CENTRO LATINOAMERICANO DE DEMOGRAFIA
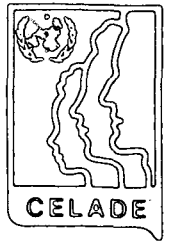
CELADE

THE EFFECTS OF INFANT AND CHILD MORTALITY
ON FERTILITY IN LATIN AMERICA

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INDEX

Figures and Tables.

A B S T R A C T

Conceptually the paths of influence of infant and child mortality
on fertility may be classified according to the source of child mortality
experience. Direct personal experience is derived from the deaths of one's
own children. Indirect personal experience is obtained through perceptions
of the existing level of child mortality in the local area. Societal
experience of child mortality is not perceived by the couple but has been
incorporated into the socio-cultural structure of the community. A further
division of the paths is that between biological effects and effect involv-
ing fertility preferences. Fertility preferences encompass goals for
completed family size and desires for the timing of births.

Problems for analysis of the paths arise from problems in measurement
of the basic data due to an absolute lack of necessary data, and inaccuracy
and ambiguity of the data. Other problems are biases in the analysis because
of the failure to correct for spurious relationships due to exposure
variables and socio-economic variables among others. Results of analyses
on direct personal experience undertaken with Pecfal-Rural data for the
rural and semiurban areas of four Latin American countries show that child
mortality has had little effect on actual fertility behavior except for a
shortening of closed birth intervals with an infant death due to a biologi-
cal effect. The lack of non-biological effects is attributed to the low
level of use of fertility control in the areas studied. Results of further
analyses show that a portion of the low level of use may be attributable to
infant and child mortality.

ACKNOWLEDGEMENTS

During the last fifty years the mortality rates, particularly those of infants and children, in Latin American countries have dropped considerably (See Appendix A).A Consequence of this reduction is that through effective health policies many children have survived, thereby increasing the need for schooling, jobs, and the number of potential parents in the next generation.

However, it is possible that reduced infant and child mortality has also led to a decrease in fertility. It is this hypothesized decline in fertility which concerns us in this paper.

The paper will be structured in the following manner: first we will discuss some hypothesized ways in which fertility may be affected by infant and child mortality, then we focus our attention on measurement problems and analytical biases; next we review some results of analyses with cross-sectional data, and finally we present some of the results of analyses done with micro-level data for rural and semiurban areas in Latin America.

PATHS THROUGH WHICH FERTILITY MAY BE AFFECTED

The paths through which child mortality[1] may influence fertility originate with three sources of experience: direct personal experience, indirect personal experience, and societal experience (see Figure 1).

Sources of Experience

Direct personal experience -- By direct personal experience of child mortality we mean the experience by a couple of the death of one or more of their own children. Obviously this is the most drastic influence of child mortality. However, because the death of a child may be experienced by a minority of couples (but see figures presented later), other types of experience may have a greater overall effect.

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[1] We will use the term child mortality to refer to mortality of both infants and children up to 15 years of age. The term infant mortality refers to mortality of children up to one year of age.

Figure I: Conceptual Scheme of the Paths of Influence Between
Infant and Child Mortality and Fertility
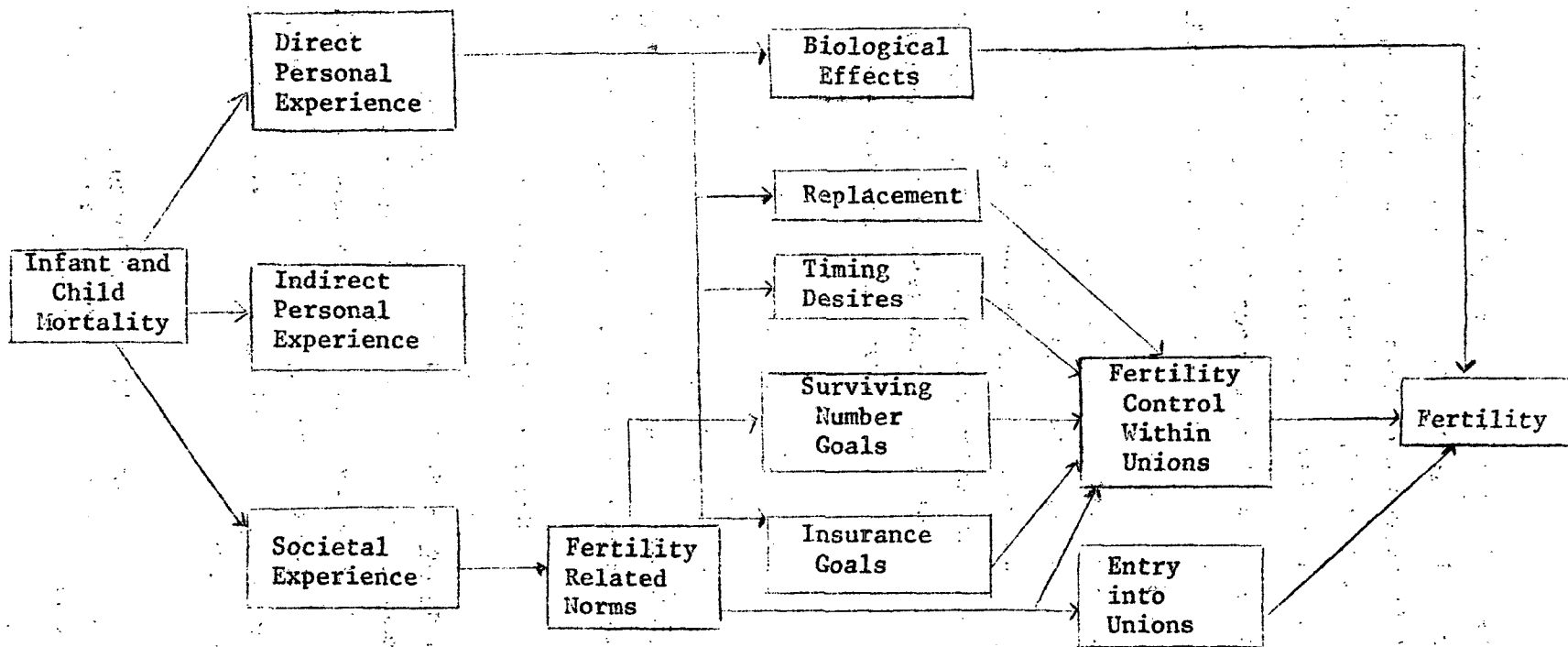
Indirect personal experience - We call indirect personal experience that
which reaches the couple by knowledge of child deaths that have occurred
among family, friends, neighbors or the community in general or knowledge
or feelings about the child mortality level in the community or local area.
In other words, the perceptions about child mortality not directly experienced
but which however, the couple takes into consideration consciously or sub-
consciously when making family size goals decisions. Like direct personal
experience, indirect experience may induce changes in both surviving children
goals and insurance goals (defined in next section) and in timing desires.
However, unlike direct experience, indirect experience will be taken into
account when family size goals are first formed.

Societal experience - By societal experience we mean that experience of
child mortality in the past which has now been incorporated into the socio-
cultural structure. Norms on specific aspects of fertility behavior such as
those on age at union (marriage), on sexual relations within marriage, and on
use of fertility control may be affected by child mortality as well as norms
involving family size goals. The process of translating societal experience
into such fertility-related norms is somewhat obscure but probably has
occurred over a lengthy period of time. We should expect norms to change
with changing community levels of child mortality only after a long time lag,
perhaps as long as one or two generations.

In this paper only the paths by which the direct personal experience of
child mortality can influence fertility are investigated. These paths are of
two types: those that act through biological effects and those that involve
fertility preferences.

<div align="center">Mechanisms</div>

Biological Effects

Certain paths of influence for child mortality involve biological effects
and are independent of fertility preferences. All involve only direct personal
experience. Most obvious are the biological consequences of reduced intervals
due to shortened periods of lactation resulting from the deaths of breastfed

children. In populations where there exists a limiting type of fertility control, this shortening of lactation should only produce a variation in the timing of births, but in populations where limiting is not practiced, the total number of births would be affected as well.

