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The Effect of Infant and Child Mortality on Subsequent Fertility

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Introduction

Declines in infant and childhood mortality are indicators of general improvement in health and living standards in developing countries. These declines have also been shown to have a direct relationship with fertility rates, being part of a cluster of changes which precipitate a shift to smaller families. These include the fact that high fertility may be a response to high mortality. The most direct relationship between improved child survival and lowered fertility occurs as women are able to have fewer births to achieve their desired family size. The focus of this study is on the replacement behavior of individual couples who have experienced the death of a child, and on the differences in the ability and/or motivation of families to replace children who have died.

Research on the relationship between infant and child mortality and fertility at the individual level has shown that the effect is quite complex. Most researchers attempt to separate the impact of the death of a child on the subsequent fertility of a couple into several components. The first is a purely biological effect : the death of an infant causes cessation of lactation and hence cuts off its inhibiting effect on ovulation. Studies of pre-contracepting societies have shown that the physiological effect is the main mechanism affecting fertility among couples who experience infant death (Chowdhury et al. 1976, Knodel 1968, 1982).

The behavioral component of the effect of child death on subsequent fertility may be seen in two ways. The "replacement effect" is defined as a direct response by an

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individual couple to replace a child who has died. Attempts to measure this effect through micro-level studies have consistently shown that the death of a child results in less than one additional birth (McGreevey and Birdsall, 1974). The second type of behavioral response to infant and child mortality is that of *hoarding*, where couples have more children than they would consider ideal as an insurance measure against expected mortality. This response may result from the actual experience of child death or from the perceived risk of death based on the community mortality rate. The hoarding response must be understood in the context that families would usually prefer to err on the side of having too many children than having too few (Lehrer 1984). Thus a drop in mortality in a community will affect couples' reproductive behavior as the lower mortality rate gains acceptance.

The complexity of the factors affecting the relationship between infant and child mortality and fertility lead us to the hypothesis that the "replacement effect" for couples who have experienced a child death will differ among population subgroups. These include the following:

1. Parity : Micro studies have shown that the replacement response depends a great deal upon the size of the families already achieved. The consensus of several studies has been that the strongest relationship between infant mortality and fertility occurs at parities near the mean desired family size (Taylor et al., 1976; Rutstein and Medica, 1978; Rukanuddin, 1982).

2. Use of contraception : Replacement as a conscious strategy is possible only where family limitation is practiced. Several studies have concluded that in natural fertility populations, the higher fertility among couples who have experienced the death of an infant is solely due to shortened birth intervals resulting from the lactation effect (Knodel, 1968; Chowdhury et al., 1976). Knodel (1982) in his study of German villages in the 18th and 19th centuries found clear evidence of replacement bahavior as family limitation spread. Thus, an examination of replacement behavior must distinguish between

populations who have knowledge and/or have used family limitation methods and those who are still under a natural fertility regime.

3. Socioeconomic groups : Much research has been done on the socioeconomic determinants of infant and child mortality. It is likely that these variables also have an impact on the motivation and/or ability of families to replace a child who has died. Mauskopf (1981), in a study of Brazilian households, found that women who were urban residents and had higher educational levels and income had higher replacement rates even though the number of surviving children in the families was lower. Suchindran and Adlakha (1984) found similar effects in Jordan using the interaction of a previous infant death with mother's education and urban residence.

Besides these differences among subgroups within a society or community, differences between cultures have an impact on the replacement effect. These include some of the factors discussed above, such as breastfeeding practices, infant and childhood mortality levels, reproductive norms, availability of contraception and degree of modernization. Other factors include religion, the status of women and degree of son preference, and age at marriage.

Methods

The purpose of this paper is to test the above hypothesis using the World Fertility Survey data for Colombia, Kenya, Sri Lanka and Pakistan. These four countries provide a wide contrast in the factors presumed to have an impact on the replacement effect. Colombia and Sri Lanka have relatively low levels of both fertility and infant and child mortality, while Kenya and Pakistan continue to have extremely high rates for both measures. Comparisons between the two pairs of countries will thus provide an indication of whether the replacement effect differs for these two types of populations.

