FERTILITY AND INFANT MORTALITY IN COSTA RICA

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Costa Rica is a small country, geographically situated in the Central American isthmus, with 2.2 million inhabitants. Although its exports are mainly of an agricultural nature, the country has reached a level of welfare somewhat higher than the Latin American average. The per capita income is approximately US $ 1700, the illiteracy rate is less than 10 per cent and in 1978 the infant mortality rate was 22 per 1000 births.

Since 1960, there has been a dramatic drop in Costa Rican fertility. The total fertility rate (TFR), which was 7.3 children in 1960, practically halved in only 15 years, reaching a value of 3.7 children per woman in 1976.

During the months of July to November 1976, the General Statistics and Census Bureau conducted a national fertility survey, as part of the World Fertility Survey (WFS). There were 3935 women interviewed, ranging from 20 to 49 years of age; their maternity histories provide valuable information regarding nearly 13000 live births, most of which took place during the last three decades.

This paper briefly examines the accuracy of the data contained in the maternity histories, or more precisely, their coherence with national vital statistics, which in Costa Rica are reasonably good. Furthermore, based on the maternity histories, a description is made of the level and change of the country's fertility, some of its relationships with nuptiality, the timing of births and the parity progression ratios, and finally, a brief view is offered regarding the biological and social factors associated with fertility and infant mortality.

ACCURACY OF THE DATA

After a careful evaluation of the accuracy of the data, which included the application of models, Guzmán (1978) concluded that the maternity histories of the Costa Rican WFS offer fertility estimations which are reasonably reliable. This point is illustrated here by comparison with estimations originating from other sources of information.

TABLE 1

Mean number of children ever born by age of the mother (WFS and other sources)

Age	Census 1973	Register's estimate 1975	WFS 1976	Survey 1978
20 - 24	1.1	1.0	1.0	1.0
25 - 29	2.5	2.3	2.0	2.0
30 - 34	4.1	3.7	3.5	3.4
35 - 39	5.5	5.1	4.8	4.4
40 - 44	6.4	6.2	6.1	5.5
45 - 49	6.7	6.7	6.7	6.4

Source: Direccion General de Estadistica y Censos, Censo de 1973, Estadisticas Vitales and WFS; Associacion Demografica Costarricense et al. (1978).

In Table 1 it can be seen that the cumulative fertility of the cohorts at the moment of the survey is quite coherent with data from other sources, and with the rapid decline of fertility which has taken place in Costa Rica. These results indicate that, in the WFS, there were no important omissions in the maternity histories reported.

Table 2 and Figure 1 show that there were no important errors in the statements regarding the birth dates. It is observed that the series of fertility rates of the 20 to 29 age group, calculated with WFS data, reflect quite well the level and accentuated tendency of decline of Costa Rican fertility, thus confirming the estimations made on the basis of the data provided by the birth registry, which in Costa Rica are reasonably reliable.

The rates for infant mortality calculated from the maternity histories seem adequate to offer an approximate idea of its level during a period not very far from the moment at which the survey was made. The coherence with estimations based on the registry is less than in the case of fertility, but this is due not so much to errors in the maternity histories as to a certain degree of under-registration (perhaps 10 %) present in mortality statistics, and because as one goes back in time the rates calculated with the WFS are not representative of all children, but correspond to children from ever younger mothers. For example, the 1955-57 rate includes only children of mothers who were less than 30 years of age.

TABLE 2

Annual fertility rate for women aged 20 to 29 and infant mortality rate (WFS and register's estimations)

Years	Rate per 1000			
	Fertility of 20 - 29 year olds		Infant mortality	
	WFS	Register	WFS	Register
1952 - 54	–	–	99	96
1955 - 57	342	348	62	87
1958 - 60	335	352	70	78
1961 - 63	323	339	86	79
1964 - 66	316	310	75	77
1967 - 69	263	262	74	67
1970 - 72	211	225	63	59
1973 - 75	182	197	52	40
1958 - 66	324	332	77	78
1967 - 75	215	225	64	55

Source: Direccion General de Estadistica y Censos, Estadisticas Vitales and WFS.

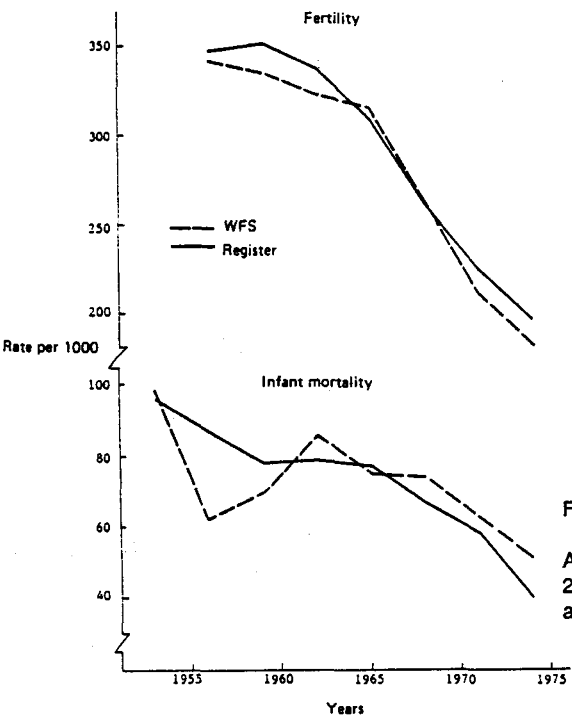

FIGURE 1

Annual fertility rate for women aged to 20 to 29 and infant mortality rate (WFS and register's estimations)

