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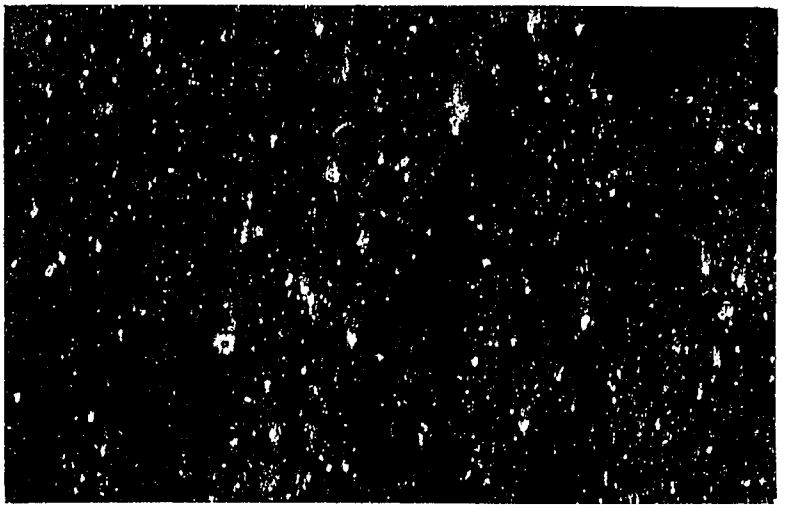

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WOMEN'S REPRODUCTIVE HISTORIES AND DEMOGRAPHIC CHANGE: A CASE FROM RURAL MEXICO

by

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Abstract: In rural areas of developing countries, the most common mode of birth control is lactation contraception. Under natural fertility conditions, lactation contraception is the major restraint on population growth. This study examines reproductive histories of rural Mexican women to analyze the effects of lactation on birth intervals. Women report beliefs about breast-feeding that encourage practices strengthening the contraceptive effects of lactation. Analysis of their birth intervals shows that infant mortality diminishes the duration of lactation and thus contributes to high birth rates. Under these conditions, diminishing infant mortality would result in a simultaneous demographic transition to lower birth rates. The result, however, would be greater rates of population growth.

About the Author: Ann Millard is an Assistant Professor in the Department of Anthropology and the College of Human Medicine at Michigan State University. She has carried out fieldwork in Mexico and her research has focused on population studies, including demography and population genetics, and nutritional adaptations in farming societies.

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WOMEN'S REPRODUCTIVE HISTORIES AND DEMOGRAPHIC CHANGE: A CASE FROM RURAL MEXICO[1]

Reproductive histories of women provide information uniquely valuable in demographic analysis. Women's reproduction is the focus here because biologically it is reproduction by females, rather than males, that limits human population growth. Biological limitations imposed by female reproduction are important in developing nations because the most common mode of birth control, particularly in rural areas, is lactation contraception. Lactation lowers birth rates by delaying the postpartum return of ovulation (Cronin 1968; Gioisa 1955; Hartfield 1972; Jelliffe and Jelliffe 1975 and 1978; Udesky 1950). It is known that child mortality lessens the duration of lactation contraception and thus can increase fertility[2] (cf. Leridon's review 1977), but the implications of this phenomenon for women's reproductive careers and for population growth have not been adequately explored.

The purpose of this study is to examine the extent to which child mortality diminishes the duration of lactation and thus reduces birth intervals. The study differs from the usual demographic study in that it is longitudinal and based on a small sample.[3] It is customary in demographic studies to analyze census materials decade by decade and project trends on the basis of population structure and demographic rates. The present study uses reproductive histories since such information is often more readily available in rural communities in developing countries where archival materials may be inadequate. These reproductive histories are analyzed to investigate causal relationships between infant mortality and fertility.

This study is primarily concerned with biological relationships; nonetheless, cultural factors are recognized as crucial determinants of family size, even under conditions of natural fertility when couples exert little conscious control over reproduction (Leridon 1977). Two recent discussions of cultural determinants of child mortality by Scrimshaw (1980) and Cassidy (1980) are particularly relevant here. Scrimshaw and Cassidy hold that in noncontracepting societies, benign neglect of children at weaning can foster high rates of child mortality. The authors interpret traditions that predispose a child to malnutrition and result in unconsciously caused infanticide as an adaptive mechanism occurring in the presence of high fertility. In the sense that child mortality can function as the major constraint on family size, the results of the present study support the analysis by Cassidy and Scrimshaw.

The present study also can be related to the theory of demographic transition, to which Cassidy's and Scrimshaw's work presents a counterpoint. According to demographic transition theory, high birth rates are a response to high child mortality rates. Studies in this theoretical tradition have considered child mortality and birth rates to be

independent factors that influence one another through social and economic interactions (cf. Davis and Blake 1956). The present study examines the biological interconnections of these rates, and shows that rates of birth depend partially on child mortality in populations practicing prolonged lactation (cf. Leriden 1977 for a similar perspective focusing on the birth interval). It is already known that lactation contraception and child mortality provide the principle constraints on ultimate family size in many developing nations. However, the focus of the present study, which is the interaction of child mortality and lactation contraception, has not been fully explored.

