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Mortality Decline in India and Karnataka, 1951-71 : Development Vs Public Health Program Hypothesis

Introduction

IT is an almost accepted fact in 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 result 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 productivity, the introduction of superior varieties of crops and live stock permitting better diats, and improvements in transportation eliminating famines due to local food shortages (Wrong, 1967 : 41). Most demographers are of the opinion that the mortality decline realized in developing countries is independent of 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 have been at the same time undergoing

economic and social modernization. Also this position brings in a new perception 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 co-ordinates, 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 wide-spread social change.

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, and Asia. The introduction of new disease control techniques in these regions, usually unaccompanied by perceptible shifts in socio-economic conditions, has led to drastic mortality declines in the last few years. It is worth noting, therefort, that a similar process may have been in operation in the acceleration of western survivorship a good deal earlier.

The objective of this paper is to look at the mortality situation in India as well as in the state of Karnataka for the decades 1951-61, and 1961-71 and to reflect on its possible determinants on the basis of an analysis of mortality of the different states in India. Kohli (1971) and Vig (1976) are 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 this conclusion.

Methodology

The present study is a cross-sectional rather than a temporal analysis. There are several reasons for choosing the 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 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 wkh the- help of single equations. Since the objectives of this study is to elicit the causes of mortality decline, instead of the conventional regression analysis frame work, path analysis 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 argue that all others being effectuated by it. If we adhere to this view of the developmental process, we have the following path model for mortality (decline) in a country.

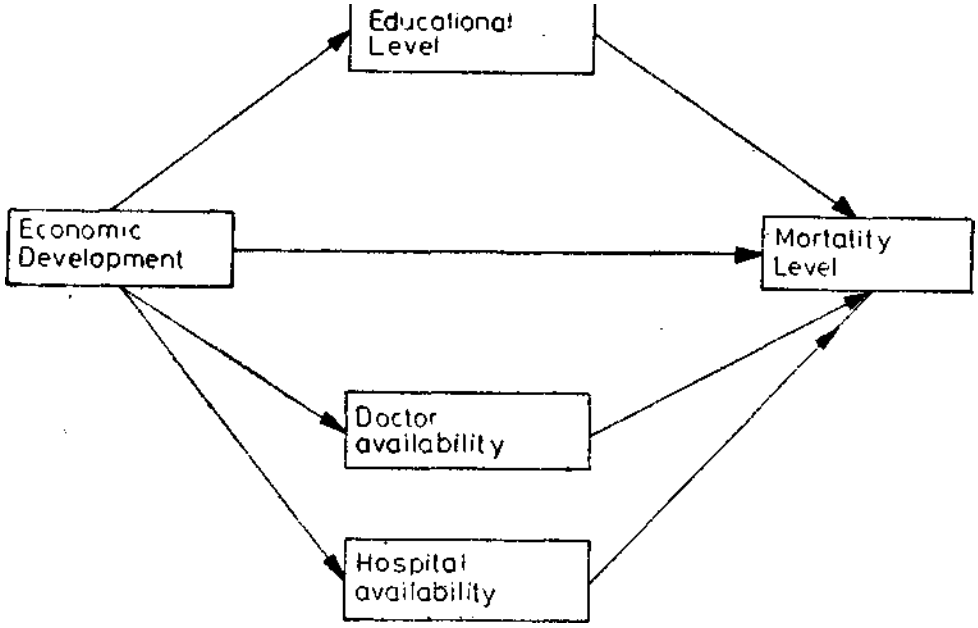

Fig. 1. Economic development-oriented model

In this model, economic development directly introduces change in mortality level through a rise in the 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	Z5
Education	State literacy rate	Z4
Doctor availability	State doctor population ratio (number of people served by one Doctor)	Z3
Bed availability	State bed population ratio (number of people served. by one hospital bed;	Z2
Mortality	Crude death rate	Z1