An apparent biological effect is that fertility may be reduced with direct experience of child mortality. Such would be the case if a health problem related to the birth of the child led to both the child's death and the mother's inability (or lessened) to have another live birth. Presumably the relation would exist only for the last birth. The relation is apparent in that an exogenous factor, the health problem, led to both the mortality and the reduced fertility.

Fertility Preferences

Terms referring to family size goals are problematic when considered together with the possibility of child mortality. Often when family size goals are discussed a distinction is not made between the number of births (childbearing goals) and surviving children (surviving children goals). Moreover, the word surviving is problematic: surviving until when? For our purposes we will define number of surviving children as surviving until fifteen years of age.[2] Once we have defined what is meant by a number-surviving goal, we may define the difference between childbearing goals and surviving goals as an "insurance" against the possibility of leaving surviving family size goals unaccomplished because of child death.

2/ Other definitions have been used: a common one is survival until one or both parents are dead (see Immerwahr, 1967). However, this definition is somewhat ambiguous and would be different for each couple and would change with changing mortality rates. The limit of survival we have selected is fixed in time and is the same for all couples. We have chosen 15 years of age as the dividing line between childhood and adulthood.

Direct personal experience acts through direct replacement, through changing goals for the number of insurance births, and through changing desires for the timing of births. Changes in the goal for number of surviving children would not occur, except as an artefact of the operational definition of survival.

Replacement - Direct personal experience of child mortality would relate to fertility through replacement if couples have additional births in order to replace a child who has died while maintaining the original childbearing goals (i.e., this is independent of any insurance factor). Replacement could only occur in populations who limit their fertility since otherwise the decision not to replace cannot be carried out.

Insurance - Couples may desire to have additional births in order to compensate for expected future mortality. It should be noted however, that direct personal experience would only change the insurance goals if it changed future expectations. Direct experience that does not change these mortality expectations (i.e., is in line with these expectations) would not result in changes in family size goals. We should also realize that child mortality expectations not met for a lack of direct experience may also act to change family size goals. A problem here is that there is no single event to which we may attribute changes in expectations. Change in expectations would appear to be the result of a gradual realization process that may extend over a long period of time of child bearing and child raising.

Timing Desires - A path of influence of child mortality on fertility, may be the effect on the desired timing of births. One form of insurance against the possibility of child death may take the form of a desire to have the number of desired children as soon as possible, in order to be able (for reasons of health, age, etc.) to have additional births in case of one or more children die.[3/]

3/ An indication of this type of thinking has been noted as one of the reasons in avoidance of permanent sterilization such as vasectomy and in the reluctance to accept certain family planning methods for fear of possible fecundity impairments even when the parents do not want any more children.

In a population where the only fertility control methods are essentially spacing rather than limiting methods (e.g., prolonged breastfeeding) the influence of child mortality through timing would reflect itself on completed family size by influencing the tempo of childbearing until menopause. Even in populations who completely control their completed family sizes, growth rates of the population would be affected through changes in the intergenerational interval.

However, for populations who only use spacing type methods of fertility control, direct personal experience could result in a decision to shorten the birth interval, in order to have a replacement birth as soon as possible. The impact of this shortening on total number of children born would depend, of course, on the age at which the child died.

Underlying Assumptions

Any of the paths of influence, excluding that involving biological effects, can have an effect on actual fertility only if there is a control over fertility. To the extent that such control does not exist for reasons not related to child mortality, such as lack of knowledge, child mortality will not affect actual fertility behavior. However, it is well known that in practically all populations there exists the possibility for strongly motivated couples of some form of intentional fertility control. That such control is not exercised may be partially dependent on the direct and indirect personal experience and the societal experience of child mortality. Since in most of Latin America, use of fertility control methods is extremely low, we do not expect to find a substantial effect of direct personal experience on fertility.

One problem with the definition we have given above is that family size goals may not exist, or even if they do exist may not be directly related to behavioral fertility decisions or may change markedly over time for other motives. It is logical to presume that couples do not establish family size goals per se. Since children are usually born one by one, parents need only to decide whether they do or do not want to have another child. Those that want another child need not have decided as yet on any further number of

children. Even if there exists a recognized family size goal, this goal may be ambiguous. That is, the couple prefers a certain range of numbers of children, but if they have not yet reached the lower limit of the range they will decide to have another child without an explicit family size goal. The nature of the influence through direct personal experience would have to be modified and limited in the case that specific family size goals do not exist. The concept of insurance births may or may not be applicable in this case.

METHODOLOGICAL PROBLEMS

In this section we discuss some of the problems involved in the analysis of the various paths of influence of child mortality on fertility. These problems may be classified into two basic groups: those involved in measurement of the phenomenon and those involved in the analysis.

Measurement Problems

Data that has been used in the analysis of the effects of child mortality on fertility have come from three sources: vital statistics, censuses and retrospective surveys (especially, pregnancy histories). A basic problem, in varying degrees for all three sources, is that of measuring fertility and, particularly child mortality. In analyzing the relationship between the two, errors in their measurements may be of crucial importance. As is well known, most vital statistics are deficient in the registration both of births and of deaths of children who die before the registration of their births. As the registration of births in many less developed countries may occur considerably after the date of birth, the undercount of births and child mortality is of substantial proportions. Moreover, most if not all of these data derived from censuses and retrospective surveys are deficient because of faulty declaration about children who have died; presumably the magnitude of the deficiency increases as the respondents recall further into the past. In addition, censuses and other retrospective data sources may include random errors (in the sense of counterbalancing uncertainty) and biases (in the sense of an unbalanced shift forward of backward) in the time location of birth and death events.

Another problem is the lack of pertinent data for the correct evaluation of the paths of influence. For many countries, data necessary to evaluate indirect personal experience (family size goals, perceptions about mortality, etc.) and community experience (norms, perceptions on family size goals and child mortality, etc.) are completely or almost completely lacking.

In many cases for the analysis of direct personal experience, data on variables such as educational levels, development, exposure, etc., necessary for the control of spurious relationships are also lacking. Where such data is present, its value is reduced because of ambiguities, particularly those which result from not having a time reference. Important and typical examples of this lack of time reference are questions on lactation and on perception of child mortality, which usually contain words such as "in the past", "nowadays", "usually" (e.g., "Do children today die less, the same, or more than before"?).

Analytical Biases

Analytical biases in the study of the influence of child mortality on fertility result, primarily from two sources: the failure to consider the two-way nature of the child mortality – fertility relationships and the failure to control for the effects of other variables that may be related simultaneously to both child mortality and fertility.

The first type of bias, the two-way relationship between child mortality and fertility, becomes especially serious when actual levels of both child mortality and fertility are used directly in the analysis, i.e., as in an analysis of the effect of direct personal experience on actual fertility behavior.[4/] A portion of the two-way relationship is real; the rest is apparent and is due to the nature of the data and how it is used. On the one hand, that fertility may affect child mortality is well known, examples being the U-shaped curves of infant mortality with mother's age

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4/ The problem exists either with absolute number of births and deaths for analysis on the microlevel or with birth and death rates for macrolevel analysis.

and parity; pregnancy-caused early weaning; and child mortality due to increased burdens cf fertility on the resources of the family and the community. On the other hand, fertility may appear to affect child mortality if the increase in exposure to the risk of child mortality due to fertility is not eliminated or adequately taken into account. An example of an analysis with such a bias would be the calculation of relating the mean number of births for women to the number of child deaths they have had.[5] A solution to the problem is to use the time sequence of the events and therefore count only those child deaths up to a certain point in time while considering only subsequent fertility behavior.

A second principal source of bias is the failure to control for the effects of those variables which are related at the same time to both child mortality and fertility. A special but very important case for the relationship between actual levels of mortality and fertility is that of the time exposure to the risk of subsequent fertility. In certain types of analysis, couples with higher numbers of child deaths are more exposed to the risk of a subsequent pregnancy. Examples are in situations of falling mortality rates over time, where couples of differing exposure to the risk of child mortality are grouped together (thus linking both exposure to mortality and exposure to fertility) or where not enough time is allowed for subsequent births to occur. When not specifically taken into account, other variables, especially socio-economic, may also distort the relationship between child mortality and fertility. Because child mortality is so strongly related to the standard of living, development, education, etc., analyses of any of the paths of influence will be biased unless such variables are taken into account.