The reproductive histories analyzed in this study were elicited from village women in Mexico. They report traditions that guide them in breast-feeding and result in strengthened lactation contraception. The analysis quantifies several rates of fertility per woman who has completed childbearing. The results show that, under conditions that apply to most populations in developing nations, birth rates are dependent on child mortality because of underlying biological ties that operate through the medium of lactation contraception. In the village examined, child mortality significantly curtails lactation contraception and promotes high birth rates. A decline in child deaths, then, would result in a major, simultaneous decline in births, giving the impression of a demographic transition toward lower population growth. Population growth, however, would actually increase because numbers of surviving children per woman would increase.

Background

The physiology of lactation contraception has not been completely elucidated. The delay in ovulation that accompanies breast-feeding appears to be related to the physical stimulation of the breast during lactation. Stimulation increases the rate of secretion of the hormone prolactin, which has both lactogenic and anovulatory effects (Cowie 1972; Jelliffe and Jelliffe 1978; Short 1976).

The contraceptive effects of lactation were quantified in four recent surveys with a range of overlapping results. Using eight countries from the World Fertility Survey, Jain and Bongaarts (1981) measured the contraceptive effect of lactation. They first excluded effects on fertility of seven intermediate demographic and social factors, i.e., age, parity, residence (rural or urban), sex of child, infant death, wife's education, and wife's work place. A multiple regression analysis that accounted for the effects of these variables first yielded the "net effect of breast-feeding" (1981:93). The net effect of one month of breast-feeding was to add from 0.3 months to 0.7 months to the birth interval of noncontracepting women. Similar results emerged in Saxena's study of Indian women (1977).

Simpson-Hebert and Huffman (1981) measured the contraceptive effect of lactation amenorrhea in sixteen samples from nine countries. Lactation contraception was strongest before the return of menstruation; only 1.5 to 13 percent conceived before resuming menstruation. Further, lactation contraception was rapidly, though not immediately, lost after menses returned (Simpson-Hebert and Huffman 1981; Prema et al. 1979). Data from India showed 8.9 pregnancies per 100 woman-years in noncontracepting women who were breast-feeding and who had not resumed menstruation; oral contraceptive data from the U.S. showed 4 to 10 pregnancies per 100 woman-years (Simpson-Hebert and Huffman 1981; Hatcher et al. 1976; Sehgal and Singh 1966). Simpson-Hebert and Huffman (1981:126) concluded that the protection afforded by lactation amenorrhea is "almost as use-effective as that offered by oral contraceptives, the condom, or the diaphragm. It is more effective than coitus interruptus, rhythm, or douche."

In a survey of nine societies, Jelliffe and Jelliffe computed the interval from birth to the succeeding conception (1978). In lactating women the interval ranged from 11.7 to 53.0 months, with most values in the range from 20 to 30 months. In non-lactating women in the same societies, the conception interval varied from only 3.0 to 16.9 months (Jelliffe and Jelliffe 1978, Table 6.1). Leridon's review (1977:81) of eleven studies showed that postpartum sterility generally lasted for a minimum of 20 months when breast-feeding was widespread and prolonged. In summary, lactation is recognized to have a contraceptive effect, though its strength and duration vary from woman to woman and from society to society for a number of incompletely understood reasons (cf. Chavez and Martinez 1973; Nag 1962; Quandt 1981; Simpson-Hebert and Huffman 1981; Solien de Gonzalez 1964 for hypotheses of cultural effects on breast-feeding and birth spacing).

A Mexican Village

Data for the present study were provided by inhabitants of a village in central Mexico, San Jeronimo Amanalco, in 1976 and 1977. Amanalco lies in the northeastern corner of the State of Mexico, a one and one-half hour bus ride from Mexico City. As described below, the economic system, in conjunction with family organization, promotes large families.

Materials and Methods

Two assistants and I elicited childbearing histories from 111 of Amanalco's women, who represented about 24 percent of the village women aged 15 years or older. Of these women, about one-fifth had completed reproduction. All women currently or formerly belonging to marital unions were interviewed in the households surveyed. We cross-checked information with relatives and other villagers.

Evaluation of the representativeness of the Amanalco sample relies on similar work in a nearby community. There we carried out the same interviewing procedures and compiled random and availability samples large enough for statistical comparison. We were able to interview members of households chosen at random because we were better known in the second

village and because the villagers were less suspicious of strangers. The Kruskal-Wallis one-way analysis of variance revealed no significant differences between the random and availability samples with respect to six variables, including demographic rates. Comparisons of data collected by different fieldworkers also yielded no significant differences. Thus, the availability sampling technique itself, used in Amanalco, introduced no evident bias. Further, the sample characterized a large proportion of the village population since one-quarter of the village's nuclear families were included in it.

