MORTALITY DECLINE IN INDIA, 1951 - 1961: DEVELOPMENT VS PUBLIC HEALTH PROGRAM HYPOTHESIS

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The decline in mortality in the developing nations is usually attributed to public health programs and imported western medical technology. Thus Kingsley Davis speaks of the "amazing decline" of mortality in underdeveloped countries. In the case of Ceylon (Sri Lanka), an oft quoted example for this "amazing decline", this has been questioned by Fredericksen. According to Fredericksen, it is economic development that is responsible for, or associated with, the decline in mortality in Ceylon. The case of India is examined here employing the path analysis technique. The analysis of cross-section data indicates that the mortality decline in India might have been due to, broadly speaking, development and not primarily a consequence of public health programs.

1. INTRODUCTION

It is an almost accepted fact in the demographic literature that the decline in mortality in the developing countries is due to the importation of western medical technology and public health programs. Research done in this area reveals that mortality fell most rapidly in western countries in the late nineteenth and twentieth centuries, and the decline was largely the resultant of medical progress achieved in disease control. But the long secular decline in mortality, before this period, largely emanated from economic improvements such as increasing agricultural efficiency, the introduction of superior varieties of crops and live stock permitting better diets, and improvements in transporation eliminating famines due to local food shortages (Wrong, 1967: 41). Demographers (Sociologists) are of the opinion that the mortality decline(s) realized in developing countries are independent of an overall economic and social modernization. Thus Davis (1956) speaks of the amazing decline in mortality in non-western societies without their undergoing thorough transformation of social and economic structures. The case of Ceylon (Sri Lanka) cited by him has been examined by Fredericksen (1960) who seems to doubt the contribution of malaria control campaign in reducing the mortality level. Fredericksen's (1961) further analysis shows that economic development by increasing per capita food consumption was an important cause for the mortality decline in that country. This study on Sri Lanka has to be viewed as an eye-opener for demographers working on developing countries, for these nations are, inter alia, undergoing economic and social modernization. Also it seems to add some precepts to an area which is conspicuous by paucity of adequate theory. Stolnitz (1955) who has drawn generalizations on international mortality trends, echoes this remarkably.

> Increasing life chances are almost always explained by reference to two broad categories of causes; rising levels of living on the one hand (income, nutrition, housing, literacy), and on the other hand technological advances (medical science, public health, sanitation). The usual approach has been to regard these sets of factors as more or less coordinate, with little attempt to assess their relative importance. At the same time there has been considerable emphasis on their interdependence, a common observation being that the development and the application of disease-control techniques would have been very different in the absence of widespread social change.
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> Both of these views, which evolved largely on the basis of western mortality experience, have also been traditional explanations of the contrasting patterns found in other parts of the world. Only recently has their adequacy been seriously questioned, mainly as a result of developments in Latin America - Africa - Asia. The introduction of new disease-control techniques in this region, usually unaccompanied by shifts in socio-economic conditions, has led to drastic mortality declines in the last few years. It is worth noting, therefore, that a similar process may have been operative in the acceleration of western survivorship a good deal earlier.

The objective of this paper is to look at the mortality situation in India for the period 1951-61 and conclude on its possible determinants Based on an analysis of mortality of the different states in India, Kohli (1971) is of the opinion that mortality decline in India has been mainly due to public health programs. The present analysis is an attempt to examine the validity of the Kohli conclusion.

2. METHODOLOGY

The study proposed in this paper is a cross sectional rather than a temporal analysis. There are several reasons for choosing a cross-section probe. A temporal analysis, will (may) not separate out the major agents of mortality decline as many events are taking place simultaneously. The different states in India show different levels of mortality, economic, and social development. Assuming that the change in mortality from a high to a low level is the resultant of the different forces of social and economic modernization, it is possible to separate out the influence of each

of the major factors on the decline of mortality. The analysis is done with the help of single equations. Since the objective of this study is to elicit the causes of mortality decline, instead of the conventional regression analysis, path analysis framework (Land, 1969; Wright, 1960), is employed.