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

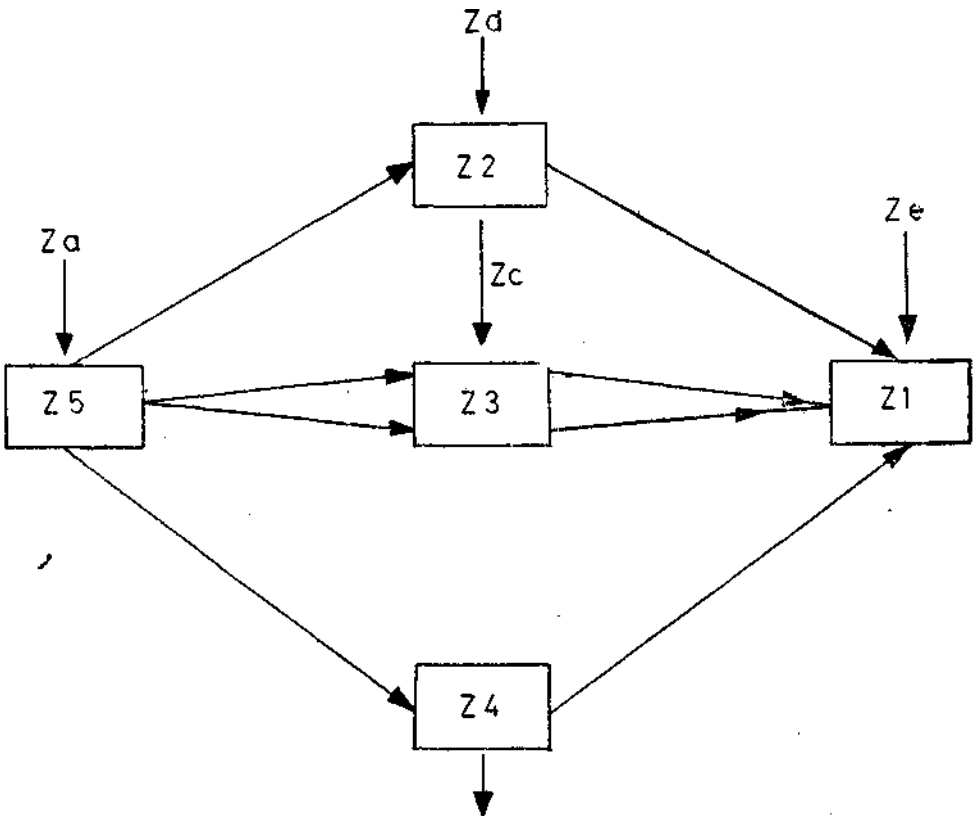

Fig. 2. Path diagram for model 1.

Legend:

Z 5 – Income	Za	Error terms
Z 4 – Literacy	Zb	
Z 3 – Doctor/ Population ratio	Zc	
Z 2 – Death rate	Zd	
Z 1 – Death rate	Ze	

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

Z5 = PlaZa
Z4 = P45 Z5 + P4d Zd
Z3 = P35 Z5 + P3c Zc
Z2 = P25 Z5 + *P2b Zb*
Z1 = P15 Z5 + P14 Z4 + P13 Z3 + P12 Z2 + Ple *Ze*

This yields the normal equations I and II

r25 = P25
r35 = P35 I
r45 = P45

r15 = P15 + P14 r45 + P13 r35 + P12 r25

r14 = P15 r45 + P14 + P13 r34 + P12 r24
II
R13 = P15 r53 + P14 r43 + P13 + P12 r23
R12 = P15 r52 + P14 r42 + P13 r32 + P12

Furthermore, we have,

r23 = P25 P 35 = r25 r35
III
r24 = P25 P45 = r25 r45

From set (II), we can solve for the path coefficients. The equations in set (III) help 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 are not 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 factors. The path diagram is shown in Figure 3.