Economic and Social Conditions

Families' livelihoods derive from agriculture, handicrafts, and wage labor (see Campos de Garcia 1973, Millard 1980, and Perez Lizaur 1975 about Amanalco; see Sokolovsky 1978 about a similar village). Amanalco is identified as Indian, and villagers speak Nahuatl, the language of the Aztecs, in addition to Spanish. Family organization, with a predominance of patrilocal stem families, resembles that of other Nahuatl communities (Montoya 1964; Madsen 1960; Nutini 1968; Sokolovsky 1978). Amanalco is endogamous; 82 percent of marriages occur between natives of the village.

Nearly every family owns at least one plot of irrigated farm land and family members usually work the land themselves. As might be expected under conditions of labor-intensive farming, large families derive greater benefits from the land than small families (cf. Cain 1977; Caldwell 1976 and 1978; Momdani 1972). Family members often commute to wage earning jobs when they are not needed on the farm. Though they spend long periods outside the village, and may even maintain a household in the city, such migrants continue to contribute to their village kin. Thus, large families are economically advantageous even when landholdings and handicrafts are insufficient for their entire support.

High rates of infant mortality may be related to public health problems in a settlement that has undergone rapid growth through this century. Recently a public water system began intermittently supplying piped-in water to many households. In recent years the construction of an all-weather road and the introduction of regular bus service have improved access to western medical care; medical care also is available sporadically in the village itself. Because most of the children in the present study already had been born by the time these changes occurred, their survival was not affected by the health improvement measures subsequently brought to the village.

Prescriptive Traditions for Weaning

Villagers tell of a number of traditions that prescribe the proper circumstances for weaning. Unlike the advice of Western medicine, Amanalco's traditions do not recommend a specific chronological age for weaning. Instead, the proper time for weaning depends on a child's physical and behavioral development. Five rules frequently mentioned by women as determinants of the timing and style of weaning are shown in Figure 1.

The third of these rules, that weaning should be an abrupt change from breast milk to other foods, appears in many societies. Sudden weaning is a practice that can potentiate malnutrition (Cassidy 1980). In rural Mexico, Hernandez et al. (n.d.) report that only 50 percent of mothers introduce food supplements by the child's tenth month of life. Weaning is rapid and occurs within one day in 66 percent of the cases. Some caution is in order in the interpretation of these findings, however; women in Amanalco would make similar reports, but they would be overstatements in the following sense. In Amanalco, children start tasting foods at early ages. Over a period of months, they become accustomed to eating small amounts of foods that will constitute their diets after weaning. Mothers do not regard this nibbling as a supplement to breast milk; not until the child eats an entire non-milk meal is the child considered to be eating food other than breast milk.

Before weaning is completed, heavy dependence on mother's milk is maintained, and the use of cow's milk and infant formulas is eschewed (Rule 4). Feeding animal milk to babies is regarded by villagers as "disgusting." Until weaning, demand feeding is practiced and regarded as proper (cf. Gussler and Briesemeister 1980 and Vis and Hennart 1978). Weaning is an abrupt shift from heavy dependence on mother's milk to total dependence on non-milk foods already familiar to the child. Abrupt weaning tends to keep lactation contraception functioning strongly up to the point of weaning, rather than conferring a gradual decline in strength expected with a gradual weaning process (cf. Kolata 1974; Jelliffe and Jelliffe 1978).

Other traditions complement lactation contraception by lowering a woman's postpartum exposure to pregnancy. A relatively short postpartum sex taboo, that appears elsewhere in Mesoamerica, extends over the cuarentena, the forty days following childbirth (Cosminsky 1977). Other social practices, such as having the baby sleep in the parents' bed until weaning, may inhibit sexual activity until after weaning.

The fifth rule, that a woman should not continue breast-feeding while pregnant, establishes an additive relationship between breast-feeding and pregnancy, that will be used in calculations below. This rule is also found elsewhere in central Mexico (Chavez and Martinez 1973). Hernandez et al. (n.d.) report that nearly 35 percent of weanings in eight rural Mexican communities occur because of a new pregnancy. In the present study, women report that pregnancy and lactation can overlap slightly, for three or four months, until pregnancy is certain, whereupon weaning follows. In summary, the prescriptive traditions outlined in Figure 1 and associated childrearing behavior complement the contraceptive effect of lactation, sustain the strength of lactation contraception until weaning, and help to make lactation and pregnancy mutually exclusive processes.

Demography

Demographic rates of families are significantly related to their economic circumstances. Though some would argue that closed corporate communities have no significant economic differentiation, stratification of wealth has been found in other Mexican farming villages (Cancian 1965; DeWalt 1979). Economic differentiation interrelates systematically with other facets of life, including fertility (DeVaney and Sarchez 1979). In Amanalco, poorer families experience significantly higher rates of birth and child mortality than others.