We propose two competing path models from substantive considerations and test them for adequacy.

Model I.

Many social scientists tend to confine development to the economic dimension only; and all others being effectuated by it. If we adhere to this view on developmental process, we have the following path model for mortality (decline) in a country.

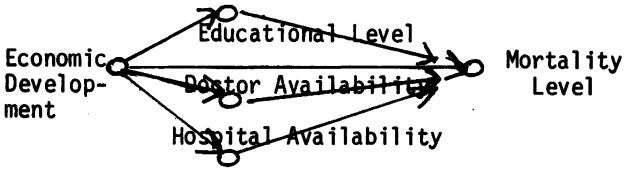

Fig. 1: ECONOMIC DEVELOPMENT-ORIENTED MODEL

In this model, economic development directly introduces changes in mortality level through a high standard of living. It also indirectly influences mortality through factors such as education, hospital services, etc. We use the following indicators.

Variables	Indicator	Label
Economic Development	State Income Per Capita	Z_5
Education	State Literacy Rate	Z_4
Doctor Availability	State Doctor-Population Ratio (Number of people served by one doctor)	Z_3
Bed Availability	State Bed-Population Ratio (Number of people served by one hospital bed)	Z_2
Mortality	Crude Death Rate	Z_1

Per-capita food intake can be included here to make the model more comprehensive. The path diagram with these variables is available in Figure 2.

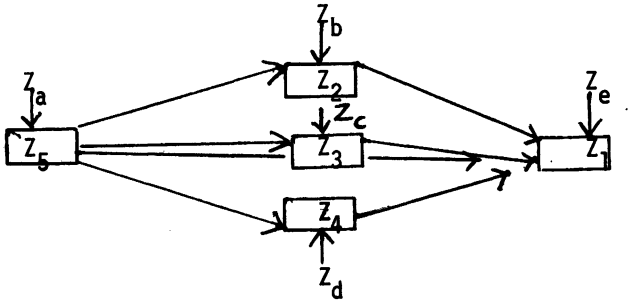

Fig. 2: PATH DIAGRAM FOR MODEL 1

Legend:

Z_5 - Income	Z_a	Error terms
Z_4 - Literacy	Z_b	
Z_3 - Doctor/Population Ratio	Z_c	
Z_2 - Bed/Population Ratio	Z_d	
Z_1 - Death Rate	Z_e	

Z's are standardized variables. Under the usual assumptions underlying path-regression analysis, the following equations can be derived.

$$Z_5 = p_{1a} Z_a$$

$$Z_4 = p_{45} Z_5 + p_{4d} Z_d$$

$$Z_3 = p_{35} Z_5 + p_{3c} Z_c$$

$$Z_2 = p_{25} Z_5 + p_{2b} Z_b$$

$$Z_1 = p_{15} Z_5 + p_{14} Z_4 + p_{13} Z_3 + p_{12} Z_2 + p_{1e} Z_e$$

This yields the normal equations I & II

$$r_{25} = p_{25}$$

$$r_{35} = p_{35} \qquad \text{I}$$

$$r_{45} = p_{45}$$

$$r_{15} = p_{15} + p_{14} r_{45} + p_{13} r_{35} + p_{12} r_{25}$$

$$r_{14} = p_{15} r_{45} + p_{14} + p_{13} r_{34} + p_{12} r_{24} \qquad \text{II}$$

$$r_{13} = p_{15} r_{53} + p_{14} r_{43} + p_{13} + p_{12} r_{23}$$

$$r_{12} = p_{15} r_{52} + p_{14} r_{42} + p_{13} r_{32} + p_{12}$$

Furthermore, we have,

$$r_{23} = p_{25}\, p_{35} = r_{25}\, r_{35}$$

$$r_{24} = p_{25}\, p_{45} = r_{25}\, r_{45} \qquad \text{III}$$

From set (II), we can solve for the path coefficients. The equations in set (III) aid in examining the empirical adequacy of the model.

Model II.

