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Socio-Economic- Determinants of Early Childhood Mortality: A Study of Three Indian States

Introduction

THE important determinants of child survival in less developed countries include infection, food intake, nutritional status, disease control, maternal factors and injury.' The socio-economic factors influence child survival by operating through these basic proximate determinants. The purpose of this paper is to examine how the social and environmental context in which a child is raised affects his or her survival chances in three states in northern India, viz., Bihar, Madhya Pradesh, and Uttar Pradesh. The analysis is based on the 1981 census data. Child mortality for both sexes is higher in north India than in the South, and the death rates of girls in the northern states relative to boys are higher than those of their southern sisters.[2]

Differentials in mortality by **sex** are now nearly universally recognised; with equal care and feeding, females experience lower mortality. The survival advantages are

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[1]See Mosley and Chen (1984). Mosley and Chen provide a conceptual framework for the study of child survival in developing countries incorporating these determinants.

[2]Various reasons have been advanced to explain this regional divide, among these are greater degree of freedom for women in the southern states since the pre-Christian era. Also marriage customs, kinship and inheritance patterns differ greatly by North/South region. See. among others. Dyson and Moore (1983) and. Kolenda (1987).

particularly strong during the neonatal period.[3] This is generally considered to be the result of the greater biological frailty of the male infant with regard to the congenital defects, and the birth process. In Western Europe and North America, female children typically have a substantial survival advantage. In contrast, countries with basic gender inequality tend to have a high ratio of female to male mortality even in 0-4 age group. In India, the bulk of excess female mortality in childhood occurs after the age of one. During the neonatal period when biological factors largely determine survival, mortality of girls is lower than that of boys (with 1,159 neonatal deaths of boys per 1,000 deaths of girls in the first month of life). The transition to a higher mortality of girls would appear to occur at the age of around six months,[4] when breast milk alone ceases to be adequate for children's nutritional requirements.[5] This is the time when children need extra care, especially as regards feeding and treatment of frequent infections mostly associated with contaminated weaning foods[6] and socio-economic influences become important in determining child survival.

A major focus of this paper will be to investigate the factors which determine the relative survival chances of female children in our three states. The child mortality variable we shall use in our regression analysis below is the probability that a child will die before attaining the age of 2. It is based on census questions on the number of children ever born and the number of children surviving. The Indian census gives four estimates of child mortality, viz., the probability that a child will die before attaining the age of 1, 2, 3, and 5, respectively. The data are presented in the form of the number of deaths per thousand live births at these various ages and denoted as Q(l), Q(2), Q(3), and Q(5), respectively. The Q(1) data are not best suited for our purpose due to biological factors being important influences on child survival in the first six months or so after birth. The Q(2) data capture more adequately the influences of many of the socio-economic factors on child survival. The determinants of mortality in early childhood may well be somewhat different from those in later childhood. Our interest is in explaining early childhood mortality and we shall accordingly use 0(2) data. The quality of census data on child mortality is rather mixed, but the 0(2) data are generally considered by the census authorities as being more reliable than the rest of the Q values.[7]

Our analysis will be based on district-level data. Earlier analysis of the determinants of demographic outcome in India based on district-level data include Rosenzweig and Schultz (1982), Kishor (1993) and Murthi *et al.* (1995). Our analysis follows in the footsteps of Kishor and Murthi *et al.,* in particular. However, our work differs from theirs

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[3]Also. at the other end. during old age. '

[4]See Cho'vdhury *et al.* (1982).

[5]Cf. Cameron and Hofvander (1983).

[6]Cf. Black *etal.* (1982),

[7]See Government of India. Census of India 1981. Occasional Paper No. 1 of 1983. "Estimates of Fertility and Child Mortality by Indirect Methods', p. 30. See also footnote 16 on p. 55 below.

in some important respects. First, our focus is on early childhood mortality, while the child mortality variable they use is the probability that a child will die before attaining the age of 5. Second, all three are country-wide studies while we concentrate exclusively on three north Indian states. Third, we include some new test variables. Finally, some of our results are seen to differ significantly from those obtained in Murthi *et al.* and we shall point out these differences at appropriate places[8].

The explanatory variables included in our analysis can be divided into four broad groups. To investigate whether the identified relationships vary significantly between different social groups, we examine the impact of the scheduled caste and tribe status on child mortality. The scheduled castes (SCs) comprise about 16 per cent of India's population, and the scheduled tribes (STs), about 8 per cent. Given the significant size of the SC and ST population, it is important to know the precise impact of the SC and ST status on child mortality in general and female child mortality in particular, especially because minority groups that have been discriminated against for centuries might organise their family structure and gender relationships in ways different from those of the dominant groups. It may also be of some interest in this context to consider the impact of being Muslim on child mortality in the three states being studied because Muslims are also a minority group of some strength in these states.

Second, we examine the role of female autonomy in reducing child mortality. Where women's autonomy is present, the expectation is that the relative survival chances of female children will be higher, and we include a set of explanatory variables that can be interpreted as proxies for female autonomy to see what impact these variables have on child mortality. A third group of explanatory variables included in the analysis is that designed to examine the impact of urbanisation, community services and public health facilities on child survival, while a final group of explanatory variables included is that designed to examine the impact of infrastructural development and indirectly of income on child mortality.