The demographic characteristics of the families of women with a history of childbearing are shown in Table 1. Women with a history of childbearing include only those with at least one live birth and who had completed childbearing. The women were at least 45 years old when interviewed. Among these women, the average number of live births is 9.39 $\pm$ 3.68 per woman.

When maternal fertility is calculated for the entire group of post-reproductive women, including those who were barren, the average number of live births per woman is 7.46 $\pm$ 5.01. The survivorship to at least 5 years of age is 4.00 $\pm$ 2.97 children per woman, for the entire group of post-reproductive women. The remainder of this paper deals with the subset of women with a history of childbearing and excludes barren women, because the focus is on fertility and lactation.

Comparison of the rates included in Table 1 with those from other sources supports their plausibility (see Table 2; Perez Lizaur 1975). First, work by Perez Lizaur on the historical demogrphy of Amanalco and neighboring villages reveals that Amanalco characteristically has had high rates of birth and of infant mortality. Perez Lizaur used national census data and parish records of births and deaths which she cross-checked with civil archives. She interprets the fertility rates as overestimates, particularly for the first three decades, because the census probably undercounted Amanalco's actual population.

The estimated national fertility rates in Mexico (from 1900 through 1940) vary considerably among studies (cf. Brito 1969; Collver 1965; Arriaga 1968). The maximum fertility rate in natural populations can be considered 58 to 60 births per 1000 (Perez Lizaur 1975). Worldwide censuses from the early 1970s show that the highest national birth rate was 50 births per 1000 (Myers 1976). Thus, Amanalco's rates in the first decades of the century are unexpectedly high, while rates in later decades are still high but more plausible.

Researchers agree that from 1950 through 1970 Mexican birth rates ranged between 43 and 46 per 1000, though they disagree about whether the rates were increasing or decreasing (Brito 1969; Keyfitz and Flieger 1971; Rowe 1979). These rates, i.e. 43 to 46 per 1000, approximate Perez Lizaur's, which show greater fluctuations because of Amanalco's small population size.

In maternal fertility, women in Amanalco show high rates, even when compared to other farming communities. Amanalco's women slightly surpass a comparable group of Hutterites, who have been characterized as the most prolific society known. Hutterite women with completed fertility and with at least one child averaged 9.24 children, compared to Amanalco's 9.39 (Hutterite rate calculated from Table 10, Eaton and Mayer 1953). Rowe calculates that the Mexican total fertility rate in 1960 was 6.69 live births and in 1970, 6.54 live births per woman. These national rates can be expected to fall below rural rates such as Amanalco's 7.46 live births per woman who had completed childbearing. Thus, the level of fertility calculated in the present study is high but plausible; additionally, it falls within the range of other peasant farming communities (Balakrishnan 1979; Nag 1962; Shedlin and Hollerbach 1981; Spuhler 1976).

The infant mortality rates shown in Table 2, like the fertility rates, may be inflated. Perez Lizaur attributes these extraordinarily high rates to inaccuracies inherent in the records. Because registration is time-consuming and requires payment, parents forestall registering births. If burial required registration, as seems true for parochial records, more dead infants would have been registered, resulting in inflated rates of infant mortality. Nationwide infant mortality was highest early in this century. In 1900 and 1910, out of 1000 live births, 324 infants died in their first year of life (Brito 1969). Internationally, the highest infant mortality among countries in the early 1970s was 208 per 1000 (Myers 1976). Thus, Amanalco's rates of infant mortality are probably inflated, though they were undoubtedly high throughout most of this century.

Interview data from this study yield a rate of death before the age of 5 years of 398 per 1000 live births. Cross-checking information among villagers, we found that surviving children do not tend to be under-reported, while the births and deaths of dead infants are underreported by their mothers. Hence, the rates calculated in this study may represent underestimates of child mortality, but it is doubtful that they represent overestimates. In summary, child mortality rates calculated from the interviews carried out for this study are high, but plausible.

Estimation of the Nonsusceptible Period

To examine patterns of lactation in relation to birth spacing, I estimate a woman's nonsusceptibility to conception between the first and last births. The technique is explained in detail below. In Figure 2, modified from Jelliffe and Jelliffe (1978: Figure 6.2), a schematic diagram of the segments of a woman's reproductive career under consideration here is presented. The nonsusceptible period has been defined as that time, following conception, during which ovulation is suppressed (Sheps and Menken 1973:8). Thus, it includes the duration of pregnancy and of postpartum sterility.

The method of calculating the sum of the nonsusceptible periods between the first and last births is shown in Table 3. The equations add the time spent in pregnancy, excluding the first pregnancy and allowing 9 months for each succeeding pregnancy, to time spent in lactation, excluding the breast-feeding of the last child as in Figure 2. Thus, the total duration of lactation and pregnancies between the first and last births (closed birth intervals) is calculated for the average mother in each community. This sum estimates the biologically ordained component of birth intervals.

