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Male-Female Disparity in Child Survival in Districts of India

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Abstract

This paper analyses male-female disparity in the probability of survival up to 15 years of age in districts of India. Based on estimates derived from the summary birth history data available from 2011 population census, the paper reveals that in majority of the districts of the country, male-female disparity in survival up to 15 years of age is quite marked in terms of either female survival advantage or male survival advantage. Majority of districts with marked male survival advantage are located in the northern part of the country. There is substantial inequality in male-female disparity in survival up to 15 years of age within district across mutually exclusive population sub-groups. The male-female disparity in survival up to 15 years of age is influenced largely by the male-female survival disparity in 5-9 and 10-14 years of age.

Introduction

District level analyses of child survival in India are rare because district level estimates of the risk of death during childhood are not available either through the civil registration system or the official sample registration system or through surveys like National Family Health Survey. The only source of data to estimate child mortality at the district level is the summary births history (SBH) data available through the decennial population census. These data have been used to estimate the risk of death during childhood at the district level using different indirect techniques of child mortality estimation. (Government of India, 1988; 1997; 2001; Mishra et al, 1994; Rajan et al, 2008; Ahuja, *no date*). In all these studies, the risk of death is estimated for the first five years of the life, although the National Policy for Children, 2013 recognises a person below the age of 18 years as the child (Government of India, 2013). District level estimates of the risk of death in children below 18 years of age are, however, not available. Similarly, very little is known about within-district residence and social class variation in the risk of death in male and female children. A recent study has analysed excess female under-five mortality in districts of India following a regression residual approach (Guilmoto et al, 2018). This study does not analyse within-district variation in excess female under-five mortality across different social classes and does not consider the male-female disparity in the risk of death beyond five years of age. To the best of our knowledge, there is no study in India which has analysed the male-female disparity in the risk of death in children older than 5 years of age.

In this paper we analyse male-female disparity in the probability of survival up to 15 years of age in districts of India. We also analyse how male-female disparity in the probability of survival up to 15 years of age varies across different population sub-groups within the same district. Children below 15 years of age can be grouped into children aged 0-1 year of age; children 1-4 years of age; children 5-9 years of age; and children 10-14 years of age. The rationale for this age grouping of children is grounded in the fact that both probability of survival and male-female disparity in the probability of survival varies across the four age groups as the primary causes of death in the four age groups are essentially different. The probability of survival in the first 15 years of life, therefore, is the cumulation of the probability of survival in the four age groups. This means that male-female disparity in survival up to 15 years of age should be analysed in the context of the male-female disparity in survival in 0-1 year; 1-4 years; 5-9 years; and 10-14 years of age.

The paper is organised as follows. The next section of the paper outlines the analytical strategy followed while section three describes the data. The analytical strategy recognises that the probability survival in the first15 years of life varies by both sex and age so that male-female disparity in survival up to 15 years of age is the cumulative effect of male-female survival disparity by age. Inter-district and within-district variation in male-female disparity in survival in the first 15 years of life is discussed in the fourth section of the paper. The fifth section of the paper classifies districts based on the contribution of male-female disparity in survival different age groups to male-female disparity in survival in the first 15 years of life. The last section of the paper summarises main findings of the analysis and discusses their policy and programme implications.

Analytical Framework

The analysis of male-female disparity in the probability of survival is essentially an arbitrary procedure (Preston and Weed, 1976). There is no plausible theory or hypothesis about what the male-female disparity in survival in general and child survival in particular should be. Male-female disparity in the risk of death is attributed to both innate biological differences between sexes and social, cultural, and economic determinants of survival (Chaurasia, 1981; United Nations, 2011). The fact that females have two X chromosomes and male one probably confers a survival advantage on females (Naeye et al, 1971). The biological or genetic advantage of females has, however, been argued to be small and largely invariant across populations (Wisser and Vaupel, 2014). On the other hand, females face a range of discrimination in the family and the society because of a host of social, cultural, and economic factors, which may confer a survival disadvantage on them, particularly, after the first year of life. The observed male-female disparity in survival, therefore, is the net of the effect of biological or genetic factors and social, cultural, and economic factors. The relative contribution of biological or genetic factors and social, cultural, and economic factors and the interaction between the two in deciding male-female disparity in survival, however, remains unclear. The relative contribution of biological or genetic factors and social, cultural, and economic factors of male-female disparity in survival varies with age. In the first year of life, females generally have better survival chances than males primarily because of biological or genetic factors. As age advances, social, cultural, and economic factors, are argued to become more dominant in deciding male-female disparity in survival.

The male-female disparity in survival can be measured in both relative and absolute terms. Historically, male-female disparity in survival has been measured in relative terms as ratio of male to female survival probability or, equivalently, ratio of female to male survival probability. There are very few studies which have analysed male-female disparity in survival in absolute terms or in terms of the arithmetic difference between male and female survival probability (Wisser and Vaupel, 2014). However, both relative and absolute difference are influenced by the level of survival probability (Preston and Weed, 1976; Houweling et al, 2007; Mackenbach, 2015). One problem with relative measures is that when male to female ratio of the risk of death goes up, the ratio of the reverse outcome (probability of survival) goes down (Scanlan, 2000). This ambiguity does not apply to absolute measures. An advantage of measuring male-female disparity in absolute terms is that the arithmetic difference in male-female survival up to a given age can be decomposed into components attributed to male-female disparity in survival in different ages below the given age.

In view of the hazards of measuring male-female disparity in survival in either relative or absolute terms, an alternative approach involves first establishing an empirically 'normal' relationship between male and female survival probability and then measuring male-female disparity as the deviation from the empirical 'normal' (Preston and Weed, 1976). This approach measures male-female disparity as the difference between the observed male-female disparity and the empirical 'normal'. One approach to establish empirical 'normal' relationship is to use orthogonal regression, which minimises the sum of squared deviations perpendicular to the line (Preston and Weed, 1976). Orthogonal regression does not require the specification of a 'dependent' variable, a specification that is difficult in case of analysing the relationship between male and female survival probability. The orthogonal regression treats males and females symmetrically. The slope of the orthogonal regression is the geometric mean of the two slopes resulting using the ordinary least square regression with male survival probability as the 'dependent' variable and using the ordinary least square regression with female survival probability as the 'dependent' variable.