In addition to these two most important sources of bias, we should briefly mention some others. The most important of these is really a conceptual bias: that of analyzing the effect of child mortality on fertility using the survival of only the immediate previous birth [6] instead of all

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5/ At the macrolevel such a bias would result if average number of child deaths and average parity were used as the variables under analysis.

6/ An example would be to consider what happens to fertility after the fourth birth by the result of the fourth birth only, ignoring the results cf the other three births.

previous births. In this case deaths to earlier-born children are disregarded
even if they came after the immediate previous birth and therefore do not
add to the couple's direct experience of child mortality. Thus, it is
assumed that an overall divergence between actual and desired number of
surviving children cannot affect fertility. Other biases may arise from a
failure to consider sex preferences, existing family sex composition and the
sex of children who have died. Likewise the failure to consider the age at
death of the child or other conditions existing at the time of death such as
family size, income, attitudes and contraceptive knowledge may bias con-
clusions about the effect of child mortality.

PREVIOUS STUDIES IN LATIN AMERICA

There appear to be very few studies undertaken in Latin America that
evaluate the effects of child mortality on fertility. Of the three studies
known to the authors, all have analyzed aggregate (macrolevel) data, for
local areas. Two of the studies were on Puerto Rico. The third analyzed
Chilean data.

The two studies of Puerto Rico were cross-sectional studies done by
Schultz (1969), and Nerlove and Schultz (1970) as part of an investigation
of the family planning process. In both studies two aspects of the child
mortality-fertility relationship are conceptually discussed -- one, a
"replacement" motivation derived from direct personal experience (not
related to changes in fertility preferences) and an "uncertainty" motivation
(related to the insurance goal). However, the empirical effects of each are
not estimated separately. The two studies use essentially the same data from
the censuses of 1950 and 1960 and from vital statistics, pooling cross-
sectional and time-series data, for geo-political units.

In the first study, using ordinary least-squares regression, Schultz
estimates the relationship between the crude birth rate and a lagged crude
death rate. Variables for adult educational level, school attendance, women's
labor force participation, income level, marital status, proportion of unpaid
family workers, and proportions urban and working in agriculture are also

included. He finds that death rates lagged one and two years have substantial effects on the birth rates one or two years later. He further concludes that in Puerto Rico the death rates have a total long run elasticity effect of about 0.4 on the birth rate (i.e., a 1 percent decline in the death rate will lead to a 0.4 percent decline in the birth rate).

The second study on the Puerto Rican data by Nerlove and Schultz, included a somewhat revised model. In this work the authors dropped the variables proportions urban and working in agriculture and added an index of female age composition. They also have taken account of the crude death rate on fertility two to five years later. The estimation procedure is changed by the inclusion of technique of two-stage least squares regression. The parameters of the equation are estimated over three more years than in the first study. They find that the crude birth rate had larger coefficients with mortality lagged two or three years than with mortality lagged four or five years. They conclude that "depending on the method of estimation, the four year effect of a once-and-for-all unit change in the crude death rate is a 0.4 to 0.7 change in the crude birth rate" (Nerlove and Schultz, p. 49). The higher response is the one estimated using ordinary least squares regression so that the results from this study do not parallel the results from Schultz's earlier study. Moreover, the authors have not considered a one year lag crude death rates, which had the strongest effect in the first study.

The crude birth and death rates used in both studies are problematic. A major factor in the crude rates is the age structure, which in turn is mostly determined by the prior fertility rates. If prior fertility rates in an area a highly correlated with current rates (likely to occur), then spurious correlation between the crude rates can result. The method used in the second study to control for this age structure effect was to introduce an index of the age structure as an independent variable in a multiple regression. This procedure is not wholly satisfactory, and the authors report obtaining unexpected coefficients for this variable. A better procedure would have been to indirectly standardize the crude birth rate,

in the absence of more detailed age specific fertility rates.

A study involving cross-sectional data for Chile was undertaken by Da Vanzo (1971). The child mortality-fertility relationship was not, however, the main focus of the investigation. Data on the rural and urban areas of twenty-five central provinces were taken from the 1960 census and publications on the vital rates for 1958 and 1960. Since the vital rates did not correspond to the rural-urban divisions in the census, the infant mortality rates for the rural and urban areas of the provinces were estimated using a weighting procedure. Fertility is measured by age-specific mean numbers of births and 0-4 and 5-9 child-women ratios. As in the Puerto Rican studies, both ordinary and two-stage least squares regression was used to estimate the parameters over the geo-political units. Da Vanzo reports obtaining significant positive relationships between fertility and infant mortality (lagged two years) for all age groups except 15-19 and 20-24. In addition she concludes that since the 5-9 child woman ratio is more of a surviving measure of fertility, "The fact that the coefficient of the infant mortality variable is usually significant even for the 5-9 child-woman ratio may indicate that parents are overcompensating for child deaths". However, no specific evidence for overcompensation (insurance births) is given.

A STUDY OF THE RELATIONSHIP IN RURAL AREAS
OF LATIN AMERICA

Data

Microlevel analysis pertaining to the influence of child mortality on fertility was done using data collected in KAP-type fertility surveys in the rural and semiurban areas (areas of less than 20 000 population) in Colombia, Costa Rica, Mexico and Peru under a program of CELADE called Pecfal-Rural. The four surveys, utilizing standarized questionnaires and coding instructions, each interviewed approximately 3 000 women (2 000 in Costa Rica) of all marital statuses between the ages 15 and 49, inclusive. Information was obtained on various attitudes related to fertility, background variables,

knowledge and use of contraceptive methods, marital history and especially valuable for us, a pregnancy history, which includes information on dates of child deaths. This pregnancy history forms the basis of the data for our analysis, along with some background and other data from the survey. In all we have between 1 400 and 2 100 women with at least one birth in each country on which to base our study.

Levels of Child Mortality and Fertility

Present levels of fertility and child mortality in the rural and semi-urban areas are relatively high. Table 1 presents age-specific fertility rates for the twelve-month period preceeding the interview or approximately midyear 1968 to midyear 1969. The total fertility rates range from a low of 6 955 children per woman for Costa Rica, to a high of 7 860 for Peru. Mexico and Colombia are about midway between the extremes.

Table 1 also presents infant mortality rates, calculated by methods of Brass and Brass-Sullivan, for the four countries. These rates are lowest in Colombia and Costa Rica and highest in Peru as with the fertility rates. Using $_1q_0$ as a guide value, we see that about 15 out of 100 children did not reach their first birthday in Peru, while in Colombia and Costa Rica the proportion is about 8 out of 100, with Mexico somewhat higher.

However, the rates of infant mortality do not exactly describe the incidence of the experience of child mortality on the parents. Table 2 presents figures on the proportion of parents who have had personal experience with a child death. Of all women who have had at least one birth, at least forty percent have had one or more children die. In Peru, fifty-five percent, or over half of the mothers have had at least one such death. For comparisons, we have included figures for all Taiwan, taken from a similar study done by Rutstein (1971). The proportion of couples there who had a child die was less than one-fifth. This remarkable difference between these Latin American areas and Taiwan is made even more notable if we examine the mean number of child deaths per mother. The means for the Latin American areas are between 0.76 to 1.19 deaths per mother, or between three to five times the average for Taiwan.

