INTERNATIONAL POPULATION CONFERENCE

BEIJING

1997

CONGRES INTERNATIONAL DE LA POPULATION

VOLUME 3

The causal role of reduced child mortality on contemporary fertility transitions

Luis Rosero-Bixby

Programa Centroamericano de Poblacion e INISA, Universidad de Costa Rica, San José, Costa Rica

Introduction

To what extent does reduced child mortality explain the fertility transition in developing countries? Is decreasing child mortality a prerequisite-a necessary condition-for decreasing fertility? May decreasing child mortality trigger by itself-as a sufficient cause-the fertility transition? Answering these questions is important to understand the dramatic demographic changes currently underway in developing countries and to guide population and health policies. If improving child survival is a precondition for birth control, family planning programs in the least developed regions are unlikely to succeed, especially if these programs have a vertical organisation independent of child health interventions. In turn, if reducing child mortality is a sufficient condition, family planning programs may be somewhat superfluous and there would be grounds for the statement that "development is the best contraceptive."

A book published about twenty years ago (Preston, 1978) is a landmark for the study of the effect of child mortality on fertility. Probably because of the lack of appropriate data at that time, this book, however, did not study the relationship at the aggregate level in developing countries. This article aims at filling the gap by examining country-level rates at two points in time and by analysing, in a multivariate fashion, the determinants of the fertility transition onset and pace in small geographic units in Costa Rica-a less developed country with a relatively long history of both child mortality and fertility decline.

A strong association between child mortality and fertility is a well documented fact in the literature. Countries with low infant mortality almost always have low birth rates (Heer 1966, Berelson et al. 1978). Couples that have experienced child losses are, in turn, less likely to use contraception, tend to have more children, and have shorter birth intervals (Taylor et al. 1976). However, this well documented association is neither proof of causation nor says anything about the causation direction. The observed association may have three closely linked origins: (1) The sharing by both child mortality and fertility of a common set of determinants, such as mother's education, access to health services, breastfeeding practices, and less observable traits such as a preference for high-quality children or a less fatalistic outlook at life (Hanson et al. 1994). (2) The fact that lower fertility may reduce child deaths by, among other reasons, lessening the maternal depletion associated to pregnancies and lactation (Trussell & Pebley 1984), diminishing sibling competition for scarce family resources and maternal care including breastfeeding (Pebley & Millman 1986), and decreasing the rates of transmission of infections in child-crowded environments (Blacker 1987, Haaga 1989). (3) The third possibilitythe one addressed in this articleis that the direction of causation runs from child survival to fertility. Although disentangling these three type of causal links is an impossible task with the data available, this article hopes that by statistically controlling the effect of third variables and by paying attention to the sequence of events over time, it will be possible to reach some conclusions about the third causal link, i.e. about the role of child mortality on contemporary fertility transitions.

There are several explanations for the postulated effect of child mortality on fertility. In the classic demographic transition theory, high fertility is in part a response to high levels of infant and child mortality (Notestein 1953; Davis 1955). Parents have many children to replace those who have died (replacement effect) or parents set excess fertility goals in anticipation of children deaths (insurance effect) (Lloyd & Ivanov 1988). Increased probabilities of child survival may thus be a necessary condition for fertility decline: parents will not control their fertility unless they have assurance their children will survive (Taylor et al. 1976). Moreover, improvements in child survival may be a sufficient condition for fertility decline as soon as parents realise that it is not longer necessary to have many children or feel economic pressures derived from increasingly larger families (Preston 1978). Under these circumstances, fertility transition would be just an adjustment process to conditions brought about by reduced child mortality (Carlsson 1966).-There is also a physiological mechanism that may be important where long periods of breastfeeding are the norm: the death of an infant substantially reduces the breastfeeding period and, consequently, the period of temporary infecundity after childbirth, which results in shorter birth intervals and more children ever born at the end of the reproductive life (Cochrane & Zachariah 1983).