Time spent in lactation is calculated differently for surviving and non-surviving infants. For the total time a woman spent breast-feeding children who survived through weaning, the number of surviving children per mother is multiplied by their average age at weaning. For those children who did not survive through weaning, the average number of non-survivors per mother is multiplied by their average age at death. Addition of the two lactation times yields the total time an average mother spends in lactation.

This quantity approximates the duration of the postpartum nonsusceptible periods, although it admittedly oversimplifies physiological and population phenomena. In addition to the oversimplified measure of postpartum sterility by lactation, the calculations in Table 3 incorporate three other potential sources of error. Birth intervals are underestimated when weaning occurs before conception. Birth intervals are overestimated when lactation overlaps with pregnancy and when pregnancy terminates with miscarriage. Miscarriage histories were not elicited and few women volunteered such information. A village in a neighboring region shows 0.9 spontaneous abortions per woman who had completed reproduction (Chavez and Martinez 1973). We systematically recorded live births, because live births constitute a validatable event and allow accurate estimation of gestation.

Despite these potential sources of error, the method of calculation used provides a reasonable approximation of birth intervals. The correspondence of the age at weaning to postpartum sterility is strengthened by traditions of intense breast-feeding and abrupt weaning discussed earlier. Additionally, Corsini's method of calculating birth intervals, presented below, yields similar results.

Results of Calculations

The values used in the calculations are shown in Table 1, methods of calculation in Table 3, and the results in Table 4. The average birth interval is 25.92 months. This birth interval falls within the range of that found in most societies in which prolonged lactation is practiced (see Jelliffe and Jelliffe 1978). Therefore, their length is plausible despite the use of a new method for their estimation.

Another method of calculation provides a means of estimating birth intervals on the basis of observations of other populations. Corsini has provided a method of calculating the duration of amenorrhea, 1.5 + 0.56 $\bar{x}_w$ (Corsini 1977, with symbols changed to those of this paper: $\bar{x}_w$ is the average age in months at weaning.) Added to this quantity is 9 months for the duration of the succeeding pregnancy which closes the birth interval, yielding an estimated birth interval of 21.81 months. This estimate equals about 85 percent of the result given earlier, which is sufficient agreement for the purposes of this paper.

The calculations using the method presented in Table 3 show that women in Amanalco spent about 18 years on the average in pregnancy and lactation, accounting for nearly their entire reproductive spans; reproductive unions begin at an average of 18.71 years. Thus, Amanalco would seem to be a natural fertility population in Leridon's sense (1977) in that members exert little or no conscious control over reproduction.

The effect of declining child mortality on natality and population growth can be predicted using estimates of the reproductive span of women in Amanalco. The predictions show that fertility would decline significantly if child mortality in Amanalco dropped to the national infant mortality rates in 1970 of 74 per 1000 (Rowe 1979).[4] A study by Chavez and Martinez found that menopause occurred at 40.4 years of age in another central Mexican village (1973). Using this age as the end of reproduction, the decline in child mortality would reduce maternal fertility by about 3 percent to 9.11 live births per mother (see Table 5.). If childbearing occupied an average span of 20.51 years, as estimated in the present study, maternal fertility would fall by 8 percent to 8.62 live births per mother. If the end of reproduction came well before menopause, as found in Chavez and Martinez's study, the maternal fertility rate would fall by 16 percent to 7.91 children per woman. The last estimate seems excessively low; from the most reasonable estimate, birth rates could be anticipated to drop by about 8 percent.

The decline in child mortality would result in a more dramatic upward jump in survivorship (see Table 5). Survivorship would increase by 30 to 40 percent, to 7.98 children per woman, resulting in a spurt in population growth even though birth rates had dropped.

Summary and Discussion

The above calculations show that child mortality occurs at a rate high enough to curtail lactation contraception significantly. Lactation lasts for 20 months for surviving children, projecting a 29-month nonsusceptible period according to calculations used in the present study. However, because of child mortality, the nonsusceptible period per birth interval averages only 25.92 months; each interval is reduced by about 10 percent. The result is a surprisingly high birth rate despite traditions of prolonged and intense lactation. These relationships offer an explanation for the correlation of high rates of child mortality with high rates of birth in the poorer segment of Amanalco.

A reduction in Amanalco's rates of child mortality to national levels of 74 deaths per thousand live births would decrease maternal fertility in Amanalco by an estimated 8 percent to 8.62 live births per mother. However, because of improved survivorship, population growth would increase. Surviving children would number an estimated 7.98 per woman, about 40 percent more than the present 5.64.

The change in fertility would constitute a major decline, and it would occur for biological rather than for conscious reasons. This mechanism of fertility reduction could only depress birth rates to a certain point, beyond which other mechanisms would have to come into play to reduce fertility further.

The theory of demographic transition describes a series of stages during the predicted transition from high to low fertility. According to the theory, infant mortality will decline before fertility, and the decline in infant mortality will motivate people to contracept. The decline in fertility projected by this study would coincide with the decline in infant mortality. Thus, to the extent that people perceive rates of birth and death, they would perceive a decline in both, and this perception could discourage them from adopting contraception to reduce fertility.