Table 1

INDICATORS OF FERTILITY AND INFANT MORTALITY FOR RURAL SEMI-URBAN
AREAS OF FOUR LATIN AMERICAN COUNTRIES

Indicator	Costa Rica	Rural Semi-urban Areas Colombia	Mexico	Peru
Age Specific Fertility Rates				
Age Groups				
15-19	105	132	115	138
20-24	314	336	290	353
25-29	326	331	365	395
30-34	275	340	334	297
35-39	207	223	247	235
40-44	117	102	137	116
45-49	47	16	28	38
Total Fertility Rate	6955	7400	7580	7860
Mean Number of births				
Per Woman	3.8	3.7	3.9	3.7
Per Mother	5.5	5.3	5.6	4.9
Mean of declared "most convenient number of children"	5.1	4.8	6.0	5.2
Infant Mortality Rate [a]				
Method:				
Brass	77.4	76.5	93.9	149.9
Brass-Sullivan	75.7	75.6	93.3	155.6
Sullivan-Marriage Duration	85.8	85.1	94.9	138.4
Mean of Estimates	79.6	79.1	94.0	148.0

Source: Pecfal-Rural Fertility Survey, 1969-1970.
    Calculation of Fertility Rates:
    Colombia: Rates of 1967-69 from Henry Elkins, "Cambio de Fecundidad en
    Colombia", ASCOFAME, La Fecundidad en Colombia, Table 1, p. 31.
    Other Areas: Claudio Vila, CELADE, SIEF B-1 (unpublished).

a/ For each of the different methods, the estimates presented of the infant
mortality rates are the means of separate estimates of $_1q_0$ derived from
$_2q_0$ and $_3q_0$ using the West family of Model life tables.

Table 2

WOMEN WITH AT LEAST ONE BIRTH ACCORDING TO THEIR DIRECT PERSONAL EXPERIENCE OF CHILD MORTALITY, FOR RURAL-
SEMIURBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL TAIWAN

| Number of child deaths | LATIN AMERICA | | | | | | | | | |
| | COSTA RICA | | COLOMBIA | | MEXICO | | PERU | | TAIWAN a/ | |
	Number	Percent-age	Number	Percent-age	Number	Percent-age	Number	Percent-age	Number	Percent-age
0	834	59.2	1 110	58.7	1 130	54.0	890	45.3	1 779	81.0
1	326	23.2	430	22.3	510	24.5	440	22.3	322	14.7
2	132	9.4	190	9.9	250	12.1	300	15.3	66	3.0
3 and more	116	8.2	170	8.6	210	9.4	330	17.1	28	1.3
Total	1 408	100.0	1 900	100.0	2 100	100.0	1 960	100.0	2 195	100.0
Total child deaths	1 070		1 480		1 720		2 340		545	
Women with child deaths	574		790		970		1 070		416	
Percentage of women with child deaths	40.8		41.6		46.2		54.6		19.0	
Mean number of child deaths: per mother	0.76		0.78		0.82		1.19		0.25	
Per mother with child deaths	1.9		1.9		1.8		2.2		1.3	

Source: Latin America: Pecfal-Rural, CELADE, 1969-70.
        Taiwan: Rutstein, Shea Oscar, op. cit. Table 3.7 - KAP II.
a/ Women of 20-44 years, married.

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The experience of child mortality is not evenly distributed. Some women are prone to have more than one child die, especially where mortality is high. In this respect we see from Table 2 that the proportion with experience of only one death is more or less constant in the Latin American areas at about 23 percent. However, the proportion with two or more deaths varies from 18 (Costa Rica) to 32 percent (Peru). In Taiwan both these proportions are much lower.

Experience of child mortality is strongly related to exposure through numbers of births. Differences in overall proportion with child mortality may be due, in part, to differences with respect to number of children born. To correct for these differences in exposure due to number of children born, Table 3 shows the figures of child mortality according to number of births (parity level). For example, from the Table we see that, of women at the third parity, one half in Peru had had a child die while only slightly more than a quarter in Costa Rica had had the same experience. In the same manner we note that at the sixth parity level over one half of women in Peru had two or more child deaths while only one-fifth of women in Costa Rica had such experience. With respect to experience with child mortality, the women in Peru are clearly in the worst position while those in Costa Rica are in the best. Colombia and Mexico, with percentages between the extremes tend much more towards the situation of Costa Rica. However, all of the Latin American areas compare disfavorably with figures for all Taiwan. Only 14 percent of Taiwanese women between their 6th and 7th birth had had two children die.

Paths Analyzed and Type of Analysis

The microlevel analysis that have been undertaken involve only those paths of influence relating fertility to direct personal experience of child mortality. Indirect personal experience and societal experience were not studied because of a lack of adequate data[7]. The paths studied are both

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7/ An attempt to use a question on the perception of changes in child mortality as a measure of indirect personal experience produced inconsistent results: fertility and use of contraception were higher for women who perceived changes in either direction than for women who perceived no change in child mortality or could not give a reply (a substantial proportion). The variable was therefore used only as a control but no results are reported. The question was: "Nowadays children die less, the same, or more than before?" ("¿Los niños hoy día mueren menos, igual o más que antes?")

Table 3

PERCENTAGE DISTRIBUTION OF WOMEN BY EXPERIENCE WITH CHILD
MORTALITY ACCORDING TO ATTAINED PARITY LEVEL, FOR RURAL-
SEMIURBAN AREAS OF FOUR LATIN AMERICAN COUNTRIES AND ALL
TAIWAN

Area	Attained Parity Level										
	1	2	3	4	5	6	7	8	9	10	11
Costa Rica											
No. of child deaths											
0	92%	82%	73%	64%	53%	47%	40%	38%	31%	23%	14%
1	8	17	22	28	33	33	32	31	34	30	21
2 +	–	1	5	8	14	20	28	31	35	47	65
Colombia											
No. of child deaths											
0	91	81	70	61	51	44	37	32	29	25	21
1	9	18	25	28	30	31	33	31	28	29	24
2 +	–	1	5	11	19	25	30	37	43	46	55
Mexico											
No. of child deaths											
0	88	76	65	56	47	41	33	27	21	20	16
1	12	22	28	31	33	33	30	28	29	24	24
2 +	–	2	7	13	20	26	37	45	50	56	60
Peru											
No. of child deaths											
0	84	65	49	38	29	20	16	9	6	4	2
1	16	29	33	32	30	28	23	19	13	10	9
2 +	–	6	18	30	41	52	61	72	81	86	89
Taiwan											
No. of child deaths											
0	96	90	83	76	65	56	47	–	–	–	–
1	4	9	15	20	26	31	53	–	–	–	–
2 +	–	1	2	4	9	14					

Source: Latin America: Pecfal-Rural Fertility Survey, 1969-70.
Taiwan: Calculated from S. Rutstein "The Influence of Child Mortality
on Fertility in Taiwan", unpublished Ph.D. Thesis, University of
Michigan, 1971, Tables 6.1 and 6.2.

those involving family size goals and those not involving such goals.

To study the effects of child mortality on actual fertility behavior
we have used as the dependent variable the parity progression ratio (PPR).[8]
We believe that this dependent variable introduces the least amount of
analysis bias when properly controlled for the effects of truncation and is
especially useful in eliminating the effects of the reverse causal relation-
ship from fertility to child mortality and in analyzing the effects of child
mortality with respect to existing family composition. As our independent
variable we use the number of deaths of children 0 to 14 years of age,
inclusive, that occurred before the conception that gave rise to the increase
in parity. For example, if a woman had had four births, her value on the inde-
pendent variable would be the number of child deaths she had experienced
before the conception of her fifth child. If the woman did not have another
birth then logically the value of the variable is the total number of child
deaths she has experienced. In this way, we take into account only the situation
upon which a decision to have another birth could have been based. Two biasing
factors still have to be controlled for. The first of these is the truncation
of length of time exposed to the risk of a subsequent birth. In other words,
some women may not as yet have had another birth, although they will in the
future, because the interval between these births was truncated by the date
of interview. We have controlled for this truncation effect by including the
time exposure, measured by date of the parity from which the woman is progres-
sing (called date of previous birth for short), in a multivariate analysis.
This variable also controls for time trends and effects due to age of mother.

The second biasing factor to be controlled for are those non-intervening
variables which are causally related to both fertility and child mortality.
We have controlled for these spurious relationship by including various socio-
economic variables in the multivariate analysis. The additional controls used
were the level of education of the woman, the quality of housing, husband's
occupation, sector (rural or semiurban) and perception of changes in child
mortality. The socio-economic variables were included to avoid spurious
relationships since both child mortality and fertility are related to level
of living.

8/ The parity progression ratio is defined as the proportion of women having
n + 1 or more births out of those having at least n births.