The arithmetic difference and the ratio of male-female survival probability can, however, be related using the logarithmic mean of male and female survival probabilities. If p^m and p^f denote, respectively, the male and female survival probability, then the logarithmic mean (*LM*) of p^m and p^f is defined as (Carlson, 1972; Bhatia, 2008)

$$LM = \frac{p^m - p^f}{ln\left(\frac{p^m}{p^f}\right)} \quad (1)$$

which means that

$$\frac{p^m}{p^f} = exp\left(\frac{p^m - p^f}{LM}\right) \quad (2)$$

Equation (2) suggests that the arithmetic difference between male-female survival probability up to 15 years of age, ∇, may be written as

$$\nabla = {}_{15}p_0^m - {}_{15}p_0^f = LM * ln\left(\frac{{}_{15}p_0^m}{{}_{15}p_0^f}\right) \quad (3)$$

The probability of survival up to 15 years of age may also be written as

$${}_{15}p_0 = {}_1p_0 * {}_4p_1 * {}_5p_5 * {}_5p_{10} \quad (4)$$

so that equation (3) becomes

$$\nabla = LM * \left[ln\left(\frac{{}_1p_0^m}{{}_1p_0^f}\right) + ln\left(\frac{{}_4p_1^m}{{}_4p_1^f}\right) + ln\left(\frac{{}_5p_5^m}{{}_5p_5^f}\right) + ln\left(\frac{{}_5p_{10}^m}{{}_5p_{10}^f}\right)\right] \quad (5)$$

or

$$\nabla = \partial_1 + \partial_2 + \partial_3 + \partial_4 \quad (6)$$

where

$$\partial_1 = LM * ln\left(\frac{{}_1p_0^m}{{}_1p_0^f}\right) \quad (7)$$

is the contribution of male-female disparity in the survival probability in the age group 0-1 year to the male-female disparity in the survival up to 15 years of age. Similarly, ∂_2 is the contribution of male-female disparity in the survival probability in the age group 1-4 years; ∂_3 is the contribution of male-female disparity in the survival probability in the age group 5-9 years; and ∂_4 is the contribution of male-female disparity in the survival probability in the age group 10-14 years to male-female disparity in the probability of survival up to 15 years of age.

Equation (6) holds for every population which means that variation in ∇ can be analysed in terms of ∂_1, ∂_2, ∂_3, and ∂_4 through an additive model using the exploratory data analysis technique of mean polish (Selvin, 1996) which is similar to median polish technique with median replaced by mean (Tukey, 1977). Equation (6), when applied to different populations, leads to a two-way table with rows representing populations and columns representing ∂_1, ∂_2, ∂_3, and ∂_4. The mean polish technique then divides the contribution of the male-female disparity in survival probability in an age group in population *j* into four components – a grand mean or average male-female disparity in survival across all populations and all age groups (*g*); average male-female disparity in survival across populations in a given age group *i* ($\bar{a}_i$); average male-female disparity in survival across age groups in population j (d^j); and a residual component which is specific to the age group i and population j (r_{ij}). For example, for population j, the contribution of the male-female disparity in survival probability in the age group 0-1 year (∂_1) to male-female disparity in survival up to 15 years of age may be decomposed as

$$\partial_1^j = g + \bar{a}_1 + d^j + r_1^j \quad (8)$$

Similarly,

$$\partial_2^j = g + \bar{a}_2 + d^j + r_2^j \quad (9)$$

$$\partial_3^j = g + \bar{a}_3 + d^j + r_3^j \quad (10)$$

$$\partial_4^j = g + \bar{a}_4 + d^j + r_4^j \quad (11)$$

Since

$$\nabla^j = \partial_1^j + \partial_2^j + \partial_3^j + \partial_4^j \quad (12)$$

It follows that

$$\nabla^j = \sum_{i=1}^{c} g + \sum_{i=1}^{c} \bar{a}_i + \sum_{i=1}^{c} d^j + \sum_{i=1}^{c} r_i^j \quad (13)$$

Notice that by construction

$$\sum_{i=1}^{c} \bar{a}_i = 0 \quad (14)$$

and

$$\sum_{i=1}^{c} r_i^j = 0 \quad (15)$$

So that equation (13) reduces to

$$\nabla^j = c * g + c * \sum_{i=1}^{c} d^j = \nabla_n + \nabla_j \quad (16)$$

Equation (16) suggests that male-female disparity in the probability of survival up to 15 years of age, measured in terms of the arithmetic difference between male-female survival probability comprises of two components - one common to all populations (∇_n) and second specific to population j (∇_j). The common component may be perceived as the empirical 'normal' while the specific component (∇_j) is the deviation of the observed male-female disparity in survival up to 15 years of age in population j from the empirical 'normal'. It is obvious that $\nabla_j > 0$ indicates female disadvantage while $\nabla_j < 0$ indicates the male disadvantage in survival up to 15 years of age. When $\nabla_j = 0$, male-female disparity in the probability of survival up to 15 years of age in population j is equal to the empirical 'normal'. In this paper, we measure male-female disparity in the probability of survival up to 15 years of age in district j by ∇_j or the deviation of the observed male-female disparity in the probability of survival up to 15 years of age in district j from the empirical 'normal' derived from equation (16). The male-female disparity in survival up to 15 years of age may be termed as marginal female advantage if ($-0.005 \leq \nabla_j < 0$); moderate female advantage if ($-0.010 \leq \nabla_j < -0.005$); and high female advantage if ($\nabla_j < -0.010$). Similarly, male-female disparity in survival may be termed as marginal male advantage if ($0 < \nabla_j < 0.005$); moderate male advantage if ($0.005 \leq \nabla_j < 0.010$); and high male advantage if ($\nabla_j \geq 0.010$). When $\nabla_j = 0$, there is no male-female disparity.

Equation (13) also suggests that empirical 'normal' contribution of male-female disparity in the probability of survival in the age group *i* to the empirical 'normal' male-female disparity in the probability of survival up to 15 years of age is given by

$$\nabla_{ni} = g + \bar{a}_i \tag{17}$$

Similarly, the contribution of male-female disparity in the probability of survival in the age group *i* to male-female disparity in survival up to 15 years of age in population *j* may be calculated as

$$\nabla_{ji} = d_i^j + r_i^j \tag{18}$$

Data

The analysis is based on the summary birth history data available through 2011 population census of India. These data are tabulated by the age of the currently married women in the reproductive age group (15-49 years) for 640 districts of the country as they existed at the time of the 2011 population census for the total population and for population sub-groups classified by residence (rural and urban) and social class (Scheduled Castes and Scheduled Tribes). Based on these data, we have estimated the probability of death in the age group 0-1 year; 0-5 years; 0-10 years; and 0-15 years for each of the 640 districts for total, rural, urban, Scheduled Castes, Scheduled Tribes, and Other Castes population and for 12 mutually exclusive population subgroups: 1) rural Scheduled Castes male; 2) rural Scheduled Castes female; 3) rural Scheduled Tribes male; 4) rural Scheduled Tribes female; 5) rural Other Castes male; 6) rural Other castes female; 7) urban Scheduled Castes male; 8) urban Scheduled Castes female; 9) urban Scheduled Tribes male; 10) urban Scheduled Tribes female; 11) urban Other Castes male; and 12) urban Other castes female. The indirect technique of child mortality estimation (Maultree et al, 2013) has been used for the purpose. Using these estimates, male and female survival probability in the age group 0-1 year; 1-4 years; 5-9 years; 10-14 years; and 0-14 years has been calculated for the total population, for rural, urban, Scheduled Castes, Scheduled Tribes, and Other Castes population, and for the 12 mutually exclusive population sub-groups. These estimates constituted the database for the present analysis. Estimates of child survival probability for different population sub-groups could, however, not be calculated for all the 640 districts because there was either no population of some of the population sub-groups in the district or the population of the sub-group was too small to provide reliable estimates of the probability of death and hence in the probability of survival in these population sub-groups.