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

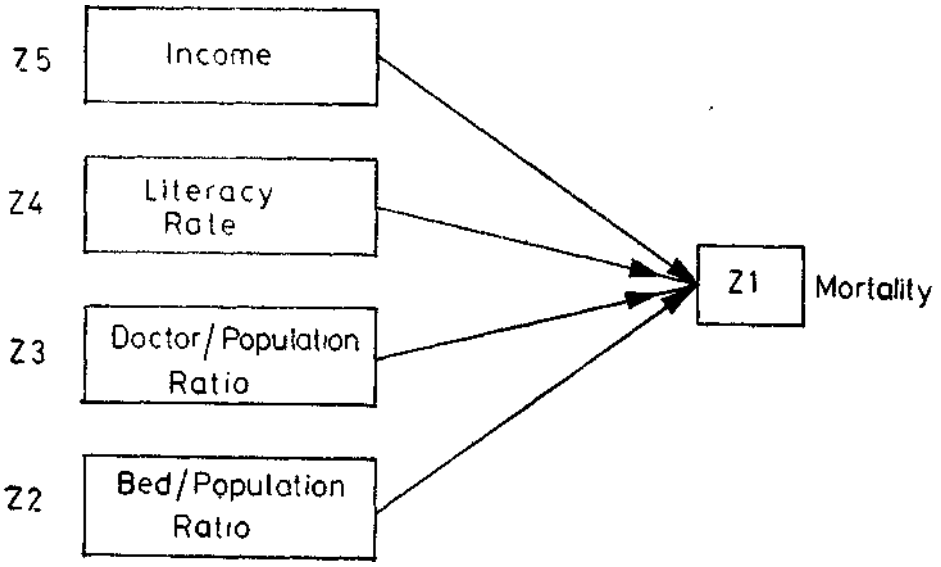

Fig. 3. The general development path model.

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

$$
\begin{aligned}
r12 &= P12 + P13\, r32 + P14\, r42 + P15\, r52 \\
r13 &= P12\, r23 + P13 + P14\, r43 + P15\, r53 \\
r14 &= P12\, r24 + P13\, r34 + P14 + P15\, r54 \\
r15 &= P12\, r25 + P13\, r35 + P14\, r45 + P15
\end{aligned}
\qquad \text{IV}
$$

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.

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) and Vital Statistics of India 1971 (India, 1971) and 1977 (India, 1982). The relevant data are given in Tables 1 and 2.

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 the requisite types of information cannot be secured easily. Furthermore, in a cross section analysis where regions are the units of analysis the question of ecological correlation 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.

As a part of case study, apart from states of India, the district level analysis has been done for the state of Karnataka. So one has to stay with the problem of small sample size. Inferences drawn have to be taken with due caution.

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/district income), health programs (bed population, doctor-population, hospital-population, dispensary-population ratios. Per capita expenditure on medical and health services), social development (per cent population urban) and social change (literacy rate) were employed as the independent variables. The performance of the different variables is approximately the same whether the dependent variable is 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 results shown in Tables 3 to *5.* 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 ratio) are significant. All others (including in particular, per capita expenditure on medical and health services) <Io 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 purpose of this study. About 70.9 per cent

TABLE 1— VALUES OF SELECTED MORTALITY, HEALTH AND SOCIO-ECONOMIC INDICATORS FOR STATES

Sl. No.	*States*	*Death Rate 1961-70*	*Death Rate by Central Death Rate 1961-70*	*Life Expectancy at Birth 1961-70*	*Percent Urban 1971*	*Percent Literates 1971*	*Per-capita Income (Rs.) 1970-71*	*Per-capita Expenditure on Health 1911-72*	*No. of Hospital Beds per 1000 Population 1971*	*No. of Doctors Per 1000 Population 1971*	*No, of Hospitals Per 1000 Population 1971*
1.	Andhra Pradesh	19.10	17.4	44.37	19.31	24.6	572	6.32	7.18	2.22	0.28
2.	Assam	18.42	19.6	45.96	8.87	28.7	523	5.46	5.17	2.90	0.52
3.	Bihar	22.38	20.0	41.04	10.00	20.0	426	3.28	2.66	1.85	0.16
4.	Gujarat	13.84	16.0	53.68	28.08	35.7	842	7.01	5.99	2.58	0.51
5.	Jammu & Kashmir	15.09	16.3	50.69	18.59	18.3	524	11.58	8.67	1.61	1.31
6.	Kerala	16.60	17.2	48.80	16.24	60.2	586	7.17	10.20	2.32	0.17
7.	Karnataka	19.43	17.8	44.59	24.31	31.5	530	5.07	8.46	2.64	0.32
8.	Madhya Pradesh	12.84	22.3	54.38	16.29	22.0	492	4.89	3.67	1.12	0.13
9.	Madras (Tamil nadu)	16.08	16.9	49.57	30.26	39.4	618	8.29	6.71	4.55	0.35
10.	Maharashtra	13.01	16.2	54.38	31.17	39.1	788	7.49	7.42	4.23	0.28
11.	Orissa	19.39	19.3	44.70	8.41	26.1	496	4.85	4.95	1.97	0.25
12.	Punjab	19.75	16.9	43.80	23.73	33.4	995	7.24	7.29	9.12	0.30
13.	Harvana	14.66	16.8	50.60	17.66	26.7	844	8.88	6.13	—	0.23
14.	Rajasthan	16.73	16.1	49.40	17.63	18.8	623	8.84	6.74	1.30	0.31
15.	Uttar Pradesh	21.05	21.8	42.97	14.02	21.6	521	3.10	4.39	1.46	0.25
16.	West Bengal	19.19	19.6	44.93	24.75	33.1	747	6.72	9.13	5.79	0.18
17.	Himachal Pradesh		17.4		6.99	31.3	639	11.51	13.27	–	1.58