The multivariate technique used is Multiple Classification Analysis (MCA), (Andrews, et. al., 1967). This technique was selected for its ability to handle non-interval variables and non-linear relationships, as some of the control variables are non-interval and we suspect that the relationships with the independent variable and the controls are non-linear. We do not think the effect of the experience of two child deaths is twice that of the experience of one death.

For the observations of each category of all included independent variables, the MCA program provides both simple (unadjusted) means and means that are adjusted by controlling for the effects of the other independent variables. Since MCA is a form of dummy-variable regression, the implied model is additive rather than interactive, but interaction terms may be included as independent variables. The results of MCA presented in this paper are in the form of adjusted means. (Some researchers present the deviations of the adjusted category means from the grand mean of all cases).

Expectations Regarding the Results

The non-biological paths relating direct personal experience of child mortality to fertility depend upon the use of some form of fertility control. We have taken the use of contraception as an indicator of the use of all forms of fertility control within marriage since the data are unreliable on such other forms as abstinence and induced abortion. In the areas under study, the declared use of contraception is very low, ranging from a maximum of 35 percent of women with at least one birth who have ever used a contraceptive method (Costa Rica) to a minimum of 10 percent (Peru). In light of this situation we believe that experience of child mortality should not have a strong effect on the parity progression ratios, and that the effect that does exist should be greatest in Costa Rica and least in Peru.

A second expectation is that the effects of child mortality, as shown by the parity progression ratios, will vary according to the parity level attained by the couple. Parents who have very many fewer children than desired are likely to have another child no matter what their experience with child mortality. In the same sense parents who have had many more children than desired are not likely to increase their likelihood to have another birth, unless child mortality has so reduced their number of surviving children that it is close to their family size goals. Thus we expect that the strength of the relationship between child mortality and actual fertility behavior should rise to a maximum around attained parity levels near to the mean desired family size and diminish in strength as the parity level is increasingly different from this mean.

Results from the Microlevel Analysis

Table 4· presents the parity progression ratios (PPR) according to direct personal experience of child mortality for various levels of attained parity for each of the rural-semiurban areas included in the investigation. A comparison is made with results obtained for Taiwan using the same procedure. The parity progression ratios are adjusted for the effects of time exposure and level of living.

Probability of Further Births

As can be clearly seen, the overall probabilities of having another birth are very high and approach those for a natural fertility population, supporting further the conclusion that fertility control is used very little. Looking at the parity progression ratios classified by number of previous child deaths, we see little difference between the ratios. Indeed the only increases in the PPR due to child mortality appear to occur in Peru, the country with apparently the least amount of fertility control, and in Costa Rica, the country with the most fertility control. The other two areas, Colombia and Mexico, show in general no increase and, for many parity levels, show a decrease[9] when the number of child deaths increases.

9/ This decrease may be due in part to health problems related to the birth causing both the death of the child and the sterility of the mother. However, it may also be due in part to a feeling of discouragement following the child's death eliminating the wish to have another child who also may die.

Table 4

ADJUSTED[a/] PARITY PROGRESSION RATIOS ACCORDING TO EXPERIENCE WITH CHILD
MORTALITY BY ATTAINED PARITY LEVEL FOR RURAL-SEMIURBAN AREAS OF FOUR
LATIN AMERICAN COUNTRIES AND ALL TAIWAN

Area	Attained Parity Level										
	1	2	3	4	5	6	7	8	9	10	11
Costa Rica Child Mortality Exp.											
0 deaths	.95	.92	.90	.88	.87	.86	.87	.81	.78	.52	*
1 death	.92	.90	.90	.92	.92	.86	.85	.81	.76	.66	*
2+ deaths	–	*	.90	.91	.90	.86	.90	.83	.84	.61	.41
Colombia Child Mortality Exp.											
0 deaths	.92	.90	.90	.87	.89	.83	.84	.83	.76	.66	.58
1 death	.89	.91	.90	.89	.84	.88	.83	.83	.75	.57	.54
2+ deaths	–	*	.86	.85	.84	.80	.81	.79	.75	.77	.44
Mexico Child Mortality Exp.											
0 deaths	.95	.95	.94	.92	.92	.91	.86	.80	.81	.80	*
1 death	.95	.92	.93	.92	.94	.90	.86	.86	.69	.63	.63
2 deaths	–	.92	.94	.90	.93	.89	.85	.85	.76	.64	.47
Peru Child Mortality Exp.											
0 deaths	.92	.92	.93	.87	.80	.83	.70	.65	*	*	*
1 death	.93	.92	.92	.85	.86	.80	.75	.74	.66	*	*
2+ deaths	–	.93	.89	.87	.85	.90	.80	.75	.72	.50	.50
Taiwan Child Mortality Exp.											
0 deaths	.97	.91	.81	.66	.56	–	–	–	–	–	–
1 death	.97	.94	.80	.73	.70	–	–	–	–	–	–
2 deaths	–	*	.91	.87	.66	–	–	–	–	–	–

Source: see Table 2.

a/ Adjusted by MCA with the inclusion of the following control variables:
Date of previous birth, education, housing quality, husband's occupation,
sector, fear of child mortality.

Note:
* Base less than 25 women
– Not applicable or not available

Now we look more closely at each individual country. For Costa Rica, it can be noted that there are only three parity levels (four, five and ten) in which the experience of one child death increases the parity progression ratio over the PPR for women with no such experience. At four other levels a one child death decreases the PPR and at three levels there is no difference. Summing algebraically the differences result in a + .14 overall increase; however, all of this overall difference is due to the difference at parity level ten, which has the smallest number of women.

The situation is very much different if we consider differences in PPR between no experience and experience of two or more child deaths. Here we have increases at six parity levels, no parity levels in which the PPR decrease with increasing experience, and two parity levels at which there is no difference. The overall difference (the algebraic sum of the differences) is + .26. However, more than half of this overall difference comes from the final two parities, which have relatively small numbers of cases.

For Peru it can be noted that there are positive differences in PPR at four parity levels, negative differences at three levels and no difference at one level, for differences in PPR between experience of no and one child death. Owing to the fact that the positive differences are in general much larger than the negative differences, the overall difference is a plus .15. It is interesting to note that in these comparisons, the parity levels nine, ten and eleven can not be included because there are not enough women at these parity levels for women to be able to calculate reliable parity progression ratios without experience of a child death[10]. The fact that there are not enough cases of no child deaths at these parity levels may signify that an analysis of the effect of child mortality at these levels may be irrelevant.

Observing the differences in PPR between no experience and experience of two or more deaths, four positive and two negative differences can be noted. At one parity level there is no difference. The overall difference is a + .19.

[10] We have taken 25 as the minimum base for the calculation of the parity progression ratios.

For Mexico and Colombia the situation is generally one of negative differences in the parity progression ratio. For Mexico there are only two positive, five negative and three zero differences in PPR between no and one child death categories.

Between categories for no and two or more child deaths there are again only two parity levels with an increase, six with a decrease and one with neither. The overall differences are a minus .26 and a minus .23 respectively between zero and one death and between zero and two or more deaths.

The situation for Colombia is similar to that for Mexico. Here there are three positive, six negative and two zero differences, with an overall difference of -.15, for differences in PPR between women with no child deaths and women with one death. For differences in the PPR's between women with two or more child deaths and women with no deaths, there is an increase at only one parity level (ten) and decreases at eight; the overall difference is -.25.

In order to get a different view of the differences between the parity progression ratios and to get an idea of the effect on completed fertility, the ratios were used to project the mean total number of additional births women would have, given their experience with child mortality. The projections calculated for each parity level are shown in Table 5. The procedure of calculation is given in Appendix B. These projections result in numbers of additional children different from those actually given birth to by the women. Apparently similar results could be obtained by calculating at each parity level the mean number of additional children actually born to the women classified by their experience with previous child death. However, two factors would make problematic interpretations of the results of such a procedure: the effects of truncation would be much more severe than in the case of calculating the parity progression ratios, and the results may be influenced by subsequent child death experience. In general the projections show that in Costa Rica and Peru, as direct personal experience with child mortality increases, the mean number of additional births also increases.

