NEW TECHNIQUES TO ESTIMATE FERTILITY AND MORTALITY

The Case of Colombia

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The present note is primarily to infer plausible levels of fertility and mortality that might have prevailed during recent times in Colombia, using data from the 1938, 1951 and 1964 censuses and some demographic techniques of stable and quasi-stable population analysis. Although it would have been desirable to make an assessment of the divergences between these results and some alternative estimates derived for the Colombian population, limitations on the length of this paper have prevented it.

CONDITIONS IN 1938-1951

The following are the annual rates of growth obtained from a comparison of the last four Colombian censuses:

Period	Male growth rate	Female growth rate
1918-1938	2.15	1.88
1938-1951	2.22	2.18
1951-1964	3.09	3.22

The male figures suggest a virtually constant rate of natural increase[1] for more than 30 years before 1951, and then a rapidly accelerating one afterwards, but the slow increase observed for the females between the first and second period seems more consistent with changes in the cumulative age structure from 1918 to 1951, as shown separately for both sexes in Table 1. It is well known that for a closed population, a sustained trend toward a younger age structure, as it seems to have

TABLE I. COLOMBIAN POPULATION UNDER SUCCESSIVE AGES ACCORDING TO OFFICIAL CENSUS DATA

Proportion Under Each Age

Age	Males				Females			
	1918	*1938*	*1951*	*1964*	*1918*	*1938*	*1951*	*1964*
5	.098	.155	.171	.181	.149	.152	.163	.172
10	.293	.302	.313	.346	.274	.292	.299	.328
15	.415	.429	.436	.479	.386	.411	.416	.454
20	.508	.526	.533	.576	.486	.519	.523	.559
25	.597	.621	.629	.654	.578	.613	.620	.643
30	.681	.699	.702	.718	.664	.695	.700	.712
35	.749	.760	.763	.776	.736	.756	.759	.772
40	.801	.822	.820	.828	.798	.816	.819	.826

TABLE 2. STABLE BIRTH RATE BY AGE REFERENCE POINT OF CUMULATIVE AGE DISTRIBUTION

Stable Birth Rate (per 1,000 per year)	10	15	20	Age 25	30	35	40
Male "South"	49.0	52.5	49.8	52.5	52.5	51.6	53.1
Female "South"	44.6	46.1	48.1	50.8	53.6	51.4	54.8

been manifest in Colombia prior to 1951, would take place only under increasing fertility or decreasing mortality or both, which would not leave constant the intervening rate of natural increase.

For the purpose of analyzing average fertility and mortality conditions in 1938-1951, the observed differences in the rate of growth in the previous period are not large enough to invalidate the applicability of stable population methods. This is particularly true in view of the slight variations in the age structure between 1938 and 1951, as well as the small differences in the rate of growth for both sexes with respect to the 1918-1938 period. At any rate, the assumption of stability can be submitted to a further test consisting of the selection of a particular family of model life tables and in the search, independently made for both sexes, of the stable birth rate consistent with the intercensal growth rate and the average cumulative age distribution up to successive ages 5, 10 . . . 40. In case of strict stability, accurate reporting of age and no deficiencies in enumeration, the estimate of the birth rate derived from stable population methods should be the same at all ages taken as reference points for the cumulative age distribution.

Use of the "South" family of regional life tables leads to the estimates shown in Table 2.

The male set of stable estimates of the birth rate shows a limited range of variation with respect to changes in the age reference point, with no discernible trend and a lowest value obtained at age ten, which may reflect a possible underenumeration of children and is consistent with results found for other Latin American countries for which stable analysis has been applied.[2] On the other side, the female set of stable estimates has a range twice as great as the male one, and also an upward trend with increasing age reference point, which is difficult to interpret in the absence of a relatively pronounced underenumeration of females at young ages.[3]

The consistency of the set of male estimates of the birth rate seems to provide a further confirmation of the approximate stable conditions of the Colombian population prior to 1951. The median of the set is used to characterize average conditions in 1938-1951, and defines the corresponding level of mortality easily obtained from Coale's and Demeny's tables. The female and overall parameters are obtained from the median male estimate, in conjunction with the average reported sex ratio of the total population and an assumed sex ratio at birth of 105 males per 100 females.

Alternative calculations made for "South" and "West" model life tables give results indicated in Table 3. The difference between the two families of model life tables essentially consists in relatively higher death risks under age five in the case of "South," for a given level of the expectation of life at birth.

With the exception of the estimate of the expectation of life at age five, the results for the other population parameters are quite sensitive to the family of life tables actually chosen. This fact, which confirms previous results obtained by Coale and Demeny for other populations, sets considerable limitations on the use of stable population analysis in cases where nothing is known about the patterns of child mortality prevailing in the population under question.

