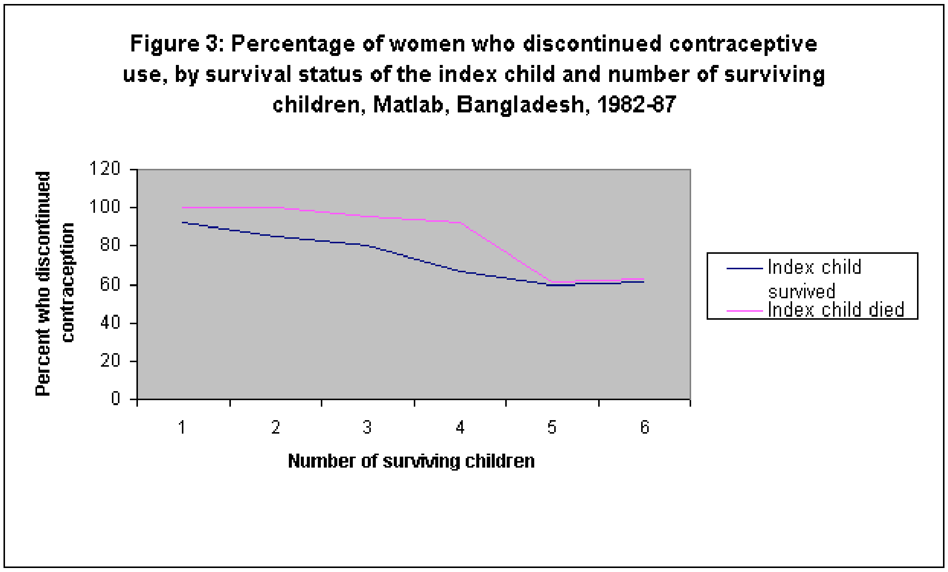
Table 6 shows that the proportion of contraceptive discontinuation was not only lower among the couples whose index child survived compared with those couples index child died but also that the median duration of use of methods was longer by one year or more.

Table 6: Duration (months) of use of temporary methods, by survival status of the index child, Matlab, Bangladesh, 1982-87

Survival status	(N)	First quartile	Median	Third quartile
Index child died before acceptance	(57)	11	20	36
Index child died after acceptance	(77)	16	21	36
Index child survived	(1,247)	23	33	52

Note: The quartiles and median refer to duration of use and percentage of sample in duration-of-use groups. For example, among mothers whose index child died before contraceptive acceptance (Row 1), 25,50, and 75 percent continued contraceptive use for 11,20, and 36 months, respectively. In contrast, among mothers whose index child survived (Row 3) 25, 50, and 75 percent continued contraceptive use for 23, 33, and 52 months, respectively. The comparison above shows higher contraceptive continuation among mothers whose index child survived than among those mothers whose index child died.

The proportions discontinuing contraception by the number of surviving children are compared for the two child-survival groups in Figure 3. The results strongly support the replacement-effect hypothesis. Discontinuation of contraception among the couples with only one surviving child, as expected, was high for both groups. However, 93 percent of the parity-one couples whose child survived discontinued within five years, compared with 100 percent of the couples whose child died (not shown). Among the couples whose index child survived, discontinuation rapidly declines with the number of surviving children, and stabilizes at around 60 percent for those couples who had five or more surviving children. Among the couples whose index child died, discontinuation remains at 100 percent for up to two surviving children and then steadily declines for three and four surviving children. Thereafter, discontinuation becomes almost equal for the two groups of couples in terms of child survival. This result indicates that if couples have five or more surviving children and one of them dies (the last one, in this case), the couples continue using contraceptives and do not attempt to replace the child who died, most likely because they have achieved or exceeded their desired family size. In contrast, before the desired family size is achieved or when the death of the index child results in a family smaller than the number of children desired, mothers discontinue contraceptive use in order to replace the child who died.



