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Research Article

Explaining Sex Differentials in Child Mortality in India: Trends and Determinants

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This study has twofold objectives: (1) to investigate the progress in sex differentials in child mortality in India in terms of within and between group changes and (2) to identify the factors explaining the sex differentials in child mortality and quantify their relative contributions. We have used three rounds of the National Family Health Survey (NFHS) data, 1992 to 2006. Life table approach and Pyatt and Oaxaca decomposition models were used as methods of analyses. The results revealed that though sex differential in child mortality is still high in India, it declined during 1992 to 2006 (Gini index from 0.36 to 0.24). This decline was primarily led by a change in within inequality of female child mortality (Gini index from 0.18 to 0.14). Among the selected predictors, breastfeeding (40%), birth order (24%), antenatal care (9%), and mother's age (7%) emerged as critical contributors for the excess female child mortality in India. From the findings of this study, we suggest that any efforts to do away with gender differences in child survival should focus more on within female child disparity across different population subgroups alongside male-female disparity. Implications are advanced.

1. Introduction

In most populations, female mortality rates are lower than male mortality rates and females are more than males, which remain consistent across all the ages [1]. However, historically South Asia is known for its male skewed child sex ratio. Researchers have attributed sex differentials in child mortality as one of the primary factors contributing to its skewed sex ratios in 0–6 year population. India's Sample Registration System (SRS) has been indicating the presence of sex differentials in child mortality since 1970s. The recent SRS report has also indicated a large gap (9 per 1000 live births) in terms of under-five mortality rate among males and females which further increases in rural areas [2]. While all the Indian states show excess female under-five mortality, the discrimination is huge in Jharkhand, Chattisgarh, Uttar Pradesh, Rajasthan, and Bihar (Figure 1). Figure 1 suggests that despite the explicitly oriented efforts to eliminate health inequalities, gender disparities in childhood mortality still persists in India. The issue of sex differentials in child mortality has remained a major hurdle for achieving gender equity and Millennium Development Goals-4 (MDG-4) in India.

There are plenty of studies that have attempted to explain sex differentials in child mortality and factors associated with it specifically in the case of India [3–17]. The thrust of these studies had been about the level of gender disparity in child survival, nutrition, and health care of children and factors associated with it. According to Das Gupta [6] excess female child mortality is an inherent part of family building strategy where girls are considered as a burden and boys as resources. Various studies [6–8, 18–20] have revealed parental discrimination in the provision of basic food and health care against their own daughters which is typically understood as one of the causes for excess female child mortality. Further abusing the girl child within the household is also a common practice [19]. Even though a number of policy interventions are in place, the persistent excess of female child mortality continues to speculate about the authentication of reported predictors and their volume of contributions [21–31].

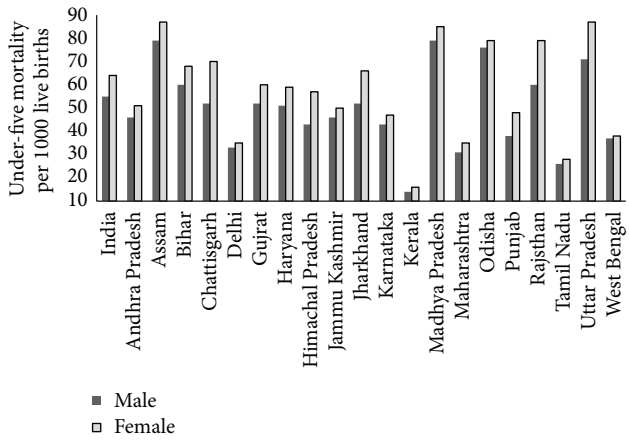

Figure 1: Under-five mortality rates by sex of the child, India and states, 2010.