Unfortunately, no direct statistical basis exists that would enable a selection between the "South" and "West" families that could objectively be claimed to provide a best fit to Colombian mortality conditions. For one thing, Colombian censuses have never included questions on the proportion of children surviving among those ever born to women in the early childbearing ages, from which mortality risks in childhood can often be effectively inferred.[4] Nor can the overall

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TABLE 3. STABLE ESTIMATES OF POPULATION PARAMETERS, COLOMBIA, 1938—1951*

	"South"	"West"
Male birth rate (per 1,000 per year)	52.5	46.2
Male death rate (per 1,000 per year)	30.3	24.0
Male level of mortality (Coale and Demeny tables)	7.2	9.7
Male e_0^o (years)	34.3	39.0
Male e_5^o (years)	48.8	49.0
Female birth rate (per 1,000 per year)	49.4	43.5
Female death rate (per 1,000 per year)	27.6	21.7
Female level of mortality (Coale and Demeny tables)	7.7	9.8
Female e_0^o (years)	36.8	42.0
Female e_5^o (years)	50.3	51.0
Female G. R. R. (mean age of childbearing: 27 yrs)	3.21	2.864
Female G. R. R. (mean age of childbearing: 29 yrs)	3.41	3.0
Total birth rate	50.9	44.8
Total death rate	28.9	22.8

* Derived from the male age distribution, male and female growth rates, reported sex ratio of the population and an assumed sex ratio at birth of 1.05.

registered birth and death rates over the period (33.1 and 15.1 per thousand per year, respectively, on the average) be meaningfully compared with the model estimates, given the substantial underregistration that was prevailing in the vital statistics.

The last procedure has been tried in some research at the Office of Population Research at Princeton University for the case of the Mexican population. It was established, on the basis of the 1950-1960 mortality experience, that the "South" model provides an excellent fit to the registered birth and death rates, which themselves are significantly higher than the results provided by the "West" model.[5] Similarly, the use of the question on children surviving among those ever born to women of ages 20-24 in the 1950 Census of Brazil, suggests that the Brazilian pattern of mortality was located at that time halfway between the "South" and the "West" families. Since it is questionable, on the basis of opposite evidence, to expect that Colombian mortality conditions might connote relatively lower death risks in childhood than Mexican or Brazilian mortality, one might infer that the "West" crude birth and death rates given for Colombia in Table 3 probably underestimate the true figures, whereas the opposite would hold for the expectation of life at birth.

A reassuring fact in Table 3 is the close agreement of the mortality levels that result for both sexes. The agreement is remarkable in the case of the "West" model and satisfactory for "South." The stability assumption is, then, consistent with intercensal rates of growth obtained from the census, as well as with the sex ratio and with the correspondence between female and male mortality that underlies the construction of model life tables.

FERTILITY AND MORTALITY IN 1951-1964

A look at Table 1 indicates the trend toward a younger age structure of the Colombian population that took place during the 1950's and early 1960's. At all ages between five and 50, the proportions of males and females under each particular age were noticeably higher in 1964 than in 1951, with relatively larger increases at the younger ages than at the advanced ones. In conjunction with the substantial acceleration of the rate of population growth during the same period, such a situation could be explained in terms of a mortality decline that, if accompanied by unchanging fertility, could be satisfactorily quantified by use of the quasi-stable techniques.

The key to detect fertility and mortality levels inherent in quasi-stable analysis lies in the calculation of an average birth rate for a given intercensal period, which is consistent with: 1. an unchanging although initially unspecified level of fertility; 2. a steady decline of mortality over a certain period, at the beginning of which the population is assumed to have been stable (the path of mortality is assumed to occur along progressive levels of one of four regional model life tables); and 3. the age composition of the population at the end of the period.[1] It seems adequate to specify the length of the period during which mortality has been declining in Colombia as if, in fact, the situation would have been stable until 1951. Again, estimates of the male birth rate serve as a basis for the results given in Table 4, which are derived in a way very similar to those of Table 3, the main difference being the correction for quasi-stability. Estimates of the male birth rate for the period are shown in Table 5.

As was the case in the stable estimates for 1938-1951, the expectation of life at age five is virtually the same for both families of model life tables. Mortality levels are higher for each family than in the previous period and illustrate the gains achieved since 1951. The gross reproduction rates show practically no discrepancy with the figures for

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TABLE 4. QUASI-STABLE ESTIMATES OF POPULATION PARAMETERS, COLOMBIA, 1951—1964*

	"South"	"West"
Male birth rate	53.4	48.7
Male death rate	22.5	17.8
Male level of mortality (Coale and Demeny tables)	10.8	12.8
Male e_0^o (years)	42.4	46.5
Male e_5^o (years)	53.5	53.3
Female birth rate	49.5	45.1
Female death rate	17.3	12.9
Female level of mortality (Coale and Demeny tables)	12.7	14.7
Female e_0^o (years)	49.3	54.3
Female e_5^o (years)	58.1	58.3
G. R. R. (mean age of childbearing: 27 yrs)	3.24	2.94
G. R. R. (mean age of childbearing: 29 yrs)	3.47	3.14
Overall birth rate	51.4	46.9
Overall death rate	19.9	15.4

* Derived from the male age distribution, the male and female growth rates, the reported sex ratio of the population and an assumed sex ratio at birth of 1.05.

