

P. M. Kulkarni, S. Krishnamoorthy and K. Devaraj

Effects of Education and Income on Infant Mortality: An Assessment of the Intermediate Variables Framework*

Abstract

This paper examines the effects of education and income on infant mortality with the aid of an intermediate variables framework. The analysis is at the cross-national level based on the data for 74 countries. The path analysis approach has been adopted to estimate the direct and indirect effects of the explanatory variables. The results show that though female literacy has a strong effect on infant mortality, most of it is not felt through the set of intermediate variables used in this analysis. Further, though a relatively greater portion of the effect of income is explained by the intermediate variables, the direct effect is also quite strong. Probable reasons for the inability of the intermediate variables to explain the effects satisfactorily are discussed.

Introduction

THE strong positive relationship between socio-economic development and the level of child survival is well recognised. There is considerable empirical evidence on the effects of two key aspects of socio-economic development, namely education and income, on child survival. These effects have been established at the macro as well as at the micro levels. For example, Palloni (1981) showed that in addition to the effect of the education of mother, the level of education in the society also has a strong effect on child survival. The latter may, possibly, be an indication of the efficiency of the social system functioning in the society. Flegg's (1982) analysis of 46 underdeveloped countries showed that both average income and income inequality have strong effects (positive and negative respectively) on infant survival. A number of other studies have confirmed the existence of such effects (for a review, see Mosley, 1984; Ware, 1984).

Socio-economic development influences child survival through one or more intermediate variables. The proximate determinants framework suggested by Mosley and Chen (1984) provides a way to examine such linkages. Some of the proximate determinants may be more easily manipulable than the socio-economic conditions and hence an understanding

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¹Dr. P. M. Kulkarni is Professor, Dr. S. Krishnamoorthy is Professor and Head, and Mr. K. Devaraj is Research Scholar, Department of Population Studies, Bharathiar University, Coimbatore-641 046, Tamil Nadu.

of these would suggest better and more cost-effective means of improving the level of child survival. It is possible that appropriate interventions directly in the proximate determinants may, over time, weaken the influence of socio-economic development *per se*. Preston (1975) observes that the role of economic development on child survival has undergone a change over time. At the same time, if the intermediate variables only partly explain the effect of socio-economic factors, implying that such factors have some direct effect as well on child survival, the proposed intermediate variables could be considered inadequate. In that case, either some relevant intermediate factors are not included or the nature of linkages not correctly specified. One way to examine the adequacy of an intermediate variables framework is to see how much of the effect of the socio-economic factors is via the intermediate variables.

Mosley and Chen (1984) have identified five proximate determinants through which child survival is influenced. These are: maternal factors, environmental contamination, nutrient deficiency, injury, and personal illness control. Jain (1985), Talwar (1988), and Nag (1988) have given listings and classification of proximate determinants according to the time at which they operate—at conception, during gestation, during the neonatal period, and during the post-neonatal period. Further, preventive and curative aspects were separately listed. Though such frameworks are quite appropriate in empirical work these can not often be used in the specified manner. This is because of the inability to quantify some of the factors and the lack of data on some others. As a result, some relevant variables on which data are available have to be used as proxies. Srinivasan (1988) has carried out such an analysis. Rama Rao (1983) has also examined the effects of some proximate determinants directly or as represented by respective proxies. However, in both these analyses, only the roles of proximate determinants were examined. Jain (1985) analysed the effects of literacy and poverty on infant mortality through two variables—attendance of trained personnel at birth and vaccination. This analysis of interstate variations in infant mortality in India is detailed since it includes separate explanations of the two components, neonatal and post-neonatal, of infant mortality; however only two intermediate variables were considered.

Conceptual Framework

In this paper, it is proposed to examine the effects of the two important factors of socio-economic development, income and education, in a cross-national analysis using the proximate determinants framework. Four indicators of the set of proximate determinants are used for this purpose. These are: per capita calorie consumption to represent nutrition; percent of newborn with low birth weight, which is partly influenced by nutrition (of the mother during gestation) as well as some maternal factors; per cent of deliveries attended by trained personnel which is an indicator of care at the time of delivery; and per cent of newborn immunized, which represents preventive post-natal care. The dependent variable is infant mortality rate. Income is expected to operate through all the four intermediate variables listed above, since it can positively influence nutrition and through it birth weight, and societies with higher incomes can provide better care at the time of delivery as well as better immunization services. Education, especially of females, can influence immunization and care at delivery because of the greater awareness that it would create. The specification is

admittedly incomplete, because no proxies have been used for environmental contamination and personal illness control, though the variable for attendance at delivery would give some indication of the health care facilities and hence of illness control. The total effect of each of the socio-economic variables on infant mortality is given by the zero order correlation coefficients. The paths from each of these through the intermediate variables to infant mortality give the effects explained via the intermediate variables. Further, as income and education are associated, there would be some joint effect as well, since no cause-effect direction between these two is assumed. The total effect to each of these two variables is first decomposed into that part explained through intermediate variables and the remainder. Since the model is unsaturated, the remainder would include the direct effect of the explanatory variable, controlled for the other, its effect jointly with the other socio-economic variable, and some residual.