Non-economists view development from a broader perspective, economic development being only one of the essential ingredients. Changes in social institutions and structures, political stability etc. have, a great role to play in the modernization of the Third World.

Achievements registered in educational sector, public health programs etc. will be considered as elements of the developmental activity and as separate inputs into the system. Growth in income is the usual indicator of economic development. For our analysis, political changes need not be considered. The political stability factor is assumed to remain the same throughout the period under consideration.

A suitable path model in this case is obtained considering all the developmental activities as exogenous variables operating on the mortality factor. The path diagram is shown in Figure 3.

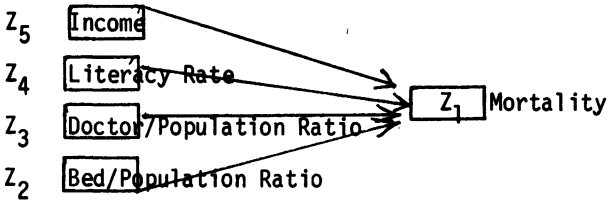

Fig. 3: THE GENERAL DEVELOPMENT PATH MODEL

In this model, we do not analyse the interrelationships of the exogenous variables.

The above model yields the conventional multiple regression situation except that it is causally interpretable. The following normal equations determine the path coefficients.

$$r_{12} = p_{12} + p_{13}\, r_{32} + p_{14}\, r_{42} + p_{15}\, r_{52}$$

$$r_{13} = p_{12}\, r_{23} + p_{13} + p_{14}\, r_{43} + p_{15}\, r_{53}$$

$$r_{14} = p_{12}\, r_{24} + p_{13}\, r_{34} + p_{14} + p_{15}\, r_{54} \qquad \text{IV}$$

$$r_{15} = p_{12}\, r_{25} + p_{13}\, r_{35} + p_{14}\, r_{45} + p_{15}$$

The set of equations (IV) is identical with the set (II). The distinction between models I and II arises from the substantive bases of the two leading to a set of conditions given in III for model I only. The constraints as given by III determine whether model I is consistent with the data or not.

3. DATA SOURCES

The data used in this analysis come from a variety of sources. Since there is under-registration of vital events in India, even death rates for the states have been estimated with the help of census age distributions. Agarwala (1967) presents several estimates of crude death rate and expectations of life at birth for the different states in India. The quasi-stable estimates of death rates have been used for the exercise attempted here. Literacy rates are again from the census returns (Agarwala, 1967: 51). Doctor-population and bed-population ratios have been computed from the data provided in the vital statistics of India 1961 (India, 1963). These data (see Table 4) were available for only eleven states.

It is worthwhile to know some of the limitations of the data and the methodology employed here. Clearly the kind of data with which the analysis is performed, is macro and all the limitations associated with official data can be stated here. No time lag is allowed for most of the independent variables as far as their effect on the dependent variable is concerned. This is because such types of information cannot be secured easily. Furthermore, in a cross-section analysis where regions are the units of analysis, the question of ecological correlations arises. This need not concern us as our aim is only to seek the relevant determinants of differential mortality with regard to such units of analysis. The sample size is small. It would have been better to take the districts of India as the units of analysis. Even with states as the units, it was difficult to gather data for all the seventeen states in India. So one has to stay with the problem of small sample size. Inferences drawn have to be taken with some caution.

4. DATA ANALYSIS

To start with, a non-causal multiple regression analysis was performed to select the relevant independent variables. Indicators of economic development (per capita state income), health programs (bed-population, doctor-population, hospital-population, dispensary population ratios, per capita state expenditure on medical and health services), social development (per cent population urban) and social change (literary rate) were employed as the independent variables. The performances of these variables were approximately the same when the dependent variable was the crude death rate or the expectation of life at birth. In view of

its simplicity, the analysis is being restricted to crude death rate as the dependent variable.

The step-wise regression yielded the following results.