Recently, some studies [27–34] have tried to provide insights on existing inequalities, but there is no evidence of decomposition of the relative proportional contribution of socioeconomic and demographic factors in sex differentials in child mortality. The lack of information on the exact relative contribution of different socioeconomic and demographic predictors of excess female child mortality obscures the planning process that can reduce gender disparity in child mortality. Thus, it is imperative to estimate the relative proportional contribution of predictors as it allows the policy makers to prioritize the factors and consequent interventions to bring balance in survival chances of male and female children in India. The other question which needs our attention is whether the reported sex differentials in child mortality consist of only the difference between male-female child mortality or within male and female differences in child mortality are also contributing to it. Hence, decomposition of between and within male-female differences in child mortality are also important in policy perspective. With this rationale, this study has twofold objectives: (1) to investigate the progress in sex differentials in child mortality in India in terms of between and within group changes and (2) to identify the factors explaining the sex differentials in child mortality and quantify their relative contributions.

2. Methods

2.1. Data Source. Data from the three rounds of the National Family Health Survey (NFHS), 1992–2006, have been used to assess the trends in child mortality stratified by sex. The NFHS is an equivalent of worldwide Demographic Health Survey (DHS) and a widely accepted source of data for estimating demographic and public health indicators in India. Three rounds of NFHS have been conducted by the International Institute for Population Sciences (IIPS) and Macro International under the aegis of the Ministry of Health and Family Welfare, India. The NFHS collects information on fertility, mortality, morbidity, and maternal and child health. A similar sampling scheme was adopted in all the three rounds and provides sufficiently large sample sizes (more than 90,000 households were interviewed in each round) to carry out analysis at the national as well as the state level. The data were collected using similar interview schedules and the household and eligible female informant response rates were consistently above 90% across the three rounds. To make the estimates representative and comparable across the three survey rounds and to account for the multistage sampling design adopted in the three rounds of the NFHS, we used appropriate weights in the analysis. The details of the sampling weights are given in NFHS reports of the various rounds. For details on sampling, see IIPS and Macro International, 1992-93, 1998-99, and 2005-06 [21–23].

2.2. Analysis. Life table approach and Pyatt and Oaxaca decomposition models were used as methods of analyses.

Life-Table Approach. Child mortality rates were estimated based on the simple life table approach using STATA 11.0 (Table 2). This approach builds up a 12–59 month matrix of exposure and deaths for each month that the child was alive between the first and fifth birthday of life. Child mortality rates are calculated using the following steps.

(1) We calculated the date of birth of the child as a century month code (cmc), denoted by bcmc.

(2) We calculated the date of death of the child as a century month code (dcmc). In this process age at death in months is calculated for all deaths, imputing the age in months.

(3) After tallying the deaths and exposure for each month, the probability of dying at exact age x (q_x) is calculated by dividing the deaths at age x by the exposure at age x for each month between first and fifth birthday of life.

(4) We calculated the probability of surviving to age x as $l_x = l_x - 1 * (1 - q_x)$, with $l_o = 1$.

(5) We calculated the probability of dying by age x as $1 - lx$,

where q is the probability of dying and l is the probability of surviving.

Pyatt's Gini Decomposition Model. Pyatt [24] has given the decomposition model of Gini coefficient. Gini index was used to calculate the change in inequality in child mortality among the male-female population of Indian states during 1992–2006. Further, the Gini index in child mortality among the male-female population across Indian states was decomposed into between group inequality, within group inequality, and inequality due to group overlapping.

Let a population of "n" individuals with mortality vector $(y_1, y_2, y_3, \ldots, y_n)$ and mean mortality $\overline{y}$ be desegregated in "k" subgroups with $n = \sum_{j=1}^{k} n_j$ and subgroup mean is $\overline{y_j}$.