Country level cross-sections

Existing data may give some clues on the causal role of reduced child mortality and whether or not this is a necessary or a sufficient condition for the fertility transition. Figure 1 shows a hypothetical scatterplot for interpreting the data on the covariations in fertility and child mortality levels. The Figure identifies four quadrants that result from combining high and low child mortality levels with high and low fertility rates. It is expected that most observations will fall in quadrants II and III, i.e. the high-high and low-low quadrants. Quadrant I of low child mortality and high fertility is expected to be near empty if a decreasing child mortality is a sufficient condition to bring down fertility rates. Quadrant IV of high child mortality and low fertility shouldn't contain observations if lowering child deaths is a precondition for fertility decline. If real data show substantial number of observations in Quadrants I or IV, the corresponding hypotheses should be rejected (which does not mean that the hypotheses are true, though). A few observations in quadrants I and IV may occur in real data as consequence of measurement errors or effect lags.

How do the countries of the world behave with regard this hypothetical association? Figure 2 shows the scatterplots for about 100 developing countries at two points on time: in 1960, just before fertility started to decline in many countries, and in 1985 when the whole range of fertility levels and stages of fertility transition were represented. The figure plots crude birth rates against infant mortality rates taken from a UNICEF publication (UNICEF 1987).

The expected positive correlation occurs in the two cross sections in the Figure, but it is weak in 1960, especially if one excludes the group of countries in quadrant III (Uruguay, Cuba, Argentina, Hong Kong, Yugoslavia and Romania). This latter group lays in a different category and its inclusion in the universe of "developing" countries is questionable. The other countries had a wide variety of infant mortality rates but uniformly high birth rates. The countries with moderate infant mortality (quadrant I) in this pack, which includes Costa Rica, stands out as counter evidence for the "sufficient condition" thesis: birth rates continued to be high in spite of a moderate infant mortality.

In 1985, the correlation between the two rates (R = 0.79) is higher than in 1960 (R = 0.58). Many countries have moved into the low-low quadrant, Costa Rica among them. Quadrant I contains again a substantial number of countries in which a moderate infant mortality rate has not been sufficient reason for birth rates to fall. Jordan, Syria and Kenya epitomise this situation. The changes in the configuration of the scatterplot since

1960 suggest that countries usually follow a trajectory from quadrant II to I and then to III, i. e. reductions in infant mortality occur before fertility declines. This trajectory is more attuned with a causation direction that goes from infant mortality to fertility rather than the other way around.

The hypothesis that a moderate infant mortality may be a precondition for fertility decline is consistent with the data in Figure 2. Neither in 1960 nor in 1985, there are observations in quadrant IV. A combination of high infant mortality rate (above 100) and moderate birth rate (below 35) appears incompatible. The only exception with a narrow margin is India in 1985 with an infant mortality of 100 and a birth rate of 30 per thousand.

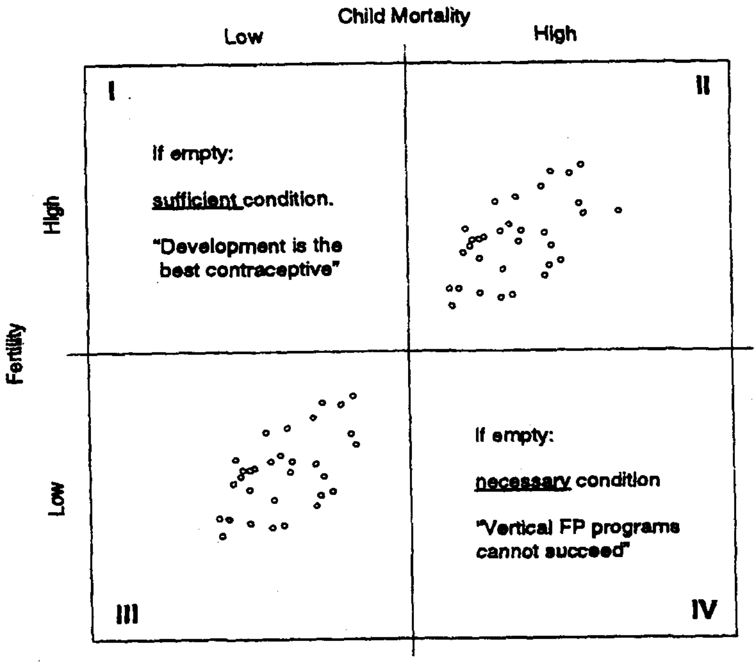


Figure 1. Expected scatterplot for the causal association of child mortality on fertility

