The Effect of Infant Death on Subsequent Fertility in Korea And the Role of Family Planning

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Abstract: This paper studies the effect of infant death on subsequent fertility in a developing country, examining spacing of children and additional births following the survival or death of the preceding infant. The material is provided by the 1971 National Fertility Survey of Korea, 23,635 retrospective birth records of 6,285 women. The findings suggest that prior to the introduction of a national family planning program, the influence of infant death was limited to the biological effect resulting from a shortened lactational period. Since fertility regulation methods have been made available throughout the country, motivational effects to replace the lost child appeared to emerge. The proportion of excess births attributable to infant deaths has increased in recent years. However, because of the lowered infant mortality, the overall impact of infant death on the national fertility level appears to be small. (*Am. J Public Health* 69:557-565, 1979.)

It is frequently argued that high infant and child mortality causes high fertility. Several hypotheses have been advanced to explain the mechanism of the possible cause-effect relationship between them. The "insurance" effect assumes that couples adjust their fertility because they expect some of their children to die. Increasing the number of births ensures the survival of the minimum number of children desired.[1] This effect is related to the perceived mortality level of the community in which the couple live. The procedure to test the effect of community level mortality on fertility of individual couples, however, is complicated.[2,3] Preston[4] says that such an effect "must be considered conjectural."

Actual experience with infant mortality may affect the fertility of couples in two different ways. The "physiological" or "biological" effect stems from premature interruption of lactation due to the death of an infant. It results in increased or earlier subsequent fertility by shortening the postpartum sterile period, and thus is largely irrelevant to couples' decision-making and planning for pregnancy. The "child replacement" or "behavioral" effect, on the other hand, involves a deliberate decision of couples to make up the lost children and is based on the fate of their previous childbearing. Hence it implies the existence of some desired number of surviving progeny in the household, and the couple's capability of using effective contraceptive methods when they attain the desired number of children.

The recent availability of household reproductive records has made the testing of the effect of personal experience with infant death on fertility relatively simple. Historical data from Europe have demonstrated an association between infant mortality and fertility.[3,5] A number of studies in developing countries have appeared recently, including Harman[6] for the Philippines, Harrington[7] for three areas in Africa, Hassan[8] for Egypt, Adlakha[9] for Turkey, Rutstein[10] and Heer and Wu[2] for Taiwan, Snyder[11] for West Africa, and Chowdhury, et al,[12] for Pakistan and Bangladesh. An investigation of the survival of genetic heterogeneity has resulted in a similar study in a developed country.[13] All these studies have found considerable reproductive compensation, in varying degrees, depending on the society, after infant deaths; they have been reviewed by Preston,[4] Taylor, et al,[14] and Ware.[15]

While the combination of the biological and behavioral effects of infant death on fertility thus appears to have been firmly demonstrated in many different cultural settings, the separation of one effect from the other has been difficult.[14] Because lactation postpones the resumption of menstruation and prolongs the birth interval,[16-20] in a breast-feeding society an increase in the risk of subsequent childbirth would be entailed even if there were no motivation to replace the child loss. Efforts to detect the replacement effect, independent of the lactation effect, have so far been limited. In analyzing fertility by the fate of two preceding children, Knodel[3] and Chowdhury, et al,[12] maintain that the increased fertility following an infant death has been due largely to the physiological effect. On the other hand, Adlakha's Ankara study[9]

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suggests that the behavioral (motivational) effect of an infant death is more important than its physiological (lactational) effect.

Studies regarding the impact of infant mortality on fertility have become further complicated by certain technical questions raised recently. To examine the effect of infant mortality, researchers generally treated the cumulative fertility (children ever born) as the dependent variable and the number of deaths in early parities as the independent variable. Chowdhury, et al,[12] however, demonstrated the fallacy of the common assumption that the higher subsequent *total* fertility of women who have experienced child loss necessarily validates the replacement hypothesis. When children ever born is used in the analysis of microlevel data, biased and spurious coefficients may often be yielded because of the artificial correlation between the dependent and independent variables.[21] An alternative model of a sequential decision-making process was suggested to relate the decision to have an additional child to the reproductive experience to date, in order to detect an influence of child mortality on fertility.[21]

This paper studies the relationship between infant death and the subsequent fertility, using Korean retrospective data. With the implementation of vigorous family planning programs since the early 1960s, the country has been experiencing a major reduction in fertility, probably for the first time in its history.[22] As such, it provides an unusual demographic laboratory, rapidly moving from a "natural" fertility society to a society progressively practicing contraception. Its infant mortality, as in many developing countries, has been declining rapidly. About 95 per cent of mothers still breastfeed their children.[23,24] This study focuses on whether the effect of an infant death on the subsequent fertility has been modified over a period of time as contraceptive methods are first made available and the family size norm has begun to decline.