Variable Added	Percent Variation Explained	Increase
Literacy Rate	47.03	47.03
Bed-Population Ratio	58.65	11.63
Doctor-Population Ratio	65.35	6.70
Per Capita Income	70.85	5.50
Hospital-Population Ratio	74.49	3.64
Dispensary-Population Ratio	78.58	4.09
Urbanization	84.41	5.83
State Per Capita Expenditure in Medical and Health Area	86.34	1.93

If 5 per cent level of significance is considered, the regression coefficients of the first three independent variables (literacy rate, bed-population and doctor-population ratios) are significant. All others (including in particular, per capita expenditure on medical and health services) do not add any significant regression components at all. Since there is considerable interest on income as such, it was decided to keep the first four variables for the purposes of this study. About 70.9 per cent of the variation in the dependent variable is accounted for by these four variables.

The four variables picked are significant ones from a developmental perspective. Bed-population and doctor-population ratios are indicators of the progress of the medical and health programs. Income per capita is an indicator of economic growth and literacy rate is an indicator of the social awareness of the population and also an agent of social change. The roles of these independent variables are sociologically interpretable.

Adequacy of Model I.

As stated earlier, both the models are based on substantive considerations. The adequacy of the models depends on how they fit with the data.

a. Model I. The equations comprising set III and II are the constraints which have to be satisfied by the empirical fit. We have (see Table 1), the following.

Since the expected and the observed correlations differ by a wide margin, the fit of the model under consideration is not satisfactory.

b. Model II. In this model, economic growth and other inputs are considered as separate forces determining a mortality situation. The observed and the expected correlations are presented below.

The model fits with the data well and hence can be preferred to Model I to explain the changing mortality situation in India.

4. DISCUSSION

Since Model I is not an adequate representation of the forces at work leading to differential regional mortality in India, the economists' contention that everything follows economic growth is not tenable. It also suggests that per capita state income (GDP) is a poor indicator of the development achieved by a province (state). Model II characterizes the mechanism behind the changing mortality situation in India. The indicators used here are those of economic development (per capita state income (GDP), public health programs (doctor/bed-population ratios) and the social awareness and change factor (literacy rate).

In path analysis, the role of these factors can be looked at from a direct and an indirect perspective. The direct effect (indicated by the path coefficients) measures the influence produced by a factor on the dependent variable by itself, while the indirect effect is the influence through other factors. Finney (1973) introduces a causal connotation to indirect effect and defines 'a causal indirect effect.' In view of the kind of setup we have in Model II, we cannot develop "indirect causal effect" estimates. The direct causal and the residual effects of these developmental factors on mortality are presented in Table 3. The indirect effects, in this situation, are not causally interpretable.

It is clear from the path coefficients given in Table 3 that the total direct effect of public health program is -.070 while those of literacy and income are much larger in magnitude. The results are in the expected direction. Even when treated separately, the roles of literacy and income are not negligible as compared to the doctor-population factor. It can be noted that the indirect effect of literacy on

mortality is almost as large as the direct effect of doctor/population ratio. Literacy (education) has a two-fold role to play. On the preventive side, literacy helps to alleviate mortality by promoting social hygiene and on the control side, the awareness generated is capitalized in making the best use of the medical facilities provided by the health program. Similar reasonings can be drawn for the direct and the indirect effects of income. A higher average per capita consumption of food leading to a more intake of cereals, may be a consequence of higher per capita GDP. This produces a reduction in mortality. Indirect effects of income are evinced through spending capacity on medical expenses.

5. CONCLUSION

From the analysis presented here, it is clear that the state differentials in mortality and hence the decline in mortality in India are a consequence of not simply public health programs only. Economic development and social change factors also had a significant contribution in reducing mortality in the period 1951-1961. The inevitable conclusion is that the public-health program hypothesis regarding mortality decline with respect to the developing nations is not tenable in some cases. Generalizations in demography regarding mortality decline need revision in the light of such experiences.

REFERENCES

Agarwala, S.N. (1967), Population - India: The Land and the People, New Delhi: National Book Trust.

Davis, K. (1956), "The amazing decline of mortality in underdeveloped areas", American Economic Review, 46, 305-318.