Table 5

PROJECTED MEAN NUMBER OF ADDITIONAL BIRTHS[a]/TOTAL NUMBER OF
EXPECTED BIRTHS, AND INCREASE IN PROJECTED BIRTHS, ACCORDING TO
DIRECT PERSONAL EXPERIENCE OF CHILD MORTALITY, BY PARITY LEVEL
ATTAINED FOR RURAL-SEMI-URBAN AREAS OF FOUR LATIN AMERICAN
COUNTRIES AND ALL TAIWAN

Item	Attained Parity Level									
	1	2	3	4	5	6	7	8	9	10
Costa Rica										
No.of additional births										
Child Mortality Exp.										
0 deaths	5.73	5.03	4.47	3.96	3.51	3.03	2.52	1.90	1.35	.72
1 death	5.73	5.23	4.81	4.35	3.72	3.04	2.54	1.99	1.46	.92
2 + deaths	-	*	4.88	4.42	3.86	3.28	2.82	2.13	1.56	.86
Increase in births due to experience of										
1 death	0	.20	.34	.39	.21	.01	.02	.09	.11	.20
2 + deaths	-	*	.41	.46	.35	.25	.30	.23	.21	.14
Colombia										
No.of additional births child mortality exp.										
0 deaths	5.45	4.92	4.47	3.97	3.56	3.00	2.62	2.12	1.55	1.04
1 death	5.30	4.95	4.44	3.93	3.42	3.07	2.49	2.00	1.41	.88
2 + deaths	-	*	3.91	3.54	3.17	2.77	2.46	2.04	1.58	1.11
Increase in births due to experience of										
1 death	-.15	+.03	-.03	-.04	-.14	+.07	-.13	-.12	-.14	-.16
2 + deaths	-	*	-.56	-.43	-.39	-.23	-.16	-.08	+.03	+.07
Mexico										
No. of additional births child mortality exp.										
0 deaths	6.69	6.05	5.36	4.71	4.12	3.48	2.82	2.28	1.84	1.28
1 death	6.39	5.72	5.22	4.61	4.01	3.27	2.63	2.06	1.40	1.03
2 + deaths	-	5.63	5.12	4.45	3.94	3.24	2.64	2.10	1.48	.94
Increase in births due to experience of										
1 death	-.30	-.33	-.14	-.10	-.11	-.21	-.19	-.22	-.44	-.25
2 + deaths	-	.42	-.24	-.26	-.18	-.24	-.18	-.18	-.36	-.34

(continued)

Table 5 (continued)

Item	Attained Parity Level									
	1	2	3	4	5	6	7	8	9	10

Peru
No. of additional
births child
mortality exp.

	1	2	3	4	5	6	7	8	9	10
0 deaths	5.04	4.48	3.87	3.16	2.63	2.29	1.76	1.52	1.33	.90
1 death	5.20	4.59	3.99	3.34	2.92	2.40	2.00	1.67	1.26	.90
2+ deaths	–	4.66	4.01	3.51	3.03	2.57	2.21	1.76	1.35	.87

Increase of births
due to experience of

	1	2	3	4	5	6	7	8	9	10
1 death	.16	.11	.12	.13	.29	.11	.24	.14	-.07	0
2+ deaths	–	.18	.14	.35	.40	.28	.45	.24	.02	-.03

Taiwan
No. of additional
births child
mortality exp.

	1	2	3	4	5	6	7	8	9	10
0 deaths	3.51	2.62	1.89	1.32	.94	–	–	–	–	–
1 death	4.08	3.13	2.32	1.65	1.28	–	–	–	–	–
2+ deaths	–	*	2.61	1.88	1.16	–	–	–	–	–

Increase in births
due to experience
of

	1	2	3	4	5	6	7	8	9	10
1 death	.57	.51	.43	.33	.34	–	–	–	–	–
2+ deaths	–	*	.72	.56	.22	–	–	–	–	–

Source: Latin America: Pecfal-Rural KAP survey, CELADE, 1969-70.
        Taiwan: Calculated from Rutstein, op. cit. 1971.

Note:
      – Not applicable or not available
      * Base less than 25 women

a/ Calculated using parity progression ratios from Table 4.

In Colombia and Mexico the opposite is true; increasing experience leads to a decline in the mean number of additional children. However, all but one of the increases or decreases are less than half a child. Therefore, even women with the highest increases due to child mortality severely under-replace their lost children.

It is interesting to note that the projected mean numbers of additional births (and therefore the total numbers of expected births) are greatest in Mexico and least in Peru with Costa Rica and Colombia almost equal. For example, for women who have had three births with no child mortality experience, the projected mean number of additional births is 5.4 for Mexico, 4.5 for both Costa Rica and Colombia, and 3.9 for Peru, resulting in 8.4, 7.5 and 6.9 total expected births, respectively. These figures compare with 1.9 additional births (4.9 total expected births) for Taiwan.

Birth Intervals

The parity progression ratios have shown whether or not a woman has an additional birth; however, the rate of growth of the population also depends on the timing of the births a woman has. The smaller the intervals between births, the smaller the interval between generations[11] and therefore the more rapid the growth of population on any given number of years.

An analysis using the Pecfal-Rural data of the effect of child mortality on closed pregnancy intervals, principally through the biological path, and presumably not strongly related to fertility preferences is part of a study undertaken by Cesar Fernandez (1974). In this analysis experience of child mortality is measured by the result of the previous birth:[12] still alive, died under one year of age, or died after one. The dependent variable

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[11] When the date of beginning child bearing is constant.
Direct personal experience can not affect the onset of childbearing as women only experience the death of a child after they have begun child-bearing. However, both the birth intervals and the age of beginning childbearing are probably affected by indirect personal experience and community experience.

[12] Since we will only review the results related to child mortality all previous terminations of pregnancies are live births.

is the mean length of time between this birth and the following conception
for all parity levels considered together.

From the results presented in Table 6, we see that there is a substantial
shortening of the interval when a child dies before its first birthday. The
decrease in average interval varies from 3.5 months (Colombia) to 6.2 months
(Peru). As the shortening due to a death after one year of age is relatively
small (from 0.1 months in Colombia to 1.5 months in Peru), we believe that
most of the decrease in the intervals is due to biological rather than moti-
vational effects.

Further support for a biological causal sequence comes from the fact
that in Peru, the only area where a death after one year of age substantially
shortens the interval, a majority of the women breastfeed for longer than
one year. It is also the only country of the four studied where a large pro-
portion breastfeed for more than eighteen months. Unfortunately no analysis
using the Pecfal-Rural data has been done to evaluate the effect on birth
timing excluding biological effects.

Contraception

The non-biological paths of influence depend primarily on whether or
not there exists the possibility to control fertility. The decision not to
have another birth or to have that birth "later" involves the decision to
use a method to control fertility. It is important, therefore, to analyze
the use of fertility control methods as affected by child mortality.

To study some of the effects of child mortality on fertility control,
we have chosen ever use of contraceptive methods as the dependent variable
and the number of child deaths experienced as the independent in a first
analysis. A second analysis studies when contraception began. Then in a third
analysis the continuance of use is studied. Unfortunately the second type of
analysis covers only Costa Rica at present. All three analyses were done
using MCA. In these analyses age of mother, total number of births, date of
the last birth, marital status, education, mass media consumption, housing
quality, husband's occupation and perception of change in child mortality
were included as independent variables to control for spurious relationships.
The results of these analyses are presented in Table 7.