The Gini index between subgroups j (male) and h (female) can be expressed as

$$G_{jh} = \frac{1}{n_j n_h \left(\overline{y_j} + \overline{y_h}\right)} \sum_{i=1}^{n_j} \sum_{r=1}^{n_h} \left| y_{ji} - y_{hr} \right|. \quad (1)$$

If $F(y)$ is the cumulative distribution function of mortality, then expected mortality difference between group j and h can be defined as

$$d_{jh}^1 = \int_0^\alpha dF_j(y) \int_0^y (y - x)\, dF_h(x), \quad \text{for } y_{ji} > y_{hr}, \quad \overline{y_j} > \overline{y_h},$$
$$d_{jh}^2 = \int_0^\alpha dF_h(y) \int_0^y (y - x)\, dF_j(x), \quad \text{for } y_{ji} < y_{hr}, \quad \overline{y_j} > \overline{y_h}. \quad (2)$$

The relative mortality affluence is defined as

$$D_{jh} = \frac{d_{jh}^1 - d_{jh}^2}{d_{jh}^1 + d_{jh}^2}. \quad (3)$$

If the population share in subgroup j is $p_j = n_j/n$ and mortality share in subgroup j is $s_j = p_j \overline{y}_j / \overline{y}$, then the contribution to total inequality attributable to the difference between the k population subgroup is defined as

$$G_b = \sum_{j=1}^{k} \sum_{h=1, j \neq h}^{k} G_{jh} D_{jh} \left(p_j s_h + p_h s_j\right). \quad (4)$$

The Gini index for subgroup j is given by

$$G_{jj} = \frac{\sum_{i=1}^{n_j} \sum_{r=1}^{n_j} \left(y_{ij} - y_{rj}\right)}{2 n_j^2 \overline{y}_j}. \quad (5)$$

Within group inequality index is the sum of Gini indices for all subgroups weighted by the product of population shares and mortality shares of the subgroups:

$$G_w = \sum_{j=1}^{k} G_{jj} p_j s_j. \quad (6)$$

If subgroups are not overlapping, total inequality can be expressed as the sum of within group and between group indices. But if subgroups are overlapping, we can add another component which is a part of between group disparities issued from the overlap between the two distributions which measures the contribution of the intensity of transvariation. The contribution of the transvariation between the subpopulations to G is

$$G_t = \sum_{j=1}^{k} \sum_{h=1, j \neq k}^{k} G_{jh} \left(1 - D_{jh}\right) \left(p_j s_h + p_h s_j\right). \quad (7)$$

Thus, Gini index can be decomposed into three components: within group inequality, between group inequality, and inequality due to group overlapping:

$$G = G_w + G_b + G_t. \quad (8)$$

Oaxaca Decomposition. Taking into account the utility of regression based decomposition analyses, we have also used the *Oaxaca* decomposition model which is appropriate for binary models to decompose the gender differences in child survival into relative contribution attributable to explanatory factors [25]. Mathematically, Oaxaca decomposition is expressed in three equations. (1) The gap between the mean outcomes y^{Male} and y^{Female} is equal to

$$y^{\text{Male}} - y^{\text{Female}} = \beta^{\text{Male}} x^{\text{Male}} - \beta^{\text{Female}} x^{\text{Female}}, \quad (9)$$

where x^{Male} and x^{Female} are vectors of explanatory variables evaluated at the means for the Male and Female, respectively.

Further, we estimated how much of the overall gap or the gap specific to any one of the x's is attributable to (1) difference in x's called the explained component rather than (2) differences in βs (also called the unexplained component). This is mathematically expressed as

$$y^{\text{Male}} - y^{\text{Female}} = \Delta x \beta^{\text{Female}} + \Delta \beta x^{\text{Male}}, \quad (10)$$

$$y^{\text{Male}} - y^{\text{Female}} = \Delta x \beta^{\text{Male}} + \Delta \beta x^{\text{Female}}, \quad (11)$$

where $\Delta x = x^{\text{Male}} - x^{\text{Female}}$ and $\Delta \beta = \beta^{\text{Male}} - \beta^{\text{Female}}$ show that in (10) (unexplained part) the differences in x's are weighted by the coefficients of the female group and differences in the coefficients are weighted by the x's of the male group whereas in (11) (explained part) the differences in the x's are weighted by the coefficient of male group and the difference in coefficients are weighted by the x's of female group.