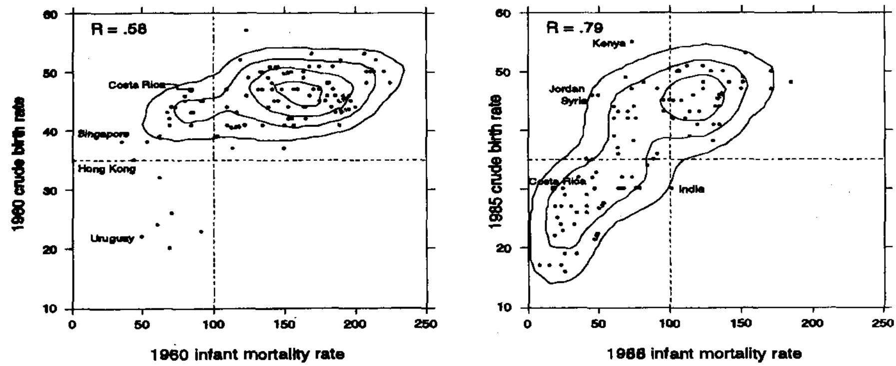


Figure 2 Relationship between infant mortality and crude birth rate. 97 developing countries by 1960 and 1985

Adapted from Hanson et al., 1994:39

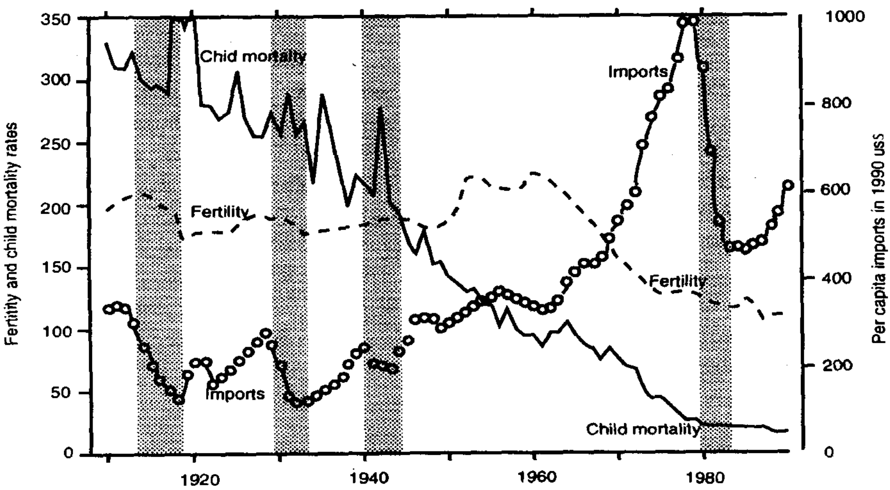
Trends in Costa Rica

Costa Rica experienced one of the earliest and fastest, although incomplete, fertility transitions in the developing world. The total fertility rate (TFR) fell from 7.3 to 5.5 between 1960 and 1968, the year when an energetic national family planning program started, and then to 3.7 by 1976, the year when the decline abruptly stopped (UN, 1985). During the decade following 1976, the TFR fluctuated erratically around 3.7 births. By 1986 the TFR started to decline again, but at a slow pace. According to the most recent national survey, the country's TFR was 3.1 births in 1991-93 and the contraceptive prevalence rate was 75% (Caja Costarricense de Seguro Social 1994).

There is not a unique and simple explanation for the fertility transition in Costa Rica. Some authors stress the role of the relatively high levels of education existing in this country, especially among women (Stycos 1982). Other authors stress the pervasiveness of the process to all regions and social sectors and the role of government (Behm & Guzman 1979). Others underscore the explosive increase in the supply of contraceptives by the private sector in the 1960s and later by the public sector (Tin Myaing Thein, & Reynolds 1972). A more recent literature stresses diffusion processes (Rosero-Bixby & Casterline 1994, 1995, Knight 1995). Although most studies mention child mortality decline among the socio-economic transformations that could induce some fertility reductions, none considers it a crucial factor.