This study predicts that a decline in infant mortality will cause a simultaneous jump in population growth. The policy implications of this finding depend on the effects of rapid population growth on the village and on the nation as a whole. One way in which the village has responded to rapid growth in the past has been to increase agricultural yields. In 1977, villagers in Amanalco were expanding the irrigation system to lands composed of hardpan, which was being broken up by expensive machinery leased by the state government. Thus, population pressure is already finding some release through the expansion of farm land. This value for population pressure, however, is limited because Amanalco is bounded on three sides by other villages and on the fourth side by altitude, limiting crops which can be cultivated successfully higher on the mountainside.

Villagers say that it may be possible to increase agricultural production through planting each plot of irrigated land more frequently. They say this change could be successful only if a substantial number of villagers changed to a more intensive system simultaneously. Pests will destroy small-scale plantings that are on a different harvest cycle from other crops. Thus, an increase in agricultural production through more plantings would require a coordinated effort on the part of villagers. The government is attempting to raise yields through encouraging the use of commercial fertilizers and new seeds. However, the 40 percent increase in the rate of population growth predicted by this study is likely to overwhelm the finite capacity for agricultural production in the village.

Once the carrying capacity of village agriculture has expanded to its limits, the remaining valve to release population pressure will be the off-farm labor market. Presently the village has one small handicraft

industry which employs about five villagers at any one time. Village families' cottage industries also are important complements to farm production now, but they probably could not become viable economic pursuits independent of farming. In addition, any increase in cottage industries in the village will remove land from cultivation and decrease agricultural production.

Out-migration to jobs in nearby towns and cities provides supplementary incomes for many farm families. Currently out-migration is largely seasonal; however, year-round commuting and out-migration to wage-labor jobs could be expected to increase if population growth is rapid. Nearby villages currently have a greater rate of population growth than Amanalco even though their farming conditions are poorer; families in these villages rely primarily on the earnings of commuters and out-migrants, and supplement those earnings with farm income. Thus, a shift to more wage-labor migration and increased reliance on cash income for subsistence will not necessarily motivate families in Amanalco to reduce birth rates.

The goals of the Mexican government include self-sufficiency in food production, fuller employment, industrialization, and slower population growth. In some ways, these goals conflict, and the locus of conflict extends to the farm family. In addressing the problem of rapid population growth, the Mexican government has not succeeded in winning over the countryside to the ideal of the small family. Many studies show that village farmers have economic motivations for large, not small, families. Children provide farm labor, and, ideally, support in old age. Further, large families in Amanalco have extra labor and members can engage in handicrafts and commute to urban jobs. Thus, off-farm work absorbs the extra labor of farm families. Because off-farm work is a viable option, it is doubtful that limited village resources, in the sense of a finite carrying capacity of village agricultural lands, would force village families to reduce reproductive rates. Migration to the city may serve the Mexican government's efforts to further industrialization; a larger pool of workers will help to keep wages low. However, the economic opportunities offered by the city to excess labor from family farms will accommodate to high rates of rural population growth, and, in this sense, will actually encourage rapid population growth in the countryside.

The outlook for population control, then, appears bleak because villagers are not motivated to limit family size. Yet, it is apparent that villagers do not experience population growth passively, but instead respond through economic expansion. Perhaps the most important question to examine, then, is whether rapid population growth can be accommodated through the same mechanism of economic expansion, and whether these mechanisms obtain beyond the village in destinations to which villagers migrate for their livelihoods.

Notes

1. This paper was improved by helpful comments from E. A. Hammel, Brigitte Jordan, Willett Kempton, Harry Raulet, K. W. Wachter, and reviewers for the WID Working Papers. Responsibility for any errors remains my own.

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2. Fertility is used here to mean rates of live births.

3. The quantitative results of this study thus are limited in their generalizability; nevertheless, the relationships found are expected to hold for all societies in which prolonged lactation is practiced.

4. The factors that could lead to a major decline in child mortality are many and their interactions are complex. Public health measures, improved health care, and improved maternal and child nutritional status are a few of the factors that have been related to the decline of mortality during the first 5 years of life.

