Maternal education, female labour force participation and child mortality: evidence from the Indian census*

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Abstract

The objective of this paper is to examine how child mortality changes with different levels of maternal education and to quantify the impact of maternal education and female labour force participation. Child mortality gradients, according to years of education, are rather steep at the primary education level for both male and female children. In post-primary stages of education incremental gains in mortality reduction are almost non-existent. Child mortality is inversely related to both maternal education and female labour force participation but disaggregated analysis showed that female labour force participation has no impact on child mortality among females with fewer than seven years of education. The relative impact of maternal education on child mortality is three times stronger than that of female labour force participation. Excess female child mortality prevailing in certain parts of India also has an inverse relationship with the length of mothers' education, and female labour force participation. Female labour force participation has a stronger influence on excess female child mortality than on absolute child mortality. The evidence in the paper lends support to Bardhan's hypothesis on excess female child mortality.

Introduction

This paper seeks to document the association between the length of mother's education and child mortality q(5) as revealed in the Indian census data. The paper focuses mainly on how the strength of the inverse relationship between child mortality rates and mother's education varies with the duration of that education (henceforth referred to as the mortality gradient) in different states of India. It also examines the impact on child mortality of female labour force participation at different levels of education. The paper also examines the related question of excess female child mortality and the levels associated with different levels of maternal education and the female labour force participation at those levels thereby testing the validity of Bardhan's hypothesis on the relationship between the excess female child mortality rate and female labour force participation rate (Bardhan 1988).

I first review the existing evidence on the relationship between maternal education and child mortality. Next I present data on child mortality for different states of India and analyse the interstate differences in the level of mortality and relative mortality risks at different stages of maternal education. Finally, I examine the different impacts of the length of mother's education and female labour force participation and discuss the issue of excess female mortality.

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Female education, labour force participation and child mortality

Overwhelming micro- and macro-level evidence suggests a negative association between maternal education and child mortality (see Cochrane, Leslie and O'Hara 1980; Cleland and van Ginneken 1988; Cleland 1990). It may be useful to recapitulate the major routes of causation identified by the earlier studies before attempting to review the possible influence of female labour force participation on child mortality. The surveys indicate that the way in which maternal education influences child mortality is fairly complex and has three different facets. First, the observed relationship between maternal education and child mortality could partly be due to certain independent factors associated with education, such as different fertility behaviour and higher economic and social status, which reduce mortality risk. Secondly, education itself can have an independent influence on child mortality by promoting better child-care practices at home and more intensive use of preventive and curative health care. Finally, certain extraneous factors may either enhance or suppress the overall strength of the relationship between child health and maternal education. What is observed is an amalgam of these three routes of causation.

Part of the observed association between maternal education and child mortality may be due to certain independent factors connected with educated mothers. Different fertility behaviour and better socioeconomic status are often cited as important associated factors. The fertility behaviour of educated mothers minimizes the child mortality risk associated with birth as they tend to have children when they are neither too young nor too old; they also may be better at spacing their births. All these factors are known to reduce the child mortality risk. Similarly, with higher education, women are likely to have higher incomes and better social status either through their direct participation in the labour market or through the higher probability of being married to wealthier men. Studies using World Fertility Survey data clearly show that education has a strong favourable effect on child mortality independent of the influence of different fertility behaviour and better socioeconomic status (Hobcraft, McDonald and Rutstein 1984; Cleland and van Ginneken 1988).

Mother's education affects child survival in two main ways: through better child-care practices and higher standards of hygiene at home, and more rational and greater use of preventive and curative medical services (Mosley and Chen 1984; Cleland and van Ginneken 1988). The first way is known as 'the household production of health' in the health-economics literature (Grossman 1972). It is hypothesized that the effectiveness with which basic child-health-promoting inputs, such as personal hygiene, prenatal and postnatal care, and feeding practices are combined, improves with the level of education of the mother. It is also argued that education gives greater independence to the mother which will help her take child-health-promoting decisions without any hindrance (Caldwell 1986). The second important pathway of influence is through the superior health-seeking behaviour of educated mothers. There is considerable empirical evidence, from the less developed countries in all parts of the world, that the propensity to use preventive and curative health services for self and children is high among educated mothers. Educated mothers are also found to have superior knowledge of diseases and they seek timely treatment more often (see Cleland and van Ginneken 1988). However, some studies deny superior health-care knowledge on the part of educated mothers, particularly among those with lower levels of education (Caldwell, Reddy and Caldwell 1983; Lindenbaum, Chakraborty and Elias 1985). To sum up, the available evidence indicates a strong and independent association between mother's education and child health, but the exact mechanisms through which it operates are not yet clear.