Material and Method

The material for the investigation was supplied by the 1971 National Fertility-Abortion Survey of the Korean Institute for Family Planning (KIFP). The survey was conducted among national probability samples representative of all ever-married women of childbearing age at the time of the survey. Detailed description of the survey may be found elsewhere.[25,26]

The main objective of the survey was to collect basic data to measure changes in fertility and the accomplishment after ten years of a national family planning program in the Republic of Korea. The basic sampling frame was supplied by 1970 Census material. A total of 88 enumeration districts (EDs) were chosen at random from 31 strata which covered the entire country. All ever-married women under the age of 54 years in the sample EDs were interviewed. In addition to the usual careful design in all stages of data collection and close supervision of the operation, special arrangements were made to evaluate non-sampling errors through such methods as postenumeration and multiple interviewing. The survey was conducted in September-October 1971. The study is based on 23,635 birth records of birth orders of seven and below for 6,285 women who responded to the questionnaire related to fertility.*

To detect possible major omissions of infant deaths in the response of women, a test parallel to the one used by Valaoras[27] to adjust vital statistics for Greece** was applied to the current data. The result was quite satisfactory, thus the data were determined to be of good quality. There are, however, certain limitations in using the KIFP pregnancy history data. The women interviewed were representative samples of the entire reproductive age at the time of survey. Necessarily, the data for years previous to the survey year are based on live births to women of limited ages. For example, in the study, the data for the year 1950 are based on the fertility history of women ages 19-33 years only. The data will be progressively biased toward younger women as the reference year moves further away from the survey date. It is considered, however, that this bias will not create serious problems in the study of the present subject.

Two variables, birth interval and parity progression ratio (PPR), are analyzed to measure the effect of infant death on the subsequent fertility. The birth interval considered here relates to the closed interval only; namely, it is the interval in months between the ith and $(i+1)$th live birth.*** Fetal wastage between any two live births can be a serious confounding variable, but it has been shown that such wastage is poorly associated with child mortality, although it is associated with the previous experience of fetal wastage.[29] The PPR from parity i to parity $i+1$ measures the proportion of women having had the $(i+1)$th births by the survey date among those who had had the ith births earlier. The term "infant death" refers to the death of a live-born child before it reaches its first birthday or the survey date, whichever comes first.

Such socioeconomic and biological factors as residence, education, occupation, age of mother, and practice of family planning were taken into consideration in the course of the analysis. The time period under study was arbitrarily divided into three parts: before 1955, 1955-64, and 1965-71. It is assumed that during the first period the society essentially remained traditional, during 1955-64 population awareness was developed and family planning programs were introduced,

*The survey collected detailed information, such as birth date, mortality data, etc., up to the seventh child. Beyond that birth order, only the total number of children born was recorded for each woman interviewed.

**The coverage of neonatal deaths is usually the least satisfactory in comparison with other age groups in a survey or registration. The heart of the Valaoras method[27] is in detecting the degree of omissions of neonatal deaths based on given levels of infant and childhood mortality by use of a regression analysis. According to the data from 30 countries with reliable vital statistics around 1955-59, relationships between the proportion of neonatal deaths to all infant deaths and the logarithm of childhood death rate (1-4 years) and between the proportion and the logarithm of infant mortality rate were inversely correlated with values over .90. Comparison of the observed proportion with the expected one will provide indications of underreporting, if any exist.

***Korean custom requires accurate records of their children's date of birth (and in the majority of cases, the hour of birth as well).[28] Given this custom, the current data on birth intervals are assumed to be very accurate.

TABLE 1—Closed Birth Intervals in Months by Survivorship of Infant, Year of Birth, and Birth Order: Korea, KIFP Survey, 1971