Results

Table 1 and figure 1 present the empirical 'normal' male-female disparity in survival up to 15 years across 640 districts of the country for total population and for different population sub-groups. The empirical 'normal' male-female disparity in survival up to 15 years of age for the total population and for different population sub-groups reveals marginal female survival advantage, although, the size or the magnitude of the disparity varies across population sub-groups. In the urban population, the magnitude of the empirical 'normal' female survival advantage is substantially higher than that in the rural population. Among different social classes, the magnitude of the empirical 'normal' female survival advantage is the lowest in the Scheduled Tribes but the highest in the Other Castes. Similarly, the magnitude of the empirical 'normal' female survival advantage varies from the lowest in the rural Other Castes population to the highest in the urban Other Castes population. In the rural population, the size, or the magnitude of the empirical 'normal' female survival advantage in the Scheduled Castes population is higher than that in the Scheduled Tribes population but, in the urban areas, the magnitude of the empirical 'normal' female survival advantage in the Scheduled Tribes population is substantially higher than that in the Scheduled Castes population. The empirical 'normal female survival advantage is the lowest in the Other Castes population in the rural areas, but it is the highest in the urban areas across the three social classes.

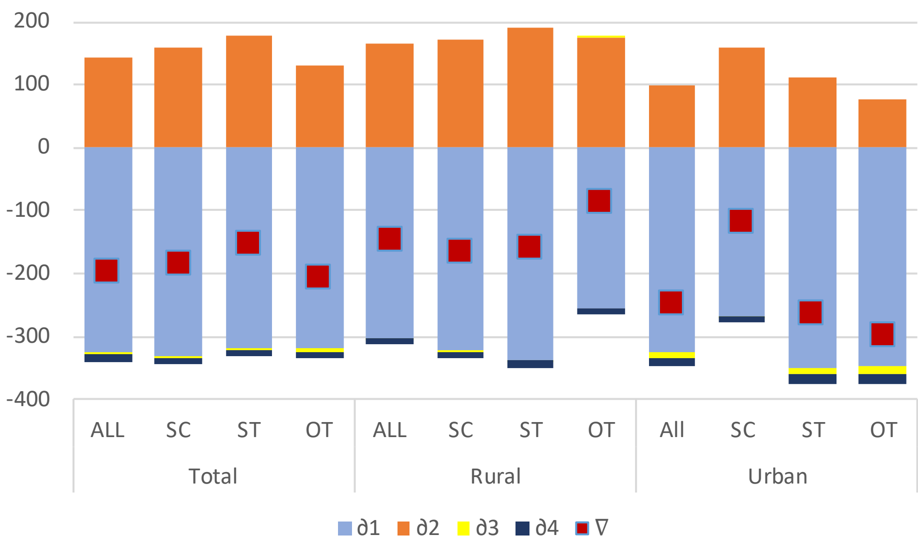

Figure 1: Empirical 'normal' male-female disparity in probability of survival up to 15 years of age (per 100 thousand births) in India and in different population sub-groups
Source: Author

Table 1: Empirical 'normal' male-female disparity (per 100 thousand births) in the survival up to 15 years of age across districts of India.

Population	Male-female disparity in survival probability 0-15 years	Contribution of male-female disparity in the probability of survival in the age group				Number of districts
		0-1 year	1-5 years	5-10 years	10-15 years	
	∇	∂_1	∂_2	∂_3	∂_4	
Total	-195	-323	144	-5	-11	640
Scheduled Castes	-184	-331	161	-3	-11	579
Scheduled Tribes	-154	-319	178	-2	-11	556
Other Castes	-205	-317	130	-6	-11	639
Rural	-145	-301	167	-1	-10	631
Scheduled Castes	-164	-322	171	-2	-11	565
Scheduled Tribes	-157	-337	191	-1	-11	540
Other Castes	-86	-257	176	2	-8	630
Urban	-248	-324	98	-10	-12	636
Scheduled Castes	-119	-268	158	0	-9	567
Scheduled Tribes	-262	-349	112	-11	-14	502
Other Castes	-298	-348	77	-13	-14	632

Source: Author

Table 1 and figure 1 also show the contribution of the empirical 'normal' male-female disparity in survival up to 15 years of age in different age groups to the empirical 'normal' male-female disparity in the age group 0-14 years. The male-female disparity in survival in age groups 0-1 year, 5-9 years and 10-14 years contributes to the increase in the female survival advantage in the age group 0-14 years but the male-female disparity in survival in the age group 1-4 years contributes to the decrease, instead increase, in the female survival advantage in 0-14 years. In all population sub-groups, there is female survival disadvantage or, equivalently, male survival advantage in the age group 1-4 years. Because of the female survival disadvantage in the age group 1-4 years, the female survival advantage in the age group 0-14 years is substantially lower than that determined by the female survival advantage in age groups 0-1 year, 5-9 years and 10-14years.

It may also be seen from table 1 and figure 1 that the empirical 'normal' female survival advantage in the age group 0-14 years is primarily due to the empirical 'normal' female survival advantage in the first year of life, although a substantial proportion of this empirical 'normal' female survival advantage is compromised by empirical 'normal' female survival disadvantage in the age group 1-4 years. Compared to the contribution of the empirical 'normal' male-female disparity in survival in the age groups 0-1 year and 1-4 years to the empirical 'normal' male-female disparity in survival in the age group 0-14 years, the contribution of the empirical 'normal' male-female disparity in survival in the age groups 5-9 years and 10-14 years is quite small. Male-female disparity in survival in 0-14 years is primarily determined by the disparity in 0-5 years.

Table 2: Distribution of districts by male-female disparity in the probability of survival up to 15 years of age by residence and social class.

Male-Female disparity in survival	Social class			
	All social classes	Scheduled Castes	Scheduled Tribes	Other Castes
	Total population			
High female advantage	81	95	164	108
Moderate female advantage	102	87	59	75
Marginal female advantage	139	103	87	137
Marginal male advantage	109	78	70	110
Moderate male advantage	87	76	56	81
High male advantage	122	140	120	128
No data	0	61	84	1
	Rural population			
High female advantage	102	123	161	123
Moderate female advantage	94	72	62	94
Marginal female advantage	128	98	84	105
Marginal male advantage	106	62	58	110
Moderate male advantage	81	71	56	61
High male advantage	120	139	119	137
No data	9	75	100	10
	Urban population			
High female advantage	102	132	192	109
Moderate female advantage	68	68	34	64
Marginal female advantage	120	64	38	112
Marginal male advantage	140	67	39	131
Moderate male advantage	73	55	46	71
High male advantage	133	181	153	145
No data	4	73	138	8

Source: Author

District level variation in male-female disparity in survival up to 15 years of age from the empirical 'normal' is quite marked (Table 2). There are 81 districts in the country where survival advantage in females is high compared to males. In these districts, the probability of a female newborn to survive to the 15th birthday is substantially higher than that of a male newborn. By contrast, in 122 districts, male survival advantage is high compared to females which implies that, in these districts, the probability of a female newborn to survive to the 15th birthday is lower than that of a male newborn. On the other hand, there are 139 districts where female survival advantage is marginal. Similarly, there are 109 districts where male survival advantage is marginal so that in 248 (39 per cent) districts of the country, the male-female disparity in survival up to 15 years of age may be termed as marginal. In 183 (29 per cent) districts, female survival advantage is substantial (either moderate or high) while in 209 (33 per cent) districts male survival advantage is substantial (moderate or high).