Discrete-time Hazards Model Results

Five models of contraceptive acceptance and discontinuation are presented in Table 7 and Table 8, respectively. All models include the variables of prime interest-index child died (ICD)" and 'number of previous deaths of children' - along with all control variables. In addition, model 1 examines the effect of sex of the index child; model 2 examines whether the effect of death of the index child varies over the number of surviving children; and model 3 examines whether the effect of death of the index child differs for sex of the dead child. Model 4 adjusts the effects of gender composition of surviving children and examines whether sex of the index child has any effect on contraceptive use. Lastly, the parsimonious model (model 5) of the effects of child mortality, family size. and gender composition of children is presented along with control variables.

Replacement Effect on Contraceptive Use

Model 1 in Table 7 shows that the variable "ICD" has a large, negative, and highly significant effect on contraceptive acceptance even after controlling for the effects of other variables. The likelihood that the couples whose index child died will accept contraception is only 0.15 times {relative risk (RR) = exp(-1.928)} that of those couples whose index child survived. Note that a stronger effect is found in the hazards-regression analysis than in the bivariate analysis. Contraceptive acceptance was 14 and 58 percent among those parents whose index child died and those couples whose index child survived, respectively. The relative risk (RR) is 0.25 (14.2/57.5).

Model 2 (Table 7) shows that, with the inclusion of the interaction term "ICD x CEB," the negative effect of ICD increases substantially and the interaction effect is positive and significant. These results indicate that the death of the index child strongly and adversely affects contraceptive acceptance among families with fewer children. The adverse effect of child mortality diminishes as the number of children increases in a family. These results support the replacement-effect hypothesis on contraceptive acceptance. Note that the bivariate results of contraceptive acceptance did not support this pattern of replacement effect.

Table 7: Hazards-model estimates of the effects of child mortality and other variables on contraceptive acceptance, Matlab, Bangladesh, 1982-87

Covariates	Model 1	Model 2	Model 3	Model 4	Model 5
Index child died (ICD)	-1.93***	-2.38***	-2.00***	-2.37***	-2.37***
Number of previous deaths of children	-0.27***	-0.27***	0.27***	-0.16***	-0.16***
Children ever born (CEB)	0.17***	0.17***	0.17***	0.06	0.06***
ICD x CEB	--	0.13*	--	0.12*	0.13*
Index child is a son (son)	0.12*	0.12*	0.12*	-0.04	--
ICD x son	--	--	0.14	--	--
No surviving son in the family	--	--	--	0.40***	-0.39***
No surviving daughter in the family	--	--	--	-0.31***	-0.32***
Number of surviving sons	--	--	--	0.13***	0.12**
Maternal age	-0.06	-0.06	-0.06	-0.11**	-0.11**
Maternal age squared	0.00	0.00	0.00	0.00	0.00
Maternal age x time	-0.01*	-0.01*	-0.01*	-0.01*	-0.01*
Maternal education (years of schooling)	0.06***	0.06***	0.06***	0.06***	0.06***
Household head's education (years of schooling)	0.01	0.01	0.01	0.00	0.00
Log of household space (square feet)	0.04	0.04	0.04	0.05	0.05
Hindu	0.20**	0.20**	0.20**	0.21**	0.21**
Postpartum duration (three monthly) [A]	0.15***	0.15***	0.15***	0.15***	0.15***
Postpartum duration squared	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
-2 log likelihood	5524	5520	5522	5502	5503

Significant at $*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$ -- = Not applicable

[A] Postpartum duration (three-monthly) is the waiting time for accepting a method or for being censored by the subsequent birth (before contraceptive acceptance), or by migration out. The duration was considered three-monthly (not monthly) for a computational advantage. The coefficients of postpartum duration and its squared terms provide a pattern of contraceptive acceptance after the birth of the index child or after use of a contraceptive. For example, the chance of contraceptive acceptance increased with postpartum duration and reached maximum during 13-14 months, and then decreased (model 5). Similarly, the chance of contraceptive discontinuation increased with duration of use reaching its maximum during 25 to 26 months, and then decreased (see model 5, Table 8).