At the fertility transition onset, the country's infant mortality rate was 76 per thousand and the child mortality risk (the probability of dying until the age of 5 years) was 96 per thousand, which are high levels for current standards but were not that bad in the late 1950s. In absolute terms, most of the possible reduction in child mortality rate has already taken place by 1960: it had declined by two thirds from the levels of about 300 per thousand observed by the 1910s (Figure 3). In relative terms, however, the fastest infant and child mortality reductions happened in the 1970s. The child mortality rate (CMR) of about 18 in 1990 is a fifth that of 1960. This acceleration in the pace of child and infant mortality decline in the 1970s has been linked to three main sets of factors (Rosero-Bixby 1991): (1) public health interventions, which probably was the most important, (2) development, including social improvements and a vigorous and sustained growth in the economy (Figure 3), and (3) the fertility decline.

Figure 3 Child mortality rate, general fertility rate, and per capita imports, Costa Rica 20th century



Shaded areas correspond approximately to economic contraction

Figure 3 compares the evolution during the 20th Century of the general fertility rate (GFR), the child mortality rate (CMR), and an indicator of the economy. Data for this figure come from official statistics, which in Costa Rica are reasonably reliable. There are no many things in common between the GFR and CMR curves in the Figure. The only apparent association is the acceleration in the relative decline in CMR during the fertility transition. Actually, this acceleration starts a few years after the fertility transition onset, which suggests that the direction of causation, if any, runs mostly from fertility to child mortality. The rapid economic growth that also took place during that period suggests, in turn, that both child mortality and fertility declines were part of a broader transformation process in society and living standards.

Figure 3 hardly supports the thesis that child mortality decline was key for the fertility transition in Costa Rica. In particular, the record until 1964, is that neither the secular decline nor the short term fluctuations (mostly due to measles epidemics) in CMR were sufficient conditions for altering fertility or starting the transition. The small fluctuations in fertility during those early years are mostly linked to marital disruption, a marriage boom in the 1950s, and declines in widowhood. The only way that Figure 1 may be compatible with the "sufficient condition" thesis would be if the effect of child mortality needs very long lags or threshold doses to act.

The data in Figure 3 is not conclusive about the hypothesis that a certain minimal level of child survival is required for fertility transition. If such prerequisite exists, the Costa Rican experience points out a CMR threshold of 100 per thousand or higher. The CMR did not need to be as low as, say, 50 for people to adopt family planning: the fertility transition started at levels substantially higher than this. In turn, it would not be appropriate to conclude that the fertility transition is not possible at a CMR of, say, 200. One doesn't know if the transition did not started in Costa Rica in, say 1945, when CMR was about 200, because of this high mortality level or because of the absence of other conditions, such as availability of contraceptives or rising costs of children.

Small area co-variations

Let us replicate the analysis of country-level rates with the rates from 89 Costa Rican "counties". The data available for these geographic units are the marital fertility rate (births per married woman aged 15 to 44) in 1965, 1975 and 1985 and the child mortality rate (probability of dying before the fifth birthday) lagged two years. The numerator for computing the marital fertility rate (MFR) is a five-year average from the country's vital statistics and the denominator is an estimate based on the 1963, 1973 and 1984 censuses. The data on births were validated with estimates obtained by projecting backward the census populations.-The child mortality rates (CMR) in 1963 and 1973 were estimated using a variation of the Brass method (UN 1983) on data from the 1973 and 1984 censuses on the proportions of surviving children by mothers' age. The CMR in 1983 is a five year average from vital statistics corrected by the ratio between the census-based estimate and a vital statistics estimate in 1973 (no correction was larger that 20%). Eleven counties with seemingly unreliable CMR or MFR estimates were excluded from the original pool of 100 counties. The unit of analysis, the "county", is a small geographic unit usually in the order of the twenty thousand inhabitants, defined on the basis of the Costa Rican administrative division in "cantones" and "distritos" (details reported in Rosero-Bixby 1991-b).