The proportion of districts having either substantial female advantage or substantial male advantage in survival up to 15 years of age varies by different population sub-groups. In the rural population, 196 (31 per cent) districts have female substantial survival advantage while 201 (32 per cent) districts have substantial male survival advantage so that in 234 (37 per cent) districts, either female or male survival advantage is only marginal. The corresponding proportions in the urban population are 27 per cent, 32 per cent and 41 per cent, respectively. Similarly, the proportion of districts having substantial female survival advantage is the highest in the Scheduled Tribes population while the proportion of districts having substantial male survival advantage is the highest in the Scheduled Castes population whereas the proportion of districts having marginal male-female disparity in survival up to 15 years of age is the highest in the Other Castes population. Among the six mutually exclusive population sub-groups, the proportion of districts having substantial female survival advantage is the highest in Urban Scheduled Tribes population while the proportion of districts having substantial male survival advantage is the highest in the urban Scheduled Castes population. On the other hand, the proportion of districts where male-female disparity in survival up to 15 years of age is marginal is the highest in the urban Other Castes population. Table 2 suggests that male-female disparity in survival up to 15 years of age varies across the districts of the country is determined by the within district variation in male-female disparity across six mutually exclusive population sub-groups in each districts. It may, however, be noted that the social class composition of the population is not the same in all districts which also has an impact on the male-female disparity in the probability of survival up to 15 years of age in the district.

Districts according to the male-female disparity in child survival are not distributed uniformly across the country. There is clear north-south divide in the total population and in all population sub-groups as may be seen from figures 2 through 13. In the northern part of the country, male advantage in survival up to 15 years of age appears to be the norm in all population sub-groups. Majority of the districts having male survival advantage or female survival disadvantage are located in the northern part of the country (Figure 2). On the other hand, the situation appears to be mixed in the southern part of the country where majority of the districts having female survival advantage are located. At the same time, male-female disparity in survival up to 15 years of age is marginal in a substantial proportion of districts of this region while there is a small proportion of districts where male advantage in survival is substantial. There are six states/Union Territories – Delhi, Uttar Pradesh, Bihar, and Nagaland – there is no district where female survival advantage in the first five years of life is either high or moderate. On the other hand, there is no district in Himachal Pradesh, West Bengal, Chhattisgarh, Andhra Pradesh, and Kerala where the male survival advantage in the first 15 years of life is either moderate or high. In West Bengal, the male-female disparity in survival up to 15 years of age is marginal in 16 of the 19 districts or in more than 84 per cent districts. In Punjab, Haryana, Nagaland, Maharashtra, Andhra Pradesh, and Kerala also, the male-female disparity in the probability of survival up to 15 years of age is found to be marginal in more than 60 per cent districts (Table 3).

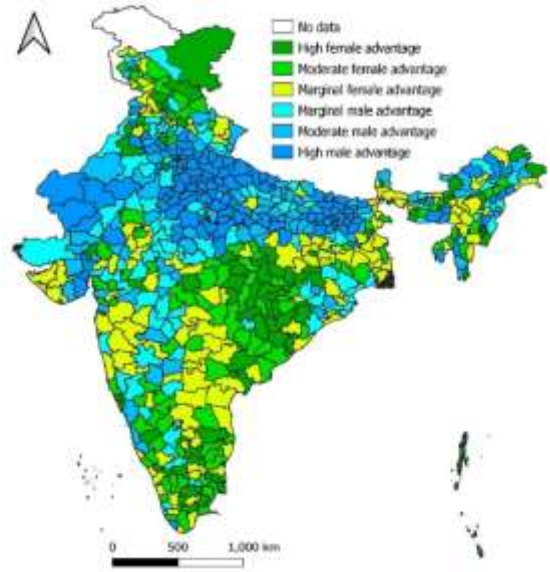

Figure 2: Inter-district variation in male-female disparity in child survival - total population.

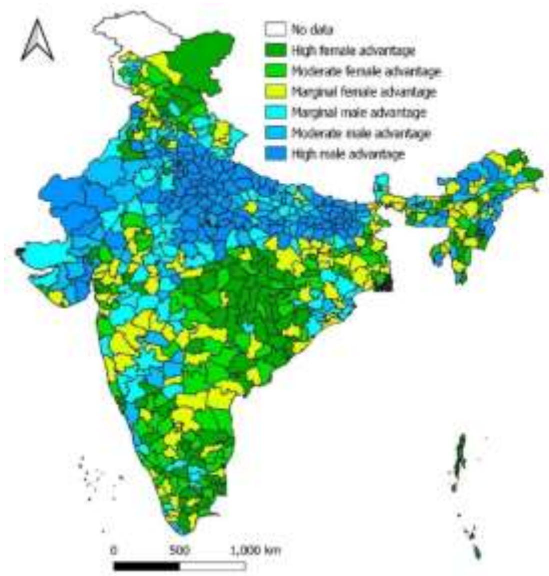

Figure 3: Inter-district variation in male-female disparity in child survival - rural population.

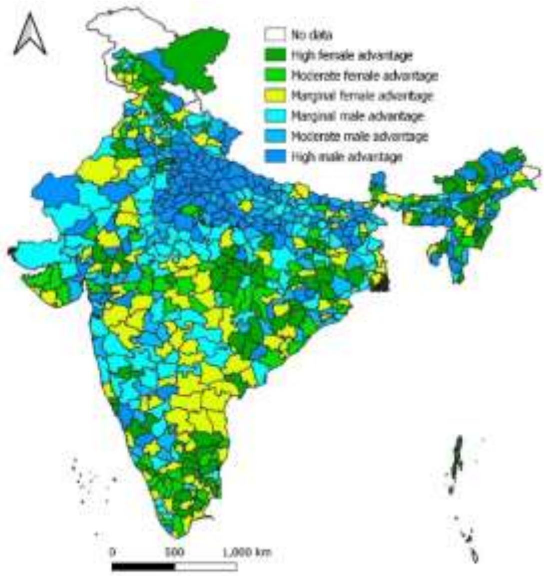

Figure 4: Inter-district variation in male-female disparity in child survival - urban population.