TABLE 5. MALE BIRTH RATE BY AGE REFERENCE POINT OF THE CUMULATIVE AGE DISTRIBUTION

Male Birth Rate	Age							Me-dian
	10	15	20	25	30	35	40	
"West"	47.9	52.4	51.9	51.3	48.7	48.2	48.4	48.7
"South"	50.9	56.4	57.1	55.6	53.4	52.4	52.7	53.4

1938-1951, at a given mean age of childbearing. Although the overall birth rates in 1951-1964 are slightly above those of 1938-1951, the difference is within the range of errors and approximation inherent in the method of estimation. The assumption of quasi-stability is confirmed in this way.

The significant sensitivity of all estimates other than the expectation of life at age five to the choice of the family of model life tables is, however, a limitation of the method to detect actual fertility and mortality conditions, given the nature of the data available for Colombia. It is nonetheless worth mentioning that the vital statistics are still indicating birth and death rates below the levels that seem

to be prevailing in Colombia. The overall registered death rate for the 1956-1958 period was 12.4 per thousand, and the corresponding figure for the birth rate was 40.2 per thousand.

CONCLUSION

Analysis of census data indicates a gain of seven to eight years in the expectation of life at age five for Colombian women from 1938-1951 to 1951-1964, and of about four years in the corresponding figure for males. Differences in these trends would be reduced if one assumes the possibility of some underenumeration of males in the 1964 census. Even then mortality risks in Colombia would seem to have recently been higher than they were in countries such as Brazil and Mexico. For example, whereas the expectation of life at age five for males would not be higher than 55 years, even if the male rate of growth for the 1951-1964 period were assumed to be equal to the female rate reported, calculations for Mexico indicate a figure of 59 years and for Brazil of about 60 years, for the period 1950-1960.

With higher mortality in Colombia and about the same rate of natural increase for the three countries, the implication is a higher level of fertility in Colombia. How much higher is impossible to say without further knowledge of the adequacy of using one or another family of model life tables to investigate Colombian mortality, but the point seems to be corroborated when one compares the cumulative age distribution of Colombian males and females in 1964 with their Brazilian or Mexican counterparts in the 1960 census. At all ages and for both sexes the Colombian data give evidence of a somewhat younger population, a fact that, in conjunction with the higher mortality prevailing in Colombia, necessarily implies a higher level of fertility than in the other two countries.

If Colombia has not yet reaped the progress in levels of health and medical care that the Mexican and Brazilian populations, taken as a whole, have achieved, and nonetheless the three countries are showing similar rates of population growth, one should expect a considerable acceleration in the Colombian demographic expansion as the decline in mortality moves along, unless a simultaneous decrease occurs in the birth rate.

SUMMARY

Estimation of overall fertility and mortality parameters in many Latin American countries is still a difficult problem, given the deficiencies in the systems of vital statistics as well as the complications involved in the adaptation of available census information to general techniques of indirect estimation. This paper attempts to apply some methods of stable and quasi-stable population analysis recently developed at the Office of Population Research of Princeton University, to the problems of inferring levels and trends in the vital rates of the Colombian population during the intercensal years 1938-1951 and 1951-1964. This question cannot be answered in a fully satisfactory way, given the lack of information on childhood mortality risks, which is required in conjunction with model life tables to arrive at reasonably accurate estimates of fertility and mortality.

Exempt from this kind of indeterminacy is the estimate of the expectation of life at age five, which is used in the text as an indicator of mortality levels and trends in Colombia during the periods in question. Whereas changes in the estimated value of this parameter illustrate the trends that took place in health conditions in the country during the fifties and early sixties, they also serve to establish a comparison of Colombian mortality with corresponding death risks in other Latin American countries, such as Mexico and Brazil. The results obtained from this analysis suggest that Colombia is still behind these two other countries as far as the transition in mortality is concerned and that, on the other hand, fertility trends are practically unnoticeable. With similar rates of growth in the three countries in the last decade and a somewhat younger population in the case of Colombia, it is also possible to infer a higher level of fertility in Colombia than in Mexico or Brazil, which, unless counteracted in the near future by changes in marriage patterns or in reproductive habits, might lead to a considerable acceleration of the rate of growth as additional gains in mortality become a reality.

REFERENCES

[1] Over the period under examination, the Colombian population has remained essentially closed to international migration.

[2] See Coale, A. J. and Demeny, P., Methods of Estimating Fertility and Mortality from Censuses of Population, Mimeographed, Princeton, Office of Population Research, Princeton University, 1966, Chapter 6.

[3] In a recent article, Mortara found that the number of women having reported ages 10-19 in the 1960 Brazilian, Mexican and Venezuelan censuses, was higher than the numbers of the same cohort enumerated ten years before, despite negligible or insufficient migration. He himself attributed this fact to frequent understatement of age on the part of young women. An alternative, or at least complementary, interpretation might lie in the deficiencies of enumeration under age ten. *See* Mortara, G., A Composicão por Sexo e Edade da Populacão do Brasil, segundo o Censo de 1960, *Revista Brasileira de Estatistica,* July-December, 1965, pp. 85-92.

[4] Brass, W., *et al.,* THE DEMOGRAPHY OF TROPICAL AFRICA, Princeton, Princeton University Press, 1968.

[5] Actual calculations assumed that the onset of the mortality decline took place in 1949.

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