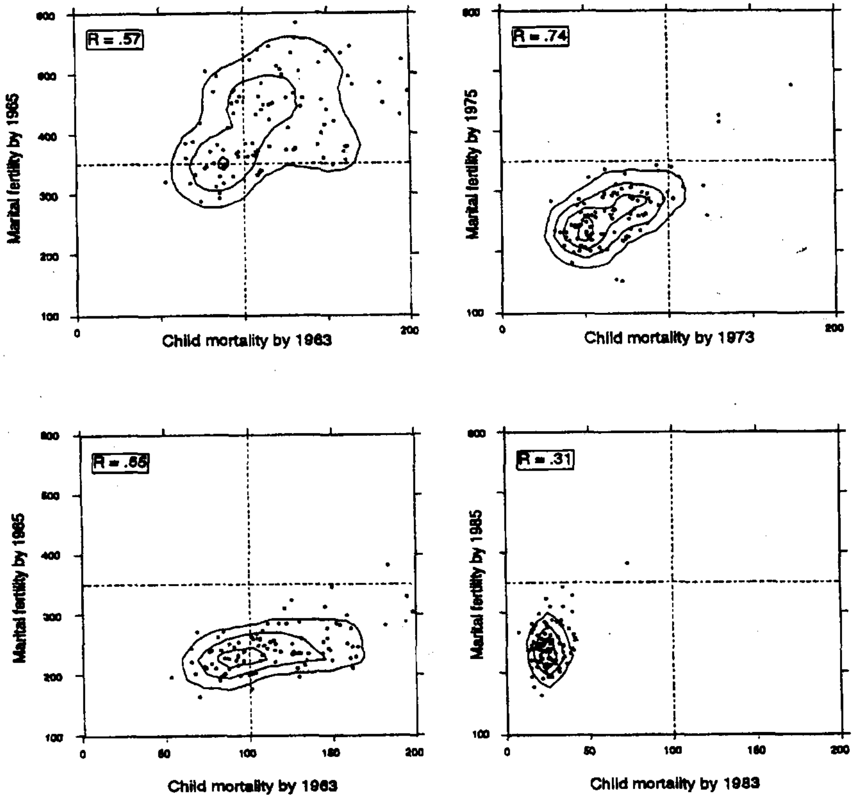
Figure 4 shows the scatterplots for 1965, 1975 and 1985. The 1985 MFR is also plotted against the CMR 22 years earlier to have an idea of the effect of considering lengthened lags. A striking feature in the Figure is the fast pace of change in both fertility and child mortality. In just ten year intervals, there are remarkable shifts in the cloud of observations toward the origin.

In 1965, although most counties lay in the high-high zone, there is a substantial number with moderate CMR and high fertility, a suggestion again that decreasing child mortality may not be enough for decreasing fertility, at least not in the short run.-By 1975, counties with either high mortality or high fertility are extinct species for practical purposes. Very few counties ever fall in the region of low fertility and high mortality (quadrant IV). The hypothesis that a reduced child mortality is a precondition for fertility decline cannot be rejected with these data.

In 1985, all counties but one have a low CMR of less than 50 per thousand. The variation in fertility rates is somewhat broader and the correlation coefficient is a modest 0.31 a suggestion that at these low levels may be little connection between the two variables.

To what extent do child mortality levels in the past influence current fertility levels? An effect may come about if the knowledge on the chances of child survival acquired in childhood and adolescence (news of child deaths heard at home from parents and other adults) is what make couples to pursue an insurance reproductive strategy later on life, i.e. to have as many children as possible to assure some will survive. Figure 4 examines this point by plotting the 1985 MFR against a 22-year lagged CMR. The new correlation coefficient (0.65) is substantially higher than that for the 2-year lagged CMR (0.31). This higher association may be, however, just an artefact of third variables such as a county's historical level of socio-economic development. In particular, less developed counties, which tend to have a somewhat high fertility in 1985, had high child mortality in the 1960s; these counties, however, do not have high child mortality in the 1980s thanks to health programs implemented in Costa Rica in the 1970s (especially primary health care interventions), which erased most of the socio-economic differentials in infant mortality (Rosero-Bixby 1986).

Figure 4 Relationship between marital fertility and child mortality. Costa Rican counties 1965-85



N=89 counties, R=correlation coefficient weighted by county's population

The scatterplot for the 22-year lagged association does demonstrate, however, that a low child mortality during childhood and adolescence is not a precondition for controlling fertility. The large number of counties in quadrant IV makes the point.