Year of birth*	Before 1955					1955–1964					1965–1971				
Outcome of birth	Survived		Died			Survived		Died			Survived		Died		
Births between	No.	Mean interval	No.	Mean interval	t[a]	No.	Mean interval	No.	Mean interval	t[a]	No.	Mean interval	No.	Mean interval	t[a]
1–2	2099	37.3	332	26.4	10.71	1844	31.4	112	23.4	7.13	845	27.1	48	19.0	5.90
2–3	1602	37.5	219	29.9	7.98	1788	33.2	113	24.6	7.75	704	29.1	43	18.6	7.27
3–4	1175	37.1	149	28.1	8.08	1532	34.0	98	22.7	9.83	557	30.5	33	19.8	6.34
4–5	814	37.0	91	28.7	5.77	1218	34.9	82	24.1	8.24	404	31.2	36	20.3	6.77
5–6	468	35.6	61	27.9	4.76	931	35.2	72	27.9	4.96	286	31.8	28	24.2	3.85
6–7	226	34.2	36	28.2	2.91	663	35.2	42	27.0	4.20	154	31.4	23	23.0	3.53
TOTAL	6384	37.0	888	28.7	17.56	7976	33.6	519	24.5	17.20	2950	29.5	211	20.4	13.29

[a]All t-values are highly significant statistically.
*The date and outcome refer to the first birth of a birth interval.

and in the last period an active national population program was put into effect.

Results

Birth interval

The birth interval following the death of an infant is definitely shorter than that following the surviving infant for all birth orders, as shown in Table 1. This shorter interval is present regardless of the time period into which the last birth falls. There is, however, a suggestion that the difference between the two intervals increases over time (an average of 8.3 months before 1955, as against 9.1 months in 1955-1964, and 9.1 months in the short reference period of 1965-1971). Birth intervals decreased by 8 months for early parities from pre-1955 to 1965-71 whether the first birth survived or died.

The difference in the birth interval by fate of preceding infant remains highly significant when other variables are taken into consideration simultaneously. For the data of 1965 and after, five additional variables that might affect fertility were considered. These variables were: longest residence after marriage (RES), education of woman (RED), occupation of husband (HOC), experience of contraceptive practice between the ith and $(i + 1)$ births (FPL), and age of mother at the ith birth (AGE). Analysis of variance and covariance (ANOVA) showed that two of the six variables, i.e., FPL and fate of the last child (MORT), consistently showed highly significant effects on the subsequent birth interval.

As a typical case, the F-ratios of ANOVA for the interval between the third and fourth births are shown in Table 2. This particular birth interval is of special interest in the study of Korean fertility, since whether or not to have a fourth child seems to be a key decision in the family building process.[30] Also shown in Table 2 are the results of multiple classification analysis (MCA). This technique is a type of multiple regression analysis using dummy variables, based on an additive model.[31] It presents unadjusted means of the dependent variable for each category of independent variables, along with the strength of the effects (eta) and relative importance (beta) of specified independent variables and the multiple correlation coefficient (R^2). While the six variables jointly explain 15 per cent of the variation in the fourth birth interval, the relative importance of the fate of the third child is marked, along with the family planning variable. The interval by fate of the last child appears to be little influenced by other variables; the adjusted intervals for the infant mortality variable are almost the same as the corresponding unadjusted intervals.

Parity Progression Ratio

In Table 3 the PPR by fate of the preceding infant is shown for each birth order. As stated earlier, the PPR is the proportion of women in parity i who have proceeded into parity i+1. As such, it may be considered as the conditional probability of a woman of a specified parity bearing an additional child.

Although the PPR is also invariably higher across the birth order when the last infant died than when it survived, the difference between the two fates is small for births before 1965: in spite of large sample sizes, most of the x^2 values failed to provide statistical significance. Since 1965, however, marked differences are observed between the two PPRs of a given birth order. The time of the emergence of definitive differences is significant in that the full scale Korean national family planning program was not put into effect until about 1964, when nearly 1,500 family planning workers were placed in the entire country for the first time.[32] Hence, it has probably been only since about 1965 that methods to control fertility were generally available to the public at large.

For the data of 1965 and after, the effect of infant mortality remains significant when other variables are simultaneously considered. According to ANOVA, for each birth order, the variables RES, FPL, AGE, and MORT significantly influence the PPR. As a typical case, the results of ANOVA and MCA for the PPR from parity three to four are shown in Table 4. The relative importance of the independent variable in the joint explanation of PPR (*beta*) is largest for the family planning variable, as might be expected. In terms of the absolute magnitude of the difference in the PPR, however, the

TABLE 2—Birth Interval between the Third and Fourth Births, Third Births Occurring 1965 and after, by Mortality and Selected Characteristics of Parents: Korea, KIFP Survey, 1971