Table 6

MEAN CLOSED PREGNANCY INTERVAL BY SURVIVAL OF PREVIOUS BIRTH FOR RURAL-
   SEMIURBAN AREAS OF FOUR LATIN AMERICAN AREAS AND TAIWAN

Survival of Previous birth	Mean Pregnancy Interval[a] in Months				
	Costa Rica	Colombia	Mexico	Peru	Taiwan
All births	14.41	16.32	17.31	19.57	16.92
Alive at interview	14.91	16.65	17.84	20.70	17.28
Died before first birthday	10.56	13.15	13.20	14.47	11.40
Died after first birthday	14.75	16.54	17.44	19.20	17.04

Source: Latin America: Fernandez, cited in text, Table 1.
        Taiwan: A.K. Jain, "Pregnancy outcome and the time required for next
        conception", Population Studies 23: 423, Table 1.

a/ Excluding gestation

Table 7

MCA ON CONTRACEPTION: USE EVER, PARITY AT FIRST USE, CONTINUANCE, AND USE AT
INTERVIEW, ADJUSTED MEANS BY CHILD MORTALITY EXPERIENCE, FOR RURAL—SEMIURBAN
AREAS OF FOUR LATIN AMERICAN AREAS AND ALL TAIWAN

Area and child mortality experience	% ever used	Mean parity level at first use	% continuing use when interviewed	% using when interviewed
Costa Rica	34.6	4.97	71.7	24.8
No. of deaths				
0	38.3	5.03	73.2	26.8
1	32.2	5.70	76.7	23.3
2	29.6	5.50	85.5	14.5
3+	15.4	*		
Colombia	19.6	--	67.1	13.2
No. of deaths				
0	20.9	--	66.6	13.9
1	17.0	--	68.2	11.6
2	20.5	--	70.5	13.2
3+	16.4			
Mexico	10.9	--	49.5	5.4
No. of deaths				
0	12.3	--	50.9	6.3
1	10.9	--	36.4	4.0
2	9.3	--	*	*
3+	3.8			
Peru	9.8	--	67.6	6.6
No. cf deaths				
0	12.1	--	64.0	7.7
1	9.1	--	69.6	6.3
2	8.6	--	78.9	6.2
3+	7.3	--		
Taiwan b/	62.2	4.34	82.8	51.5
No. of deaths				
0	64.0	4.28	82.0	52.5
1	56.0	4.71	81.0	45.4
2+	61.9	4.86	88.6	54.8

a/ Adjusted for age number of births, date of last birth, marital status,
   fear of child mortality, education, use of mass media, housing quality
   and husbands occupation.
b/ Source: Calculated from Rutstein, op.cit. 1971.

Note:
        * Base less than 25
        -- Not Available

The overall percentage of mothers who have ever used a contraceptive method varies from a high of 35 percent in Costa Rica to a low of 10 percent in Peru. For all countries, direct experience with child mortality lowers the proportion who have ever used contraception. The largest absolute reduction 14 percent, comes in Costa Rica while the smallest, 4 percent, comes in Colombia and Peru. Taking into account the overall level of use, the largest relative reduction (42 percent) is in Mexico. Colombia has the smallest relative reduction in use due to child mortality experience. Compared to Taiwan, the women in Latin American areas have made much less use of contraception. However, the relative reduction in use due to child mortality is generally greater in Latin America than in Taiwan.

To see if experience of child mortality delays the first use of contraception among those who ever do use, the following procedure was used: for each parity level reached, and for each category of experience with child mortality, the adjusted mean proportion that began to use contraception before the next birth, out of those who had reached the parity level without previous use of contraception, was calculated by use of MCA. From these proportions, the mean parity level at first use was calculated as the weighted average of all those who ever use[13]. The calculations reveal that in Costa Rica, experience with child mortality does delay first use. The delay is approximately 0.7 of a child if there has been experience of one death and half a child for two deaths. A delay was also found for Taiwan.

Continuance of use of contraception, once that use has begun, is in general higher with experience of child mortality. Mexico, where continuance is low in general, has the only reduction in percent continuing with an increase in experience. Perhaps a reason that continuance of use is higher among women with experience of child mortality is that fewer of these women ever use contraception and those that do use, begin later. Therefore, these women are more sure of what they want when they do begin and as such are

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13/ Since the last parity level (7) included use of contraception at all higher levels, an arbitrary level of eight was assigned. See Appendix B for the original proportions.

less likely to discontinue once they begin. The dependent variable in this analysis is the proportion of women who used a contraceptive method when interviewed out of those who have ever used a method.

By multiplying the adjusted proportions who ever use contraception and the adjusted proportions continuing such use, the adjusted proportions using contraception when interviewed were calculated and appear in column four of Table 7. In the Latin American countries under study, the percentage of women using contraception at the time of interview is reduced with increasing experience. The largest decrease comes about in Costa Rica. Usage by women with 2 or more deaths is almost half as much as by women with no child deaths. The reduction with child mortality is more consistent in the Latin American areas than in Taiwan, where a higher proportion of women with experience of two or more child deaths used contraception at interview than women with no experience.

DISCUSSION

We have seen from Table 1 that the rural-semiurban areas of the two countries with the highest infant mortality rates, Mexico and Peru have the highest fertility rates while the country areas with the lowest mortality rates, Costa Rica and Colombia, have the lowest fertility rates. It would be incorrect, however, to attribute the high fertility of the former to their relatively high rates of child mortality without further evidence, given the two way nature of the relationship and the various confounding factors that may intervene. It is therefore imperative to analyze the various paths of influence of child mortality to determine whether, how, and by how much fertility is affected. Of the three sources of experience with child mortality, direct and indirect personal experience and societal experience, only direct personal experience has been analyzed, largely due to the lack of adequate data for analysis of the other two. The other two sources of experience may be related to fertility, in the rural-semiurban areas if not in all areas of Latin America, given the high child mortality levels encountered during the survey (1969-70), which are undoubtedly lower than in the past, and given the high levels of direct personal experience of the women in the survey as shown in Table 2.

Results have been presented to show the effects of direct personal
experience of child mortality on replacement of lost children, on the timing
of births as a biological reaction, and on use of contraception. The results
indicate that in only two of the four rural-semiurban areas of the countries
does there exist an increase in the probability of having an additional birth,
(parity progression ratios, PPR) with increasing experience of child
mortality. In the other two areas there are decreases in the parity progres-
sion ratios. Moreover in the two areas where there are increases in the
ratios, these are small and do not occur at all parity levels. We believe
that part of the reason that the PPR may decrease with increasing experience
is that a woman with a child death may have health problems that led both
to the death of the child and to lowering her probability of having another
birth. This health factor may also lead to lowered increases in the PPR as
more women with child mortality who want another birth may not be able to
have one. Since Peru has presumably the worst health conditions as implied
by the infant mortality rates, the presumed effect should be greatest there
and least in Colombia and Costa Rica. However, our results are not able to
support this hypothesis. For Costa Rica and Peru, the areas with positive
differences in the PPR, the increases reach local peaks around parities
three to five, the numbers which over half of the women in both country
areas have declared as most convenient. The biological response to child
mortality, which is mainly a timing phenomenon, is seen from Table 6 to
exist for all areas as expected.

Obviously child mortality cannot exercise a behavioral effect on actual
fertility unless the possibility of some form of fertility control exists.
It is equally obvious though, that child mortality may play a significant
role in the decision of whether to use a form of fertility control or not.
In all societies there exists the possibility of delayed entry into regular
sexual union (age at first marriage), voluntary abstinence and celibacy.
The decision about the use of such forms of fertility control are strongly
regulated by the norms of the society. It is probable that societal experience
of child mortality has played a large, if not primary, role in the formation
and maintainance of such norms. With respect to forms of fertility control

once a regular sexual union has been established, there is more of a
possibility that knowledge of the techniques and the materials employed
in the methods will not be widespread, although withdrawal and abortion
are believed to be generally known.

Since fertility control within marriage is necessary for a behavioral
response in actual fertility to direct personal experience of child mortality,
it could be a precursor to such a response. Evidence of differences in control
according to child mortality experience may be able to indicate the
beginning of such behavioral responses even though changes in actual
fertility may not yet have occurred. It is in this sense that the relation-
ships between child mortality and the use of contraception are examined.

In general it was found that direct experience with child mortality
decreases the proportion of families who have decided to use a contracep-
tive method and, at least in Costa Rica, postpones the beginning of use for
those that do decide to use. There is evidence, however that once women
with child mortality do begin use of contraception that they are more likely
to continue using a method. We have interpreted these results to mean that
women with child mortality experiences are using contraception more for
limiting than for spacing births than are women with no direct experience.
The overall result is that at any one time (such as when interviewed)
women with experience are slightly less likely to be using a contraceptive
method.