GENERAL FERTILITY BY AGE

Because the survey does not include the maternity histories of women older than 50 years of age, there is a truncation effect. This becomes evident when one tries to study the past fertility by age, but is not so clear when, for example, the fertility rates by duration of marriage are being calculated. Thus, for 1960 there is no information for those aged above 35 years, but there are data regarding those whose duration of marriage is 20 years and more. The problem is that these are strongly perturbed because they refer to those young women who got married before they were 15-years old. Due to the problems caused by truncation at the current age, this chapter only analyses the rate series which refers to the totality of the reproductive period: that corresponding to the cohorts born between 1926 and 1931 (aged 45-49 in the survey) and to the period nearing the time when the survey was carried out (the last 5 years, and in some cases, the last 10 years).

Table 3 and Figure 2 show the sharp decline in fertility which took place during a short period of time in Costa Rica. The women who at the time of the survey were ending their reproductive life (cohorts 1926-31) have a total fertility rate (TFR) of 6.7 children, while the age-specific fertility rates of the time period 1971-75 imply a TFR of only four children. It can be observed that the fertility curve has suffered changes in its age structure, with a tendency towards becoming younger and more concentrated.

Table 3 and Figure 2 also include estimations based on data provided by the registry of births, once again giving proof of the coherence which exists beween these and the estimation derived from the maternity histories of the WFS.

FERTILITY AND NUPTIALITY

The birth data from the Costa Rican vital statistics do not allow a deeper analysis than the simple study of general fertility. This is because no information is published regarding births according to duration of marriage and because a large proportion of these are classified as 'unwed' mothers (about a third). Due to this, the information in the maternity histories of the WFS acquires great value by allowing for the first time, the study of Costa Rican marital fertility.

Fertility by duration of union

In this paper, the study of marital fertility includes both legal marriages and common law marriages or consensual unions. The analysis refers to all ever-married women and the duration of union was accounted from the first, so that the fertility rates by duration of union (Table 4 and Figure 3) are affected by the dissolutions and remarriages.

TABLE 3

Annual fertility rates by age for the period 1971 - 75 and cohorts 1926 - 31 (WFS and register's estimations)

Age (years)	Annual fertility rate per 1000 women			
	Cohorts 1926 - 31		Period 1971 - 75	
	WFS	Register	WFS	Register
15 - 19	84	114	110 [a]	103
20 - 24	300	325	194	216
25 - 29	360	342	187	192
30 - 34	304	276	146	148
35 - 39	213	202	99	111
40 - 44	72	69	59	51
45 - 49	11	9	11	9
TFR (per women)	6.70	6.69	4.03	4.15

[a] 1971 - 72.

Source: Direccion General de Estadistica y Censos, Estadisticas Vitales and WFS.

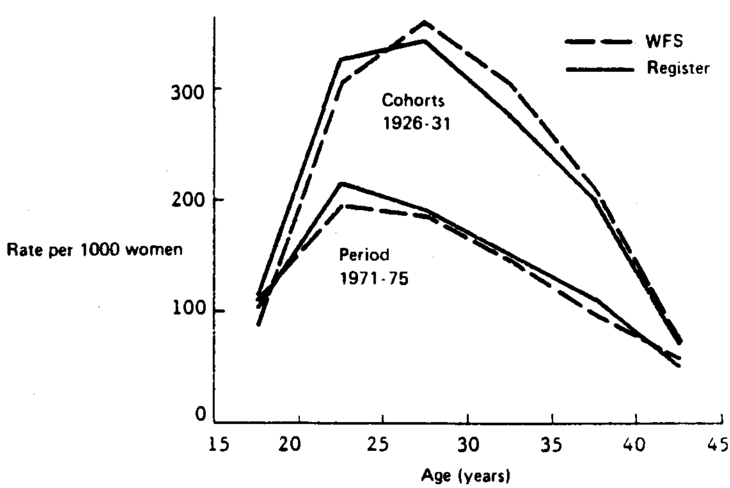

FIGURE 2

Annual fertility rates by age for the period 1971 - 75 and cohorts 1925 - 31 (WFS and register's estimations)

According to Table 4, the index of completed fertility per marriage has declined from 7 to 4 children in the two groups studied, that is, a decrease similar to the one observed in general fertility, so that it can be said that is not the result of changes in nuptiality. At the same time, it can be seen in Figure 3 that in the period 1971-76 the fertility curve is clearly concave and very concentrated in the first years of marriage, unequivocal signs that it is a population practicing contraception.

Fertility and marital status

In some populations, such as the ones in the Caribbean islands, it has been found that the fertility of marriages is usually higher than in consensual unions, since the latter are less stable (see, for example, Leridon, 1970). However, in other populations, the inverse has been found, because the *de facto* unions occur mainly in the rural zones or in the lower social strata, in which birth control is not practised (Camisa, 1975). Regarding this subject, the data of the WFS (Table 5) show that this last situation is present in Costa Rica, that is, fertility is higher in common law marriages, despite the fact that these are less stable. Those women currently married and still in first union constitute 88 per cent of the women who started their conjugal life with a legal marriage, and only 56 per cent of the women who started their conjugal life with a consensual union.