2.3. Variables Used in the Study. The socioeconomic and demographic variables were dichotomized into disadvantageous and advantageous groups (based on inputs from the simple bivariate analyses) to perform the differential decomposition analyses: place of residence as rural/urban, caste SCs or STs/others, religion as Hindu religion/non-Hindu religion, mother's age as risky (less than 19 years and above 30 years) age group/nonrisky (20–29 years) age group, education of mother as no education/education, mass media exposure of mother as no/yes, mothers' body mass index less than 18.5 kg/m^2/more than 18.5 kg/m^2, economic status as poor/nonpoor, place of delivery as home/other, birth weight as low/high, birth order less than 3/above 3, antenatal care received/not received, and breast feeding less than 6 months/above 6 months. For more details on variables, see IIPS and Macro International, 2005-06 [23].

3. Results

3.1. Trends in Difference of Male-Female Child Mortality. The child mortality estimates ($_4q_1$) by sex are given in Table 1. The results showed that, in 1992, female children were at a

Table 1: Trends in child mortality ($_4q_1$) by sex of the child in India and major states, 1992–2006.

States	NFHS-1 (1992-93)			NFHS-2 (1998-99)			NFHS-3 (2005-06)			$D_1 - D_3$
	M	F	D_1 (F − M)	M	F	D_2 (F − M)	M	F	D_3 (F − M)	
Delhi	13.6	21.2	7.6	10.6	13.4	2.8	7.6	8.9	1.3	6.3
Haryana	18.4	43.2	24.8	13.8	30.2	16.4	10.4	21	10.6	14.2
Himachal Pradesh	17.6	25.3	7.7	9.0	9.3	0.3	5.0	4.2	−0.8	8.5
Punjab	12.7	23	10.3	5.9	23.8	17.9	6.0	15.5	9.5	0.8
Bihar	34.5	53.5	19	31.4	43.6	12.2	24.5	40.4	15.9	3.1
Madhya Pradesh	46.7	56.8	10.1	49.4	66.3	16.9	24.7	32.6	7.9	2.2
Rajasthan	26.5	42.2	15.7	29.4	52.3	22.9	18.5	26.2	7.7	8
Uttar Pradesh	38.5	65.6	27.1	28.8	53.4	24.6	21.7	43.2	21.5	5.6
Assam	52.9	59.6	6.7	21.4	16.9	−4.5	22.6	29.9	7.3	−0.6
Orissa	16.1	23.4	7.3	29.6	27.9	−1.7	31.1	26.5	−4.6	11.9
West Bengal	21.7	35.4	13.7	18.5	23.9	5.4	13.1	14.9	1.8	11.9
Gujarat	27.1	38.6	11.5	25.1	31.4	6.3	9.7	21.4	11.7	−0.2
Maharashtra	19.1	23.6	4.5	15.5	20	4.5	7.9	9.1	1.2	3.3
Andhra Pradesh	21.5	27.6	6.1	16.6	27.8	11.2	9.2	13.2	4	2.1
Karnataka	25.6	33.4	7.8	21.1	23.8	2.7	14.7	13.1	−1.6	9.4
Kerala	10	9.4	−0.6	6	4.5	−1.5	1.4	2.4	1	−1.6
Tamil Nadu	29	23.2	−5.8	12.7	15.8	3.1	4.9	10.5	5.6	−11.4
India	29.4	42	12.6	24.9	36.7	11.8	14.2	22.9	8.7	3.9

Table 2: Pyatt's Gini decomposition of change in male-female differential in child mortality in India during 1992–2006.

Decomposed categories	1992-93 (NFHS-1)		1998-99 (NFHS-2)		2005-06 (NFHS-3)	
	Gini indices	%	Gini indices	%	Gini indices	%
Contribution from between inequality	0.004	0.99	0.004	1.02	0.001	0.53
Contribution from overlap	0.177	48.95	0.173	48.91	0.135	49.41
Contribution from within inequality	0.181	50.05	0.177	50.72	0.137	50.06
Total inequality	0.361	100	0.353	100	0.273	100

Note: figures might be affected by rounding.