The plan of the rest of the paper is as follows. The next section describes the explanatory variables. Section III presents the regression model. Section IV then discusses the determinants of child mortality in the model, while Section V pinpoints the main factors contributing to the differences between female and male child mortality. Section VI concludes.

The Study Area and Explanatory Variables

Bihar, Madhya Pradesh, and Uttar Pradesh together account for a little over a third of the total population of the country. In 1981, Bihar comprised 31 districts, had a total population of about 70 million, and a population of women ofchildbearing age (15-49)

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[8] The estimation procedure used in our paper, however, is different from that used in Murthi *et al.*

of about 15.5 million. Madhya Pradesh comprised 45 district, had a total population of about 52 million, and a population of women of childbearing age of about 11.5 million;
Uttar Pradesh, India's most populous state, comprised 56 districts, had a total population of about 110 million, and a population of women of childbearing age of about 24 million. The first group of explanatory variables is made up of caste and tribe status, and religion.

Caste and Tribe Status

The scheduled castes (SCs) comprise about 15 per cent of Bihar's population, 14 per cent of Madhya Pradesh's population and 21 per cent of Uttar Pradesh's population. Together, they account for about 39 per cent of the country's total SC population. The scheduled tribes (STs) comprise about 8 per cent of Bihar's population, 23 per cent of Madhya Pradesh's population and less than 1 per cent of Uttar Pradesh's population. Together, they account for about 35 per cent of the country's total ST population.

What effect can we expect SC and ST status to have on child mortality? In her study of the determinants of child mortality in eleven villages in one district in the state of Punjab, Das Gupta (1990) found that high caste status improved child care and child survival independently of income, wealth and education. In her study, however, she distinguished only between high caste and low caste, with low caste including many other caste groups besides SCs. We concentrate instead specifically on the SCs and STs. If, and as mentioned in the introduction, SCs and STs do organise their family structure and gender relationships in ways different from those of the other groups, then it is not impossible for the level of child mortality, especially that of female child mortality, to be lower in the case of SCs and STs than for the rest of the population. At this stage we, therefore, keep an open mind about the likely impact of the SC and ST status on child mortality.

Religion

The effect of religion on fertility has been studied quite extensively in the literature; its possible impact on child mortality has received less attention. Caldwell's (1986) study of superior health achievers among states concluded that ethnic, religious, and cultural differences may help explain why Costa Rica, Sri Lanka and the Indian state of Kerala have such low infant mortality rates (IMRs) relative to their average income levels. A consistent difference between Caldwell's poor and superior health achievers was religion; the former were almost all Muslim states and many of the latter were Buddhist. Similarly, in Malaysia, where Chinese ethnicity is related to lower IMRs, Da Vanzo (1988) has noted that among Malaysia's ethnic groups, the Malays are all Muslim and many of the Chinese are Buddhist. Caldwell attributed much of the Muslim/Buddhist differences to education. In her study, however, Da Vanzo found that the Malayan Chinese had much lower IMRs even when education was controlled. In the present study, we include an explanatory variable in the form of 'the percentage of a district's female population whose head of household is Muslim' to see what impact, if any, being Muslim has on child mortality in our three states. Muslims comprise about 14 per cent ofBihar's population, 5 per cent of Madhya Pradesh's population and 16 per cent of Uttar Pradesh's population.

(ii) The second group of explanatory variables is designed to throw light on the impact of female autonomy. The variables included in this group are literacy, labour-force status, and the ratio of females to males in the population.

Literacy. Education, it is believed, helps women overcome the barriers set by low autonomy, low social and low economic status. The relationship between maternal education and child mortality has been a topic of much discussion in the literature.[9] Considerable evidence from numerous studies—beginning with Caldwell's(1979) study of Nigeria—shows that the maternal education has a positive effect on child health in its own right and nor merely (in its role) as an indicator of either general economic development or socio-economic status. Education strengthens mothers' role in the decision-making process and supplies women with knowledge and skill necessary for raising healthy children. In particular, when water supply and sanitation services at the community level are limited, literate and educated mothers can use their knowledge and skills to protect their children from a contaminated environment outside the home and to promote hygiene and cleanliness within the home. Father's education may also, of course, influence attitudes and thus preferences in choice of consumption goods, including child care services. Accordingly, we include two explanatory variables, 'the percentage of a district's female population that is literate' and 'the percentage of a district's male population that is literate' to see what impact, if any, literacy has on child mortality in our three states. For the 1981 census, a person who could both read and write with understanding in any language was to be considered literate. All children aged four and under were treated as illiterate even if some of them were going to school and might have been able to read or write a few words. In 1981, in Bihar only 13.62 per cent of women were literate, in Madhya Pradesh 15.53 per cent and in Uttar Pradesh 15 per cent. The male literacy was higher at 38.11 per cent in Bihar, 39.49 per cent in Madhya Pradesh and 38.76 per cent in Uttar Pradesh.

Labour-force status. In a recent review of maternal education and child survival in developing countries, Cleland and van Ginneken (1988) noted that most studies have failed to find effects of maternal employment and the increased value of mother's times.