Multivariate analysis

The international and local evidence examined so far has shown that the association between child mortality and fertility may be high at some points on time but may also be weak under some circumstances. Are these bivariate associations, and their fluctuations over time, just a manifestation of third determinants shared by both child mortality and fertility? This question is addressed below by statistically controlling the effect of potential confounders in multivariate regression models.-Seven indicators of socio-economic, programmatic, diffusionist and geographic conditions were included in the regressions. Given that these indicators are modelled only for the purpose of controlling their confounding effects, no details about their meaning, operationalization and purpose are given here (details in Rosero-Bixby 1991b).

Multiple regression models estimated for the three cross-sections of CMRs and MFRs (1965, 1975, and 1985) and for the two cross sections of their changes over time (1965-75 and 1975-85), resulted in relatively modest net effects of child mortality lagged 2 and 12 years on marital fertility (results are not shown).-The elasticities, i.e. the percent change in the MFR resulting from 1% change in the CMR, ranged between 0.02 and 0.18.-As with the univariate correlation coefficient, the association is weak in the cross sections before and after the fertility transition. The CMR regression coefficients in the two equations on changes over time were not statistically significant. In short, these analyses did not support the thesis that child mortality has been an important determinant of fertility in Costa Rican counties above and beyond socio-economic and other conditions.

The aforementioned pattern of variation over time in the associations shows that the link between child mortality and fertility, emerges or strengthens only in cross sections taken halfway the transition process. It may be that there is not a general causal relationship but one just on that "one time, irreversible event" that constitutes the fertility transition. The effect of child mortality on the fertility transition event could be: that of a true causal agent that promotes the transition (the sufficient condition hypothesis), that of a precondition for the transition to happen, or that of a mild facilitator of other determinants. To explore this point, we shift to two new dependent variables: (1) the onset year of the fertility transition in the county, defined as the first year of a minimum decline of 20% in six years, and (2) the pace of fertility transition, defined as the proportional decline in the MFR during the 8 years following the transition onset.

In about 90% of Costa Rican counties the fertility transition started between 1959 and 1968 (median in 1965); i.e. before the government established the family planning program in 1968. The child mortality level by the fertility transition onset ranges between 50 and 190 per thousand, with an inter-quartile range from 90 to 130 approximately. In one-fourth of counties the fertility transition onset happened at high child mortality levels of 130 or more. A CMR of 130 means a 50% probability of experiencing the death of a child by couples with five children. In spite of people's close contact with child's deaths in these counties, fertility started to declinea suggestion that a moderate child mortality often is not a prerequisite for the fertility transition.

Does the CMR correlate with the timing in the fertility transition onset? Given the positive correlation between fertility and child mortality, the expectation is of an earlier transition onset in counties with lower child mortality. Interestingly enough, those counties with CMR of 130 or higher were not the laggards for the transition onset. The late adopters (1969 or later) actually had somewhat lower CMR when the transition started. This, however, is an artefact of the time trends in child mortality: the laggards benefited from the substantial fall in child mortality occurred in the 1970s. Looking at the CMR in a fixed point in time (1963) shows that counties with higher CMR lag behind in the fertility transition. The median 1963-CMR is about 150 among counties with transition onset in 1968 or later, while it is about 100 among the early adopters. The data is thus consistent with the expectation that high CMRs may delay the fertility transition.

With regard to the pace of the fertility transition, the expectation is that lower child mortality may facilitate or promote faster declines. Data for the 89 Costa Rican counties do not support this expectation. The MFR fell by 56% in the eight years following the transition onset independently of the CMR in the county (data not shown).

As with previous bivariate covariations, the association between the CMR and the transition onset may be contaminated by interrelated county's characteristics. To check this possibility, a Cox multiple regression model was estimated. Cox regression gives estimates of the proportional rate of occurrence of a discrete event given some observed time-to-response variable (Cox 1972). In the present analysis the time-to-response variable was the onset year of the fertility transition. Table 1 shows the elasticity in the risk of "transition onset", estimated by the Cox regression coefficients for explanatory variables entered in the model as natural logarithms. The Table also shows the elasticities in the pace of fertility decline during the first eight years of transition. These elasticities were evaluated at the variable's means with regression coefficients estimated by Ordinary Least Squares. Note that the explanatory variables in the model for the onset are measured at the early 1960s, whereas in the pace model, are measured at the onset year.