Finney, J.M. (1973), "Indirect effects in path analysis", Sociological Methods and Research, 1: 175-186.

Frederiksen, H. (1960), "Malaria control and population pressure in Ceylon", Public Health Reports, 75(10) - Reprinted in Readings on Population (ed.: David M. Heer), Englewood Cliffs: Prentice-Hall, 69-73.

Frederiksen, H. (1961), "Determinants and consequences of mortality trends in Ceylon", Public Health Reports, 76(80) - Reprinted in Readings on Population, 74-80.

India, Government of (1963), Vital Statistics of India 1961, New Delhi: Ministry of Home Affairs.

Kohli, K.L. (1971), "Spatial Variations of Mortality in India, 1951-61", Dissertation Abstracts, 32, 4733A.

Land, K. (1969), "Principles of path analysis", Sociological Methodology 1969 (eds. E.F. Borgatta and G.W. Bohrnstedt), San Francisco: Jossey Bass, 3-37.

Stolnitz, G.J. (1955), "A Century of international mortality trends: I", Population Studies, 9, 26-55.

Wright, S. (1960), "Path coefficients and path regression: alternative or complementary concepts?", Biometrics, 16, 189-202.

Wrong, D.H. (1967), Population and Society, New York: Random House, Inc.

Table 1

OBSERVED AND EXPECTED CORRELATIONS FOR MODEL I

Corr. Coef.	Observed (1)	Expected (2)	Difference Col. 1-Col. 2
r_{23}	.156	.300	-.144
r_{24}	.262	-.147	+.409
r_{34}	-.552	-.164	-.388
r_{15}	-.405	-.893	+.488

Source: Statistical Analysis

Table 2

OBSERVED AND EXPECTED CORRELATIONS FOR MODEL II

Corr. Coef.	Observed	Expected	Difference
r_{12}	-.289	-.289	0
r_{13}	.663	.662	.001
r_{14}	-.686	-.685	-.001
r_{15}	-.405	-.405	0

Source: Statistical Analysis

Table 3

DIRECT AND INDIRECT EFFECTS ON MORTALITY, INDIA 1951-61

Development Factor	Direct Effect (Path Coef) On Mortality	Indirect Effect (Path Coef) On Mortality	Indirect Effect Through
Economic Development Factor			
Income	-.349	-.056	Doctor/Pop. .244 Bed/Pop. -.231 Literacy -.069
Public Health Program Factor			
Doctor/Population	-.469	.180	Income .182 Bed/Pop. .062 Literacy -.064
Bed/Population	.399	.264	Income .202 Doc/Pop. -.073 Literacy .134
Social Change Factor			
Literacy	-.243	-.443	Doc/Pop. -.123 Income -.099

Table 4

DATA EMPLOYED FOR ANALYSIS

	Deathrate 1951-1961	Per Cent Literate 1961	Population In Thousands Served By One Bed 1961	Population* In 1000's Served By One Doctor	Per Capita State Income (R s)
Assam	26.9	27.4	3.40	3.81	330.96
Andhra Pradesh	25.2	21.2	1.79	11.14	296.13
Kerala	16.1	46.8	1.40	20.92	305.03
Madhya Pradesh	23.2	17.1	3.25	13.66	274.73
Madras (Tamilnadu)	22.5	31.4	1.40	2.90	359.95
Maharastra	19.8	29.8	1.43	3.52	398.81
Mysore	22.2	25.4	1.53	6.73	257.08
Orissa	22.9	21.7	3.19	12.25	237.05
Punjab	18.9	24.2	1.53	3.73	432.19
Uttar Pradesh	24.9	17.6	2.80	9.89	272.75
West Bengal	20.5	29.3	1.20	7.20	461.09

* Data on registered medical practioners refers to 1959 and the population to 1961. The rate for Maharastra refers to old Bombay State which included the present states of Maharastra and Gujarat.

Source: 1 Statistical Abstract of Indian Union 1960, Central Statistical Organization, New Delhi

2 Health Statistics of India 1961 and 1962, Ministry of Home Affairs, New Delhi