[9]For some recent reviews, see Cleland (1990), Cleland and van Ginneken (1988), and Ware (1984).

There are contradictory effects to consider here. First, outside employment can impair women's ability to ensure the good health of their children by reducing the time available for child-care activities. On the other hand, however, such employment can add to the family incomes, thus possibly having an indirect but positive effect on child survival. For the survival of female children, an additional consideration is that higher levels of female labour-force participation may increase the value attached to the survival of a female child. We examine the impact of the labour force status in our three states in terms of 'the percentage of main workers in the female population of a district'. In the 1981 census, a main worker is defined as a person whose main activity was participating in an economically productive work by her physical or mental activities and who had worked for 183 days or more. Work involved not only actual work but also effective supervision and direction of work. The reference period was the one year preceding the date of enumeration.

Female-male ratio. In Europe and North America, because of the greater survival rates of women, the female-male ratio in the total population averages around 1.05. By contrast, India has an abnormally low female-male ratio of 0.93. However, even in Indian context, it is clear that where women's autonomy is present, the female-male ratio in the population tends to be high.[10] Further, it is possible that a higher proportion of females in the population itself has a positive effect on female autonomy. In such an environment, one would also probably expect child mortality rate to be low, especially if, as has been suggested by the 'female autonomy view', autonomy has a powerful effect on fertility and child mortality. Accordingly, we include in our regression analysis an explanatory variable—the number of females per 1000 males in a district—to determine the impact of the female-male ratio on child mortality. It could, of course, be argued that as the female-male ratio may itself be the result of sex differentials in child mortality, it is improper to use this in the analysis as a proxy for female autonomy. However, the force of this argument is weakened by the fact that, as Kundu and Sahu (1991) have noted, "at the district level, migration is the single most important factor explaining the temporal and cross sectional variations in sex ratio".

(iii) The third group of explanatory variables included in the analysis is that designed to throw light on the effects of urbanisation, community services and public health facilities on child mortality.

Urban-rural residence. Urban areas are, of course, not necessarily healthier places to live than rural areas, but urban residents do tend to have more facilities available to them and have better access to different types of relevant information. Also, in urban areas, women may enjoy greater autonomy than in rural areas, and discriminatory

[10]See Dyson and Moore (1983). Sen (1992;

practices against female children may be less pronounced in urban than in rural areas due to the greater impact of modernising influences in urban areas. One would therefore expect that a district with a higher percentage of its female population living in rural areas will have higher level of child mortality and vice versa."

Availability of safe drinking water and medical facilities. Many diseases are water borne. Thus, the purer and less contaminated the water supply, the less likely people are to become sick and survival chances to be higher. We include two variables 'the percentage of villages in a district having tap water' and 'the percentage of villages in a district having water sources of tube well/handpump' to see what impact, if any, the availability of clean drinking water has on child survival in our three states.

The availability of medical facilities, similarly, should lead to lower level of child mortality and we include an explanatory variable in the form of 'the percentage of villages in a district having a medical amenity' to examine the impact of the availability of medical facilities on child mortality.

(iv) The final group of explanatory variables included in the analysis is that designed to throw light on the effects of infrastructural development and indirectly of income on child mortality:

Pucca roads and availability of electricity. These variables are intended to stand partly as proxies for income. The relationship between income and child mortality, if it exists, will clearly be an indirect one, for income/w *se* cannot reduce child mortality. Thus some statistics for developing countries suggest that there is often only a weak relationship between infant mortality rates and GNP per capita (in parentheses in the following). In 1986, infant mortality rates in China ($300) and Sri Lanka ($400), for example, were less than a quarter of those in Yemen PDR ($470), one-third of those in Gabon ($3,080) and Oman ($4,980) and half those of Jordan ($1,540) and Brazil ($1,810).[12] At the same time, however, a negative relationship between income and child mortality has been established in several household-level studies.[13] The rationale given for this negative relationship is that higher income provides access to better medical

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"The following criteria were adopted for treating a place as urban for the 1981 census:

(a) all statutory towns, i.e., all places with a municipal corporation, municipal board, cantonment board or notified town area etc.;

(b) all other places which satisfy the following criteria:

i. a minimum population of 5,000;

ii. at least, seventy-five per cent of the male working population engaged in non-agricultural (and allied) activities; and

iii. a density of population of at least 400 per square km.

[12]These data are from the World Development Report 1988 (World Bank, 1988).