			Unadjusted		Adjusted	
Characteristics	F-ratio	N	Mean Interval	eta	Mean Interval	beta
Main Effects	13.69***					
RESIDENCE	1.24			0.06		0.06
City		151	30.97		30.94	
Middletown		49	29.20		29.58	
Rural		389	29.62		29.58	
EDUCATION	<1			0.03		0.02
<6 years		166	29.85		30.28	
7-9 years		328	29.78		29.79	
≥10 years		95	30.58		29.82	
OCCUPATION	<1			0.01		0.03
Unskilled		364	29.89		30.19	
Skilled		225	30.00		29.50	
FPL	50.19***			0.28		0.28
No		506	28.81		28.82	
Yes		83	36.77		36.69	
MORTALITY	38.02***			0.25		0.24
Survived		556	30.53		30.50	
Died		33	19.79		20.38	
Covariate—AGE	<1					
2-way interaction	<1					
TOTAL		589	29.93			
R^2						0.145

Note: Variable labels
RESIDENCE—longest residence after marriage of mother
EDUCATION—education of mother
OCCUPATION—occupation of father
FPL—experience of family planning between the third and fourth births
MORTALITY—survivorship of the third child in infancy
AGE—age of mother at the third birth

**P < 0.01
***P < 0.001

TABLE 3—Parity Progression Ratio by Survivorship of Infant, Year of Birth, and Birth Order: Korea, KIFP Survey, 1971

Year of Birth	Before 1955					1955-1964					1965-1971				
Outcome of birth	Survived		Died			Survived		Died			Survived		Died		
Birth Order	No.	Prog. Ratio	No.	Prog. Ratio	χ^2	No.	Prog. Ratio	No.	Prog. Ratio	χ^2	No.	Prog. Ratio	No.	Prog. Ratio	χ^2
1st	2,162	97.1	333	99.7	6.88**	1,901	97.0	116	96.6	.00	1,350	62.6	56	85.7	11.43***
2nd	1,658	96.6	225	97.3	.13	1,880	95.1	118	95.8	.01	1,325	53.1	65	66.2	3.72
3rd	1,227	95.8	152	98.0	1.27	1,713	89.4	102	96.1	3.94*	1,204	46.3	47	70.2	9.47***
4th	847	96.1	93	97.8	.31	1,449	84.0	87	94.2	5.80*	991	40.8	55	65.4	12.04***
5th	501	93.4	61	100.0	3.16	1,176	79.2	83	86.7	2.30	757	39.8	41	68.3	13.92***
6th	238	95.0	38	94.7	.12	929	71.4	55	76.4	.42	503	30.6	38	60.5	13.03***
All Orders	6,633	96.2	902	98.4	10.78***	9,048	88.2	561	92.5	9.38***	6,130	48.1	302	69.9	53.58***
Partition of χ^2 by Mantel-Haenszel procedure															
χ^2 total (6df)					14.98*					14.76*					69.53***
χ^2 homogenity (5df)					4.02					3.95					5.14
χ^2 association (1df)					10.96***					10.81**					64.39***
Odds ratio					2.43					1.73					2.73

Note:
*p < 0.05
**p < 0.01
***p < 0.001

TABLE 4—Parity Progression Ratio from Three to Four for Third Births Occurring in 1965 and after by Survivorship of Infant and Selected Characteristics of Parents: Korean Women, KIFP Survey, 1971

			Unadjusted		Adjusted	
Characteristics	F-ratio	N	Ratio	eta	Ratio	beta
Main Effects	21.79***					
RESIDENCE	10.56***			0.19		0.12
City		442	34.2		39.2	
Middletown		96	51.0		53.2	
Rural		712	54.6		51.2	
EDUCATION	1.92			0.16		0.06
≤6 years		286	58.0		52.4	
7-9 years		688	47.7		46.1	
≥10 years		276	34.4		44.2	
OCCUPATION	3.15			0.15		0.05
Unskilled		673	54.1		49.5	
Skilled		577	39.0		44.4	
FPL	69.36***			0.26		0.23
No		923	54.8		54.0	
Yes		327	25.4		27.8	
MORTALITY	7.94**			0.09		0.07
Survived		1,203	46.2		46.4	
Died		47	70.2		64.2	
Covariate—AGE	13.55***					
2-way interactions	1.18					
TOTAL		1,250	47.1			
R^2						0.118

Note: RESIDENCE—longest residence after marriage of mother
EDUCATION—education of mother
OCCUPATION—occupation of father
FPL—experience of family planning between the third and fourth births
MORTALITY—survivorship of the third child in infancy
AGE—age of mother at the third birth
$^{**}P < 0.01$
$^{***}P < 0.001$

fate of the last child provides as large a difference as FPL in the adjusted figures. The relatively small beta for MORT may be due to a small number of infant deaths. Again, the adjusted ratios are not any different from the corresponding unadjusted ratios. Hence, the consideration of other variables is dropped in further analysis.