A number of external factors influence the strength of association between maternal education and child mortality. The overall strength of the association is greater among children in the age group three to seven years than among infants (Cleland and van Ginneken 1988), because biological factors rather than child-care practices, including breastfeeding, play an important role in determining mortality among younger children. As they grow, the influence on health of environmental factors and child-care practices becomes important. Further, the influence on mortality differentials of the improved availability of basic public health facilities such as clean drinking water, good primary health facilities and sanitary disposal of human and animal wastes is found to be indeterminate (Cleland and van Ginneken 1988). In some societies, notably Costa Rica, China and Sri Lanka, improved access to better public health facilities has reduced the differences in child mortality rates between well educated and poorly educated mothers; but in many developing countries the mortality differentials due to maternal education do not change appreciably even after some improvement in public-health facilities have become more available. Thus, the supportive role of public-health infrastructure in strengthening the influence of maternal education on child health is not clear.

The relationship between female labour force participation and child mortality is even more complex. On the one hand, labour force participation can have an adverse impact on child health as the child will not get full attention from its mother and may even forgo the benefits of breastfeeding. This will probably happen in those families where because of poverty the mother must participate in the labour market soon after delivery. On the other hand, the mother's work force participation will enhance the family income which will in turn have a positive impact on child nutrition and health. Thus, the eventual outcome of female labour force participation on child mortality depends on the relative influence of these two routes of causation.

The empirical evidence on this issue also reflects this conflict. Many of the international studies cited in Dwyer and Bruce (1988), suggest an inverse relationship between child health and female labour force participation. Some studies suggest that, after controlling for family income, children are better fed and looked after in households where women work. In such households, a larger proportion of the family's earnings are expended on child care and related activities. A study by Kumar[1] (1977) in Kerala indicated a positive association between female earnings and child nutrition, but a similar association between paternal income and child nutrition was not found. Another study of poor households in Kerala and Tamil Nadu categorically states that

> eliminating female work, even if it means some improvement in male employment, would have a very negative effect, not only on the females themselves, but also on the families they support (Mencher 1988:119).

On the contrary, some studies indicate a direct relationship between child mortality and labour force participation (Hobcraft et al. 1984; Basu and Basu 1991). For instance, a recent Indian study reported an adverse impact on child mortality of the mother's participation in the labour force (Basu and Basu 1991). The authors trace this to the inability of working mothers to give adequate care to infants and to breastfeed them properly.

Mortality gradient

As noted in the preceding section, the mortality level changes with the length of maternal education. How it changes is essentially an empirical question. A theoretical answer is difficult to find as the gradient is an outcome of the interaction between the length of mothers' education and a complex set of socioeconomic factors. This section presents empirical evidence on how child mortality q(5) has changed with mothers' education in different states of India, and how the relative risk of mortality and mortality gradient have changed.

1 As cited in Dwyer and Bruce (1988)

The study uses child mortality estimates based on the 1981 census data (India 1988). Other sources of information have serious drawbacks. India's civil registration system suffers from abysmally low coverage. Fairly accurate annual estimates of births and deaths at the state level are obtained through the Sample Registration System, but the sample size on which these estimates are based does not permit any further disaggregation of data. The Census of India gives disaggregated estimates of child mortality (India 1988) and the female labour force participation rate[2] (India 1987a) in different states according to five different levels of mother's education. The data on child mortality have been derived using the 'indirect estimation method' suggested by Brass, which is known to yield fairly accurate estimates (India 1988:1). Under this method, the child mortality estimates have been made using the 1981 census information on 'children ever born' and 'children surviving' cross-classified by the age of the mother. The mortality estimates for four age groups, q(1), q(2), q(3) and q(5), by five different levels of mother's education are available. The educational levels are: illiterates, literates and up to middle school (0–7 years of education); middle school and up to matriculation (7-10 years); matriculates and up to graduation (10-15 years); and graduates and above (15-17 years). The midpoints of the duration of education of the last four classes indicated above, namely 3.5 years, 8.5 years, 12.5 years and 16 years respectively, have been taken as the average length of education. Broadly speaking, the first two categories of education impart basic skills and in the latter two categories specific job-related skills are acquired.