[13]*See* Casterline. Cooksey and Ismail (1989), Merrick (1985), Thomas, Strauss and Henriques (1990), and Victor. Smith and Vaughan (1986).

care, clothing, shelter, food and sanitation. Unfortunately, in our case, we do not have income data at the level of disaggregation needed to test the relationship between income and child mortality. While per capita income for the states can be easily computed from the available data, such income data are not available for the districts. We have therefore decided to proxy the level of income and income earning opportunities in a district by two variables: 'the percentage of villages in a district having approach by pucca roads (properly surfaced roads)', and 'the percentage of villages in a district having electricity' The availability of motorable feeder roads connecting the villages to the highways is regarded as one of the important indices of development by the Indian authorities. They facilitate communication to nearby towns, help commerce by facilitating the sale of agricultural surplus and import of manufactured goods, and also bring in the impact of outside events through the delivery of such items as newspapers. The importance of electricity as a vital input in both agricultural and industrial production is obvious. In rural areas, in particular, the availability of electricity can stimulate development. Agro-industries can modernise, pumpsets can be converted to electricity to help exploit ground water resources, and village and cottage industries can be mechanised. With the availability of electricity, such services as telephone, radio, television, and cinema, can also be provided. Both pucca roads and the availability of electricity are important elements in the process of modernisation and important indicators of both income and income earning opportunities. Accordingly, we examine the impact of 'pucca roads' and 'availability of electricity' on child mortality. We must, of course, be careful not to try to read too much into our results because these variables are proxies. In the absence of more specific income data, however, they will give us a broad idea of the effect of economic development and income on child mortality.

Data and the Model

Data for the analysis comes from the 1981 census. Full references for all data sources are given in Appendix 1. The states of Bihar, Madhya Pradesh, and Uttar Pradesh together comprise 132 districts and observations were gathered on a district-by-district basis. However, a weakness of our data set is that the data for five of the variables used, viz., 'the percentage of villages in a district having tap water', 'the percentage of villages in a district having water sources of tube well/handpump', 'the percentage of villages in a district having a medical amenity', 'the percentage of villages in a district having approach by pucca roads (proper surfaced roads), and 'the percentage of villages in a district having electricity', while published as part of the 1981 census data set by the Government of India are, in fact, based on data originally collected for District Census Handbook Series of 1971 census. A further weakness is that, during the decade 1971-81, a number of new districts were formed by splitting some of the existing ones, and for these new districts—18 out of 132 in the case of our three states

—no data are provided for these five variables. Accordingly, in the following analysis we have assumed that a new district has the same availability of these facilities as the district of which it was previously a part.[14] These limitations of our data should be borne in mind while evaluating the results of the paper.

As mentioned in the introduction, our child mortality variable is the number of deaths per thousand live births by age 2.[15] The census data enable us to use three dependent variables, as the data are given for male and female children separately and for all children together. In our discussions below, we proceed as follows. First, we shall regress the mortality variable for all children, MOR, on our explanatory variables and discuss the results of this regression in the next section. We shall then in Section V regress the mortality variable for male children, MMOR, and the mortality variable for female children, FMOR, on our explanatory variables, respectively. An F-test will be carried out to see whether the coefficients of the explanatory variables are the same for male and female child mortality. If they are not, a new variable DIFF (defined as FMOR – MMOR) will be formed and regressed on the same explanatory variables, thus allowing us to pinpoint the main factors contributing to the differences between female and male child mortality.

The first model we estimate using OLS, therefore, is the following:

$$\begin{aligned}\text{MOR} = {} & a_0 + a_1\text{PSC} + a_2\text{PST} + a_3\text{PM} + a_4\text{PFMN} + a_5\text{PFLIT} \\ & + a_6\text{PMLIT} + a_7\text{PFEM} + a_8\text{PRUP} + a_9\text{PTAPW} + a_{10}\text{PWELL} \\ & + a_{11}\text{PMED} + a_{12}\text{PPUC} + a_{13}\text{PELEC} + b_1D1 + b_2D2 + e_1.\end{aligned}$$

Definitions of independent variables are presented in Table 1. Two dummy variables have been introduced, $D1$ for the state of Bihar and $D2$ for Madhya Pradesh (Uttar Pradesh being the reference state), e_1 is an error term, assumed to follow a 'normal' distribution, with zero mean and constant variance.

Results of the MOR Regression

The results of the regression equation with MOR as the dependent variable are presented in Table 2. The variables PSC, PM, PMLIT, PWELL, PPUC and PELEC were omitted from the final equation as their coefficients were found not to be significantly different from zero.[16] All of the included variables, with the exception of PFMN (the percentage of a district's female population, aged 15-49, that is categorised

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[14]Details regarding formation of new districts are given in Census of India, 1981, Series I-India, Part II-A[i], General Population Tables, Appendices 1 and 2, and in Census Atlas, India, 1981.

[15]We use 'graduated' estimates of Q(2) from Government of India (1988). Estimates of Q values were graduated to remove inconsistencies between the estimated probabilities of death at different ages. Government of India (1988) provides a discussion of the procedures used for estimation of infant and child mortality values from the data on children ever born and children surviving.

[16]Appendix 2 provides the regression with all the variables.

as main workers), are significant at the 5% level of testing. A plot of the residuals against the predicted values revealed no obvious hetroskedasticity.