Fate of Two Preceding Infants

Birth interval by fate of two preceding children has been studied in the hope of evaluating biological and behavioral effects separately.[9, 12, 20] The rationale of such an approach is that if the shortened birth interval after an infant death is due solely to the lactational interruption, the current interval should not be influenced by the fate of the infant before the last child. On the other hand, if there is indeed a replacement effect of infant loss, then the birth interval following a surviving infant will still be shortened in case the child preceding the last birth died. Hence, it is speculated that if there is a replacement effect, the birth intervals following the sequences of "survival-death" and "death-survivial" may be similar.

This approach of "two-child fate" and birth interval is applied to the current data, and the results are shown in Table 5 with the four intervals by sequence of fates of the two preceding children forming two distinctive categories across the birth order. The birth interval is essentially determined by the fate of the last child only. The fate of the child preceding the last child seems to have little influence on the birth interval. Thus, the birth interval following the sequence SS (survival-survival) is very similar to that following the sequence DS (death-survival; analogous abbreviations will be used hereafter), as are those following sequences SD and DD.

The PPRs by fate of the two preceding children present a somewhat different picture from the birth interval (Table 6). It appears that PPR is more or less determined by the number of deaths in the two children rather than by the fate of the last birth only. Although the PPRs following one infant death have values intermediate between the two PPRs following the fates SS and DD (the latter frequently reaching 100 per cent), the death of the last child (SD) tends, with time, to result in a higher PPR than DS. If an arbitrary scoring system (−2, −0.5, +0.5, and +2) is given to the sequence of fates in the order of SS, DS, SD and DD, a linearity is noticed in the PPR. Especially in the recent data, practically the entire overall x^2 statistics belong to the component of linear trend, suggesting an increasing fertility impact of the fate of the last two infants by order (Table 7a).

The hierarchial classification analysis[33] provides further evidence of the emerging influence of the fate of the infant preceding the last birth on PPR in recent days. Since there are two possible fates for the last child within each parity and

TABLE 5—Closed Birth Intervals (in Months) by Fate of the Last Two Children, Year of Birth, and Birth Order: Korea, KIFP Survey, 1971.

Interval between Births	Fate of the Births[a]		Year of Birth					
			Before 1955		1955-1964		1965-1971	
i to i + 1	i − 1	i	No.	Mean Interval	No.	Mean Interval	No.	Mean Interval
2-3	S	S	1378	37.5	1672	33.2	663	29.0
	D	S	224	38.1	116	33.5	41	31.7
	S	D	162	29.6	103	24.7	37	18.8
	D	D	57	30.8	10	22.9	6	17.2
3-4	S	S	1026	37.1	1435	34.1	520	30.6
	D	S	149	37.1	97	33.0	37	29.7
	S	D	112	27.8	84	22.4	31	19.9
	D	D	37	29.2	14	24.6	2	18.0
4-5	S	S	703	36.7	1146	35.0	379	31.0
	D	S	111	38.8	72	33.2	25	34.6
	S	D	73	29.1	70	24.4	29	20.7
	D	D	18	27.3	12	22.7	7	18.7
5-6	S	S	422	35.4	863	35.2	269	31.9
	D	S	46	36.8	68	34.2	17	31.6
	S	D	44	28.3	61	28.0	21	22.6
	D	D	17	27.0	11	27.7	7	29.1
6-7	S	S	190	34.0	614	35.2	143	31.3
	D	S	36	35.1	49	34.4	11	33.4
	S	D	31	29.0	33	26.8	19	20.0
	D	D	5	23.8	9	27.4	4	37.0

[a]S for surviving infant and D for infant died

TABLE 6—Parity Progression Ratios in Per Cent by Fate of the Last Two Infants, Year of Birth, and Birth Order: Korea, KIFP Survey, 1971.