Two methods of analysis were used to investigate the hypothesis. The first, multiple classification analysis, is a form of dummy variable regression in which the variation in the dependent variable accounted for by an independent factor may be adjusted by a number of covariates. This analysis was used to compare women at a given parity as to their motivation and ability to replace a child who has died. The second type of analysis, the proportional hazards model developed by Cox (1972), has the advantage of enabling both complete and incomplete birth histories to be combined without bias due to truncation at the time of the interview. By estimating the multivariate model, factors which differentiate women as to their replacement behavior were identified.

Additional Children Wanted

In order to test the motivation of women to replace a child who has died, a multiple classification analysis was done with the number of additional children wanted by the respondent as the dependent variable. This question was only asked of women who were married and fecund at the time of the interview. As shown in Table 1, the analysis was run seperately by parity, with the independent variable being experience with child death (aged 0-4) up to and including that parity. Four covariates that affect additional fertility, independent of child death experience, were added to the model. These are age of the woman at the time of the interview, fecundity, educational level; and urban/rural residence. Fecundity was measured by the length of the first birth interval, which is the best measure of fecundability available; the log of the interval was taken to make a linear distribution. Age and the woman's knowledge of her fecundity would influence the number of additional children she would want at a given point in time. Additionally education and urban residence have an independent effect on both fertility and child mortality levels.

Table 1 shows the unadjusted and adjusted mean additional children wanted by parity for the four countries. It is seen that, while the means vary widely for the four countries, women who have experienced child death consistently state that they want more additional children than those who have not. For the two relatively low fertility

countries, Colombia and Sri Lanka, this effect is less strong at higher parities, indicating that replacement motivation is diminished as the desired family size is reached. In Kenya and Pakistan the effect remains strong even at parity 5, as completed family size is much higher in these countries. In nearly every instance however women who have experienced one or more child deaths intend, on the average, to have less than one more additional birth than those who have experienced no deaths. Thus not all women who experience a death want or feel themselves able to replace the child.

Table 1. Mean additional children wanted by parity and experience of child death (Married, fecund women only and deaths of children age 0-4)

Number of previous child deaths	Sri Lanka			Colombia			Pakistan			Kenya		
	Un-adjusted	Adjusted	(N)	Un-adjusted	Adjusted	(N)	Un-adjusted	Adjusted	(N)	Un-adjusted	Adjusted	(N)
Parity 2												
No Deaths	0.58	0.58**	(666)	0.65	0.66**	(360)	1.75	1.77**	(321)	4.02	4.04**	(390)
1+ Deaths	1.11	1.08	(68)	1.52	1.50	(40)	2.60	2.55	(132)	5.20	5.14	(88)
Parity 3												
No Deaths	0.27	0.27**	(588)	0.52	0.53*	(277)	1.63	1.66	(248)	3.21	3.32*	(328)
1+ Deaths	0.47	0.46	(115)	0.88	0.84	(65)	1.90	1.87	(165)	4.14	3.90	(139)
Parity 4												
No Deaths	0.12	0.12**	(447)	0.30	0.30	(180)	0.97	0.99**	(180)	2.54	2.61**	(274)
1+ Deaths	0.28	0.27	(162)	0.44	0.45	(71)	1.46	1.44	(190)	3.11	3.85	(149)
Parity 5												
No Deaths	0.07	0.07**	(358)	0.26	0.27	(138)	0.69	0.73**	(146)	2.45	2.29	(213)
1 Death	0.11	0.10	(103)	0.26	0.26	(53)	1.15	1.17	(114)	2.82	2.79	(108)
2+ Deaths	0.49	0.48	(43)	0.76	0.68	(21)	1.54	1.45	(85)	3.13	3.04	(53)

Note : Adjusted for: age at interview; length of first birth interval (log); education; urban residence.

* $P < 0.05$
** $P < 0.01$

Subsequent Fertility

While women may state that they intend to replace a child that has died, their ability to do so may be hampered by several factors. Women who experience infant and child mortality at early parities tend to be in groups at high risk of child mortality, and will remain so throughout the childbearing period. In addition women in these groups may have health problems that will limit their fertility.