Table-1. Multiple regressions on the fertility transition onset year and the following transition pace-Costa Rican counties-1960-1988

	Onset risk*		Pace**	
Explanatory variables	Elasticity	(z)	Elasticity	(z)
Child mortality (interval)	-0.67	(-1.0)	0.05	(-0.6)
Socio-economic development index	1.97	(2.0)	0.23	(-2.1)
Social security coverage	-0.06	(-0.4)	-0.02	(-0.6)
Legal marital union proportion	-1.95	(-2.1)	0.03	(-0.2)
Family planning service supply	...		0.03	(-1.8)
Diffusion: out-county fertility	-7.65	(-2.3)	-0.48	(-1.7)
Pre transition in-county fertility	3.58	(3.2)	0.78	(-4.6)
Travel time to San Jose	-0.23	(-0.9)	-0.02	(-0.3)
Onset year (1959=0)	...		-0.11	(-1.6)
Constant	...		8.34	(-0.2)
(Pseudo) R-square	0.06		0.26	
Proportional effects for child mortality categories				
<75	2.64	(1.7)	1.02	(0.2)
75-99	1.24	(0.5)	0.95	(-0.5)
100-124	0.60	(-1.1)	0.94	(-0.6)
125-149	0.95	(-0.1)	1.00	Refer.
150+	1.00	Reference		

* Cox regression on the onset risk and the natural logarithm of the explanatory variables measured by 1963.

** OLS regression on the percent fertility decline in the 8 years following the transition onset.-Elasticity measured at the mean. Explanatory variables measured by the-transition onset, lagged 2 years.

N = 89 counties.-

All regressions weighted by the square root of county's population.

One percent increase in the CMR would decrease by 0.7% the likelihood of starting the fertility transition. This effect is not, however, statistically significant. The child mortality effect on the transition pace is nil and non significant. Both the onset and pace are significantly accelerated by socio-economic development (a summary index of seven indicators) and by a reduced fertility in other relevant counties. These effects are much stronger for the onset of fertility transition than for the pace. For the later, there is also a small marginally significant effect of the family planning program.

To allow curvilinear effects, the CMR was re-entered into the regression models as a categorical variable. The lower panel in Table 1 shows the risk ratio and the relative pace for categories of CMR. There is now a marginally significant effects of CMR on the transition onset. Counties with a CMR below 75 per thousand by 1963 are two or three times more likely to begin the fertility transition than counties with a CMR of 150 or more. The pace of fertility decline, however, continue to be unrelated to child mortality.

Discussion

The aggregate-level evidence from developing nations and small areas in Costa Rica examined in this article does not support the claims that decreasing child mortality is critical for decreasing fertility.

Just as there are developing countries that in spite of having a moderate infant mortality continue having high birth rates, the falling of child mortality in Costa Rica during several decades did not impact fertility trends. The data show that one cannot expect that trespassing a child mortality threshold of 200 or 150 per thousand will automatically bring about fertility decline. Don't even going below 100 per thousand child deaths will generate such an automatic response. Too many counter examples among Costa Rican counties and world nations fail to show that at these mortality levels such response exists. In short, neither decreasing child mortality appears a sufficient condition for fertility to decline nor the Costa Rican fertility transition can be explained as just an adjustment process to moderate child mortality rates.

The data is not conclusive on the thesis that reduced child mortality is a precondition for fertility decline. Supporting this thesis is the evidence that-there are not populations with both moderate fertility and high child mortality. This statement depends, of course, on what one considers high child mortality. If one draws the line by a CMR of 100 per thousand or higher, it is indeed almost impossible to find populations with controlled fertility. However, a closer look at the data shows that in a substantial number of Costa Rican communities the fertility transition onset took place at high child mortality levels (above 130 per thousand in 25% of counties). The obstacle of a high child mortality does not seems impossible to beat.- A very high mortality (say 200 per thousand or higher) may, however, be an insurmountable obstacle.

References

Behm, H., & Guzman, J. M. (1979). Diferencias socioeconomicas del descenso de la fecundidad en Costa Rica 1960-1970. Setimo Seminario Nacional de Demografia. San Jose,. (pp. 158-183). San Jose, Costa Rica: Direccion General de Estadistica y Censos.

Blacker, J. G. (1987). Health impacts of family planning. Health Policy and Planning, 2(3), 193-203.