Parity Progression from i to i + 1	Fate of the Birth[a]		Year of the i-th Birth					
			Before 1955		1955-1964		1965-1971	
	i − 1	i	No.	PPR i to i + 1	No.	PPR i to i + 1	No.	PPR i to i + 1
2-3	S	S	1428	96.5	1760	95.0	1261	52.6
	D	S	230	97.4	120	96.7	64	64.1
	S	D	168	96.4	107	96.3	56	66.1
	D	D	57	100.0	11	90.9	9	66.7
3-4	S	S	1071	95.8	1606	89.4	1148	45.3
	D	S	156	95.5	107	90.6	56	66.1
	S	D	115	97.4	88	95.4	43	72.1
	D	D	37	100.0	14	100.0	4	50.0
4-5	S	S	734	95.8	1368	83.8	945	40.1
	D	S	113	98.2	81	88.9	46	54.3
	S	D	75	97.3	74	94.6	47	61.7
	D	D	18	100.0	13	92.3	8	87.5
5-6	S	S	451	93.6	1096	78.7	717	37.5
	D	S	50	92.0	80	85.0	40	42.5
	S	D	44	100.0	72	84.7	34	61.8
	D	D	17	100.0	11	100.0	7	100.0
6-7	S	S	200	95.0	865	71.0	467	30.6
	D	S	38	94.7	64	76.6	36	30.6
	S	D	33	93.9	45	73.3	33	57.6
	D	D	5	100.0	10	90.0	5	80.0

[a]S for surviving infant and D for infant died

TABLE 7—Partition of χ^2 for Parity Progression Ratios by Fate of Two Children Preceding
(a) Test of linearity[a] (combined parities two and above)

Source	df	χ^2—Values		
		Before 1955	1955-1964	1965-
Linear regression	1	6.49*	15.88***	59.21***
Deviation from linearity	2	0.47	0.02	0.36
Overall	3	6.96*	15.90**	59.57***

[a]Score for SS −2.0, for DS − 0.5, for SD + 0.5 and DD + 2.0.

(b) Hierarchial classification analysis

Source	df	χ^2—Values		
		Before 1955	1955-1964	1965-
Parity	4	11.07*	376.17***	92.11***
Fate of the ith child	5	6.59	15.55**	54.93***
Fate of the (i−1)th child	10	4.92	10.34	23.39**
Total	19	22.58	402.06***	170.44***
N		5,040	7,592	5,026

*p < .05
**p < .01
***p < .001

there are two further fates for the (i-l)th child within each fate of the ith child, the effect of the ith child's fate is statistically nested in parity, and the effect of the fate of the (i-l)th child is nested in ith child's fate. As shown in Table 7b, the effect of the fate of the last child within parity was already significant in 1955-1964, but the effect of the fate of the infant preceding the last birth, has become significant only since 1965.

Conclusions and Discussion

The present study is based on a secondary analysis of a national fertility survey. As such, there are certain limitations in the data. There may be some inherent problems stemming from retrospective fertility information. The data do not answer the important question of whether a child died before or after the next conception took place. By dealing with infant death only, the difficulty is largely overcome, since it means death before the age of 12 months and the usual birth interval is more than 30 months. A large number of induced abortions is taking place in Korea.[34] It is likely that the frequency of abortion varies according to fate of the preceding child.

Nevertheless, the present Korean data seem to indicate conclusively that the experience with infant death has increased the sequential risk of childbearing across the birth order and irrespective of time, whether family planning services were available or not. A joint examination of birth interval and parity progression ratio (PPR) by fate of preceding children suggests, however, that in early days the influence of infant mortality on fertility may have been due largely, if not solely, to physiological effect. On the other hand, since about 1965 when vigorous contraceptive programs were offered to the public, the replacement effect, in addition to the physiological effect, of infant mortality has begun to emerge.

During the pre-program days, the deaths of infants reduced the birth interval but did not increase the PPR. The minimum eight-month difference in birth interval by the fate of preceding infants is, therefore, presumably due to the lactational interruption. The mothers with surviving infants eventually, after some lag in conception, catch up to the mothers with infant death, in bearing an additional child. Because of this lag in conception, there would be more chance for the mothers with surviving infants to become physiologically sterile, resulting in their slightly lower PPR in comparison with the mothers who experienced infant death.

It is claimed that less than 5 per cent of Korean women practiced contraception before the introduction of the national family planning program in 1962.[35] The total fertility around 1960 exceeded six children per woman.[22] Although it is lower than maximum fertility, about six live births in a lifetime appear to represent natural fertility in a traditional society.[36] Because of ignorance of family planning methods or failure in framing family size goals in terms of surviving number of children, volitional replacement mechanisms seem to have been non-existent in the population in those days.

The marked difference between the two PPRs by fate of the preceding birth, and the graduation of PPRs by number of deaths in two earlier births seem to indicate an emergence of the replacement effect in recent years, and coincide with the general availability of family planning services. It is puzzling that the birth interval is still influenced by the fate of the last child only. The contradiction may be explained, however, if Korean women use contraceptive methods predominantly for terminating fertility but not for spacing births. When the infant survives, more women use contraceptives to control fertility, resulting in a reduction of PPR.