Table 8 shows five hazards models of contraceptive discontinuation. The coefficient for ICD is positive, large, and highly significant and indicates that the couples whose index child died had a risk 1.92 times {RR = exp (0.651)} greater of discontinuing contraception than did those couples whose index child survived. The interaction "ICD x CEB" (model 2) is significant and negative, indicating the likelihood that contraceptive discontinuation because of the death of the index child decreases as the number of children increases. These results confirm the hypothesis that couples' decisions about continuing contraception are consistent with the replacement effect.

Table 8: Hazards-model estimates of the effects of child mortality and other variable on contraceptive discontinuation, Matlab, Bangladesh, 1982-87

Covariates	Model 1	Model 2	Model 3	Model 4	Model 5
Index child died (ICD)	0.65***	1.36***	0.74***	1.49***	1.50***
Number of previous deaths of children	0.12*	0.13*	0.12*	-0.06	-0.07
Children ever born (CEB)	-0.16***	-0.15***	-0.16***	0.03	0.03
ICD x CEB	--	-0.17*	--	-0.20**	-0.20**
Index child is a son (son)	-0.18**	-0.17**	0.17**	-0.01	--
ICD x son	--	--	-0.19	--	--
No surviving son in the family	--	--	--	0.40***	0.44***
No surviving daughter in the family	--	--	--	0.57***	0.54***
Number of surviving sons	--	--	--	-0.18***	-0.20***
Maternal age	-0.03*	-0.03*	-0.03*	-0.02*	-0.02*
Age of last child at acceptance (in log)	0.28***	0.28***	0.28***	0.28***	0.27***
Maternal education					
Primary	-0.18	-0.19*	-0.18	-0.21*	-0.21*
Above primary	-0.13	-0.13	-0.13	-0.11	-0.11
Household head's education					
Primary	-0.13	-0.13	-0.13	-0.11	-0.11
Above primary	-0.06	-0.07	-0.06	-0.07	-0.07
Log of household space					
(square feet)	-0.01	0.01	-0.01	-0.03	-0.03
Hindu	-0.24**	-0.23**	0.24**	-0.24**	-0.24**
Postpartum duration (three	0.08***	0.08***	0.08***	0.09***	0.09***

monthly)					
Postpartum duration squared	-0.01**	-0.01**	-0.01**	-0.01**	-0.01**
-2 log likelihood	3694	3691	3694	3669	3670

Significant at *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001 -- = Not applicable

Insurance Effect and Contraceptive Use

The hazards models presented in Tables 7 and 8 include the variable "number of previous deaths of children' that is expected to capture the insurance effect. The number of deaths of children refers to the time period prior to the birth of the index child. This variable can capture insurance as well as replacement effects of child mortality on contraceptive use. Couples who have had one or more children who die prior to the index birth are particularly likely to adopt the insurance strategy of childbearing. Contraceptive use may also be lower among couples who have experienced a child's death, because they may anticipate more deaths and, therefore may desire to continue childbearing to achieve an excess of births, thus ensuring that they achieve their desired family size or desired gender composition. Couples with a small to moderate number of surviving children (say, four or fewer) who have not yet achieved their desired family size because of a child's death are likely to defer using contraceptives or else use them for a shorter period, because they want another child to replace the one who died. As noted above, these two effects cannot be identified in the present analysis.

In the acceptance analysis (Table 7), the coefficient of the variable "number of previous deaths of children" is negative, large, and highly significant. The variable "number of previous deaths of children" has a significant impact on contraceptive discontinuation (Table 8, models 1-3).

The Effect of Son Preference

Previous research in Matlab has documented evidence of discrimination against girls in terms of lower allocation of food and health care, which results in greater malnutrition and higher mortality of girls than of boys (Chen et al., 1981); (D'Souza and Chen, 1980); (Muhuri and Preston, 1992); (Muhuri and Menken, 1997). The selective deprivation of girls is largely due to son preference in Bangladeshi society. Son preference was observed in family-building strategies in Matlab (Rahman and DaVanzo, 1993); (Rahman et al., 1992).