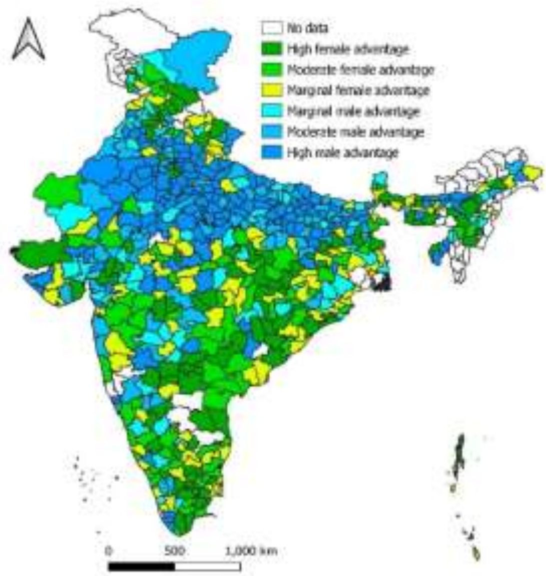

Figure 5: Inter-district variation in male-female disparity in child survival - Scheduled Castes, total.

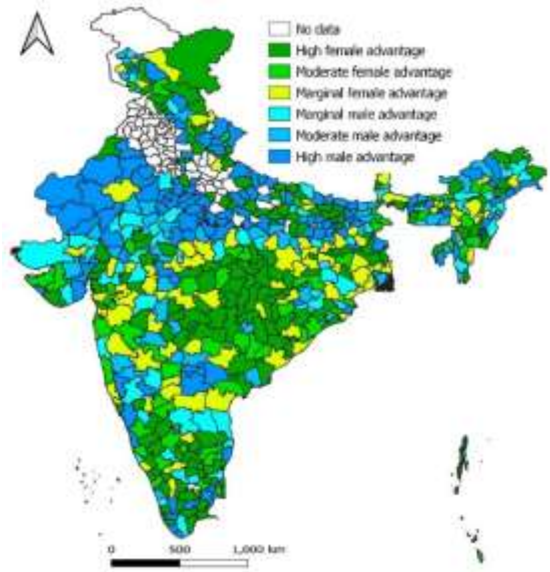

Figure 6: Inter-district variation in male-female disparity in child survival - Scheduled Tribes total.

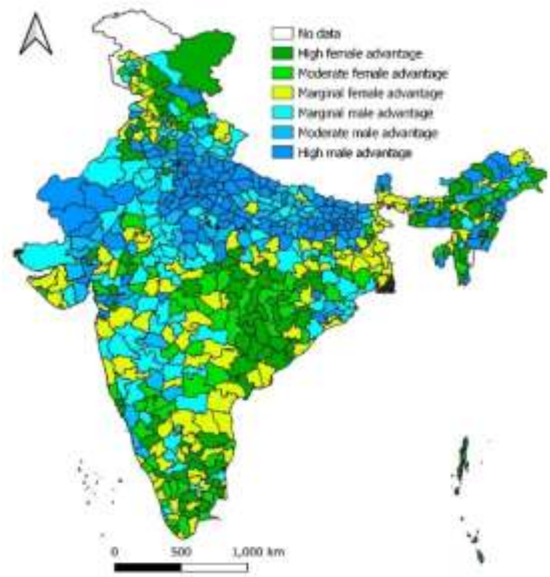

Figure 7: Inter-district variation in male-female disparity in child survival - Other Castes total.

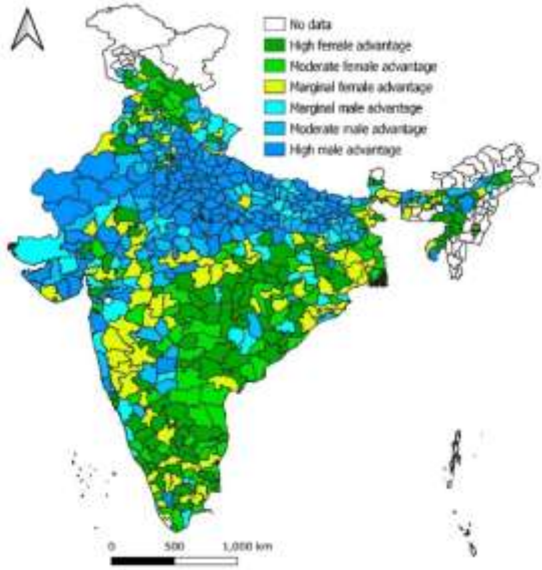

Figure 8: Inter-district variation in male-female disparity in child survival - Scheduled Castes, rural.

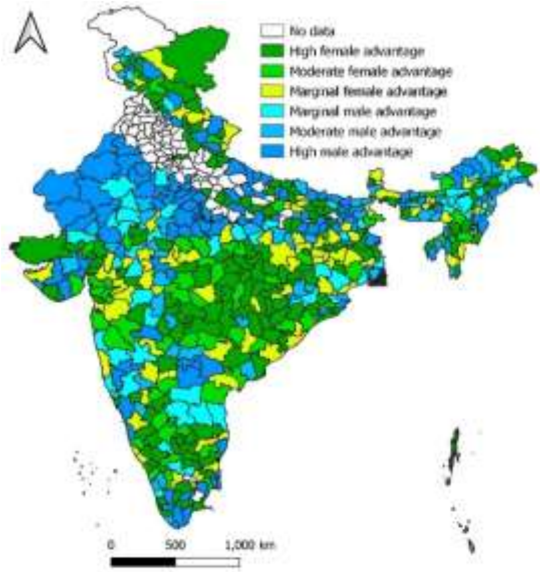

Figure 9: Inter-district variation in male-female disparity in child survival - Scheduled Tribes, rural.

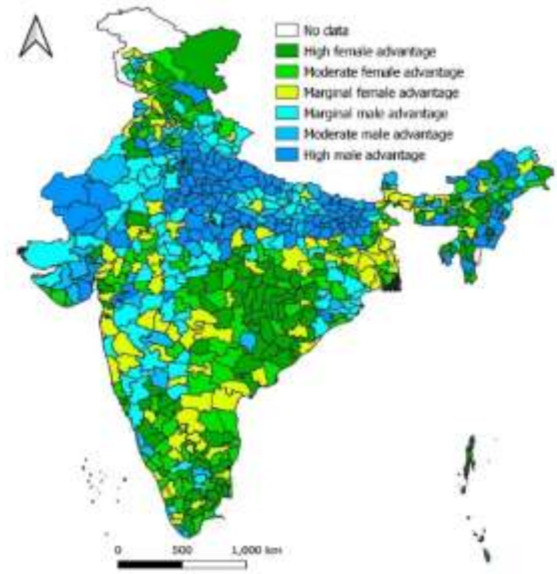

Figure 10: Inter-district variation in male-female disparity in child survival - Other Castes, rural.