Figure 1. Prescriptive Traditions Surrounding Weaning

1. Once a child has teeth, the child should be weaned. (The number of teeth, or which teeth, is not specified.

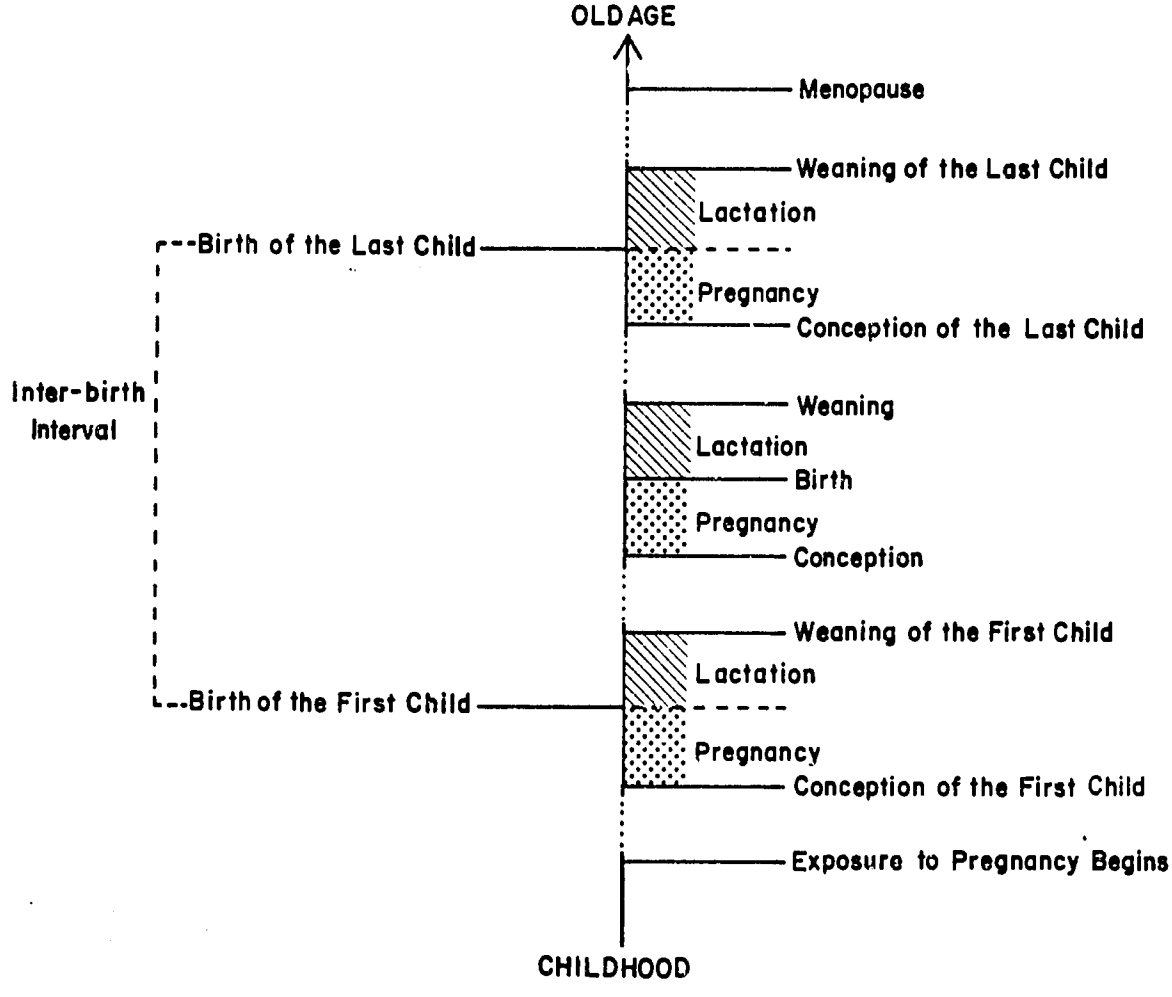
2. If a child is breast-fed for too long, the child will be boorish and ill-mannered ("grosero").

3. Weaning should not be gradual, because a diet of both mother's milk and other food will sicken a child.

4. Children should not be given animal milk.

5. If a lactating woman knows she is pregnant, she must wean her breast-feeding child to avoid damage to the fetus she is carrying.

Figure 2. The Span of a Woman's Reproductive Career Showing Intervals of Nonsusceptibility to Conception



Nonsusceptibility to conception because of pregnancy, here assumed to last 9 months

Nonsusceptibility to conception because of lactation; sterility is assumed here to occur uniformly to all women and to last until weaning or infant death preceding weaning.

Adapted from Jelliffe and Jelliffe (1978: Figure 6.2)

Table 1. Demography and Lactation in Families of Women with Completed Fertility and at Least One Live Birth.

I. Reproduction and Childhood Mortality	
Mother's age at initiation of reproductive union $\bar{x}_R \pm$ s.d., years	18.71 ± 3.98
Maternal fertility (number of live births per woman) $\bar{x}_F \pm$ s.d., live births	9.39 ± 3.68
Child mortality (number of deaths per sibship) $\bar{x}_M$	3.74
Survivorship (number of surviving children per sibship) $\bar{x}_S \pm$ s.d.	5.64 ± 2.78
II. Duration of Lactation	
Age at weaning for children who survived through weaning $\bar{x}_W \pm$ s.d., months	20.19 ± 7.75
Age at death of children who died before weaning $\bar{x}_D$, months	12.04

Women with completed fertility are defined as those at least 45 years old when interviewed. Mother's age at initiation of reproductive union is the age at which a woman began cohabitation, regardless of whether the couple was formally married; weddings generally follow several years of cohabitation and childbearing. Maternal fertility differs from the conventional demographic measure, completed fertility, by excluding barren women. Child mortality is the difference between maternal fertility and survivorship. Sibship is defined as the children born to each woman, regardless of whether they share the same father. Survivorship includes the members of a sibship who survived to the age of 5 years. Age at weaning is the child's age when weaning was completed, when the child no longer took any mother's milk. For variables in Section I, women numbered 21 to 26. Numbers of children for variables in Section II totaled 444.