The average level of child mortality, the absolute level of mortality among children of illiterate mothers, and the relative mortality risk (relative to the child mortality risk of illiterate mothers) among children of educated mothers of varying lengths of education are given in Table 1. The information is presented by state and sex of the child. The relative mortality risk in Table 1 refers to the risk of mortality among children of educated mothers relative to the child mortality of illiterate mothers. Important inferences may be drawn from this information. First, rates of child mortality vary widely between states. For example, the average female child mortality varied from 76 per thousand in Kerala to as high as 208 per thousand in Uttar Pradesh. Secondly, the interstate variation in the mortality of male children is lower than that of female children. This is clearly indicated by the smaller coefficient of variation. Larger interstate differences in female child mortality were caused mainly by excess female child mortality in all major states of the northern region of the country. Thirdly, child mortality among illiterate mothers was fairly high even in the low-mortality states. For instance, the absolute difference in female child mortality of illiterate mothers in Kerala and Bihar was about ten per thousand, but the difference in the overall mortality was 46 per thousand. Fourthly, dispersion of relative child mortality rates among mothers with one to seven years and seven to ten years of education is very similar. Roughly, more than two-thirds of states fall within a band of eight to 12 per cent of either side of the mean mortality of each stage of education. Educated mothers with fewer than ten years of education form anywhere between 85 and 95 per cent of the literate female population in different states. This means, that interstate variation in mortality differences is influenced in an important way also by the manner in which a given state's population is distributed across different stages of education; it is usually felt that the differences arise mainly through interstate differences in mortality rates across different educational classes.

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2 The census gives the number of women main workers by age groups for five different educational classes, the same educational classes for which child mortality data are available. The study considered only those in the age groups of 15 years and above who were main workers. The main worker is defined as 'a person whose main activity was participation in any economically productive work by his physical or mental activities and who had worked for 183 days or more' (India 1987a:5). The female labour force participation rates have been calculated from these data.

The major finding of the analysis, however, is the appreciable decline in the average mortality risk associated with increase in the level of maternal education. The children of mothers with one to seven years of education faced a relative risk of about two-thirds of the child mortality risk of illiterate mothers. The relative child mortality risk then drops to one third of that of illiterate mothers with about ten to 15 years of education and to one-fifth with higher education of duration exceeding 15 years. This pattern is roughly the same for both male and female children. Although the interstate variation in relative risks is not high, because of considerable variation in absolute levels of mortality, the quantum of reduction in mortality for additional years of education may vary substantially across states.

To examine this issue and also to see how mortality gradients change across different stages of education, the decline in child mortality for an additional year of maternal education was computed for each level of education (Table 2). This was done by dividing the difference between the child mortality of an educational class and the class preceding it by the difference in the average duration of education of the respective classes. For example, the difference in the male child mortality rate of mothers with an average education of 3.5 and 8.5 years duration is 38 in Andhra Pradesh. This means that movement from an average education of 3.5 years to 8.5 years (five years of additional education) results in a marginal decline in mortality by 7.60 (38/5) per additional year of education (see Table 2). This is evidently a rough method but can serve as a first approximation.

Table 2
Decline in the child mortality rate for an additional year of maternal education

	Decline[a] – male child Years of mothers' education				Decline[a] – female child Years of mothers' education			
	1–7	**7–10**	**10–15**	**>15**	**1–7**	**7–10**	**10–15**	**>15**
Madhya Pradesh	23.14	9.00	4.75	4.00	25.71	10.60	5.75	6.29
Uttar Pradesh	19.43	5.60	6.50	4.86	23.43	9.20	6.25	6.57
Rajasthan	19.14	6.20	4.75	6.00	22.86	8.60	6.25	2.29
Maharashtra	15.71	7.60	7.75	5.71	17.14	8.00	8.25	4.00
Himachal Pradesh	15.43	4.60	2.75	–	14.29	5.40	5.00	–
Karnataka	14.29	6.20	7.00	7.43	16.57	6.20	6.50	6.86
Jammu & Kashmir	14.29	3.60	3.50	2.86	14.57	3.00	4.75	4.29
Gujarat	14.00	5.00	4.50	4.86	18.29	1.80	9.25	5.14
Andhra Pradesh	13.71	7.60	4.75	5.14	15.14	7.00	4.50	4.29
Tamil Nadu	11.71	6.00	6.75	6.57	13.71	6.40	5.75	6.57
West Bengal	11.71	8.60	5.25	2.57	12.86	9.40	3.75	3.14
Kerala	11.71	4.80	5.75	–	10.86	5.60	4.25	–
Meghalaya	11.43	8.40	8.00	–	12.57	7.80	8.00	–
Nagaland	11.14	5.40	2.00	–	12.00	5.40	-0.75	–
Orissa	11.14	12.40	9.50	6.00	10.86	12.20	8.50	6.29
Bihar	10.86	4.60	4.50	6.00	11.14	6.20	5.25	5.14
Haryana	10.57	5.60	3.75	7.14	19.43	5.00	5.75	5.43
Tripura	10.57	9.80	6.25	–	9.71	10.20	7.25	–
Punjab	8.57	4.80	4.25	4.29	10.00	6.60	5.25	2.29
All India	16.20	6.80	5.80	4.90	20.00	7.80	5.50	4.50
Coefficient of variation	0.26	0.33	0.34	0.27	0.30	0.36	0.37	0.31