On the other hand, the difference in the fertility of the currently married women in first union with regard to all those ever-married gives an idea of the net effect of the dissolutions and remarriages, which according to Table 5 will consist of reducing completed marital fertility by three per cent. This result is much smaller than the estimated seven per cent obtained in a study of the rural zones of four Latin American countries (Rosero, 1978, p. 82), which is probably due to the fact that the phenomenon of conjugal instability (as in consensual unions) is present mainly in the lower socio-economic strata, as was seen in the first Country Report of the WFS (Direccion General de Estadistica y Censos, 1978, p. 57).

TABLE 4

Annual fertility rates by duration of union: cohorts 1926 - 31 and period 1971 - 76

Duration (years)	Rate per 1000		Cumulative percentage	
	Cohorts 1926 - 31	Period 1971 - 76	Cohorts 1926 - 31	Period 1971- 76
0 - 1	486	422	–	–
2 - 3	454	296	14.5	20.6
4 - 5	426	243	28.0	35.2
6 - 7	354	187	40.7	47.1
8 - 9	325	171	51.2	56.3
10 - 14	267	130	60.9	64.7
15 - 19	186	93	80.7	80.6
Children per marriage	6.72	4.08	100	100

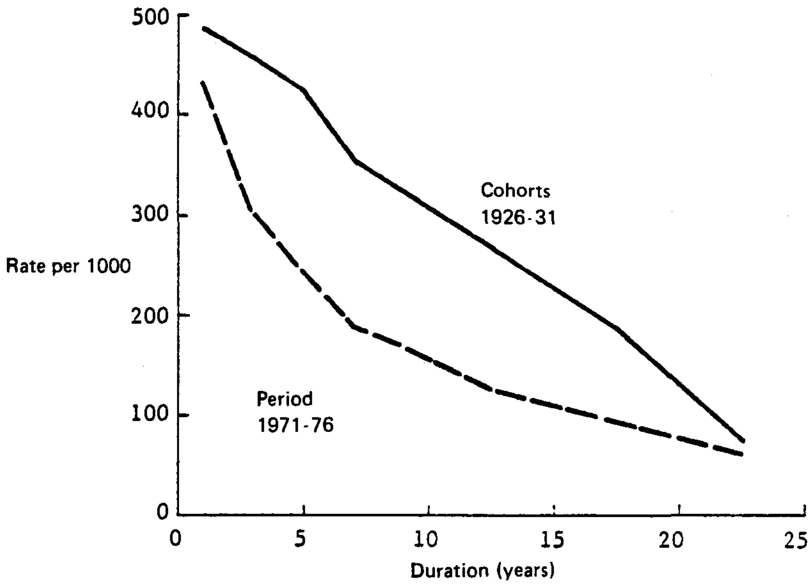

FIGURE 3

Annual fertility rates by duration of union; cohorts 1926-31 and period 1971-76

TABLE 5

Annual fertility rates by duration of union according to marital status and union stability, period 1966 - 1976

Duration (years)	Annual fertility rate per 1000			
	All unions	First union status		Stable unions [a]
		Legal	Consensual	
0 - 1	443	450	417	456
2 - 3	329	326	344	358
4 - 5	293	281	339	295
6 - 7	230	225	256	229
8 - 9	204	195	243	205
10 - 14	178	170	219	180
15 - 19	145	138	188	150
20 - 24	94	84	166	95
Children per marriage	5.08	4.91	6.06	5.21

[a] Currently married women still in first union.

Fertility and age at marriage

In Table 6 and Figure 4 a very well known association in "Malthusian" populations is verified: age-specific marital fertility rates tend to be higher in marriages occurring to women of older ages. Nevertheless, in Costa Rica this association seems to be less marked than in other populations due, in part, to the difficulty of forming groups sufficiently differentiated by age at marriage, since the country's nuptiality schedule is characterised by a large concentration in a few years. Another factor is that precocious unions (such as the free unions and their dissolutions) are present mainly in the lower social strata and so occur within a context of high fertility.

It is convenient to point out that the positive association of the age fertility rates with the age at marriage does not mean that the completed fertility is higher in the marriages which began later. On the contrary, in Table 6 it can be observed that the index of current married fertility (children per marriage) diminishes as the age of initiation of conjugal life increases, because the period of exposure to the risk of child bearing is smaller.

TABLE 6

Annual marital fertility rates by age according to age at first union : period 1966 - 76

Age of fertility	Annual marital fertility rate per 1000				
	All ages	Age at first union			
		12 - 16	17 - 19	20 - 23	24 +
15 - 19	476	443	528	–	–
20 - 24	369	319	340	451	–
25 - 29	259	238	233	250	362
30 - 34	194	196	181	168	243
35 - 39	155	148	160	134	178
40 - 44	73	84	72	67	74
45 - 49	12	9	8	14	15
Children per marriage	–	7.19	5.76 [a]	4.52 [b]	4.36

[a] 18.5 age at first union
[b] 22.0 age at first union

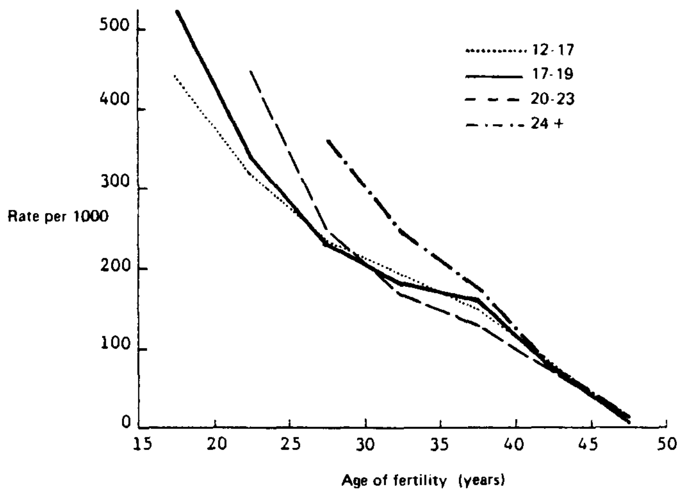

FIGURE 4

Annual marital fertility rates by age according to age at first union, period 1966 - 76