Contraceptive acceptance was higher and discontinuation was lower (see models 1-3, Tables 7 and 8) if the index child was a son than if it was a daughter. Model 3 in both Tables 7 and 8 considers the interaction between gender and the death of the index child, and the interaction effects were not significant. This finding indicates that the death of a son does not have a different effect on contraceptive acceptance or discontinuation than does the death of a daughter. Model 4 (Tables 7 and 8) examines whether contraceptive acceptance or discontinuation is affected by the gender of the index child after adjusting for the effect of the gender composition of surviving children. Apparently once a couple has its desired number of children of preferred gender composition, the gender of the index child has no effect on subsequent contraceptive behavior. Desired gender composition seems to be at least one daughter and at least one son, or preferably several sons in the family. Thus, model 5 excludes the variable "son." This model shows a slightly different effect of son preference on contraceptive acceptance or discontinuation.

Changes in both the replacement and insurance effects on contraceptive acceptance or discontinuation are noticeable once the effect of the gender composition of children is adjusted for. First, both the main effect of ICD (measuring the replacement effect) and the interaction effect of ICD x CEB on contraceptive discontinuation increase (model 2 versus model 4 or model 5, Table 8). This result probably means that imbalance in the preferred gender composition of children due to the death of the index child leads parents to discontinue temporary methods. The interaction effect (ICD x CEB) that is larger in model 4 or 5 than in model 2 or 3 indicates that this behavior is less common among large families, probably because the death of the index child does not bring about an imbalance in the preferred composition of children. Second, the insurance effect is substantially reduced in the contraceptive-acceptance model and disappears in the contraceptive-discontinuation model after the adjustment for the gender composition of children (models 2 or 3 versus models 4 or 5, Tables 7 and 8). These results probably indicate the prominence of gender composition over parents' insurance strategy of family building.

Effects of Other Variables

Table 7 shows that the number of children ever born has a positive effect on contraceptive acceptance and that the effect diminishes once the gender-composition variables are entered in the model (models 1-3 versus models 4-5). Contraceptive acceptance increased with maternal education and was higher among Hindus than among Muslims. Table 8 shows that contraceptive discontinuation had differentials nearly similar to those for acceptance.

In two previous studies, the author and his colleagues reported the effects of the variables shown in Tables 7 and 8 on contraceptive use (Rahman et al., 1992) and on birth spacing (Rahman and DaVanzo, 1993). The results were discussed in greater detail for some of the variables, and, therefore, are not discussed here. Some of the statistics reported here may differ slightly from those reported earlier, mostly because of differences in the specifications of either variables, sample groups, or minor corrections in the data set made at a later stage.

The Missing Replacement-effect Pattern

According to the replacement hypothesis, a child's death is expected to have a negative impact on contraceptive acceptance and continuation and the impact is expected to be stronger among couples who have fewer children than among couples who have a large number of children. Such an impact is found in the hazards-regression models where the effects of demographic and socio-economic factors are controlled. In the bivariate analysis, however, child mortality is found to have a negative impact on the contraceptive acceptance of all couples, regardless of the number of surviving children. According to expectation, child mortality has a positive impact on contraceptive discontinuation (or a negative impact on contraceptive continuation) among couples with four or fewer children but not among couples who have five or more children.

Fertility in Bangladesh is substantially lower than it might be because of the universal and remarkably prolonged practice of breast-feeding. The average duration of breast-feeding in Bangladesh is the longest in the world; in Matlab, the median duration of breast-feeding and postpartum amenorrhea were about 30 and 16 months, respectively, during 1976-77 (Huffman et al., 1987). Truncation of breast-feeding due to the death of the index child in the neonatal period, during infancy, and during the early childhood period exposes the mother to a high risk of subsequent pregnancy in the absence of contraceptive use. In Figure 4 (Figure 4 is missing) and in Table 9, the cumulative probabilities of subsequent conception of two groups of non-acceptors of contraception are compared according to postpartum duration. The two groups are: those non-acceptors whose index child died before a subsequent conception or within the five-year follow-up period and those non-acceptors whose index child survived until a subsequent conception or within a five-year follow-up period. Conception occurred much earlier among those women whose index child died than it did among those women whose index child survived. For example, one-fourth of the non-acceptors whose index child died conceived within eight months and one-half conceived within 14 months after their child died. In contrast, the same proportion of non-acceptors whose index child survived conceived by 18 and 25 months, respectively. The delay in conception of non-acceptors whose child survived is associated with the anovulatory protection provided by continued breast-feeding. In contrast, the non-acceptors whose index child died did not have such protection soon after the child died.