Notes: [a]In child mortality rate per 1,000.
[b]Statistically significant at five per cent level or better.
Source: Based on Table 1.

The mortality gradient estimates show that at the all-India level, male child mortality declines by 16.2 per thousand for every year of additional education in the one-to-seven years education class, which corresponds approximately to the primary education phase. But the decline in male child mortality per year of additional education falls steeply to about six per thousand and stays at that level during all the remaining post-primary educational stages. Although there are a few exceptions, this pattern typifies the situation of male child mortality in most of the states. In the case of female child mortality too, there is a steep fall in the mortality rate by 20 for every additional year of education in the primary education stage at the all-India level. Then the reduction in the mortality rate falls steeply to 7.8 per additional year of education in the seven-to-ten years of education range. Thereafter it gradually declines to 4.5 per additional year of education for higher education exceeding 15 years duration. Thus, unlike the case of male children, the rate reduction in female child mortality mildly declines with additional years of education. This indicates gains in terms of reduced female child mortality as the duration of maternal education increases. The above findings show the crucial role primary education plays in the reduction of child mortality. As the unit costs of primary education are lower than the subsequent stages of education, the results indicate that primary education could be highly cost-effective in reducing child mortality.

Table 3
Mortality gradients derived from weighted least-squares regressions

Variable/Equation	1	2
1. Dependent variable: male child mortality		
Length of education	-0.13**	-0.14**
	(-7.09)	(-7.66)
Labour force participation rate	–	-2.08*
		(-2.30)
Use of state dummies	yes	yes
$\bar{R}^2$	0.38	0.42
F-statistic	3.88**	4.17**
Diagnostics (F-statistics)		
functional form	0.68[a]	0.04[a]
heteroscedasticity	2.85[b]	2.63[b]
2. Dependent variable: female child mortality		
Length of education	-0.13**	-0.14**
	(-7.15)	(-7.69)
Labour force participation rate	–	-2.84[b]
		(-2.25)
Use of state dummies	yes	yes
$\bar{R}^2$	0.38	0.42
F-statistic	3.89**	4.17**
Diagnostics (F-statistics)		
functional form	0.45[c]	0.22[c]
heteroscedasticity	3.41[d]	3.30[d]

Notes: **Sgnificant at 99 per cent level of confidence.
*Significant at 95 per cent level of confidence.
[a]Functional form is appropriate at 95 per cent level of confidence or better. F-statistic is based on Ramsey's RESET test.
[b]Errors are homoscedastic at 95 per cent level of confidence or better. The test is based on the regression of squared reminders on squared fitted values.

Obviously, the results are approximations of the relationship between mortality and the length of education as the entire reduction in mortality cannot be attributed to education alone. Besides female labour force participation, one can identify a large number of state-specific factors, such as infrastructure, level of income, poverty; and factors specific to certain stages of education such as social class, level of family income, which will have an independent influence on child mortality rate. Many of these variables are either difficult to measure or unmeasured.

To estimate the mortality gradient more accurately, the following equation has been used:

$$M = a_0 + a_i + b_1 E + b_2 L + u$$

where M denotes child mortality rate by sex of the child; a_0 is a general intercept; a_i, are state dummies; E is the length of education; L is female labour force participation rate at different lengths of education; b_1 and b_2 are regression coefficients; and u is the random error. Dummies were included only when found, indicated by variable addition-deletion tests. Since the data are available only by groups, the equations have been estimated using weighted least-regression squares using the actual number of women in each educational class in the respective states (India 1987b) as weights.[3] The model was estimated under alternative functional forms by taking a different transformation of the variables, and an exponential form was selected (as also suggested by the rough estimates of mortality gradients). Results of the regression equations along with diagnostics are presented in Table 3. The table shows results of the best equations separately for male and female children.