A multiple classification analysis examining the subsequent fertility at each parity of women, grouped by their experience with infant death, is shown in Table 2. Only women who stated that they wanted no more children at the time of the interview were included in this analysis. In order to simplify the interpretation of the results, only women still married to their first husband and who had no multiple births were included.

The dependent variable was the number of births that occur after a given parity for all women who reach that parity. The independent variable was the number of infant deaths (aged under one year) that occurred before the given parity level.[1] Four covariates, which have an independent effect on fertility level, were included in the model: age at parity; log of the length of the first birth interval, as a measure of fecundity; and two socioeconomic variables, educational level and urban/rural residence.

The unadjusted means in Table 2 show that, in all four countries and at every attained parity, women who had experienced and infant death had a higher number of subsequent births. The impact of an infant death appears to be greatest at the early parities for Colombia and Sri Lanka, and the difference was greatest in the middle parities for the high fertility countries. When the means were adjusted by adding the four covariates, the difference between the groups was diminished. This occurred because many of the factors associated with high infant mortality, such as socioeconomic status, are also associated with high fertility and because, due to the lactation effect, a woman who has experienced an infant death would tend to be younger

at a given parity. Nevertheless, in all four countries women who experienced infant mortality still had significantly higher subsequent fertility when the means are adjusted.

The problem in interpreting this analysis is that we are unable to differentiate how much of this higher fertility of women with infant death experience is due to the lactation effect. Women who experience infant mortality at early parities are likely to be at higher risk of infant and child mortality at subsequent parities, and hence may have higher subsequent fertility solely due to shorter birth intervals. Knodel (1982), in a similar analysis of German village populations, attempted to adjust for this effect by estimating the average (expected) differences in mortality, birth interval and hence births for the two groups [2]. The percent of difference in subsequent fertility accounted for by this estimate, as given in Table 2, in most cases is less than 10% of the difference in subsequent fertility of the two groups of women.

Thus the two multiple classification analyses have shown not only motivation to replace children who have died but some degree of success in doing so. A higher number of subsequent births for those with an early experience with infant mortality was found even in the high fertility/high mortality countries of Pakistan and Kenya. Cochrane and Zachariah (1984) also found a substantial impact of child loss on fertility using WFS data from 25 countries. This finding is contrary to the hypothesis that natural fertility societies are unable to effectively replace births. Other factors besides the lactation effect may contribute to this higher subsequent fertility, as will be discussed in more detail below. Our second analysis is based only upon those women who state they want no more children and hence is biased towards those who are older and/or want fewer children. In the proportional hazards model all birth intervals of women who were married once are analyzed, and the factors that may influence the replacement effect may be examined explicitly.

Table 2. Subsequent births by parity and experience of infant death

Number of infant deaths before given parity	Sri Lanka [2]			Colombia			Pakistan			Kenya		
	Un-adjusted Mean	Adjusted	(N)	Un-adjusted Mean	Adjusted	(N)	Un-adjusted Mean	Adjusted	(N)	Un-adjusted Mean	Adjusted	(N)
Parity 2												
No Deaths	2.99	3.01***	(2426)	3.39	3.41**	(1196)	4.10	4.15***	(1302)	4.93	4.97*	(638)
1 Death	3.93	3.54	(138)	4.62	4.27	(63)	5.32	5.05	(228)	5.78	5.46	(88)
% Difference Due to Lactation [1]		5.2%			5.4%			6.9%			9.0%	
Parity 3												
No Deaths	2.44	2.47*	(1973)	3.04	3.08**	(928)	3.29	3.38***	(994)	3.98	4.06**	(570)
1+ Deaths	2.93	2.70	(255)	3.93	3.59	(121)	4.28	4.08	(433)	4.89	4.58	(138)
% Difference Due to Lactation		10.4%			4.9%			5.0%			5.4%	
Parity 4												
No Deaths	2.06	2.10	(1460)	2.73	2.79	(681)	2.52	2.62***	(755)	3.15	3.24***	(459)
1+ Deaths	2.45	2.25	(320)	3.37	3.14	(173)	3.49	3.36	(548)	4.09	3.89	(204)
% Difference Due to Lactation		16.0%			6.5%			6.2%			3.1%	
Parity 5												
No Deaths	1.76	1.81*	(1005)	2.53	2.59	(494)	2.01	2.12***	(521)	2.55	2.64***	(375)
1+ Deaths	2.17	2.01	(321)	2.79	2.63	(185)	2.80	2.70	(592)	3.44	3.27	(214)
% Difference Due to Lactation		7.4%			23.0%			9.1%			2.9%	