The figure and table also show that the pattern of the postpartum interval before contraceptive use was initiated matches quite well with that of the conception of mothers who did not accept contraception and whose index child survived. On average, adoption of contraceptives among mothers, regardless of child-survival status, occurred earlier than did conception among those mothers whose index child survived. This timing of adoption of contraception appeared to be optimal with the least wastage of resources because of minimal overlap between postpartum amenorrhea and contraceptive use for those mothers whose index (last) child survived. But the timing of adoption was not appropriate for those couples whose index child died. To prevent another pregnancy, the couples whose last child died should have adopted contraception much earlier than those couples whose last child survived, because the former were at risk of conception immediately after the death of the index child.

Table 9: Birth-to-conception interval (months) of mothers who did not accept contraception, by the survival status of the index child, and birth-to-contraceptive acceptance after the index birth, Matlab, Banglaesh, 1982-87

Survival status	(N)	First quartile	Median	Third quartile
Birth-to-conception interval of non-acceptors whose Index child died Index child survived	(343) (883)	8 18	14 25	26 36
Birth-to-contraceptive acceptance interval for those who accepted contraception	(1,616)	10	24	-

= Fewer than 75 percent of couples accepted contraception.

Community health workers, who provide information to mothers and counsel about contraceptive use and Supply methods at the doorstep, probably recommended that after a birth, women begin using contraceptives immediately after the start of menstruation or immediately; after the cessation of breast-feeding, whichever is earlier. This strategy seems to have worked well for the couples whose index child survived but not for those couples whose index child died. The mothers whose index child died conceived, on average, ten months earlier than did the mothers whose index child survived. As noted earlier, the death of the index child exposes the mother to a high risk of conception because of the abrupt truncation of breast-feeding. Apparently, this high risk was not recognized by the community health workers or the women in the sample.

One plausible reason why the mothers of the large families whose last child died did not accept contraception is the bereavement effect. Couples were not willing to accept contraception until they recovered from. the shock of the child's death. Often, by the time the mothers were ready to accept contraception, they had already become pregnant. The workers may have been reluctant to approach the bereaved mothers to motivate them or provide them with contraceptives immediately after the loss of a child.

Another, though less plausible, reason may be that Matlab women presume that the long average duration of postpartum amenorrhea in the population applies to all women, consequently, they may not recognize the linkage between the cessation of breast-feeding and the return of fecundity following a child's death.

Discussion and Conclusions

The findings of this study indicate a substantial and significant adverse impact of child mortality on fertility regulation behavior, which can be explained by replacement and insurance effects. Previous research on the effect of child mortality on fertility-regulation behavior was conducted when voluntary fertility regulation (birth spacing and control) was at a low or nearly absent (Chowdhury et al., 1976); (Chowdhury et al., 1992); (Sufian et al., 1989). Those studies found no limited effects of child mortality on contraceptive practice. Few mechanisms exist through which replacement and insurance effects can be at work when fertility regulation is uncommon or: fertility control is limited. However, with the increase in fertility regulation, parents make their decisions concerning contraceptive acceptance and continuation, and child mortality becomes an important factor in the decision-making processes. The findings suggest that adverse replacement and insurance effects on parents' fertility behavior become pronounced as the fertility transition progresses.

The study shows the importance of further reductions in neonatal, postneonatal, and child mortality for family planning to have success in Bangladesh. These mortality rates are still high in Bangladesh and in many developing countries. The study's results justify the approach of integrating maternal and child health and family planning programs to ensure the success of family planning in Bangladesh and elsewhere.