As noted above, the exponential form passes the functional-form test and also has homoscedastic residuals. These models were estimated using weighted least squares. Results show that both the length of mother's education and the female labour force participation rate have a statistically significant inverse relationship with child mortality. This is true for both male and female children. The explanatory power of this equation was approximately 42 per cent for both female and male children. The estimates of β coefficients, which indicate the relative influence of education and the female labour force participation on mortality rates (Table 4), suggest that the impact of education is approximately three times stronger than that of the female labour force participation rate, for both sexes.

Table 4
Relative influence of maternal education and female labour force participation on child mortality

	b value of	
	Length of education	**Labour force participation rate**
1. Female child mortality equation (with state dummies)	-0.84	-0.27
2. Male child mortality equation (with state dummies)	-0.84	-0.27
3. Excess female child mortality (with state dummies)	-0.74	-0.32

Note: β values are obtained as follows:

$$\beta = \frac{\beta_x S_x}{S_y}$$

Where β_x is regression slope coefficient of independent variable 'X'; S_x is standard deviation of variable 'X'; and S_y is standard deviation of the dependent variable y. Thus β values normalize the regression coefficients for the differences in their magnitudes and put them on a relative scale for the purpose of direct comparison.

These results apparently contradict Basu and Basu's (1991) findings but rather seem to confirm the findings of the studies suggesting a favourable impact of female labour force participation on child mortality. But this is not entirely true. The difference between Basu and Basu's conclusions and mine could be due to the fact that their study is based on aggregate data, whereas, the present study controls for the level of education by considering participation rates at different levels of female education. Disaggregated analysis of the data showed that there was no statistically significant relationship between the female labour force participation rate and child mortality among illiterate females and those with fewer than seven years of education (Table 5). This is in line with Basu and Basu's findings and

[3] Unweighted regression on grouped data will have zero mean and variance σ^2/n_g; where n_g is the size of the **'g'**th group. This violates the equal variance assumption of OLS if group sizes are different. Multiplication of both sides of the equation by $\sqrt{\mathbf{n}}$ will meet the requirements of classical regression but is not a good substitute to using ungrouped data. The information loss in grouped data is directly proportional to within-group variation (Greene 1990: 290-291).

their arguments. It may be noted here that job-related skills are obtained mainly after the first seven years of general education. Thus the factors implicit in Basu and Basu's argument seem to play a significant role mainly in households with low levels of female education, which are generally also poor households. Yet the overall relationship between child mortality and female labour participation was inverse and statistically significant.

Table 5
Impact of female labour force participation rates on child mortality, disaggregated analysis, based on weighted least-squares regression

Variable/Equation	Illiterates and up to seven years of education	Above seven years of education
1. Dependent variable: male child mortality		
Labour force participation rate	-0.35	-5.31**
	(-0.40)	(-6.14)
Constant	6.37	4.98
$\bar{R}^2$	0.00	0.43
F-statistic	0.16	37.78**
Diagnostics (F-statistics)		
functional form	4.47	0.10[a]
heteroscedasticity	3.33	0.09[b]
2. Dependent variable: female child mortality		
Labour force participation rate	-0.59	-5.66**
	(-0.65)	(-6.61)
Constant	6.43	4.98
$\bar{R}^2$	0.01	0.47
F-statistic	0.43	43.76**
Diagnostics (F-statistics)		
functional form	3.49	0.22[a]
heteroscedasticity	2.65	0.16[b]

Notes: **Significant at 99 per cent level of confidence.
[a]Functional form is appropriate at 95 per cent level of confidence or better. F-statistic is based on Ramsey's RESET test.
[b]Errors are homoscedastic at 95 per cent level of confidence or better. The test is based on the regression of squared reminders on squared fitted values.