THE FIRST BIRTH

For many reasons, it is convenient to study the first birth separately from the rest. An adequate way to study this event is to consider it as a consecutive occurrence after marriage. However, this is not advisable in the particular case of the Costa Rican population, because a high proportion (26 % according to WFS data) of the eldest are born or conceived prior to the conjugal union (legal or consensual) and there is a high incidence of common law marriages existing in the country whose starting dates are often difficult to define. Thus, in this chapter the study of nuptiality has been omitted, and instead, the first is analysed directly in terms of the age of the mother. This type of analysis is valuable *per se,* and furthermore, it is a possible substitute measure of patterns of nuptiality of the single woman.

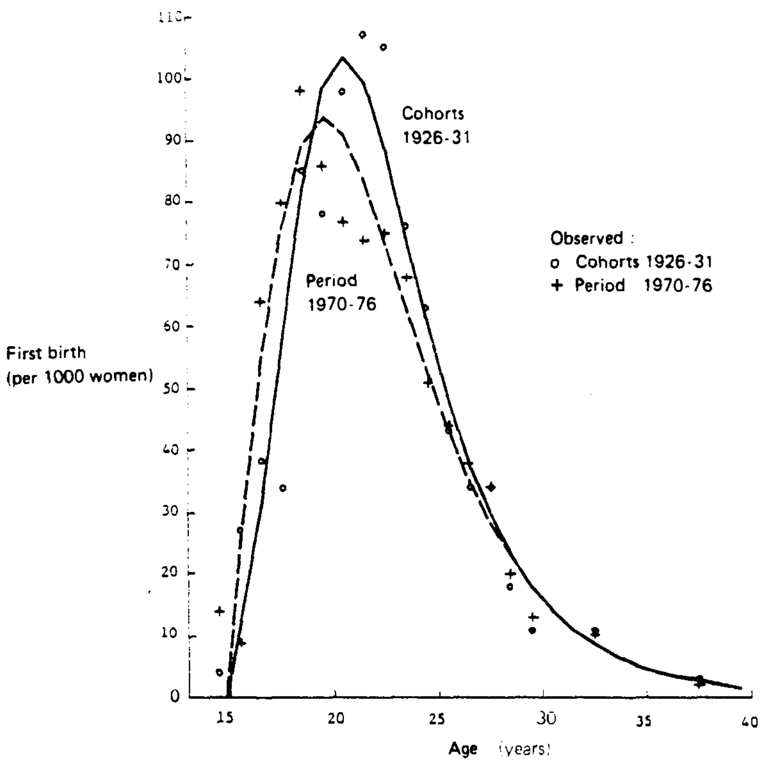

FIGURE 5

First birth schedules by age, observed and fitted with double logistic model, cohorts 1926-31 and period 1970-76

Table 7 and Figure 5 present the series of the first births, according to the age of the woman, that occurred in synthetic cohorts (not exposed to mortality) representative of the experience of women born between 1926 and 1931 and the observed pattern during the period 1970-76. This last series was calculated by means of a procedure similar to the one that is used to calculate a current life table, using as a starting point the probability that the phenomenon occurs in each age. The probability is the ratio of first births to the number of women which arrived nulliparous at that age.

TABLE 7

First births by age in a generation of 1000 women representative of cohorts 1926 - 31 and of the period 1970 - 76

Age	Cohorts 1926 - 31			Period 1970 - 76		
	Observed	Fitted		Observed	Fitted	
		Coale	Logistic		Coale	Logistic
13	–	–	–	–	1	–
14	4	1	–	14	9	1
15	27	10	9	9	24	25
16	38	29	31	64	46	54
17	34	51	57	80	75	76
18	85	73	82	98	86	89
19	78	88	98	86	92	94
20	98	95	104	77	93	91
21	107	92	99	74	83	84
22	105	90	88	75	72	73
23	76	72	75	68	64	63
24	63	60	61	51	50	52
25	43	50	49	44	42	43
26	34	42	38	38	34	35
27	34	34	30	34	27	28
28	18	28	23	20	23	23
29	11	24	18	13	18	18
30 - 34	54	59	46	52	48	48
35 - 39	14	22	14	10	18	10
40 - 44	4	7	5	–	5	–
All ages	927	927	927	907	907	907
Nulliparous	73	73	73	93	93	93
All women	1000	1000	1000	1000	1000	1000
Mean age	22.67	23.29	22.73	22.13	22.38	22.15

The irregularities present in the series of first births in the table were corrected with two models which have been suggested for the adjustment of nuptiality schedules. The first one is widely known and was conceived by Coale (1971). It has three parameters and describes the first marriage frequencies by means of a double exponential. The second model, less well known than the first one, consists of a double logistic relation with five parameters which Bocaz (1979) has shown summarises quite satisfactorily the cumulated distributions of fertility or of nuptiality. The parameters of the double logistic model are the age at which the process is initiated (α) and the age at which it ends (β), the proportion of women which become mothers ($G(\beta)$) and the coefficients b_1 and b_2 of the following linear relation:

$$y = b_1 + b_2 x$$

where y is the logit of the proportion of women that up to age a have participated in the process:

$$y = \ell n \, (G(\beta) \, / \, G(a) - 1)$$

and x is the logit of the proportion of time up to the age a :

$$y = \ell n \, ((\beta - \alpha) \, / \, (a - \alpha) - 1)$$

The models were adjusted so that the sum of the squares of the differences between the original and graduated first births schedules was minimal. So as to have an idea of the appropriateness of the adjustment, the correlation coefficient between the original and the adjusted values was calculated, and presented in Table 8, together with the parameters of the models.