Data

The analysis is performed on a set of data that are available for a large number of countries (UNICEF 1989) and refer to a time around 1985. Since for a number of countries data on one or more variables were not available, only 74 countries for which data on all the variables in the model could be obtained are included in the analysis. These include developing as well as developed countries.

The variables used in the analysis are:

JMR : Infant mortality rate (per 1000 births)

FLIT : Per cent of adult females literate

PCI : Per capita GNP in U.S. dollars

CAL : Average daily per capita calorie consumption as percent of requirements

LBW : Per cent of infants with low birth weight

IMM : Per cent of infants with completed polio immunization

TRP : Per cent of deliveries attended by health personnel.

For nutrition, average daily per capita consumption as per cent of requirements is used. In the case of immunization, though data on different types (DPT, Polio, TB, Measles) are available, per cent fully immunized with polio is used as the variable for immunization here mainly because this is spread over a longer period and would generally imply complete immunization of other types as well.

Results

The path coefficients are estimated from the linear regression equations:

$$\begin{aligned} IMR &= f(FLIT, PCI, CAL, LBW, IMM, TRP), \\ IMM &= f(FLIT, PCI), \text{ and } TRP = f(FLIT, PCI). \end{aligned}$$

Some path coefficients, of course, are directly obtained from the correlation matrix (Table 1). The regression results are presented in Table 2.

TABLE 1: CORRELATION MATRIX FOR VARIABLES USED IN REGRESSION ANALYSIS BASED ON 74 COUNTRIES

	<i>IMR</i>	<i>FLIT</i>	<i>PCI</i>	<i>CAL</i>	<i>LBW</i>	<i>IMM</i>
<i>FLIT</i>	-0.830	1.0				
<i>PCI</i>	-0.633	0.489	1.0			
<i>CAL</i>	-0.698	0.563	0.518	1.0		
<i>LBW</i>	0.582	-0.549	-0.573	-0.588	1.0	
<i>IMM</i>	-0.777	0.732	0.499	0.715	-0.589	1.0
<i>TRP</i>	-0.782	0.757	0.626	0.655	-0.557	0.670

TABLE 2 : SUMMARY RESULTS OF REGRESSION ANALYSIS

<i>Explanatory variable</i>	<i>Dependent Variable</i>						
	<i>IMM</i>		<i>TRP</i>		<i>IMR</i>		
<i>IMR</i>	<i>r</i>	<i>Std. reg. coeff.</i>	<i>r</i>	<i>Std. reg. coeff.</i>	<i>r</i>	<i>Std. reg. coeff.</i>	
<i>FLIT</i>	-0.830	-0.439***	0.732	0.641***	0.757	0.593***	-0.684***
<i>PCI</i>	-0.633	-0.187**	0.499	0.185**	0.626	0.336***	-0.299***
<i>CAL</i>	-0.698	-0.164*	-	-	-	-	-
<i>LBW</i>	0.582	-0.041	-	-	-	-	-
<i>IMM</i>	-0.111	-0.187**	-	-	-	-	-
<i>TRP</i>	-0.782	-0.123	-	-	-	-	-
<i>R</i> ²		0.81		0.56		0.66	0.76

respectively, and

— implies that the variable is not included in the regression equation.

The two socio-economic variables are highly (negatively) correlated with infant mortality rate, as are all the four intermediate variables with the expected signs. Further, literacy and income have significant relationship with each of the intermediate variables and with each other. The six variables (two socio-economic and four intermediate) together explain 81 per cent of the variation in infant mortality rate. The net effects of both literacy and income are highly significant, calorie consumption and immunization also have significant (at 5 or 10% level) effects, but the other two, low birth weight and deliveries by trained personnel do not. The highly significant direct effects of literacy and income on infant mortality indicate that a large portion of their effect is not felt through the intermediate variables used.

For a clearer understanding, the total effect of each of the two variables— literacy and income — is decomposed into the effect through the intermediate variables, the direct effect, and the effect jointly with the other socio-economic variables. The balance is the unexplained or residual effect. These can be computed from the path diagram (Fig. 1). The decompositions are given in Table 3. Of the total effect (-.830) of literacy, only -.193 is explained through the two intermediate variables in the model (literacy is not hypothesized to act through the other two intermediate variables) and the direct effect is very large. The intermediate variables explain only a small portion (-.149) of the total effect of income (-.633), the direct effect is -.187; there is considerable effect jointly with literacy as well (-.309). For both the variables, only a small portion of the effect has remained unexplained.