Note : Women married to first husband who want no more births and have had no multiple births only.
Covariates: Age at parity, length of first birth interval (log), residence (urban/rural),

1. See footnote 2 for explanation
2. Estate population not included

* $P < 0.10$
** $P < 0.05$
*** $P < 0.01$

Factors Affecting Replacement Behavior

The influence of an infant death on the probability and timing of the next birth, for parity one through five, may be seen in Tables 3 and 4. The life table parity progression ratios in Table 3 show that for most of the countries the probability of going on to the next birth is increased slightly if the child dies. An exception is Kenya, where women who experience a child death at early parities are actually less likely to go on than if the infant survives. The median birth intervals shown in Table 4 provide an indication of the impact of differing breastfeeding patterns in the four countries. Birth intervals are much shorter in Colombia and the difference in the intervals by survival outcome is also comparatively less. Since the median length of breastfeeding for a surviving child is only 7.4 months in Colombia (vs. 16.2 months in Kenya, 21.5 in Pakistan and 21.4 in Sri Lanka) this is not a surprising finding (Ferry and Smith 1983). While the life tables provide some information on the probability and timing of births, we are unable to measure how other factors besides the lactation effect have an impact on the probability of the next birth. For this reason the multivariate proportional hazards model is estimated.

Table 3. Life table Parity Progression Ratios (PPR) by survival outcome of previous infant and parity

Parity	Sri Lanka			Colombia			Pakistan			Kenya		
	PPR	S.E.	(N)	PPR	S.E.	(N)	PPR	S.E.	(N)	PPR	S.E.	(N)
1												
Survived	.9777	.002	(5564)	.9821	.003	(2438)	.9872	.002	(3342)	.9863	.002	(4708)
Died	.9874	.007	(367)	.9801	.013	(164)	.9906	.004	(699)	.9812	.007	(580)
2												
Survived	.9539	.004	(4651)	.9460	.007	(2014)	.9784	.003	(2998)	.9864	.002	(4236)
Died	.9740	.012	(267)	.9901	.010	(161)	.9843	.007	(483)	.9772	.010	(365)
3												
Survived	.9357	.005	(3803)	.9172	.101	(1587)	.9781	.004	(2600)	.9843	.003	(3644)
Died	.9634	.016	(205)	.9391	.027	(117)	.9859	.008	(357)	.9741	.011	(280)
4												
Survived	.9188	.007	(2972)	.9064	.011	(1231)	.9673	.005	(2157)	.9838	.003	(3057)
Died	.9209	.026	(163)	.9371	.036	(69)	.9710	.012	(312)	.9912	.007	(236)
5												
Survived	.8955	.008	(2265)	.8926	.013	(955)	.9466	.007	(1767)	.9743	.004	(2516)
Died	.9184	.031	(136)	.8943	.049	(60)	.9863	.009	(253)	.9767	.014	(191)

Table 4. Life table median birth intervals (months) survival outcome of previous child and parity