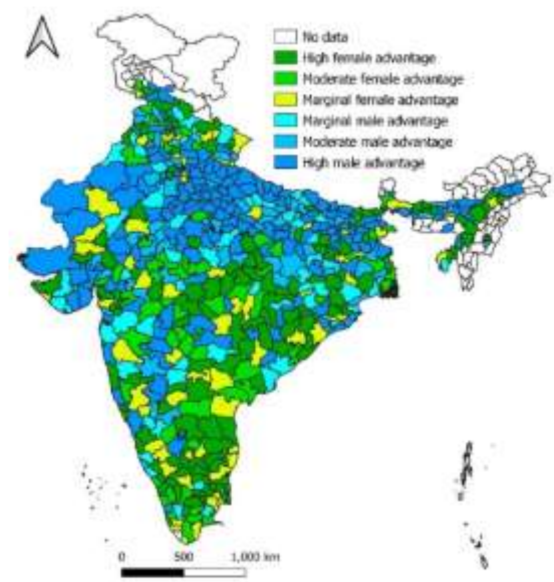

Figure 11: Inter-district variation in male-female disparity in child survival - Scheduled Castes urban

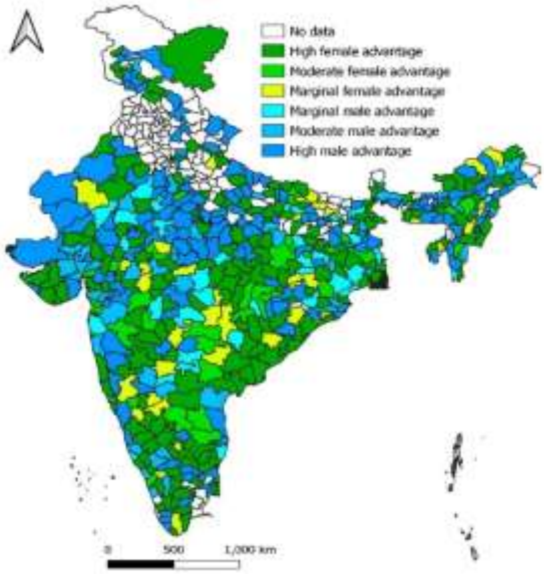

Figure 12: Inter-district variation in male-female disparity in child survival - Scheduled Tribes, urban.

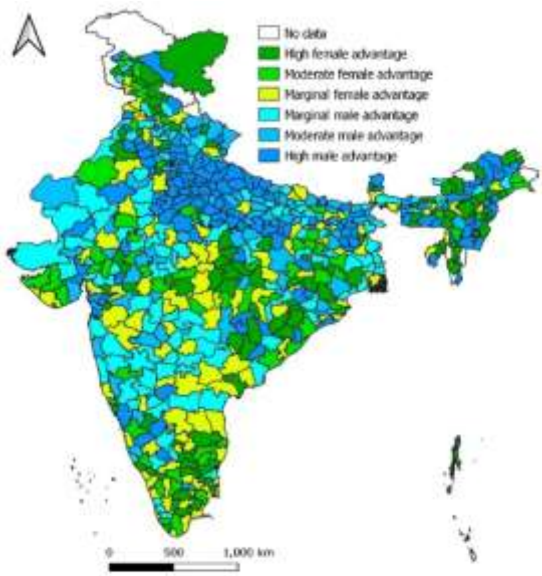

Figure 13: Inter-district variation in male-female disparity in child survival - Other Castes, urban.

Table 3: Distribution of districts by male-female disparity in the probability of survival up to 15 years of age across states/Union Territories.

Country/State/ Union Territory	Male-female disparity in survival in 0-14 years of age						Number of districts
	Female advantage			Male advantage			
	High	Moderate	Marginal	Marginal	Moderate	High	
AN Islands	3	0	0	0	0	0	3
Andhra Pradesh	4	5	13	1	0	0	23
Arunachal Pradesh	3	0	4	1	4	4	16
Assam	5	6	8	4	3	1	27
Bihar	0	0	1	3	7	27	38
Chandigarh	0	1	0	0	0	0	1
Chhattisgarh	8	7	2	1	0	0	18
Dadra & Nagar Haveli	0	0	1	0	0	0	1
Daman & Diu	0	1	1	0	0	0	2
Delhi	0	0	0	3	2	4	9
Goa	2	0	0	0	0	0	2
Gujarat	1	5	7	4	7	2	26
Haryana	2	1	1	3	7	7	21
Himachal Pradesh	6	5	0	1	0	0	12
Jammu & Kashmir	2	6	7	5	2	0	22
Jharkhand	3	4	9	5	2	1	24
Karnataka	2	10	6	7	5	0	30
Kerala	1	4	6	3	0	0	14
Lakshadweep	0	0	0	0	0	1	1
Madhya Pradesh	6	9	8	11	8	8	50
Maharashtra	1	8	14	10	2	0	35
Manipur	4	1	2	1	0	1	9
Meghalaya	1	1	1	1	0	3	7
Mizoram	1	2	1	1	2	1	8
Nagaland	0	0	2	5	2	2	11
Odisha	7	5	6	9	3	0	30
Puducherry	4	0	0	0	0	0	4
Punjab	2	1	7	5	2	3	20
Rajasthan	1	1	2	11	7	11	33
Sikkim	1	0	1	1	1	0	4
Tamil Nadu	11	13	7	1	0	0	32
Tripura	0	2	1	0	0	1	4
Uttar Pradesh	0	0	2	7	17	45	71
Uttarakhand	0	1	4	4	4	0	13
West Bengal	0	3	15	1	0	0	19
India	81	102	139	109	87	122	640

Source: Author

The male-female disparity in survival up to 15 years of age also varies by the six mutually exclusive population sub-groups within each district. There are only There are only 42 (6.6 per cent) districts in the country where females have a survival advantage – high, moderate, or marginal – relative to males in all the six mutually exclusive population sub-groups (Figure 14). Similarly, there only are 61 (9.5 per cent) districts where male have a survival advantage – high, moderate, or marginal - in all the six mutually exclusive population sub-groups. In most of the districts of the country, female, or male survival advantage in one or more mutually exclusive population sub-groups is associated with female or male survival disadvantage or male or female survival advantage in other population sub-groups.