Caja Costarricense de Seguro Social (1994). Fecundidad y Formacion de la Familia. Encuesta Nacional de Salud Reproductiva 1993. San Jose, Costa Rica: Caja Costarricense de Seguro Social.

Carlsson, G. (1966). The decline of fertility:-innovation or adjustment process. Population Studies, 20(2), 149-174.

Cochrane, S. H., & Zachariah, K. C. (1983). Infant and child mortality as a determinant of fertility:-the policy impl. [World Bank Staff Working Papers No. 556].

Cox, D. R. (1972). Regression models and life tables. Journal of the Royal Statistic Society, Series B 34, 187-202.

Davis, K. (1955). Institutional patterns favouring high fertility in underdeveloped areas. Eugenics Quarterly, 2(1), 33-39.

Hanson, L. A., Bergstrom, S., & Rosero-Bixby, L. (1994). Infant mortality and birth rates. in K. S. Lankinen (Editors.), Health and Disease in Developing Countries. (pp. 37-48). London: The MacMillan Press.

Heer, D. (1966). Economic development and fertility. Demography, 3(2), 423-444.

Joseph, A. E., & Bantock, P. (1982). Measuring potential physical accessibility to general practitioners in rural areas: a method and case study. Social Science and Medicine, 16(1), 85-90.

Knight, R. (1995). The Diffusion of information and adoption of contraception in Costa Rica. [International Seminar on the Population in Central America]. Universidad de Costa Rica.

Knodel, J. (1978). European populations in the past.-Family-level relations. In S. Preston (Editor.), The Effect of Infant and Child Mortality in Fertility. (pp. 21-45). New York: Academic Press.

Lloyd, C. B., & Ivanov, S. (1988). The effects of improved child survival on family planning practice and fertility. Studies in Family Planning, 19(3), 141-161.

Notestein, F. W. (1953). Economic problems of population change. In Proceedings of the Eight International Conference of Agricultural Economists. (pp. 13-31). London: Oxford University Press.

Pebley, A., & Millman, S. (1986). Birthspacing and child survival. International Family Planning Perspectives, 12(3), 71-79.

Preston, S. H. (1978). Introduction. In Preston S.H. (Editor.), The Effects of Infant and Child Mortality in Fertility. (pp. 1-18). New York: Academic Press.

Rosero-Bixby, L. (1986). Infant mortality in Costa Rica: explaining the recent decline. Studies in Family Planning, 17(2), 57-65.

Rosero-Bixby, L. (1991). Socio-economic development, health interventions, and mortality decline in Costa Rica. Scandinavian Journal of Social Medicine, Supplement N. 46, 33-42.

Rosero-Bixby, L. (1991b). Interaction Diffusion and Fertility Transition in Costa Rica. Unpublished doctoral dissertation, University of Michigan, Ann Arbor.

Rosero-Bixby, L., & Casterline, J. (1994). Interaction diffusion and fertility transition in Costa Rica. Social Forces, 73(2), 435-462.

Rosero-Bixby, L., & Casterline, J. (1995). Diffusion por interaccion social y transicion de la fecundidad:-evidencia cuantitativa y cualitativa de Costa Rica. Notas de Poblacion, 61, 29-78.

Stycos, J. M. (1982). The decline of fertility in Costa Rica:-literacy, modernisation, and family Planning. Population Studies, 36(1), 15-30.

Taylor, C., Newman, J., & Kelly, N. (1976). The child survival hypothesis. Population Studies, 30(2), 263-278.

Tin Myaing Thein, & Reynolds, J. (1972). Contraception in Costa Rica.-The Role of the Private Sector, 1959-1969.-San Jose,, Costa Rica: Asociacion Demografica Costarricense.

Trussell, J., & Pebley, A. (1984). The potential impact of changes in fertility on infant, child, and maternal mortality. Studies in Family Planning, 15(6), 267-280.

UN (1983). Manual X: Indirect Techniques for Demographic Estimation. New York: United Nations (UN) Department of International Economic and Social Affairs.

UN. (1985). Socio-economic Development and Fertility Decline in Costa Rica. New York: United Nations (UN) Department of Economic and Social Affairs.

UNICEF (1987). The state of the World Children 1987. New York: United Nations Children's Fund (UNICEF).