Parity	Sri Lanka			Colombia			Pakistan			Kenya		
	Median Interval	S.E.	(N)	Median Interval	S.E.	(N)	Median Interval	S.E.	(N)	Median Interval	S.E.	(N)
1												
Survived	26.41	0.31	(5564)	21.40	0.53	(2438)	29.41	0.50	(3342)	26.38	0.24	(4708)
Died	20.87	1.05	(367)	19.31	1.06	(164)	22.61	0.56	(699)	21.70	0.66	(580)
2												
Survived	28.18	0.37	(4651)	22.38	0.41	(2014)	29.20	0.43	(2998)	26.15	0.29	(4236)
Died	21.91	2.15	(267)	17.98	0.73	(161)	22.37	1.05	(483)	23.29	0.85	(365)
3												
Survived	29.42	0.47	(3803)	23.65	0.47	(1587)	29.41	0.44	(2600)	26.26	0.31	(3644)
Died	23.33	1.17	(205)	18.00	1.03	(117)	22.54	1.14	(357)	22.59	0.91	(280)
4												
Survived	29.60	0.65	(2972)	23.13	0.72	(1231)	29.80	0.47	(2157)	26.53	0.32	(3057)
Died	24.95	4.11	(163)	18.96	2.79	(69)	22.89	0.80	(312)	22.04	1.38	(236)
5												
Survived	30.36	0.57	(2265)	23.65	1.37	(955)	30.10	0.52	(1767)	27.50	0.49	(2516)
Died	24.01	1.08	(136)	20.10	1.28	(60)	21.45	1.78	(253)	20.83	1.30	(191)

Note : Median interval is conditioned on going on to the next birth.

Independent variables which are thought to have an impact on fertility are included in order to control factors which may confound the impact of an infant death. These include the age of the mother at the time of the birth, mother's educational level, urban residence, and parity. In Colombia and Kenya, where births outside of marriage are common, a variable for illegitimacy was also included. Controls for differences in marriage patterns were also included for Colombia (consensual unions) and Kenya (polygamous unions). It should be noted that we did not explicitly include contraceptive use in the models, for two reasons. One is that data on contraceptive use in each birth interval was unavailable. Secondly, it has been found in many developing countries that it is the more fecund and therefore higher parity women who are more likely to use contraception, and thus the variable would not add significant information to the model. Instead we may compare the models for countries of low (Pakistan and Kenya) and high (Colombia and Sri Lanka) contraceptive use to assess its influence on the replacement effect.

The full models are shown in Table 5. The single order variables that contribute to the probability of the next birth are not our major interest here. Instead they control for influences which may confound the impact of an infant death on subsequent fertility. The survival outcome of the previous birth is positive and significant in all four countries, as would be expected from the life table analysis. This main effect variable allows us to control for the lactation effect. The main focus of the model however, is to examine how the impact of an infant death differs among subgroups of the populations. This is accomplished by including interaction terms for the infant death variable with other independent variables.

Table 5. Proportional hazards model of probability of an additional birth

	Sri Lanka		Colombia		Pakistan[1]		Kenya[2]	
	B	S.E.	B	S.E	B	S.E.	B	S.E.
Mother's Age (Log)	-1.538***	0.048	-1.361***	0.077	-1.509***	0.058	-0.539***	0.046
Primary Education (ED1)	-0.060***	0.020	-0.050	0.033			0.068***	0.019
More than Primary Education (ED2)	-0.143***	0.025	-0.385***	0.051			0.099***	0.025
Residence Urban (URB)	-0.037*	0.021	-0.187***	0.027	0.090***	0.021	-0.121***	0.032
Residence Estate (EST)	-0.270***	0.039						
Parity 4-7 (PAR1)	0.104***	0.021	0.105***	0.031	0.177***	0.025	-0.007	0.021
Parity 8+ (PAR2)	0.030	0.041	0.201***	0.050	0.096**	0.045	-0.354***	0.037
Illegitmate Birth (ILG)			-0.273***	0.086			-0.230***	0.057
Consensual Union (CONS)			-0.136***	0.036				
Polygamous Union (POLY)							-0.091***	0.018
Previous Infant died (IFD)	0.225***	0.076	0.321***	0.120	0.399***	0.044	0.212***	0.056
Interaction Terms								
IFD x ED1	0.078	0.082	-0.039	0.111	0.223***	0.107	-0.025	0.068
IFD x ED2	0.173*	0.103	0.069	0.210			0.050	0.109
IFD x URB	-0.016	0.088	0.109	0.096	-0.108*	0.057	-0.175	0.122
IFD x EST	0.275**	0.114						
IFD x PAR1	-0.023	0.075	-0.064	0.101	0.057	0.056	0.118*	0.063
IFD x PAR2	-0.186	0.133	-0.216	0.104	0.175*	0.100	0.114	0.094
IFD x ILG			-0.064	0.244			-0.345**	0.172
IFD x CONS			-0.004	0.129				
IFD x POLY							-0.052	0.061
(N)	19345		8930		15494		21387	

Note : Omitted Categories: No education; rural residence; parity 2-3; legitimate birth; legal marriage; monogamous union; previous infant survived.