It is possible that the recent marked difference in the PPR by fate of the last child is due to a truncation effect since the average reference period is only four years for the births in 1965–1971. To control the period of observation, the probability of an additional birth in a specified period of time after a birth is shown in Table 8, applying the life table technique. Because of the small sample size for infant death in recent years, cautious observations are called for in certain cases. Nevertheless, the Table seems to indicate that for a given period after the ith birth the difference in the fate-specific probabilities of the (i+1)th birth increases with time. It further seems that the probability of low order births has considerably increased, but that of high order births has decreased recently, suggesting a decline in family size norm over time. It may be noticed that even in higher order births, infant mortality has considerably increased the subsequent birth probability.

It does not seem that the custom of breastfeeding has changed a great deal in Korea. Except when physiologically incapable, practically all women still breastfeed their babies.[23] On the other hand, there is some tendency to shorten the period of breastfeeding, especially among young women and in urban areas.[24] Such changes, however, would have diminished the physiological effect of infant death. Coital taboos or restrictions for breastfeeding mothers are unknown in Korea. It has been suggested that such a custom causes differential birth interval by fate of infant in Africa.[37]

The ideal family size has declined in Korea of late, from 3.9 in 1965[38] to 3.1 in 1973,[30] and the society has rapidly undergone the process of modernization, especially since the conclusion of the Korean War, 1950–1953. The introduction of a national contraceptive campaign at this stage appears to have provided strong impetus to control fertility. The traditional preference for sons began to show its impact on subsequent fertility only after family planning services were made available.[30] Breastfeeding is not an intervening factor in the effect of son preference. It may be said that since the introduction of a national family planning program the survival of a child for at least one year results in a considerable decrease in subsequent fertility.

Although a reduction in infant mortality thus facilitates a decline in fertility, the question still remains whether a reduction in child mortality is a necessary prerequisite for the spread of family limitation still remains unanswered.[3,14] Taylor considers that it would be unreasonable for anyone to

TABLE 8—Probability of an Additional Birth at Specified Period after the i-th Birth, by Year of Birth and Fate of the i-th Birth: Korea, KIFP Survey, 1971

		Year of the i-th birth					
		Before 1955		1955–1964		1965–1971	
		i-th Infant					
Birth Following Order i	Months after i-th Birth	Survived	Died	Survived	Died	Survived	Died
1	18	.050	.318	.078	.466	.103	.510[b]
	24	.177	.508	.310	.621[a]	.385	.726[b]
	36	.537	.775	.712	.828[b]	.767	.922[c]
	48	.756	.859	.879	.922[b]	.894	.922[c]
2	18	.046	.236	.046	.288	.041	.530[b]
	24	.148	.418	.219	.585	.240	.752[b]
	36	.512	.733	.671	.822[b]	.667	.804[c]
	48	.769	.849[a]	.836	.924[b]	.805	.878[c]
3	18	.034	.250	.034	.402	.034	.350[b]
	24	.130	.460	.162	.628[a]	.163	.578[b]
	36	.545	.763[a]	.597	.872[a]	.535	.848[c]
	48	.784	.888[b]	.792	.931[c]	.691	.848[c]
4	18	.047	.226	.032	.333	.012	.420[b]
	24	.138	.495[a]	.135	.552[a]	.130	.652[b]
	36	.528	.747[b]	.539	.839[b]	.470	.877[c]
	48	.778	.846[b]	.732	.897[c]	.600	.959[c]
5–6	18	.058	.202	.033	.261	.024	.298[a]
	24	.156	.444	.128	.413	.101	.494[a]
	36	.551	.778[b]	.484	.671[a]	.382	.754[b]
	48	.819	.899[b]	.645	.753[a]	.492	.789[b]

[a]number of cases at risk <50
[b]number of cases at risk <30
[c]number of cases at risk <10

claim that replacement desires would override all other considerations as a motivational force.[14] The interrelations among family size norms, infant mortality, birth order, sex preference of children, and many other factors would doubtless contribute to a couple's decision about whether to have an additional child. For instance, the death of a sixth-order child in a society with a three-child norm would have an entirely different effect on the probability of having a seventh child than would the death of a second-order child in a five-child norm society.