Both models offer similar results (see Table 7), although the bilogistic model seems to be less rigid than Coale's and, in this case, reproduces in a better way the mean age observed for the first birth. The results coincide, in that the first birth schedule of the period 1970-76 is not very different from that corresponding to the 1926-31 cohorts, or at least, the differences are of slight significance when compared with the dramatic change which took place in the total fertility. The current schedule shows an earlier age at the time of the first birth than the cohort schedule, and the proportion of women who become mothers is somewhat smaller (90.7 vs. 92.7 per cent). However, these changes, more than indicators of a tendency, seem to be of a transient nature resulting from timing modifications at the moment when the involved cohorts are having their first child.

TABLE 8

Correlation between original and adjusted values

Parameters	Cohorts 1926 - 31		Period 1970 - 75	
	Coale	Double logistic	Coale	Double logistic
G (ß)	927	927	907	907
α	14.6	14.8	13.7	14.8
ß	–	51.0	–	40.0
k	0.76	–	0.76	–
b_1	–	– 3.359	–	–1.926
b_2	–	2.358	–	2.094
Correlation (*r*)	0.957	0.954	0.966	0.96

INTENSITY AND TIMING OF OTHER ORDER BIRTHS

Method of analysis

For a precise description of the sequence of family building it is convenient to study the birth of each one of the children as a consecutive event (therefore, not renewable) following the previous birth, that is, in relation to the number of children already born and the time passed since the last birth. In an analysis of this sort, both the intensity and timing of the phenomenon must be considered. The intensity is studied through the 'parity progression ratios', which inform us about the proportion of women who continue procreating by each family size, and the timing can be summarised with the birth intervals.

Intervals between successive births are easily understood and the calculation of the average does not involve any difficulty in the groups whose members have reached the end of the reproductive period. On the contrary, problems associated with open intervals are met when there is truncation in the reproductive span of the cohorts or when one wishes to study birth timing as a current index.

In this paper, life table techniques were applied to determine both the intensity and timing of each one of the other order births from the period corresponding to the 10 years prior to the survey (current indexes of approximately 1966-76). With the data stemning from the maternity histories, the quotient or probability of having an additional child (of the order $i + 1$) of the women who reached z anniversary since they had their i th (and last) child was estimated:

$q(z, i+1)$ = births of the order $i + 1$ in the duration z/births of the order i which reached duration z without losing their condition of being the last one.

From these quotients one can determine, among others, the following functions (for reasons of simplicity, the symbols adopted are the same one as that used in both life and nuptiality tables)

$$\ell(z,i)$$

indicates the proportion of women who reach duration z without having an additional child and who pertain to the cohort (synthetic) that had their ith child. In other words, it is the proportion of births of orders i who reach duration z without losing their condition of being the last ones.

$$g(z, i+1) = q(z, i+1) * \ell(z, i)$$

is the number of births of order i by duration in this synthetic cohort.

$$L(z, i) = \int_{z}^{z+1} \ell(z, i)\, dz \;; \quad \text{and} \quad T(i, b) = \int_{o}^{b} \ell(z, i)\, dz$$

have a meaning analogous to the one given in a life table, being b, the maximal interval between two births, which for practical purposes can be assumed to be nearly 10 years.

From these functions, the following summary indicators can be derived:

$$a(i) = 1 - \ell(b, i)$$

which is the parity progression ratio of order i, a summary of the intensity of the phenomenon;

$$I(i) = (T(i, b) - b * (1 - a(i))) / a(i)$$

which is the mean interval between births of order i and i + 1, a summary of the timing; and

$$T(i,b) = I(i) * a(i) + b * (1 - a(i))$$

which is a summary index of both intensity and timing of the fertility of rank i + 1 in women who already have i births.

Since in general it is expected that the decline of fertility occurs by means of the combined action of increments in the birth intervals and reductions in the parity progression ratios, the level of fertility is found to be associated positively with the parity progression ratios and negatively with the I and T indexes.

On the other hand, with the grouping of these rank fertility tables, the following indexes of lifetime fertility can be calculated:

$$F = 1 + a(1) + a(1)\,a(2) + a(1)\,a(2)\,a(3) + \ldots.$$

which is the average number of children per mother and, consequently, $1 - 1/F$ will be the average value of *a* for all orders of births;

$$I = (a(1)\,I(1) + a(1)\,a(2)\,I(2) + a(1)\,a(2)\,a(3)\,I(3) + \ldots) / (F - 1)$$

which is the mean interval between successive births of all orders in the complete families; and

$$T(b) = I\,(1 - 1/F) + b/F$$

which could be interpreted as the quantity of time required to produce an additional child in a period of b years.

Rank fertility tables for the period 1966-76 and for the first five birth intervals can be found in the appendix.