TABLE 1 : VARIABLE DEFINITIONS

Variable	*Definitions*
PSC	The percentage of a district's female population belonging to scheduled castes
PST	The percentage of a district's female population belonging to scheduled tribes
PM	The percentage of a district's female population whose head of household's religion is Islam
PFMN	The percentage of a district's female population, aged 15-49, that is categorised as main workers
PFLIT	The percentage of a district's female population that is literate
PMLIT	The percentage of a district's male population that is literate
PFEM	The number of females per 1000 males in a district
PRUP	The percentage of a district's female population living in rural areas
PTAPW	The percentage of villages in a district having tap water
PWELL	The percentage of villages in a district having water sources of tube well/handpumps
PMED	The percentage of villages in a district having a medical amenity
PPUC	The percentage of villages in a district having approach by pucca roads (proper surfaced roads)
PELEC	The percentage of villages in a district having electricity

TABLE 2 : REGRESSION ANALYSIS OF CHILD MORTALITY (MOR)

	Linear Regression Regressand MOR N = 132		
Variable	*Regr. Coeff.*	*Std. Dev*	*t.*
constant	347.0852	34.9928	9.919
01	-21.3959	5.8923	-3.631
02	30.0948	5.0642	5.943
PST	-0.4021	0.1238	-3.248
PFMN	0.2559	0.1654	1.547
PFLIT	-1.0076	0.4451	- 2.264
PFEM	-0.2719	0.0400	-6.806
PRUP	0.8623	0.2502	3.446
PTAPW	-0.6475	0.2894	-2.237
PMED	-3.2267	1.0914	-2.956

Variance of regressand MOR = 1127.1124
Residual variance = 312.3444
R^2 = 0.7229

The *t*-value of-3.248 for the PST variable shows that the scheduled tribe status has a negative effect on child mortality. The coefficient of the scheduled caste variable, PSC, by contrast, was found to be statistically insignificant and excluded in the initial stages. We also found the coefficient of the PM (percentage of Muslims) variable not significantly different from zero and excluded it in the initial stages. These results then raise the question of why the ST status is associated with lower level of child mortality. Do the STs have more egalitarian gender relations within and outside the households and this has an effect in reducing child mortality? The STs are outside the Hindu caste system, and it is not inconceivable that they would organise their family structure and gender relationships differently from other groups. The limited sociological and anthropological evidence available appears not to dispute the view that, in general, the ST women enjoy greater autonomy.[17] Clearly, this would appear to be an important area for future research.[18]

Of our female autonomy variables, PFLIT (the percentage of a district's female population that is literate) and PFEM (the number of females per 1000 males in a district) are each seen to have a negative effect on child mortality; PFLIT, in particular, with a coefficient of-1.0076. The female labour force participation variable, PFMN, however, has a positive effect on child mortality, though the effect is not statistically significant. The male literacy variable, PMLIT, as we noted, was found to be statistically insignificant and excluded in the initial stages.

So far as the effects of urbanisation, community services and public health facilities are concerned, these go in expected directions. PRUP (the percentage of district's female population living in rural areas) is seen to have a positive effect on child mortality, thus indirectly showing that an increased share of urban female to the total female population leads to a reduction in child mortality. PTAPW (the percentage of villages in a district having tap water) and PMED (the percentage of villages in a district having a medical amenity) are each seen to have a negative effect on child mortality. PMED, in particular, is seen to have a very substantial negative effect with a coefficient of -3.2267.

Our infrastructure variables and proxies for income and income-earning opportunities in a district, PPUC (the percentage of villages in a district having approach by 'pucca roads') and PELEC (the percentage of villages in a district having electricity) were both found to be statistically insignificant and excluded in the initial stages.

Finally, the level of significance of dummy variables and the signs of coefficients show how child mortality in Bihar and Madhya Pradesh differs from that in the reference state, Uttar Pradesh. These results for the state dummies show that the differences in child mortality in the three states cannot be explained entirely in terms of the variables included in the regression. India is a country with diverse characteristics and even within states otherwise perceived to be fairly similar, there usually exist slight differences in

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[17]See S. Banerjee, *Impact of Industrialisation on the Tribal Population ofJharia-Ranigunge Coal Field Areas* (Calcutta: Anthropological Survey of India, 1981); S. L. Kayastha, *The Himalayan Beas Basin* (Varanasi:
Banaras Hindu University Press, 1964); I. M. Simon, *Meghalaya* (New Delhi: Ministry of Information and Broadcasting, 1980).

[18]In any such research, one would also have to allow for the possibility that the observed inverse relationship between scheduled tribe population and child mortality could, as the anonymous referee suggested, be "indicative of problems in conducting the census and underreporting of child deaths in tribal areas".

cultural norms and values, and these can have differing demographic consequences. Unfortunately, data on measures such as dowry and bride price practices, precise form of joint family systems, and inheritance patterns are not available through census or any other macro-data sources.

Factors Contributing to the Differences between Female and Male Child Mortality

Our aim in this section is to pinpoint the factors which contribute to the differences between female and male child mortality. In addition to reproducing the results of the regression equation with MOR as the dependent variable to facilitate comparison, Table 3 presents four new least square estimates. In equations 2 and 3, MMOR (male child mortality) and FMOR (female child mortality) are the dependent variables, respectively. The explanatory variables are the ones included in the final equation when MOR was the dependent variable. To test whether the factors for male and female child mortality are jointly significantly different from each other, MMOR and FMOR observations were combined to create a new dependent variable, MFMOR, and regressed on the common set of variables (equation 4). To test the null $H_0 : [\tilde{B}] = [\tilde{A}]$ vs $H_A : [\tilde{B}] \neq [\tilde{A}]$ where B is vector of MMOR coefficients and A is vector of FMOR coefficients, an F-test was carried out. The F-statistic was 3.547 which is greater than the critical value of $F^{10}_{120} = 2.157$ and H_0 was accordingly rejected. To identify which factors contribute most individually to the differences between female and male child mortality, the variable DIFF (defined as FMOR-MMOR) was then formed and regressed on the same explanatory variables (equation 5). The significant t-values (denoted by asterisks) in equation 5 thus pinpoint the main factors contributing to the differences between female and male child mortality.