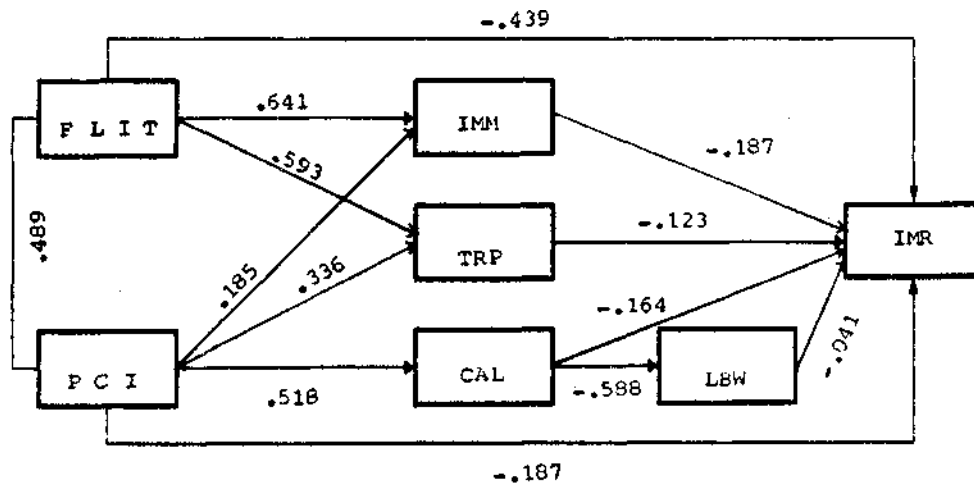


Fig. 1: Path Diagram Linking Literacy and Income to Infant Mortality.

Because of the high degree of association between literacy and income, a part of the effect is felt jointly as noted above. Therefore, the effect of one variable controlled for the other was also obtained (from the last regression in Table 2) and the decomposition given in the last two columns of Table 3. Even when controlling for income, female literacy has

TABLE 3 : DECOMPOSITION OF THE EFFECTS OF LITERACY AND INCOME ON INFANT MORTALITY

<i>Effect of</i>	<i>FLIT</i>	<i>PCI</i>	<i>FLIT</i> <i>(Controlled for PCI)</i>	<i>PCI</i> <i>(Controlled for FLIT)</i>
Total	-.830	-.633	-.684	-.299
Through :				
CAL—LBW	-	.012	-	.012
CAL	-	-.085	-	-.085
IMM	-.120	-.035	-.120	-.035
TRP	-.073	-.041	-.073	-.041
Sub-total of effects through intermediates variables	-.193	-.149	-.193	-.149
Direct	-.439	-.187	-.439	-.187
Jointly ^a with PCI/FLIT	-.164	-.309	.	-
Residual ^b	-.034	.012	-.052	0.037

a. This effect is computed as:

(corr. coeff. between FLIT and PCI) X (Subtotal of effects through intermediate variables + direct effect, of the other variable),

b. Residual effect = Total effect - (Sub-total of effects through intermediate variables + direct effect + joint effect)

a very large effect on infant mortality (-.684) and most of this (-.439) is the direct effect. On the other hand, after literacy is controlled, the effect of income becomes small (-.299) and about half of this (-.149) is felt through the intermediate variables.

Discussion

The regression analysis and the decomposition of effects show that the intermediate variables used in the model do not explain a large portion of the total effect of literacy and income on infant mortality. In the case of literacy, a much greater part of the effect is the

direct effect. It is true that the model postulates only two intermediate variables for literacy. Including the literacy—calorie intake or birth weight paths would increase the portion explained through intermediate variables, but this would not be interpretable since literacy is not expected to influence calorie intake directly. The failure of the model used in the analysis should instead be attributed to the non-inclusion of some relevant factors. Two important intermediate variables, environmental contamination and personal illness control, are not included in the present analysis because of the unavailability of good proxies. The overall income level could affect both sanitation and medical services positively and also housing conditions. A more literate population would, through greater demands on sanitation services and better personal hygiene, reduce environmental contamination. Further, the quality of curative services and of the non-medical care at birth and during infancy (some of the factors mentioned by Jain, Talwar and Nag) would also be better in a more literate population.

The importance of personal hygiene and sanitation, along with nutrition, has earlier been discussed by McKewon (1976) in the context of European mortality decline. The difficulty, however, is in quantification and measurement. Some aspects of hygiene can perhaps be better included in a household level analysis rather than a cross-national analysis as performed here. But even at the macro level, there is a need to find appropriate proxies. Data on per cent of houses with a hygienic toilet, or a separate bathroom, or on population living in localities with underground sewage system could be useful. Some anthropological investigations into infant care, particularly bathing and feeding practices, will also provide valuable information. Further, though some data on access to health services are available, the quality of such services is also relevant but not easily quantifiable. Some success along with the measurement of such factors could provide a more complete way of assessing the adequacy of the intermediate variables framework.

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