It is evident that the construction of these rank fertility tables requires a substantial number of maternity histories, therefore, it is not feasible to make them for segments of the population with the objective of studying the differentials and the determining factors of fertility. Because of this, it has been considered convenient to explore the possibility of estimating the summary indexes of tables by means of a procedure based on a simple classification of births according to whether or not they are the last child the woman had. A procedure which would be less limited by the number of observations and which would offer good possibilities for the study of the determinants of family building.

Under the supposition that the maximum interval between births is of 10 years and in a stationary situation, it is evident that the index $I\,(i,10)$ is equal to 10 times the proportion of births of order i (occurring in the 10 years prior to the survey) which currently maintain the condition of being the last child the woman had. In symbols:

$$T(i,10) = 10\,PL\,(i, 0 - 9)$$

In a parallel manner, if fertility has remained constant, the parity progression ratios can be estimated on the basis of these proportions of presently last children, referred to the births occurred in, say, the 9-11 years prior to the survey:

$$a(i) = 1 - PL\,(i, 9 - 11)$$

Knowing these two summary indexes it is easy to determine the mean intervals between births with one of the relations previously described.

Results

Table 9 and Figure 6 show the summary indexes of the rank fertility schedules corresponding to the generations which at the time of the survey were ending their reproductive span (cohorts 1926-31) and the estimations for the period 1966-76. It can be seen that the patterns of family building of the last

TABLE 9

Summary indexes of rank fertility schedules; cohorts 1926 - 31, tables of the period 1966 - 76 and approximate solution of the same period

Indexes	Birth order i , i + 1						All orders
	1 - 2	2 - 3	3 - 4	4 - 5	5 - 6	6 +	
			Cohorts 1926 - 31				
Ratios a(i)	0.94	0.94	0.87	0.90	0.93	0.79	7.27 [a]
Years I(i)	2.40	2.22	2.38	2.16	2.22	2.09	2.21
Years T(i, 10)	2.86	2.69	3.37	2.94	2.76	3.75	3.28
			Period 1966 - 76 (tables)				
Ratios a(i)	0.92	0.82	0.81	0.79	0.77	0.74	5.22 [a]
Years I(i)	3.11	3.07	3.36	3.07	2.92	2.82	3.04
Years T(i, 10)	3.59	4.26	4.54	4.53	4.53	4.60	4.37
			Period 1966 - 76 (approximation)				
Ratios a(i)	0.94	0.90	0.82	0.82	0.84	0.82	6.61 [a]
Years I(i)	3.38	4.22	3.89	3.26	3.45	3.33	3.54
Years T(i, 10)	3.78	4.80	4.99	4.47	4.50	4.53	4.52

[a] Total fertility per mother (F).

decade register a clear decrease in the parity progression ratios, which translates in nearly two children less per mother, and in an increase of approximately 10 months in all birth intervals. Seen from another angle, this decline in fertility, expressed in terms of the index T(10) , consists of an increment of 33 per cent in the time required to produce an additional birth.

It is interesting to note that the traditional analysis based on the age-specific rates frequently forgets that a modification in the birth timing can introduce perturbations in the fertility tendencies. Thus, it is probable that in a first stage of the decline in Costa Rican fertility, the tendency accelerated thanks to the increment of the birth intervals shown here. Afterwards, this event might have produced an unusually high number of births, a temporary phenomenon resulting from the accumulation of postponed children. This is one of the explanations given for the increase observed in recent years in the country's fertility.

Regarding the estimation of the timing and the intensity of family building by means of the proportions of currently last births, it is observed that the direction of the change that has occurred is adequately described, but not its magnitude (Table 9 and Figure 6). In particular, due to the effect of the drastic decline which has taken place in the fertility of the country, this procedure is hardly appropriate for the correct estimation of the value of the parity progression ratios, and because of this, of the value of the birth intervals derived from them. On the other hand, the proportion of births that maintains the status of last child had by the woman (in all of the ones that occurred in the last 10 years) produces a more satisfactory estimate of index T (i,10) of the period, despite the fact that the great modifications which took place in the fertility represent very adverse circumstances for the application of this method in Costa Rica.