The t-value of – 2.9077 for the PST variable in equation 5 shows that the scheduled tribe status has a negative effect on DIFF, our measure of the female disadvantage in child survival. PST has a negative effect on both male and female child mortality, but the effect on female child mortality is larger.

Of our female autonomy variables, PFEM (the number of females per 1000 males in a district) has a small negative effect on DIFF with a coefficient of – 0.0930. PFEM has a negative effect on *both* male and female child mortality, but the effect on female child mortality is larger.

The female literacy variable, PFLIT, is also associated with lower levels of both male and female child mortality, but in this case the effect is significant only in the case of male children. Its effect on DIFF is positive, though statistically insignificant. These results for the PFLIT variable would seem to suggest that while female literacy has a positive effect on the knowledge and skill necessary for raising healthy children, the culture of discrimination against female children in the three states being studied is currently too deeply rooted to be dislodged by female literacy. Our results for female literacy, it may be noted, differ from those obtained in Murthi *et al.* (1995) where they found female literacy to have a negative (and statistically significant) effect on female disadvantage in child survival. Our results, however, are in accord with findings in Das Gupta (1987) and Bhuiya and Streatfield (1991).

TABLE 3 : REGRESSION ANALYSIS OF DIFFERENCES BETWEEN FEMALE AND MALE CHILD MORTALITY

Independent Variable	*Dependent Variable*				
	(1) MOR	*(2) MMOR*	*(3) FMOR*	*(4) MFMOR*	*(5) DIFF*
Constant	347.0852	313.2092	365.8226	339.5159	52.6134
	(9.919)	(8.283)	(9.632)	(12.079)	(2.0627)
Dl	-21.3959	-19.3428	-23.4164	-21.3796	-4.0736
	(-3.631)	(-3.038)	(-3.662)	(-4.5172)	(- 0.9484)
D2	30.0948	29.4700	28.3625	28.9162	-1.1074
	(5.943)	(5.385)	(5.160)	(7.1086)	(- 0.3000)
PST	-0.4021	-0.2770	-0.5393	-0.4082	-0.2624
	(-3.248)	(-2.071)	(-4.014)	(-4.1049)	(-2.9077)*
PFMN	0.2559	0.3781	0.1639	0.2710	-0.2142
	(1.547)	(2.115)	(0.913)	(2.0392)	(-1.7764)**
PFLIT	-1.0076	-1.1993	-0.7645	-0.9819	0.4349
	(- 2.264)	(- 2.494)	(- 1.583)	(- 2.7466)	(1.3404)
PFEM	-0.2719	-0.2169	-0.3099	-0.2634	-0.0930
	(-6.806)	(- 5.023)	(-7.146)	(- 8.2060)	(-3.1930)*
PRUP	0.8623	0.6130	1.0820	0.8475	0.4689
	(3.446)	(2.267)	(3,984)	(4.2165)	(2.5708)*
PTAPW	-0.6475	-0.4280	-0.9388	-0.6834	-0.5108
	(-2.237)	(-1.369)	(-2.989)	(- 2.9397)	(-2.4212)*
PMED	-3.2267	-3.6066	-2.7434	-3.1750	0.8631
	(-2.956)	(-3.058)	(-2.316)	(-3.6215)	(1.0849)
N	132	132	132	264	132
Variance ot'regressand	1127.1124	1098.0115	1258.8020	1188.2050	295.6856
Residual variance	312.3444	364.7170	367.9172	403.0520	165.9616
R^2	0.7229	0.6679	0.7077	0.6608	0.4387

Notes: *t* - values in brackets.
* Significant at the 5 per cent level, using a two-tailed test.
** Significant at the 10 per cent level.

The female labour force participation variable, PFMN. is associated with *higher* levels of both male and female child mortality, but the effect is significant only in the case of male children. Its effect on DIFF is negative, significant at the 10% level of testing. The female labour force participation is thus seen to lead to an increase in the relative survival chances of female children, but mainly via an increase in male child mortality. This result is in accord with findings in Rosezweig and Schultz (1982),Kishore (1993), and Murthi *et al.* (1995). We offer the following as an explanation of our result:

outside employment reduces the time available to women for child-care activities and this leads to an increase in male child mortality; working women, however, do not discriminate against female children; and female children, because of their natural biological advantages, survive better relative to male children. And it would appear that the effects via the reduction in time available for child-care activities outweigh any indirect but positive effects increased family incomes resulting from gainful employment by women may have on child survival. It is, of course, possible that, over time and with economic development, wages and earnings from outside employment may increase substantially relative to the current level of earnings, and any indirect but positive effects of increased family incomes on child survival may then become dominant. But, at this stage of development, this is clearly not the case.