[1] categories are no education/some education

[2] categories are rural & urban/metropolitan

* $P < 0.10$

** $P < 0.05$

*** $P < 0.01$

As outlined above, we expected to find evidence of replacement motivation only among women who are able to exert some control over the family building process. Just as the notion of fertility control gains acceptance first in certain subgroups of a society, so would we expect success at replacing a child who has died to be more likely among women who live in societies where contraceptive use is prevalent and who tend to be better educated and living in urban areas. The relative risks of having an additional birth within those categories found to be significant are shown in Table 6. These are the ratios of the instantaneous rate of birth when the previous infant died to the rate when the infant survived, and thus show the differential impact of an infant death explicitly. A value of 1.00 would indicate that women in that category are equally likely to go on to the next birth if the infant dies or if it survives. The findings for each country will be discussed seperately.

In Sri Lanka the expected interaction effect was found for the educational categories. While a woman with no education was less likely to continue childbearing after experiencing an infant death, a woman in the highest educational class was more than twice as likely to continue if her child died than if it survived. Of interest is the strong impact of an infant death among estate residents. Speculation on the low levels of fertility among estate workers, in the absence of contraceptive use, has posited that a high level of induced abortion is the most likely explanation (Langford 1982). While fertility has fallen in Sri Lanka as a whole since the 1960's, it appears that the Tamils living on the estates began to control their fertility even before this time, and that they were able to space their children, as well as limit the size of their families. The finding that estate women who experience an infant death have nearly three times the probability of an additional birth provides further evidence of fertility control. Our findings indicate that, as expected, there are differentials in the Sri Lanka population as to who is more effective at replacing an infant that dies. The absence of a significant interaction with the parity variable means that the impact of an infant death is similar at all parities.

Similar results for educated women were found in the model for Pakistan. The educational categories were combined in Pakistan as only 13% of women reported

receiving any schooling. This group had a much higher relative probability of going on to the next birth if the previous infant died: the group with education was 3.47 times more likely to have an additional birth if the infant died than if it survived while the ratio was only 1.42 for the group with no education. The interaction of an infant death with parity was also significant for Pakistan, with those at the highest parities having the greatest difference in risk of an additional birth (3.15 times the probability if an infant at parity 8 and above survived). These two results are in the expected direction, since educated women would be more likely to be able to exert control over their fertility and it is expected that the impact of an infant death is greatest at parities near the mean desired family size, which is high in Pakistan. More surprising is the finding that women in rural areas have a higher probability of replacement than urban women (relative risk of 2.76 vs 1.79). These findings for Pakistan are in contrast to those of Chowdhury et al.(1976) who found no behavioral effects at any parity. One possible explanation for the rural/urban differential is that family sleeping arrangements may differ. Besides the effect of lactation on the likelihood of conception is the fact that in South Asian countries infants usually sleep with their mother, which inhibits or at least lessens the frequency of intercourse. For these reasons an infant death may have a greater impact on the probability of an additional birth in rural than in urban areas.

The interaction effects by parity were also found in the Kenya model. Women at parity 4 and above were nearly twice as likely to have an additional birth in the event of an infant death, while women at early parities were less likely to continue if the infant died. Because fertility is so high in Kenya this result is probably related to the fact that infant mortality is higher among sub fecund women, who do not continue childbearing after the early parities. The interaction of infant death with legitimacy status was also significant, indicating that women were much less likely to continue chilbearing if an infant death occurred outside of marriage than within marriage. We did not expect to find any significant interactions in Kenya, where fertility is extremely high and contraceptive use is low. A recent analysis of the proximate determinants of fertility reported that Kenya has one of the shortest postpartum non- susceptible periods in sub-saharan Africa (Bongaarts et al., 1984). This would further decrease the differential between intervals where the child died or where it survived. The significance

of the interaction affects by parity and legitimacy status may be indications of the health status of women who experience infant death at early parities. The lack of differential between educational groups or rural/urban residence confirms that the replacement effect does not vary among these groups.