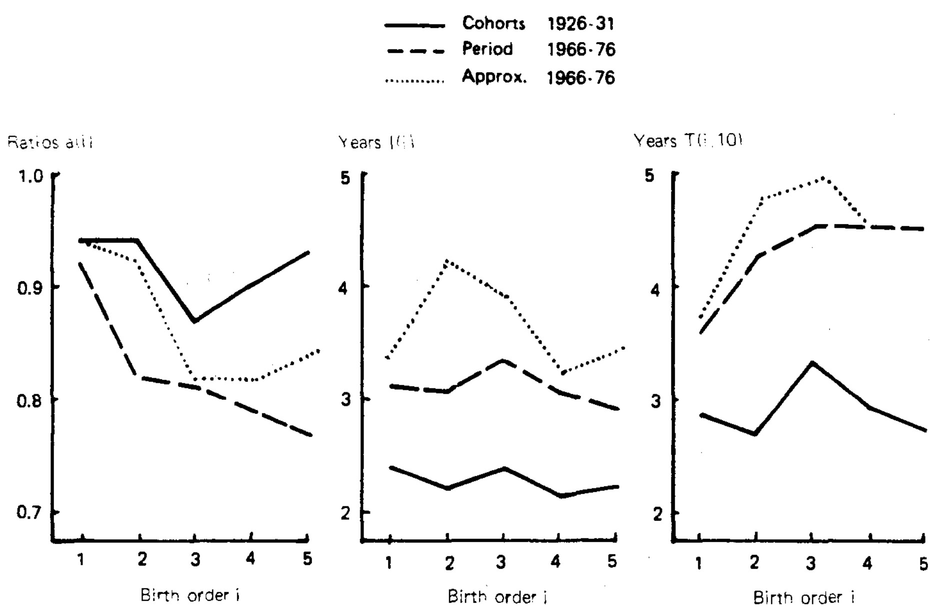

FIGURE 6

Summary indexes of rank fertility schedules

FACTORS ASSOCIATED WITH FERTILITY

In this section an exercise is developed regarding the analysis of the factors of fertility, making use of multivariate regression techniques in which no statistical refinements are introduced and where there is no conceptual framework previously defined from whence to start.

An adjustment was made in an additive linear model without interaction exclusively with dummy variables, equivalent to a cross-classification of proportions model of analysis. The unit of analysis considered was each one of the births occurring in the 10 years prior to the survey and the dependent variable, the current attribute of being the last child had by the woman; which, as it has been seen, has a concrete meaning in terms of timing and intensity of family building and is inversely correlated with the level of fertility.

The starting point was a substantial number of dependent variables and of classifications according to these variables, but finally only those factors and classifications statistically significant at 1 per cent (values of F higher than 2) were included in the model. In symbols, the model can be thus expressed:

$$Y = 0.140 + V(1) + V(2) + ... V(9)$$

where Y is the forecasted probability that the birth that occurred during the 10 years prior to the survey is actually the last, or said in a different way, the adjusted proportion of births which actually are the last; and the functions V are obtained from Table 10 (the use of contraceptives was not included because it is a variable too complex for this sort of analysis).

In consequence, the estimated proportion of last children among, for example, the births of fourth order, that were breastfed for more than 6 months, survived the first year, and whose mothers had 35 or more years of age, had less than three years of schooling, first union was not dissolved, first pregnancy was after 18 years of age, had a family ideal of four children and who live in the city, is

$$Y = 0.140 + 0.335 + 0 + 0 + 0.127 + 0.050 + 0 + 0.058 - 0.052 + 0.027$$
$$= 0.685$$

a number which indicates a low fertility in this stage of the family building.

The results of the model are, in general, the expected ones regarding both the sign and the magnitude of the effect of the variables considered in fertility, except in the case of breastfeeding. Since everything else remained constant, a prolonged period of breastfeeding appear to have favoured higher fertility.

TABLE 10

Variable (i)	V (i)	Variable (i)	V (i)
1. **Mother's age**		5. **Birth order**	
Less than 20	0	1	0
20 - 34	0.173	2	0.081
35 and more	0.335	3 - 4	0.050
		5 and more	0.007
2. **Mother's educational level (last course completed)**		6. **Current status of the mother's first union**	
Less than 3	0	Dissolved	0
3 - 5	0.071	Not dissolved	– 0.666
6 and more	0.193		
3. **Did the child die before the first birthday?**		7. **Mother's current residence**	
No	0	Rural	0
Yes	– 0.136	Urban	0.058
4. **Was the ideal size of the family reached with this child?**		8. **Breastfeeding (months)** [a]	
No	0	Less than 6	0
Yes	0.127	6 and more	– 0.052
		9. **Mother's age at the first pregnancy**	
		Less than 18	0
		18 or more	0.027

[a] If the mother declared that she breastfed her last or next-to-last child for more than 6 months, it was assumed that she did the same with the rest.

Another suggestive result in the one related to the birth order: *ceteris paribus*, the families with one child appear to be the ones more prone to have an additional birth, while those with two children appear to be the less prone ones, and from this size of the family the association is inverted, registering increases in the fertility of the bigger families.

Finally, it is convenient to point out that altogether the model has a limited capability for explanation, with a multiple correlation coefficient (R) of only 0.306, a result which seems to be frequent when trying to explain a dummy variable.

FACTORS ASSOCIATED WITH INFANT MORTALITY

For the study of this subject an exercise similar to the previous one was made, with information regarding the births occurring in the period corresponding to 1-9 years prior to the survey. In this case, the dependent variable was the child who died before his first birthday and the prediction equation resulted as follows:

$$Y = 0.154 + V(1) + V(2) + \dots V(7)$$

where functions V are now obtained from Table 11.

For example, for the first births which have not been breastfed, whose mother had finished high school, had less than 20 years of age, is currently married and in first union and her first pregnancy began within a legal marriage, the probability of death in the first year is

$$\begin{aligned} V &= 154 + 0 + 0 - 50 - 32 + 0 - 14 + 0 \\ &= 58 \text{ per thousand} \end{aligned}$$

and if these same children had been breastfed there is a tendency towards a null infant mortality rate.

TABLE 11

Variable (i)	V (i)	Variable (i)	V (i)
1. **Was breastfed?** [a]		4. **Current status of the mother's first union**	
No	0	Dissolved	0
Yes	− 0.058	Not dissolved	− 0.032
2. **Was there a birth within 2 years prior to this one?**		5. **Mother's age**	
		Less than 20	0
No	0	20 - 34	− 0.021
Yes	0.040	35 and more	0.003
3. **Mother's educational level (last year completed)**		6. **Legal status of the mother's first pregnancy**	
Less than 3	0	Illegitimate	0
3 to 10	− 0.027	Legitimate	− 0.014
11 and more	− 0.050		
		7. **Birth order**	
		Les than 5	0
		5 and more	0.015

[a] If the mother declared that she breastfed her last or next-to-last child, it was assumed that she did the same with the rest

Although the results of the model are expected, it is very suggestive that lactation, the previous birth interval and conjugal stability have such an important effect on infant mortality. It is also interesting that urbanization and the order of birth up to the fifth child have not shown a significant association with the studied phenomenon, thus they were not included in the model.