Excess female child mortality

India recorded an excess female child mortality of ten per thousand in the 1981 census (Table 6). The excess female child mortality was even higher for illiterate mothers at 13 per thousand. But it disappeared among mothers with one to seven years of education. Among mothers with higher levels of education, female children had progressively and proportionately lower levels of mortality than male children at the all-India level. Excess female child mortality, which is rather unusual, exists in some of the states in the northern region of the country. Biological factors endow female children with better abilities to survive than male children and, therefore, male children usually have a higher level of mortality than female children. This is true even in many parts of India (Table 6). However, in some regions the problem of excess female child mortality is acute. For instance, the excess female child mortality of 34 per thousand in Uttar Pradesh is almost half of the overall female child mortality of 74 in Kerala. Even in a state like Haryana, which has higher *per capita* income, the excess female child mortality is almost one-third of the overall female child mortality in Kerala.

Table 6
Excess female child mortality rates[a]

		Years of mothers' education				
States	**Overall**	**0**	**1–7**	**7–10**	**10–15**	**>15**
Uttar Pradesh	34	37	23	5	6	0
Haryana	28	33	2	5	-3	3
Bihar	22	11	10	2	-1	2
Rajasthan	20	22	9	-3	-9	4
Punjab	14	17	12	3	-1	6
Gujarat	10	24	9	25	6	5
Madhya Pradesh	8	9	0	-8	-12	-20
Jammu and Kashmir	3	3	2	5	0	-5
Maharashtra	-2	0	-5	-7	-9	-3
Tamil Nadu	-3	0	-7	-9	-5	-5
Karnataka	-3	-1	-9	-9	-7	-5
Tripura	-4	-8	-5	-7	-11	–
Orissa	-5	-5	-4	-3	1	0
Himachal Pradesh	-6	-7	-3	-7	-16	–
West Bengal	-7	3	-1	-5	1	-1
Nagaland	-8	-7	-10	-10	1	–
Andhra Pradesh	-8	-7	-12	-9	-8	-5
Kerala	-9	-10	-7	-11	-5	–
Meghalaya	-10	-8	-12	-9	-9	–
All India	10	13	0	-5	-4	-3

Note: [a]Excess of female child (q_5) mortality over male child mortality (q_5) per 1,000. Positive numbers indicate excess female child mortality.

Source: India (1988).

Besides female education, three important factors are identified to explain excess female mortality (Bardhan 1988; Basu 1989; Das Gupta 1990). They are, first, cultural preference for male children[4]; secondly, low social status of women; and thirdly, low female labour requirements in areas where rice is not grown. Among these three, the last hypothesis, propounded by Bardhan (1988), is intuitively the most appealing. The underlying factor in the hypothesis is the low economic value of women and hence female children in areas where the labour force participation rates of women are low. It appears that the other two factors (low social status and cultural preference) responsible for excess female child mortality stem partly from the low economic value of women. This is not to say that there are no other factors; but womens' economic value will have a significant bearing on the other two factors. In view of the importance of Bardhan's hypothesis, the paper makes an attempt to test it.

Table 7
Excess female child mortality rates, regression results

Variable/Equation	**1**	**2**	**3**
Dependent variable:			
Relative excess female child mortality – CMR_f/CMR_m			
Weighted least squares (log linear)			
Labour force participation rate	-0.31*	-0.46**	-0.45**
	(-2.12)	(-3.52)	(-4.08)
Length of education	–	-0.22**	-0.33**
		(-4.95)	(-11.14)
Use of state dummies	none	none	yes
Constant	0.04	0.05	–
$\bar{R}^2$	0.04	0.24	0.70
F-statistic	4.53*	15.17**	11.34**
Diagnostics: F-statistics			
functional form[c]	0.09[a]	0.09[a]	0.00[a]
heteroscedasticity[d]	7.07	0.28[b]	0.08[b]

Notes: **Significant at 99 per cent level of confidence.
*Significant at 95 per cent level of confidence.
[c]Functional form is appropriate at 95 per cent level of confidence or better. F-statistic is based on Ramsey's RESET test.
[d]Errors are homoscedastic at 95 per cent level of confidence or better. The test is based on the regression of squared residuals on squared fitted values.

The model employed to test Bardhan's hypothesis is similar to the one described in the previous section. In the place of absolute child mortality, the ratio of female child mortality to male child mortality, henceforth referred to as relative excess female child mortality is taken as the dependent variable. The independent variables are the length of mother's education and the female labour force participation at different lengths of female education. State dummies to capture the impact of excluded variables are included in one of the equations. In this model an inverse and statistically significant

[4] A variety of reasons are behind male preference. Important among these are a dowry, a strong cultural desire to have continuity of family lineage (in most regions only male children can inherit the family title), and the belief that those with no male children will have to go to hell after death. It should be noted that in Meghalaya and Kerala, where a matriarchal system exists, female children have the lowest mortality in relation to male children (Table 6).

relationship between relative excess female child mortality and the female labour force participation rate would lend support to Bardhan's hypothesis. The model was estimated using weighted least-squares regression with the same weights as used earlier (see footnote 3). Unlike the case of absolute child mortality equations where the exponential form passed the functional form test, the log-linear form was found to be the most appropriate functional form for this application.