higher risk of mortality in all the states except in Kerala and Tamil Nadu where female children reflected a better position. A positive shift towards gender equalities in child survival was clearly evident from the estimates of child mortality trends during 1992 to 2006. Yet, female children consistently remained at a higher risk, though there was a decline in the volume of risk. The state specific analysis revealed that, over the time, Kerala and Tamil Nadu turned favourable towards male child, whereas Himachal Pradesh, Orissa, and Karnataka emerged as the states favourable towards female child. Uttar Pradesh consistently showed greater sex differentials in child mortality with a difference of 21 deaths per 1000 live births between male and female children. The state was able to reduce a difference of only 6 deaths per 1000 live births during 1992 to 2006. A similar trend was reflected in Bihar and Haryana where male-female difference in child mortality was quite high with an impressive progress during 1992 to 2006. A more unexpected outcome was observed in two of the southern states, that is, Kerala and Tamil Nadu, which initially showed a female advantage in child survival, but this replaced with male advantage in the latest period. Nevertheless, the results in Table 1 clearly evident that female child mortality was always higher in the north and central regions of India with Uttar Pradesh and Madhya Pradesh being the states with highest female child mortality. The sex differentials in child mortality decreased in almost all the states with the exception of Assam (6.7 to 7.3), Gujarat (11.5 to 11.7), Kerala (−0.6 to 1), and Tamil Nadu (−5.8 to 5.6) where it was slightly increased in 2006 as compared to 1992.

3.2. Pyatt's Decomposition Results. Consistent with the results of Table 1, the results in Table 2 showed that considerable gender inequalities persist in child mortality during 1992–2006. However, this difference was less in 2005-06 ($G = 0.23$) as compared to 1992-93 ($G = 0.36$). The decomposition of gender based inequalities in child mortality revealed that within male and female inequalities contribute more than

Table 3: Oaxaca decomposition: contribution of selected predictors to child mortality difference between female and male children, India 2005-06.

Summary of Oaxaca decomposition		
	Coef.	Std. error
Female	0.14	0.0154
Male	0.09	0.0122
Difference	0.05	0.0196
Explained	0.04	0.0139
Unexplained	0.01	0.0141
% explained	81.95	—
% unexplained (residual)	18.05	—
Details of explained part		
Predictors	% contribution to total difference	Std. error
Rural place of residence	5.98	0.0010
Mother's no education	4.73	0.0012
Mother's age (15 to 19 and 30+)	5.61	0.0008
Mothers do not have mass media exposure	2.31	0.0014
Non-Hindu religion	0.22	0.0003
SCs/STs caste	0.61	0.0006
Noninstitutional place of delivery/home delivery	−1.39	0.0012
Poor household economic status	3.93	0.0004
No antenatal care received	9.14	0.0013
≥3 birth order	24.27	0.0017
<6 months breastfeeding	40.46	0.0036
<18.5 kg/m^2 mother's body mass index	0.01	0.0001
Low birth weight	4.12	0.0003
Total explained part	100	

between male-female inequalities. The contribution of within male and female inequalities to total gender inequalities in child mortality was consistently over 50% for all the three rounds of the NFHS. This gives a strong message that rather than male-female inequalities, inequalities within the female and male children by socioeconomic, demographic, and health care characteristics of the households contributed more to the total inequality in the child mortality. The other important finding from Table 2 was the contribution of overlapping factors which was consistently high (nearly 49%) during 1992–2006. Here, overlapping factors were neither the individual factors of female nor the individual factors of male. These factors can be referred to parents, community, and other contextual factors which might be having an equal probability of favoring either of them. Therefore, the entire female child population cannot be treated as a disadvantaged group rather a certain section of this population is in a disadvantageous position depending on their exposure to parents, community, and other contextual discriminations. Further, to identify the explanatory factors in the form of socioeconomic, demographic, and health care characteristics of the households, we have decomposed the sex differentials in child mortality by their socioeconomic and demographic characteristics in the following section.