In summary we conclude that where it exists, that is, Peru and Costa
Rica, the increase in actual fertility as a response to direct experience
of child mortality is small, much less than that necessary for the replace-
ment of children lost to mortality. The small response is to be expected
given the low overall levels of contraceptive use in these areas. There is
some indication from the results obtained on contraception that as the
knowledge and materials of contraception become widespread, direct
experience of child mortality may begin in the near future to affect
fertility levels in those countries, Mexico and Colombia, that have not as
yet shown such effects. Further decreases in child mortality in these four
areas would be little offset by decreases in fertility due to reductions

in direct personal experience. Therefore, unless reductions in indirect personal experience and societal experience would bring sufficient concomitant decreases in fertility, such a mortality decrease would bring substantial increases in the rate of growth of the population. Further investigation into the existence and time lags of these other paths of influence is strongly in need, as well as deepening the analyses with respect to direct experience.

APPENDIX   A

TABLE A-1

CRUDE BIRTH RATES[A/] (CBRC) AND INFANT MORTALITY RATES (IMR) FOR VARIOUS LATIN AMERICAN COUNTRIES, 1920-1970
(RATES PER THOUSAND)

COUNTRY		1920-1924	1925-1929	1930-1934	1935-1939	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965	1966	1967	1968	1969	1970
ARGENTINA	CBR	34	32	28	25	24	24	24	24	22-23	-	21	22	22	-	-
	IMR	115	111	95	98	83	74	65	62	60	57	54	58	-	-	-
BOLIVIA	CBR	-	-	-	-	45[B/]	45	41	-	43-45	-	44	44	44	44	44
	IMR	-	-	-	82	101	123	99	84	-	77	77	-	-	-	-
CHILE	CBR	40	41	38	36	36	35	36	39	34-36	-	32	31	27	25	30
	IMR	241	224	206	213	176	150	128	117	113	102	103	92	92	88	79
COLOMBIA	CBR	42	43	42	42	42	43	44	45	41-44	-	36	45	45	45	45
	IMR	105	133	120	116	152	142	113	101	90	82	80	78	70	-	-
COSTA RICA	CBR	45	47	45	44	43	43	46	49	45	45	41	40	36	34	33
	IMR	178	169	156	144	131	100	87	76	73	76	65	62	60	67	62
CUBA	CBR	42	36	33	31	30	29	30[B/]	-	34-36	-	-	27	27	27	27
	IMR	163	120	85	99	-	39	-	33	37	38	38	40	41	48	38
ECUADOR	CBR[A/]	48	49	49	48	46	46	46	47	47-50	-	45	45	45	45	45
	IMR	-	170	147	149	142	127	112	107	96	93	90	87	86	91	77
EL SALVADOR	CBR	47[B/]	47[B/]	44	43	44	44	48	49	47-49	-	45	44	43	42	40
	IMR	134	139	139	125	114	102	82	80	70	71	62	63	59	63	67
GUATEMALA	CBR[C/]	48	49	46	44	45	49	51	49	46-48	-	-	43	43	43	41
	IMR	87	94	93	104	119	109	100	97	90	93	89	89	92	91	87
HONDURAS	CBR	44[B/]	44[B/]	41	42	45	46	49	50	47-50	-	-	49	44	44	44
	IMR	-	101	92	99	109	92	65	57	48	41	38	36	34	37	-
MEXICO	CBR	41	40	41	42	43	45	46	48	44-45	-	44	43	43	43	43
	IMR	226	194	135	128	119	105	92	78	70	55	52	72	64	68	69
NICARAGUA	CBR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IMR	-	-	105	96	111	102	77	72	60	52	55	45	46	45	-

(CONT.)

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COUNTRY		1920-1924	1925-1929	1930-1934	1935-1939	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965	1966	1967	1968	1969	1970
PANAMA	CBR	40$^{B/}$	37	36	37	39	39	40	44	41-42	-	38	39	39	38	37
	IMR	-	-	-	-	70	66	56	57	49	45	45	43	40	40	41
PARAGUAY	CBR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IMR	-	-	-	-	-	98	-	-	-	42	40	37	52	33	33
PERU	CBR	-	-	-	-	46	47	48	49	44-45	-	40	42	42	42	42
	IMR	-	-	-	113	117	109	100	99	87	74	67	62	-	-	-
PUERTO RICO	CBR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IMR	-	-	128	123	106	78	64	52	45	43	37	31	29	30	29
URUGUAY	CBR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IMR	106	101	99	94	86	57	54	50	45	50	43	50	54	49	43
VENEZUELA	CBR	41$^{B/}$	43$^{B/}$	40$^{B/}$	38	40	44	46	48	46-48	-	42	41	41	41	41
	IMR	155	150	152	135	117	98	75	64	50	48	47	41	46	47	49

- NOT AVAILABLE

A/ AGE AND SEX STANDARDIZED FROM 1920 TO 1959

B/ NOT STANDARDIZED

C/ ALL RATES NOT STANDARDIZED

SOURCES: CRUDE BIRTH RATES, 1920-1959: COLLVER, "BIRTH RATES IN LATIN AMERICA: NEW ESTIMATES OF HISTORICAL TRENDS AND FLUCTUATIONS", INSTITUTO OF INTERNATIONAL STUDIES, RES, SERIES N° 7, UNIVERSITY OF CALIFORNIA (BERKELEY), 1965.

CRUDE BIRTH RATES, 1960-1970;
AND INFANT MORTALITY RATES : UNITED NATIONS, DEMOGRAPHIC YEARBOOK, VARIOUS YEARS.

APPENDIX B

CALCULATION PROCEDURES

Expected Additional Births

The calculation of the number of expected additional births from parity progression ratios is a procedure analogous to the calculation of life expectation in a life table. Then the formula

$$w_x = \frac{x-1}{\prod_{i=1} P_i}$$

gives the number of women reaching a parity level x, w_x (corresponding to l_x), as the product of the parity progression ratio at each level, P_i, up to level x (corresponding to $1-q_x$).

Summing from below,

$$S_x = \sum_{i=x+1}^{n} w_i \qquad \text{(n = last level considered)}$$

then gives the number of additional women-levels attained, S_x, (corresponding to T_x) by women reaching level x. Dividing each S_x by the corresponding w_x gives the expected number of additional births for women attaining parity level x.

In the few cases at the highest parity levels where the PPR were not available separately by number of deaths due to the small number of cases, the overall PPR for the level was used instead.

Time of First Use of Contraception

A somewhat similar procedure to that described above was used to calculate the mean parity level of first use of contraception. If P_x is the proportion of women beginning use of contraception between parities x and x+1, then

$$NU_x = \frac{x}{\prod_{j=1}} (1-P_j)$$

is the proportion of non-users at parity level x. The mean parity at first use, MPFU, given by

$$MPFU = \frac{\sum_{x=1}^{n}(1-NU_x) \cdot x}{\sum_{x=1}^{n}(1-NU_x)}$$

where n is the last level used in the calculation. The P_x are given in Table C-1. Since P_{7+} pertains to all women above the seventh parity level, we have arbitrarily chosen a value of 8 to use in the calculation.

Table B-1

ADJUSTED[a/] PERCENTAGE OF WOMEN INITIATING USE OF CONTRACEPTION BEFORE
NEXT PARITY LEVEL ACCORDING TO EXPERIENCE OF CHILD MORTALITY, BY
ATTAINED PARITY LEVEL, FOR RURAL-SEMIURBAN AREAS OF COSTA RICA

Child Mortality Experience	Attained Parity Level						
	1	2	3	4	5	6	7+
0 deaths	7.5%	7.1%	4.6%	4.5%	2.3%	4.5%	27.1%
1 death	4.5	4.7	3.1	3.0	2.4	3.8	27.3
2 deaths	--	*	2.8	4.6	2.4	2.0	24.0
3+ deaths	--	--	*	*	*	0.2	7.4
total	7.3	6.6	4.2	4.2	2.3	3.7	24.6

a/ Adjusted by MCA with inclusion of the following variables: Date of
previous birth, education, mass media consumption, quality of housing,
husbands occupation, marital status, fecundity and fear of child mortality.

Note:

   -- Not Applicable

   * Base less than 25 women

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