Contraceptive acceptance and continuation were found to be substantially lower among couples whose last child died than among the couples whose last child survived. Such an effect attenuates as the number of children increases or if the surviving children are of the parents' preferred gender composition. The decrease of the child-mortality effect in association with a family's increasing number of children or in families' having their preferred gender composition suggests that parents with small families or parents who have not yet achieved children of their preferred gender composition will not use contraceptives if the youngest child dies because they want to replace that child. However, the death of the last child in large families may not affect contraceptive use negatively, because such families have enough children who may also satisfy their preference in terms of gender composition. These couples are likely to accept contraception and to continue to use it.

The study's results suggest that family planning workers should focus on couples who have experienced child mortality to offer them special family planning information, motivation, and supply of methods. Mothers whose children have died should be encouraged to begin practicing contraception immediately after their child's death because they are at a high risk of conception. The parents of large families who have children of their preferred gender composition are less likely to want more children, even after the death of the last child. They may be motivated to adopt temporary or even permanent contraceptive methods.

From the viewpoint of demand for children, focusing on couples who have not yet achieved their desired family size and composition and who have lost their last child is probably not an optimal strategy. If couples want to replace the child who died, they will not want to use a contraceptive. These couples should be screened anyway, because contraceptive use may improve the mother's reproductive health and benefit the health of the next child. Short previous and subsequent birth intervals have an adverse effect on neonatal and childhood survival in Matlab (Koenig et al., 1990). Family planning workers, by providing information, should motivate and encourage couples who want to replace a child who has died to adopt a contraceptive method for longer spacing of the subsequent birth. They may recommend short-term temporary methods. The argument that longer spacing between children can improve the survival chance of the next child may be especially appealing to couples who have recently experienced the trauma of a child's death.

Family planning workers may fear that discussions about contraceptive use with parents who have just experienced a child's death may have a negative impact on the program. Mothers should be told, however, that, for their own sakes and the sake of the health of their next child, births should be spaced through contraceptive use. Those parents who do not want to have additional children even after the death of the last child should be counseled to begin contraceptive use immediately.

A complementary strategy is to work to prevent deaths through a carefully designed appropriate health care delivery system. A discussion of these issues is beyond the scope of this paper. A substantial proportion of couples whose last child died in early childhood constitute a high-risk group. They need information, motivation, and contraception both for spacing and limiting of births. A well-organized contraceptive-delivery approach should focus on couples whose last child died to combat excess fertility and infant mortality as well as to improve maternal reproductive health in Bangladesh and similar developing societies with a high burden of mortality.

Appendix Table A1: Selected fertility and child mortality indicators for Matlab, Bangladesh 1982-93

Indicator	**Treatment area**			**Comparison area**		
	1982	**1987**	**1993**	**1982**	**1987**	**1993**
Total fertility rate	5.0	4.2	2.9	6.3	5.4	3.8
Probability of death per 1,000 live births						
Infants younger than 1 month	58.1	43.8	42.8	68.1	54.9	64.5
Children younger than 1 year	105.6	78.4	53.1	118.3	94.3	99.3
Children younger than 3 years	na	103.9	80.4	na	134.3	121.6
Children younger than 5 years	169.4	113.1	86.1	207.2	145.2	135.1

na = Data not available.

Sources: (International Centre for Diarrhoeal Disease Research, Bangladesh 1984; 1992; and 1996).

Notes

(1). Infant and child mortality in the treatment area is lower than that in the comparison area.

(2). Among the 3,435 mothers who had singleton live births in 1982 in the treatment area, 3,305 provided information on contraceptive use. Of those, 3,158 were matched with requisite demographic and household data. Further checks for consistency and linkage identified 11 records lacking the requisite data on background socio-economic characteristics, leaving a sample of 3,147 treatment area women in the study sample. Therefore, about 8 percent of the women who gave birth in 1982 were excluded from the study because of missing data. Although conceivably selection bias could arise from sample loss, this is unlikely: The characteristics of unmatched individuals were not significantly different from those of individuals who were included in the analysis with regard to birth spacing and childhood mortality (tabulation not shown).

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