TABLE 2— VALUES OF SELECTED MORTALITY, HEALTH AND SOCIO-ECONOMIC INDICATORS FOR STATES

Sl. No.	*States*	*Death Rate 1951-61*	*Expectation of Life at Birth Both Sex 1951-60*	*Percentages* Urban Popu~ to Total 1961*	*Literacy Rate 1961*	*Percapita of Income lotion 1960-61 Population*	*Percapita Government Expenditure Health 1960-61 (Govt,)*	*No. of Hospital Beds per on Thousand Service Population 1961*	*Population in Thousand per Doctor 1961*
1.	Andhra Pradesh	25.2	36.9	11.89	21.2	287.0	2.03	0.56	5.32
2.	Assam	26.9	36.8	15.83	27.4	333.3	2.58	0.29	3.81
3.	Bihar	26.1	37.6	6.70	18.4	220.7	1.64	0.22	6.47
4.	Gujarat	23.5	40.0	19.81	30.5	393.4	2.00	0.32	4.35
5.	Jammu & Kashmir	N.A		4.17	11.0	289.0	N.A	N.A	N.A
6.	Kerala	16.1	48.3	43.99	46.8	314.9	3.15	0.72	4.80
7.	Madhya Pradesh	23.2	40.6	6.42	17.1	285.3	2.91	0.31	7.59
8.	Madras (Tamil Nadu)	22.5	39.8	16.80	31.4	334.1	2.56	0.71	5.65
9.	Maharastra	19.8	45.2	16.49	29.8	468.5	'2.48	0.70	3.28
10.	Mysore (Karnataka)	22.2	'40.2	13.81	25.4	304.7	2.17	0.65	3.54
11.	Orissa	22.9	40,9	7.90	21.7	276.2	1.53	0.31	8.13
12.	Punjab	18.9	47.5	14.05	24.2	451.3	2.17	0.66	2.89
13.	Rajasthan	19.4	46.8	5.91	15.2	267.4	2.84	0.52	7.52
14.	Uttar Pradesh	24.9	38.9	7.34	17.6	297.3	1.18	0.36	8.10
15.	West Bengal	20.5	44.3	19.35	29.3	464.5	2.90	0.83	2.40

*Percentage of total population living in towns with Population 20,000 and more.

SOURCE : (1) Jain S. P., Census of India, 1961, Paper No. 2 of 1963, Life Tables, 1951-60 (2) Jain S P., "Mortality Trends and Social and Economic Development in India," in Minoru Tachi and Minoru Muramatau (ed.) *Population Problems in the Pacific,* Tokyo, Pacific Science Cong. 1966.

TABLE 3-PRODUCT MOMENT (ZERO ORDER CORRELATION MATRIX)
CORRELATION COEFFICIENTS MATRIX

Variables	*Death Rates (1951-61)*	*Percent Literates 1961*	*Population in Thousands Served by One Bed 1961*	*Population in Thousands Served by One Doctor*	*Per capita Income (Rs.)*
	XI	X2	X3	X4	X5
XI	1.0000				
X2	—0.6858	1.0000			
X3	0.6628	—0.5519	l..00000		
X4	—0.2888	0.2624	0.1556	1.0000	
X5	—0.4051	0.2827	—0.5795	—0.5213	1.0000
Variable	*Reg. Co- efficient*		*Variance*		*T Statistics*
0	28.6911		49.1556		4.0922
5	—0.0146		0.0002		—1.0640
4	—0.2622		0.0279		-1.5701
3	1.4140		1.2252		1.2775
2	—0.0919		0.0127		—0.8151