Table 6. Relative risk of having an additional birth if infant dies for variables found to be significant

	Sri Lanka	Pakistan	Kenya
Education			
No Education	0.95	1.42	
Primary Level	1.83	3.47	
More Than Primary	2.22		
Residence			
Rural	0.93	2.76	
Urban	1.52	1.79	
Estate	2.72		
Parity			
2-3		1.40	0.96
4-7		2.49	1.93
8+		3.15	1.92
Legitimacy			
Legitimate			3.05
Illegitimate			0.77

No significant interactions were found in the proportional hazards model for Colombia, even though the multiple classification analysis indicated that women who experienced an infant death at early parities went on to have more children. These results are perplexing, for Colombia is the most "developed" of the four countries and contraceptive use was found to be high in the WFS (51% of ever married women reported that they had used contraception at some point (Lightbourne, 1980)). We attempted to account for this finding by investigating other factors that may are affected the results. The number of total previous infant deaths was added as a main effect variable to test if there is a cumulative effect of child loss. This variable was found to be highly significant, indicating perhaps that while infant mortality does have an effect on subsequent fertility, the impact is similar across categories. In another model not

shown here, we attempted to look at the impact of labor force participation by adding single-order and interaction variables of whether the woman had worked since marriage. In this case the interaction term was significant: working women who experienced an infant death had 2.55 times the probability of an additional birth than if the child survived, while the ratio for nonworking women was 1.17. These results are presented only tentatively since we do not have data on whether the woman was working at the time of a specific birth. The finding would indicate that women who work have a degree of motivation and/or success at replacement which is independent of residence or level of education. Aside from this finding, the lack of significant interactions indicates that while there is a replacement effect among women who experience infant deaths in Colombia, the effect is similar across all groups.

Conclusions

Evidence of motivation to replace a child who died was found in all four countries that we examined. In addition we found that women who experienced an infant death had higher subsequent fertility than those who did not, though in all cases replacement was less than complete. We attempted to identify factors which may have influenced the ability or motivation to replace an infant who died by estimating a proportional hazards model of birth intervals. Suchindran and Adlakha's (1984) analysis of Jordan found that the impact of an infant death differed among population subgroups: specifically, those who were highly educated and at higher parities had a higher probability of replacement. Our major finding is that these differentials vary from country to country. Similar effects for highly educated women were found in Sri Lanka and Pakistan, while differentials by parity were found in Pakistan and Kenya. In addition we found that residence had a differential influence on the probability of a subsequent birth in Sri Lanka and Pakistan. In contrast, we found that in Colombia the motivation and/or ability to replace an infant is similar across all categories. We would conjecture that this is due to the fact that contraceptive use is widespread in Colombia.

Notes

1 Only infant deaths were considered since it was difficult to determine the point at which child deaths influence subsequent fertility : such deaths may occur after several more births have taken place or towards the end of childbearing when replacement is more difficult.

2 Knodel (1982) estimates the size of the bias due to higher subsequent infant mortality among women who experience infant mortality at early parities by:

a estimating the average length that childbearing continues after a given parity by subtracting the average age that women reach that parity from the average age at last birth for women who continue childbearing:

b estimate the average proportion of subsequent children who die for the two groups of women (those who experienced infant mortality at early parities and those who did not):

c obtaining an average birth interval for the two groups of women by using a weighted average of observed intervals following an infant who dies and an infant who survives, with the weights being the proportions found in b;

d dividing the average time remaining for childbearing by the average birth interval for the two groups to get the expected number of additional children;

e multiplying this by the proportion of women who continue childbearing after the given parity. The difference in expected subsequent births between the two groups is the size of the bias due to subsequent mortality.

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