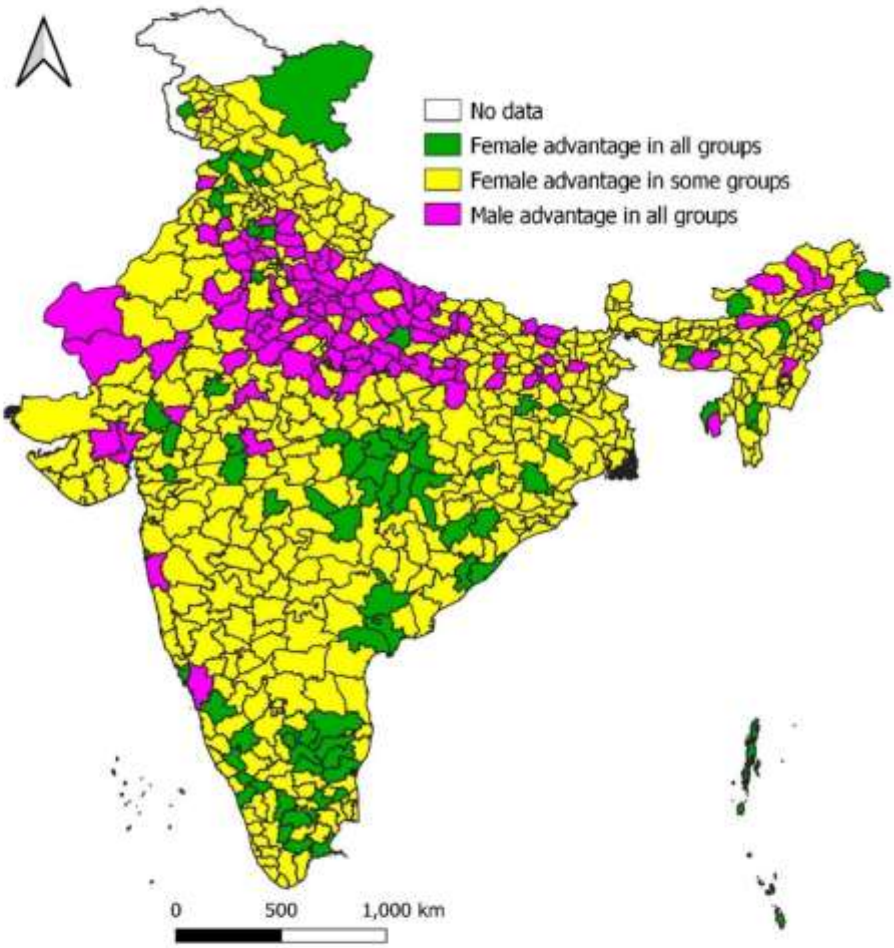

Figure 14: Inter-district variation in within-district male-female disparity in survival up to 15 years of age.

The male-female disparity in survival up to 15 years of age is the cumulation of the male-female disparity in survival in the age groups 0-1 year; 1-4 years; 5-9 years; and 10-14 years. We have carried out a classification modeling exercise using the classification and regression technique (CRT) to classify districts in terms of male-female disparity in survival up to 15 years of age in the context of the contribution of male-female disparity in survival in age groups 0-1 year; 1-4 years; 5-9 years; and 10-14 years to the male-female disparity in survival up to 15 years of age. Districts were first classified into six categories for the purpose of classification modelling exercise based on male-female disparity in survival in the first 15 years of life: 1) districts having high female survival advantage; 2) districts having moderate female survival advantage; 3) districts having marginal female survival advantage; 4) districts having marginal male survival advantage; 5) districts having moderate male survival advantage; and 6) districts having high male survival advantage. On the other hand, independent variables used for the classification modelling exercise are: 1) contribution of male-female disparity in survival in the first year of life to the male-female disparity in survival up to 15th birthday; 2) contribution of male-female disparity in survival in 1-4 years of life to the male-female disparity in survival up to 15th birthday; 3) contribution of male-female disparity in survival in 5-9 years of life to the male-female disparity in survival up to 15th birthday; and 4) contribution of male-female disparity in survival in 10-14 years of life to the male-female disparity in survival up to 15th birthday. The dependent variable in the classification modelling exercise is a categorical one while all the four independent variables are scale variables.

Results of the classification modelling exercise are presented in table 4 and the associated classification tree is depicted in Figure 15. The classification modelling exercise suggests that 640 districts of the country can be grouped into 6 mutually exclusive groups or clusters of districts on the basis of the contribution of male-female disparity in survival in the age groups 5-9 years and 10-14 years and the male-female disparity in survival up to 15 years of age in the clusters identified is different. The first cluster comprises of 80 districts and in all districts in this cluster have high female survival advantage. In all districts of this cluster, the contribution of male-female disparity in survival in the age group 5-9 years is $\leq$0.005 per 1000 live births while the contribution of male-female disparity in survival in the age groups 10-14 years is $\leq$-0.300 per 1000 live births. The second cluster comprises of 109 districts and 102 districts of this cluster have moderate female survival advantage while 1 district has high female survival advantage while 6 districts have marginal female survival advantage. The contribution of male-female disparity in survival in the age group 5-9 years is $\leq$0.005 per 1000 live births in all these districts while the contribution of male-female disparity in survival in the age group 10-14 years ranges between -0.300 and -0.135 per 1000 live births. The third cluster comprises of 134 districts and 131 districts of this cluster have marginal female survival advantage while 3 districts have marginal male survival advantage. The contribution of male-female disparity in survival in the age group 5-9 years, in districts of this cluster, is $\leq$0.005 per 1000 live births while the contribution of male-female disparity in survival in the age group 10-14 years is $>$-0.135

per 1000 live births. The fourth cluster has 105 districts and 103 districts of this cluster have marginal male survival advantage while two districts have marginal female survival advantage. The distinguishing feature of the districts of this cluster is that the contribution of male-female disparity in survival in the age group 5-9 years ranges between 0.005 to 0.315 per 1000 live births. The fifth cluster has 89 districts and all but three districts have moderate male survival advantage while three have marginal male survival advantage. The distinguishing feature of districts of this cluster is that the contribution of male-female disparity in survival in the age group 5-9 years ranges from 0.315 to 0.665 per 1000 live births in districts of this cluster. Finally, the sixth and the last cluster has 123 districts and all but one of these districts have high male survival advantage while one district has moderate male survival advantage. The distinguishing feature of the districts of this cluster is that the contribution of the male-female disparity in survival in the age group 5-9 years is more than 0.665 per 1000 live births in districts of this cluster. The accuracy of the classification modelling exercise in classifying a district into one of the six categories of male-female disparity in survival up to 15 years of age is found to be 97.5 per cent. There are only 16 districts where model classification differed from the actual classification. The most important classification or independent variable is found to be the contribution of the male-female disparity in survival in the age group 10-14 years , closely followed by the male-female disparity in survival in the age group 5-9 years. The importance of the contribution of the male-female disparity in survival in the age group 1-4 years to the male-female disparity in survival up to 15 years of age has been found to be the lowest among the four independent variables used in the classification modelling exercise. The analysis also reveals that male-female disparity in survival in the first year of life and male-female disparity in survival in 1-4 years of life contribute little in determining the male-female disparity in survival up to 15 years of age across the districts of the country. The classification modelling exercise suggests that the male-female disparity in survival up to 15 years of age is determined largely by the male female disparity in survival in 5-9 years and 10-14 years and not by male-female disparity in survival in either 0-1 year of age or in 1-4 years of age.

The classification modelling exercise highlights the importance of male-female disparity in survival in the age groups 5-9 years and 10-14 years in deciding the male-female disparity in survival in the age group 0-14 years across the districts of the country. Male-female disparity in survival in the age groups 0-1 year and 1-4 years also matters in determining the male-female disparity in survival in the age group 0-14 years but the contribution of the male-female disparity in survival in 0-1 year and in 1-4 years of age in deciding the male-female disparity in survival up to 15 years of age is not as important as the contribution of male-female disparity in survival in the age groups 5-9 years and 10-14 years. This observation bears significance in the policy and programme context as the strategy and the interventions required for addressing male-female disparity in survival in the age group 5-9 years and in the age group 10-14 years are different from the strategy and interventions required for addressing male-female disparity in survival in age groups 0-1 year and 1-4 years.