Finally it should be noted that as in the explanatory model of fertility, in this case there was also a very low (R = 0.184) multiple correlation coefficient.

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APPENDIX

RANK FERTILITY TABLES FOR THE PERIOD 1966-76

First birth interval (i = 1)

Duration year z	Number [a]	q (z, i+1)	ℓ(z,i)	g (z, i+1)	L (z, i)
0	1210	0.058	1000	58	995[b]
1	1133	0.390	942	367	758
2	633	0.297	575	171	489
3	403	0.261	404	105	351
4	265	0.272	299	81	258
5	171	0.187	217	41	197
6	126	0.183	177	32	161
7	91	0.088	144	13	138
8	77	0.104	132	14	125
9	60	0.067	118	8	114
10	60	0.083	110	9	105
11	52	0.038	101	4	99
12	45	0.089	97	9	93
13	39	0.051	88	5	86
14	34	0.059	84	5	81
15		–	79		
a (1), I (1), T (1, 10)			0.921	3.11	3.586

Second birth interval (i = 2)

Duration year z	Number [a]	q (z, i+1)	ℓ(z,i)	g (z, i+1)	L (z, i)
0	966	0.042	1000	42	997[b]
1	892	0.334	958	320	798
2	565	0.306	638	195	540
3	356	0.177	443	78	404
4	260	0.173	365	63	334
5	182	0.099	302	30	287
6	146	0.123	272	33	256
7	108	0.083	239	20	229
8	85	0.035	219	8	215
9	73	0.082	211	17	202
10	55	0.018	194	3	192
11	52	0.019	191	4	189
12	39	0.051	187	10	182
13	31	–	177	0	182
14	29	–	177		
a (2), I (2), T (2,10)			0.823	3.07	4.262

Third birth interval (i = 3)

Duration year z	Number [a]	q (z, i+1)	(z,i)	g (z, i+1)	L (z, i)
0	669	0.024	1000	24	998[b]
1	671	0.323	976	315	818
2	460	0.241	661	159	582
3	327	0.205	502	103	450
4	244	0.193	399	77	360
5	184	0.087	322	28	308
6	156	0.077	294	23	282
7	130	0.069	271	19	262
8	110	0.045	252	11	246
9	84	0.024	241	6	238
10	72	0.028	235	6	232
11	65	0.062	229	14	222
12	55	0.036	215	8	211
13	46	0.043	207	9	202
14	40	0.025	198	5	196
15		–	193	-	
a (3), I (3), T (3, 10)			0.807	3.36	4.544

Fourth birth interval (i = 4)

Duration year z	Number [a]	q (z, i+1)	(z,i)	g (z, i+1)	L (z, i)
0	523	0.042	1000	42	997[b]
1	521	0.347	958	332	792
2	352	0.216	626	135	558
3	257	0.160	491	78	452
4	205	0.146	413	60	383
5	160	0.119	353	42	332
6	129	0.108	311	34	294
7	102	0.108	277	30	262
8	78	0.077	247	19	238
9	56	0.018	228	4	226
10	48	0.021	224	5	222
11	36	0.028	219	6	216
12	31	–	213	–	216
13	26	–	213	–	216
14	22	–	213	–	216
15		–	213	–	
a (4), I (4), T (4, 10)			0.787	3.07	4.534

Fifth birth interval (i = 5)

Duration year z	Number [a]	q (z, i+1)	(z,i)	g (z, i+1)	L (z, i)
0	418	0.036	1000	36	997[b]
1	432	0.326	964	314	807
2	301	0.296	650	192	554
3	203	0.167	458	76	420
4	159	0.132	382	50	357
5	127	0.102	332	34	315
6	96	0.083	298	25	286
7	80	0.038	273	10	268
8	61	0.000	263	0	263
9	51	0.020	263	5	260
10	39	0.077	258	20	248
11	29	0.034	238	8	234
12	21	–	230	–	234
13	14	–	230	–	234
14	10	–	230	–	234
15			230	–	
a (5), I (5), T (5, 10)			0.770	2.92	4.527

Sixth and more birth intervals (i = 6+)

Duration year z	Number [a]	q (z, i+1)	(z,i)	g (z, i+1)	L (z, i)
0	1563	0.045	1000	45	996[b]
1	1630	0.328	955	313	798
2	1083	0.288	642	185	550
3	727	0.166	457	76	419
4	561	0.114	381	43	360
5	432	0.074	338	25	326
6	340	0.050	313	16	305
7	259	0.046	297	14	290
8	189	0.016	283	4	281
9	129	–	279	–	279
10	83	0.024	279	7	276
11	62	–	272	–	272
12	39	–	272	–	272
13	31	–	272	–	272
14	19	0.053	272	14	265
15		–	258	–	
a (6), I (6), T (6, 10)			0.742	2.82	4.604

[a] Denominator of quotients.

[b] $L(0) = 0{,}92 \quad \ell(0) + 0.08 \ \ell(1)$.