So far as the effects of urbanisation, community services and public health facilities are concerned, PRUP (the percentage of a district's female population living in rural areas) is seen to have a positive effect on DIFF, showing, in other words, that an increased share of urban female to the total female population leads to a reduction in female disadvantage in child survival. A part of the explanation of this result is likely to be that the culture of discrimination against female children is less pronounced in urban than in rural areas. (This result again is different from that in Murthi *et al.* where they found their measure of urbanisation amplifies rather than reduces female disadvantage in child survival.) PTAPW (the percentage of villages in a district having tap water) is seen to have a negative effect on DIFF with a *t* -value of-2.4212. PTAPW is associated with lower levels of both male and female child mortality, but the effect is significant only in the case of female children. As noted earlier, male children typically receive more care and attention from parents; therefore, the availability of safe drinking water has a much greater impact on improving the survival chances of female relative to male children. PMED (the percentage of villages in a district having a medical amenity) is also associated with lower levels of both male and female child mortality. However, its effect on DIFF, while positive, is statistically insignificant.

Concluding Remarks

In this paper we have examined some of the determinants of early childhood mortality in three states in northern India. Our results show that the scheduled tribe status, a high ratio of females to males in the population, availability of safe drinking water, and increased share of urban female to the total female population are each associated with lower levels of both male and female child mortality, and increased relative survival chances of female children. Female labour-force participation is also associated with increased relative survival chances of female children, but, in this case, mainly via an increase in male child mortality. Female literacy and availability of medical facilities, on the other hand, are associated with increased female disadvantage in child survival, though these effects are not statistically significant.

These results suggest that a multi-pronged strategy would be needed to reduce child mortality and gender bias in child survival in our three states. Urbanisation and provision of safe drinking water can be expected to increase over time. However, it is worth noting that our results for the PPUC (the percentage of villages in a district having approach by 'pucca roads') and PELEC (the percentage of villages in a district having electricity) variables suggest that infrastructural development which do not directly affect the variables with proximate influences on child survival, such as the provision of safe drinking water and availability of medical facilities, etc., may have little or no effect in reducing child mortality. Female labour force participation can also be expected to increase over time. However, if female labour-force participation is not to lead to an increase in male child mortality, we need to understand more fully the reason why female labour force participation is associated with increased male child mortality. If, as we have suggested above, this is due to a reduction in the time available for child-care activities, then clearly help needs to be provided to working mothers. Here targeted visits by health visitors from the community health centres may be helpful. Also, so far as the provision of medical facilities are concerned, it is important to ensure that they meet the needs of female children as much as those of the male children. But, when all is said and done, the important challenge must be to bring about a change in the perception of the relative value of female children, for if this does not change, then, irrespective of the policies pursued, many parents may still find ways of discriminating against female children.

References

Banerjee, S.. 1981. *Impact a/Industrialisation on the Tribal Population ofJharia-Ranigunge Coal Field Areas.* Calcutta: Anthropological Survey of India. Bhuiya, A. and Streatfield, K., 1991, Mothers' education and survival of female children in a rural area of Bangladesh. *Population Studies,* **45.** Black, R. E., Brown, K. H., Becker, S., Alim, A. R. M. A. and Merson, M. H., 1982, Contamination of weaning foods and transmission ofenterotoxic *Escherichia coli* diarrhoea in children in rural Bangladesh. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* 76(2) : 259-64. Caldwell. J. C., 1979. Education as a factor in mortality decline: An examination ofNigerian data. *Population Studies,* 33 •.395-413. Caldwell. .1. C.. 1986, Routes to low mortality in poor countries. *Population and Development Review,* **12** : 171-220.

Cameron. M. and I lofvander, Y., 1983, *Manual of Feeding Infants and Children,* 3rd ed. Delhi and Nairobi. Casterline. J. B.. Cooksey, E. C. and Ismail, A. F. E., 1989, Household income and child survival in Egypt. *Demography,* **26** : 15-35.

Chowdhury, M. K.., Razzaque, A., Becker, S., Sarder, A. M. and D'Souza, S., 1982, Demographic Surveillance System - Matlab, vol. 9, Vital Events and Migration - 1979 (ICDDR, B Dhaka). Cleland, .1. G. and van Ginneken, J. K. (1988): 'Maternal education and child survival in developing countries: the search for pathways of influence'. *Social Science and* Medicine, 27, pp. 1357-68. Cleland, J. G., 1990, Maternal Education and Child Survival: Further Evidence and Explanations. *In:* J. Caldwell, S. Findley, P. Caldwell, G. Santow, W. Cosford, J. Braed and Broers-Freeman (eds.), *What We Know about Health Transition: The Cultural, Social and Behavioural Determinants of Health,* Vol. 2, pp. 400-19. Canberra: Australian National University. Das Gupta, M.. 1987, Selective discrimination against female children in rural Punjab. *Population and Development Review,* 13. Das Gupta, M., 1990, Death clustering, mothers' education and the determinants of child mortality in rural Punjab, India. *Population Studies,* **44** : 489-505. DaVanzo,.!., 1988, Infant mortality and socio-economic development: Evidence from Malaysian household data. *Demography,* 25(4) : 581-595. Dyson, T. and Moore, M., 1983, On kinship structure, female autonomy, and demographic behaviour in India. *Population and Development Review,* 9(1) : 35-60. Kayastha, S. L., 1964, *The Himalayan Beas Basin: A Study in Habitat, Economy and Society.* Varanasi: Banaras Hindu University Press. Kishor, S., 1993. "May God Give Sons to All": Gender and child mortality in India. *American Sociological Review,* 58. Koeing. A. and D'Souza, S., 1986, Sex differences in childhood mortality in rural Bangladesh. *Social Science and Medicine,* 22(1) : 15-22.