3.3. Oaxaca Decomposition Results. Table 3 presents the results of decomposition analysis for proportional contributions of selected predictors. The socioeconomic and demographic predictors can explain up to 82% of the total mortality difference between male and female children in India. The remaining 18% constitutes the unexplained residual component. The results in Table 3 also illustrate the relative contribution of selected predictors by taking the total explained components (i.e., 82%) equivalent to 100%. Among all the explanatory factors, breastfeeding up to less than six months contributed 40% of the difference in male and female child mortality. Women of birth order of 3 and above and those who have not received antenatal care each contributed 24% and 9%, respectively, to the sex differential in child mortality. Rural place of residence and mother's age contributed 5% each. The variables like mothers with no education, no mass media exposure, non-Hindu religion, scheduled caste and tribe, low body mass index (<18.5 kg/m^2), and low birth weight of baby contributed less than 5% of the gender differential in child mortality. The negative contribution (−1.39%) of home delivery indicates that the place of delivery is not a significant factor for sex differentials in child mortality in India.

4. Conclusion

This study assessed the trends and determinants of sex differentials in child mortality in India during 1992 to 2006. The findings foster that there was reduction in sex differentials

in child mortality during 1992 to 2006. Yet, the female child continues to be at greater risk of death in the majority of the states of India with the only exception in Kerala and Tamil Nadu where the earlier female advantage in child survival chances was replaced with male advantage. This pattern also reflected in the results of recent Census (2011) in the form of a remarkable decline in child sex ratios in many districts of Tamil Nadu [35]. Similarly, in case of Kerala the studies documented emerging female discrimination in traditionally matriarchal societies like Nayars [36–38]. Thus, we can attribute the reversal in female advantage in child survival to emergent manifestation female discrimination in these states. The findings of Pyatt's decomposition analyses suggested that the discrimination within the female and male children contributed in greater proportion to total inequality in child mortality compared to between male and female differences. Moreover, the overlapping factors, namely, parental, community, and other contextual factor, also contributed largely to sex differences in child mortality. Thus, the contribution from overlapping factors clearly indicates that male children are treated at par with female children irrespective of the subgroup of the population to which they belong to. Conversely, female children are treated differently across different subgroups of the population. The results of the Oaxaca decomposition model suggested that the demographic variables such as breastfeeding, birth order, antenatal care, and the mother's age emerged as critical contributors for excess female child mortality compared to other socioeconomic variables. Further, variables, namely, higher order births and younger maternal age, also contributed in a significant proportion to the excess female child mortality in India. The results advance that proximate determinants as discussed by Mosley and Chen [26] are playing a greater role in creating sex differentials in child mortality compared to distal socioeconomic factors.

Though, we agree with some of the previous studies which have attributed gender differences in child mortality to girl child discrimination in accordance with the cultural context of social and religious values in Indian society [6, 11, 17–20], however, our findings are in tune with the studies which advanced the argument that socioeconomic factors play a critical role, but these factors do not directly influence sex differences in child mortality, rather they operate through factors like breastfeeding, birth order, and antenatal and child health care [27–33]. This could be one reason why the relative contribution of the socioeconomic factors in this study was very less compared to demographic and health care variables. Breastfeeding variable alone contributed phenomenally to overall sex differences in child mortality because, in absence of variables like children vaccinated, nutrition, and other health care variables, breastfeeding might be showing a compound effect of all these variables which in turn is closely associated with breastfeeding. We have not included child immunization, nutrition, and other health care variables in Oaxaca decomposition model because these questions are not asked for dead children in the NFHS surveys. This is one of the limitations of the analyses based on NFHS data.

In conclusion, the study advances the argument that the gender discrimination is mainly operating through the unequal provision of breastfeeding, negligence of higher order female births, and consequences in terms of allocation of intrahousehold resources in health care provisions. At policy perspective, this study evidently suggests that the issue of sex differentials in child mortality still remains a daunting task for the policy makers, social scientists, and public health professionals in India. Any efforts to eliminate gender differences in child survival should focus on within female children discrimination across different population subgroups alongside male-female discrimination. Also we need to overcome the discrimination in the terms of proximate factors such as breastfeeding and other nutritional and health care requirements and neglect of higher order female births in India. The study has some data limitations because NFHS collects data on mortality retrospectively for the last five years and this has a potential for recall bias especially in case of reporting girls' deaths in India.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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