Table 2. Twentieth Century Demography by Decade in Amanalco.

Infant Year	I Total Population	II Fertility[a]	III Mortality[a]
1900	1008	55.15	352.51
1910	1006	49.70	260.00
1921	986	58.41	409.71
1930	1184	27.87 (51)	--
1940	1339	43.53	365.35
1950	1501[b]	29.90 (43)	480.00
1960	1593[c]	42.87	390.00
1970	2010	--	--

Source: Perez Lizaur, 1975: 65 and 176. Her sources included national censuses, parish and civil archives. Numbers in parentheses are corrections calculated in Millard 1980 by plotting the surrounding years on graphs.

Fertility, Mortality and Infant Mortality were calculated using three-point averages. Fertility = [births/(total population)] x 1000; Mortality = [deaths/(total population)] x 1000; Infant Mortality = q_0 = [(deaths of those aged less than one year)/(births in that year)] x 1000. Rates are approximations by Perez Lizaur; archives often did not show age at death of infants in months.

Calculated population size. Size given by graph (Perez Lizaur, 1975: 1456).

Corrected using Benitez and Cabrera's estimate that the population aged 0-4 years was underenumerated by 14.56 percent (1966:26).

Table 3. Method of Calculating the Contribution of the Nonsusceptible Period to Birth Intervals.

A. The calculations, simplified:

$$L + P = B$$

where L is nonsusceptibility conferred by lactation. Lactation of the last child is not included in the inter-birth interval.

P is nonsusceptibility conferred by pregnancy. Pregnancy with the first child is not included in the inter-birth interval.

B is nonsusceptibility conferred by lactation and pregnancy during the interval between the first and last births.

B. Method of calculation used in this paper. (This is represented by equation A.)

$$\frac{\bar{x}_W}{12}\left(\bar{x}_S - \frac{\bar{x}_S}{\bar{x}_F}\right) + \frac{\bar{x}_D}{12}\left(\bar{x}_M - \frac{\bar{x}_M}{\bar{x}_F}\right) + \frac{9}{12}\left(\bar{x}_F - 1\right) = B$$

where $\frac{\bar{x}_W}{12}$ is the mean age at weaning (in years) for children who survived beyond weaning.

$\bar{x}_S$ is the mean number of surviving children per woman.

$\bar{x}_F$ is mean fertility, defined as the number of live births per woman; $\frac{9}{12}$ is the duration of pregnancy (in years).

$\bar{x}_D$ is the mean age at death of children who died before weaning.

$\bar{x}_M$ is the mean number of children per woman who died before reaching 5 years of age. Virtually all of them died before weaning.

$\frac{\bar{x}_S}{\bar{x}_F}$ and $\frac{\bar{x}_M}{\bar{x}_F}$ are subtracted to exclude lactation of the last child from the sum of inter-birth lactation. These fractions assume that the last child's probability of surviving is the same as that of the average liveborn child.

B is the mean nonsusceptible period per woman, in years, between her first and last births.

Table 4. Results of Calculations of the Inter-Birth Nonsusceptible Period.

B	=	Total of nonsusceptible periods between the first and last births (in years)	18.13
x_B	=	average nonsusceptible period per birth interval, calculated from above (in months)	25.92

Table 5. Predicted Effects of Diminished Child Mortality on Reproductive Careers of Women with Completed Fertility and at Least One Live Birth

Length of Reproductive Span (years)	Fertility % Change from Present ($\bar{x}$, Predicted Live Births/Mother)	Survivorship % Change from Present ($\bar{x}$, Predicted Surviving Children/Mother)
21.69[a]	-3% (9.11)	+50% (8.44)
20.51[b]	-8% (8.62)	+41% (7.98)
19.29[c]	-14% (8.10)	+33% (7.50)
18.82[d]	-16% (7.91)	+30% (7.32)

Among women who had at least one live birth, present completed fertility is 9.39 live births per woman and survivorship is 5.64 children per woman (Table 1).

Reproductive spans are calculated using the mother's age at initiation of reproductive union from the present study, 18.71 years (Table 1). The end of reproduction is calculated as follows:

[a]Menopause at 40.4 years of age (Chavez and Martinez 1973).

[b]Reproductive span estimated from the total time pregnant or lactating in the present study.

[c]Menopause at 38 years of age.

[d]Gyneco-obstetric data from Chavez and Martinez (1973) were used to estimate an average age at last childbearing of 35.9 years. Their study suggests that poor nutritional status has resulted in lower fertility.

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