Kolenda, P., 1987, *Regional Differences in Family Structure in India.* Jaipur: Rawat Publications. Kundu, A. and Sahu, M., 1991, Variation in sex ratio: Development implications. *Economic and Political Weekly,* October 12. Merrick, T. W., 1985, The effect of piped water on early childhood mortality in urban Brazil, 1970 to 1976, *Demography,* 22 : 1-23. Mosley, W. H. and Chen, L. C., 1984, An Analytical Framework for the Study of Child Survival in Developing Countries. *In:* W. H. Mosley and L. C. Chen (eds.). Child Survival: Strategies for Research, pp. 25-48. Supplement to *Population~wid, Development Review,* **10.** Murthi, M., Guio, A. and Dreze, J., 1995, Mortality,- fertility, and gender bias in India: A district-level analysis. *Population and Development Review,* 21(4) : 745-82. Rosenzweig, M. and Schultz, T. P., 1982, Market opportunities, genetic endowments, and intrafamily resource distribution: Child survival in rural India. *American Economic Review,* 72. Sen, G., 1992, Social Needs and Public Accountability: The Case ofKerala. *In:* Wuyts, M., MacKintosh, M. and Hewitt, T. (eds.), *Development Policy and Public Action,* pp. 253-277. Oxford: Oxford University Press.

Simon, I. M., 1980, *Meghalaya.* New Delhi: Publications Division, Ministry of Information and Broadcasting. Thomas, D., Strauss, J., and Henriques, M. H., 1990, Child survival, height for age and household characteristics in Brazil. *Journal of Development Economics,* **33** : 197-234. Ware, H., 1984, Effects of Maternal Education, Women's Roles, and Child Care on Child Mortality. *In:* W. H. Mosley and L. C. Chen (eds.), *Child Survival: Strategies for Research.* Supplement to *Population and Development Review,* **10.** Victora, C. G., Smith, P. 0. and Vaughan, J. P., 1986, Social and environmental influences on child mortality in Brazil: Logistic regression analysis from census files. *Journal ofBiosocial Science,* **18** : 87-101. World Bank, 1988, World Development Report 1988.

Appendix 1

Data Sources

Child Mortality Data (MOR, FMOR, MMOR): *Census of India 1981*. Occasional Paper No. 5, 'Child mortality estimates of India'. 1988. Scheduled Castes (PSC) and Scheduled Tribes (PST): *Census of India 1981*. Series, 1, India. Paper 2, 'General population and population of scheduled castes and scheduled tribes', 1984.

Religion (PM): *Census of India 1981*. Series 1, India. Paper 3, 'Household population by religion of head of household',-1985. Labour-Force Status (PFMN): *Census of India 1981*. Series 4 (Bihar), Series 11 (Madhya Pradesh), and Series 22 (Uttar Pradesh). Part III (A&B) Volume I, General Economic Tables. Literacy (PFLIT, PMLIT) and Females per 1000 males (PFEM): *Census of India 1981*. Series 4 (Bihar),

Series 11 (Madhya Pradesh), and Series 22 (Uttar Pradesh). Part II (A&B), General Population Tables. Urban-Rural Residence (PRUP): *Census of India 1981*. Series 1, India. Part II, General Population Tables, 1985. Drinking Water (PTAPW, PWELL), Medical Facilities (PMED), Pucca Roads (PPUC), and Availability of Electricity (PELEC): *Census of India 1981*. Occasional Paper No. 1, 'Study on distribution ofinfrastructural facilities in different regions and levels and trends of urbanization', 1986.

Appendix 2

Variable	*Linear Regression* *Regressand MOR N = 132* *Regr. Coeff.*	*Std. Dev.*	
Constant	315.1100	47.3944	6.649
D	-22.1385	6.5102	-3.401
D1	31.3709	5.8288	5.382
PSC	0.2751	0.4697	0.586
PST	-0.3151	0.1730	-1.822
PM	0.2643	0.3104	0.851
PFMN	0.2206	0.1855	1.189
PFLIT	-1.0667	0.5621	-1.898
PMLIT	0.1097	0.1811	0.606
PFEM	-0.2559	0.0455	-5.623
PRUP	0.9226	0.2847	3.241
PWELL	-0.0477	0.0918	-0.520
PTAPW	-0.5888	0,3116	- 1.890
PMED	-3.0183	1.1804	-2.557
PPUC	0.0172	0.2712	0.063
PELEC	0.0571	0.1545	0.369
Variance of regressand MOR = 1127.1124			
Residual variance = 342.6253			
R^2= 0.712			