The results of the best equations presented in Table 7 show that female labour force participation alone has a statistically significant inverse relationship with relative excess female child mortality; but the equation had a heteroscedasticity problem. The inclusion of the length of mothers' education as an additional variable improved the explanatory power of the equation considerably and also helped to overcome heteroscedasticity. Both length of education and female labour force participation were inversely related with relative excess female child mortality, and statistically significant. As expected, inclusion of state dummies improved the explanatory power, and did not appreciably change the magnitude of the coefficient for length of education and female labour force participation.

The β coefficients presented in Table 4 show that the relative impact of female labour force participation on excess female mortality is slightly less than half of that of the influence of education. Thus, even though Bardhan's hypothesis is supported by the census data, maternal education seems to have a stronger influence in explaining relative excess female child mortality than the female labour force participation rate. But as between excess female child mortality and absolute child mortality, female labour force participation has a stronger influence in explaining excess female mortality than in explaining the absolute level of male and female child mortality.

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Table 1

Child mortality risk for mothers with different levels of education, by sex of child and state of residence

States	Mortality of male child						Av. female child mort. rate[a]	Mortality of female child				
	Av. male child mort. rate[a]	Rate[a] for illit. mothers	Relative risk[b] by years of maternal education					Rate[a] for illit. mothers	Relative risk[b]			
			1–7	7–10	10–15	>15			1–7	7–10	10–15	>15
Madhya Pradesh	193	208	61.1	39.4	30.3	23.6	201	217	58.5	34.1	23.5	13.4
Orissa	181	193	79.8	47.7	28.0	17.1	176	188	79.8	47.3	29.3	17.6
Uttar Pradesh	174	183	62.8	47.5	33.3	24.0	208	220	62.7	41.8	30.5	20.0
Rajasthan	166	175	61.7	44.0	33.1	21.1	186	197	59.4	37.6	24.9	20.8
Tripura	150	169	78.1	49.1	34.3	–	146	161	78.9	47.2	29.2	–
Meghalaya	147	166	75.9	50.6	31.3	–	137	158	72.2	47.5	27.2	–
Maharashtra	146	172	68.0	45.9	27.9	16.3	144	172	65.1	41.9	22.7	14.5
Karnataka	143	160	68.8	49.4	31.9	15.6	140	159	63.5	44.0	27.7	12.6
Andhra Pradesh	143	156	69.2	44.9	32.7	21.2	135	149	64.4	40.9	28.9	18.8
Himachal Pradesh	142	156	65.4	50.6	43.6	–	136	149	66.4	48.3	34.9	–
Tamil Nadu	134	153	73.2	53.6	35.9	20.9	131	153	68.6	47.7	32.7	17.6
West Bengal	132	138	70.3	39.1	23.9	17.4	125	141	68.1	34.8	24.1	16.3
Bihar	131	133	71.4	54.1	40.6	24.8	153	144	72.9	51.4	36.8	24.3
Haryana	125	133	72.2	51.1	39.8	21.1	153	166	59.0	44.0	30.1	18.7
Gujarat	119	140	65.0	47.1	34.3	22.1	129	164	61.0	55.5	32.9	22.0
Jammu & Kashmir	114	120	58.3	43.3	31.7	23.3	117	123	58.5	46.3	30.9	18.7

Punjab	104	115	73.9	53.0	38.3	25.2	118	132	73.5	48.5	32.6	26.5
Nagaland	104	122	68.0	45.9	39.3	–	96	115	63.5	40.0	42.6	–
Kerala	85	123	66.7	47.2	28.5	–	76	113	66.4	41.6	26.5	–
All India	147	164	65.2	44.5	30.5	20.1	157	177	60.5	38.4	28.0	16.9
Coefficient of variation	0.19	0.17	0.08	0.09	0.15	0.15	0.23	0.19	0.10	0.12	0.16	0.20

Notes: [a]Child mortality rate per 1,000.
[b]Relative risk per cent.
Source: India (1988).