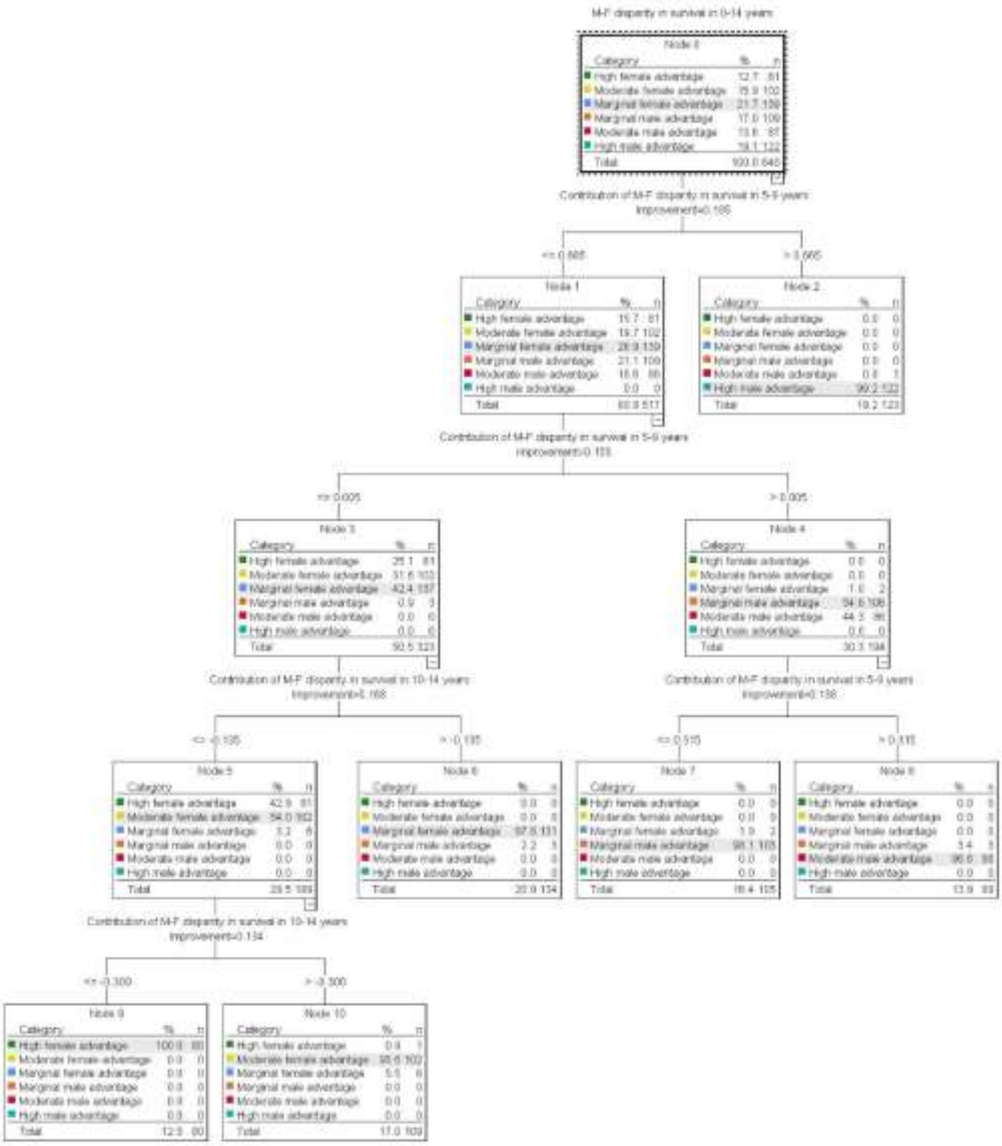

Figure 15: Classification of districts by male-female (M-F) disparity in survival (per 1000 live births) in 0-14 years of age by the contribution of M-F disparity in survival (per 1000 live births) in age groups 0-1 year, 1-4 years, 5-9 years, and 10-14 years.

Table 4: Results of the classification of districts in terms of male-female disparity in survival up to 15 years of age per 1000 live births by the contribution of male-female disparity in survival in age groups 0-1 year, 1-4 years, 5-9 years, and 10-14 years

Node ID	Contribution of male-female disparity in different age groups				Male-female disparity in survival in the age group 0-14 years per 1000 live births						Total
					Female advantage			Male advantage			
	0-1 year	1-4 years	5-9 years	10-14 years	High	Moderate	Marginal	Marginal	Moderate	High	
9	All	All	≤0.005	≤-0.300	80	0	0	0	0	0	80
10	All	All	≤0.005	>-0.300 ≤-0.135	1	102	6	0	0	0	109
6	All	All	≤0.005	>-0.135	0	0	131	3	0	0	134
7	All	All	>0.005 ≤0.315	All	0	0	2	103	0	0	105
8	All	All	>0.315 ≤0.665	All	0	0	0	3	86	0	89
2	All	All	>0.665	All	0	0	0	0	1	122	123
All	All	All	All	All	81	102	139	109	87	122	640

Source: Author

Discussions and Conclusions

This paper follows a non-parametric approach to establish empirical 'normal' male female disparity in the probability of survival in the first 15 years of life across the districts of India. Based on district level estimates of the risk of death in the first 15 years of life derived from the summary birth history data from the 2011 population census, our analysis suggests that the empirical 'normal' male-female disparity in child survival up to 15 years of age in the country is marginal female survival advantage for the total population and for different population sub-groups. Deviations from this empirical 'normal' across the districts are substantial and in more than 60 per cent districts of the country, the male-female disparity in the probability of survival up to 15 years of age is quite marked. The analysis also reveals that districts having marked male survival advantage or marked female survival disadvantage are mostly located in the northern part of the country. There are states and Union Territories where there is not a single district with female survival advantage up to 15 years of age. Similarly, there are states and Union Territories where there is not a single district with male survival advantage. The analysis also reveals that there is substantial male-female disparity in the probability of survival within district across different mutually exclusive population sub-groups characterised by residence and social class. There are very few districts where there if female survival advantage in all mutually exclusive population groups in the district. Similarly, there are very few districts where there is male survival advantage in all mutually exclusive population sub-groups. In most of the districts of the country, female survival advantage or male survival disadvantage in 0-15 years of age in some population sub-groups is found to be associated with female survival disadvantage or male survival advantage in other population sub-groups. Moreover, the classification modelling exercise suggests that male-female disparity in survival in age groups 5-9 years and 10-14 years largely determines the male-female disparity in survival up to 15 years of age.

The findings of the present analysis have important policy and programme implications. It is obvious that a district-based approach is needed to address the male-female disparity in child survival. There is substantial within-district inequality in male-female disparity in child survival across mutually exclusive population sub-groups. This inequality needs to be taken into consideration while planning and programming for improving child survival at the district level by identifying factors that influence male-female disparity in survival differently in different population sub-groups within the same district. Finally, planning and programming for improving child survival and reducing male-female disparity in child survival should give particular attention to male-female disparity in survival in children older than 5 years of age as male-female disparity in survival in children above five years of age determine, substantially, male-female disparity in survival up to 15 years of age.

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