The estimated error variance is 4.69313
R Square = 0.708501
R Bar Square = 0.4656
Multiple *R* = 0.8418
F Statistics with *D.F.* (4, 6) = 3.645821
Durbin Watton Statistics = 1.2179
Average Relative error = 0.0618

TABLE 4—RESULTS OF THE STEP-WISE REGRESSION

Variables 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

TABLE 5- ARITHMATIC MEAN AND STANDARD DEVIATION OF INDIVIDUAL VARIABLES

Variables			*n=1* *Mean*	*M=5* *Standard Deviation*	
X1			*22.10*	*2.9634*	
X2			*26.54*	*7.8672*	
X3			*2.084*	*0.8352*	
X4			*8.7045*	*5.3011*	
X5			*329.62*	*70.9151*	
Variables	*Mean*	*Standard Deviation*	*Standard Error of Regression Coefficient*	*Partial Correlation Coefficients*	*Variance Explained*
X1					
X2				$rx_1x_2x_3x_4$	
X3				$rx_1x_3x_3x_4$	
X4				$rx_1x_4x_2x_3$	
X5					

Standard error estimate.

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 equation comprising set III and II are the constraints which have to be satisfied by the empirical fit. The observed and expected correlations are presented in Table 6.

TABLE 6-OBSERVED AND EXPECTED CORRELATIONS FOR MODEL I

Correlation Coefficient	*Observed*	*Expected*	*Difference Col. (l)-Col. (2)*
r23	0.156	.300	—.144
r24	0.262	—.147	+ .409
r34	-0.552	—.164	—.388
r15	-0.405	-.893	+.488

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 in Table 7.

TABLE 7—OBSERVED AND EXPECTED CORRELATIONS FOR MODEL II

Correlation Coefficient	*Observed*	*Expected*	*Difference Col. (l)-Col. (2)*
r12	—.289	—.289	*0*
r \3	.663	.662	.001
r14	—.686	—.685	—.001
R15	—.405	—.405	0

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

Discussion

Since the 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 (G D P) is a poor indicator of the development achieved by a province (state). Model II characterises the mechanism behind the changing

mortality situation in India. The indicators used here are those of economic development (per capita state income or GDP), public health programs (Doctor/ bed-population ratios) and the social awareness and change factor (literacy rates).

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 co-efficients) measures the influence through other factors. Finney (1973) introduces a casual connotation to indirect effect and defines a casual indirect effect. In view of the kind of set-up we have in Model II, we cannot develop "indirect casual effect" estimates. The direct casual and the residual effects of these developmental factors on mortality are presented in Table 8. The indirect effects, in this situation, are not casually interpretable.

TABLE 8—DIRECT AND INDIRECT EFFECT ON MORTALITY, INDIA 1951-61

Development Factor	*Direct Effect (Path coefficient) on mortality*	*Indirect Effect (Path coefficient) on mortality*	*Indirect Effect Through*	
Economic Development Factor Income	-.349	-.056	Doctor/Pop. Bed/Pop. Literacy	.244 -.231 -.069
Public Health Program Factor				
Doctor/Population	-.469	.180	Income Bed/Pop. Literacy	.182 .062 -.064
Bed/Population	.399	.264	Income Doc/Pop. Literacy	.202 0.073 .134
Social Change Factor Literacy	-.243	-.443	Doc/Pop. Income	-.123 -.099

It is clear from the path co-efficients given in Table 8 that the total direct effect of public health program is — 0.07, 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 con-

trol side, the awareness granted is capitalized in making the best use of medical facilities, provided by the health program. Similarly 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 care.

Conclusion

From the analysis presented here, it is clear that the state differentials in mortality and the decline in mortality in India are a consequence not simply of . public health programs only. Economic development and social change factors also made a significant contribution in reducing mortality in the period 1951-61. The obvious inference is that the hypothesis regarding public health being the sole factor in mortality decline in respect of the developing nations is not tenable in some cases. Generalizations in demography regarding mortality decline need revision in the light of such experience.

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