During the past few decades, especially since the conclusion of the Korean War in 1953, great changes in socioeconimic conditions have taken place in Korea. The economically active female population (age 14 and older) increased from 28 per cent in 1960 to 32 per cent in 1966 and 38 per cent in 1970.[39] While the number of employed women increased from 2,010,000 in 1960 to 3,575,000 in 1970, the proportion engaged in farming and fishing decreased from 70 per cent to 60 per cent.[39] Among women aged 15 years and over, 33 per cent were illiterate in 1955, 26 per cent in 1960 and 19 per cent in 1970.[40] In 1955, less than 25 per cent of the entire population lived in cities; By 1970 the proportion had risen to more than 40 per cent. During the four-year period 1966-70, there was a 36 per cent increase in the urban population, while the rural population lost 7 per cent.[22] The crude death rate was practically halved in 15 years, from 16.3 per 1,000 persons in 1955-60 to 8.4 in 1966-70.[22] The present data also indicate that the infant mortality rate declined from 119.7/1,000 live births before 1955 to 58.4 in 1955-64 and to 47.0 in 1965-71. Changes in the birth rate are somewhat less spectacular but nevertheless striking, a decline from 43.3/1,000 in 1955-60 to 30.0 in 1966-70.[22] As has been observed in many other societies, Korean vital statistics rates have changed hand-in-hand with levels of other socioeconomic indicators. Nevertheless, analyses using adjusted parity progression ratios and birth intervals suggest that the impact of infant death on fertility persists in all the social strata considered in the study.

The personal experience of an infant death does increase the risk of an additional birth. But what impact does it have on the national fertility rate? The procedure to measure the risk attributable to part of a given population, developed by Levin,[41] measures the impact that a specified exposure may have on the total population with respect to a particular outcome.[42, 43] In computation it uses the effect of relative risk of the causative factor on the proportion of persons in the population who are exposed to the factor. As the level of infant mortality determines the proportion of mothers exposed to the risk factor of early conception, and considering that the relative risk for additional births is obtained by the ratio of two corresponding PPRs according to fate of the last infant, application of Levin's procedure to the present data is straightforward.

Unfortunately, it may not be suitable for measuring population impact in the case of repetitive events, such as fertility or common colds, as it disregards possible differences in risks through the time interval between two successive events. Even under the condition that the incidence of the next birth (PPR) is the same whether the last infant has survived or died, higher subsequent fertility per unit of time will follow from infant deaths, as long as the following birth interval is shorter than that following a surviving infant.

A new indicator has been used to estimate the excess births due to infant deaths in the present study. Two components contribute to such excess: shortened birth intervals and increased PPR owing to infant death. Suppose the difference between the birth intervals by fate of infant is D. Then the mean birth interval following the surviving infant divided by D would represent the number of infant deaths replaced by an excess birth.* The estimated annual number of infant deaths in the nation is then divided by this number to give the excess births derived from the first component. The contribution from the second component is obtained by multiplying the annual number of infant deaths and the increment of PPR due to infant death. The addition of these two sources of excess births amounts to 2.9 per cent of total births both before 1955 and after 1965, and 1.8 per cent in 1955-64. This in turn would mean that elimination of infant mortality entirely would cause about one point reduction in the crude birth rate. For example, before 1955 the annual average number of births and infant deaths were estimated as 830,000 and 99,350 respectively. The difference in the mean birth interval by survivorship of infant was 8.3 months (Table 1). As the mean interval for surviving infants is 37.0 months, 37.0 divided by 8.3 = 4.5 infant deaths resulted in one extra live birth during the same elapsed time. Since there are a constant 99,350 infant deaths per year, there will be 99,350 divided by 4.5 = 22,100 excess births accounted for by the difference in birth interval according to fate of the infant. The PPR for infant death was 0.022 higher than for the surviving infant (Table 3). Multiplying this number by the total number of infant deaths, we obtain 2,180, which is the excess in births owing to the difference in PPR by fate of infant. Addition of the two sources of excess births gives 24,280, which is 2.9 per cent of the total births.

Although the impact of infant mortality on the national birthrate level was rather small before 1955, it appears that the augmented risk of fertility attributable to infant mortality increased as the level of infant mortality declined. This makes sense in that by the time infant mortality reaches a low level, social progress has occurred, family size norms have dropped, and rational fertility planning has taken place. If every childbirth were planned, there would be a strong desire to replace the loss of a child. Because of low infant mortality, however, such replacement would not have much effect on the national fertility. Thus, the effect of infant mortality on fertility may be of microlevel concern but may not have much impact on the macrolevel.

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*This approach is analogous to that of Potter, who estimates the number of births averted in a family planning program by dividing the length of the average interruption of childbearing due to the use of contraceptives by the average length of birth interval in the absence of the contraceptive.[44]

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