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Examining the Effect of Prenatal and Postnatal Factors in the Context of Changing Pattern of Sex Ratio among under-5 in India and Its Major States

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Introduction

Most countries in the developing world had high fertility and mortality in the past due to the combination of low child survival and low female education. Over time these countries, including India, have experienced fertility transition at a varying pace and many have reached the replacement level. India has also experienced fertility decline over time and its total fertility rate (TFR) has decreased from the `level of 5.2 births per woman in 1971 (Registrar General of India (RGI), 1973) to 2.3 births per woman in 2013 (RGI, 2015). This decline is not uniform across the country. There is a significant diversity within India in terms of fertility levels and pace of fertility transition. Southern India, urban areas, and higher socio-economic groups have low fertility (1.3 TFR) as compared to the North Indian states (Arokiasamy & Goli, 2012). Many demographers believe that a strong desire to have a son is one of the major causes of high fertility among rural Indians (Gupta, 1987; Das Gupta & Bhat, 1997; Griffiths *et. al.*, 2000; Guillot, 2002; Sekher & Hatti, 2010; Shekhar & Ram, 2003; Bhat & Zavier, 2003; Arokiasamy & Goli, 2012; Yadava *et al.*, 2013).

In the 1901 census, the child sex ratio (0-4) in India was more favorable towards females compared to the males; now the situation is different. India is passing through a phase where there is an excess of males, which is an alarming situation as it can have an impact on the future population stabilization. If this pattern continues, it will have an impact on marriage as there will be more grooms than brides (Guilmoto, 2007). If the present pattern of sex ratio continues, it will lead to a serious social distortion such as an increase in gender violence, trafficking, discrimination against women and girl. Many studies reveal that there is a preference for the male child in the developing countries and also in some developed countries, where the household size is small. Historical findings suggest that parents were less likely to move to next parity in case the last-born child was male. In the agrarian societies of the past, sons were preferred over daughters from the economic point of view as also for taking the family forward in terms of inheritance. Even today, the society gives more preference to sons as it views them as heirs and also as assets for the old age. Some Asian countries show different phases of demographic transition in case of fertility and mortality as well as different trends and patterns of population sex ratio with a higher predominance of the male population. The scenario of sex ratio in the Asian countries is the same as in the other countries. Sex ratio at birth mainly considers prenatal sex selection, and it is favorable towards the male child. Gender inequality is one of the consequences of sex-selection. Further research is needed for the development of policy actions to prevent sex-selective abortions and to prevent the child sex ratio from becoming even more skewed in India as a whole and in the states individually.

Since the 1980s, due to the advancement in medical sciences and due to socioeconomic improvements, the under-five mortality rate has also decreased. It has declined from the level of 200 per 1000 live births in India in 1976 (RGI, 1976) to the level of 49 per 1000 live births in 2011 (RGI, 2013). Faster improvements in child survival since the 1980s, coupled with an increase in female education, has probably reduced the demand for large families. There is evidence that the decline in fertility, with son preference more or less remaining intact, has led to a highly unfavorable child sex ratio. The Sample Registration System (SRS) data for Sex Ratio at Birth (SRB) at the national level for the period 2014-16 (3-years average) has been estimated at 898 females per 1000 males – 902 in the rural areas and 888 in the urban areas. Among the bigger States/UTs, the sex ratio at birth varies from 963 in Chhattisgarh to 832 in Haryana. In the rural areas, the highest and the lowest sex ratios at birth are in the States of Chhattisgarh (995) and Haryana (835) respectively. The sex ratio in the urban areas varies from 957 in Madhya Pradesh to 820 in Gujarat. The sex ratio at birth is affected mainly by prenatal sex selection, sex selective abortion, and preconception genetic diagnosis (Bongaarts & Guilmoto, 2015). On the other hand, the child sex ratio is affected by sex ratio at birth (SRB; defined as male live births per 100 female live births), sex differentials in child mortality, and data quality (Bongaarts & Guilmoto, 2015).

Globally, the number of missing females has been increasing continuously since 1970 (61 million). It had increased to 126 million by 2010 and will further increase to 150 million by 2035 before declining to 142 million by the mid of this century (Bongaarts & Guilmoto, 2015). Bhattacharya and Heriot (2012) have estimated that if India and China had the same sex ratio as sub-Saharan Africa, then, given the number of males in these countries, there would have been 37 million more women in India and 44 million more women in China in the mid-1980s. In India, socio-economically well-off states like Punjab, Haryana, Himachal Pradesh, Gujarat, Maharashtra, Chandigarh, and Delhi recorded a decline in the child sex ratio during this time period (ORG, 1991 & Premi, 1991). The case of 'missing women' in India has a historical cause and deviates with the discussion of the skewed sex ratio in the northern parts of India (Smith *et. al.,* 1999). The Census of India 1881 contained a detailed discussion on son preference and female infanticide among certain regions of North India, especially Punjab and Haryana. The 1901 Census of India showed a systematic regional division in sex ratio, with the North and the West having ratios that are unfavorable to women compared to the East and the South. A number of studies have been done to make a comparison of the sex ratio in North, South, and East India. These studies conclude that in North India, son preference remains stronger than in the South (Dyson and Moore, 1983). There is greater female autonomy in the South, and the traditional marriage patterns are also different compares with the North (Jejeebhoy, S. J. & Sathar, Z. A., 2001). Fisher (2000) has explained as to why the sex ratio would become balanced in the absence of mortality differences. His argument applies to the evolutionary time scale of hundreds of generations. Sen (1990) had noted that more than 100 million women are missing in Asia; however, he had focused only on female mortality, not on prenatal sex selection. As a result of the combination of prenatal sex selection and excess postnatal mortality, the number of "missing girls" has increased globally (Bongaarts & Guilmoto, 2015). According to Sen (1990), "These numbers tell us, quietly, a poor story of inequality and neglect leading to the excess mortality of women". The selective abortion of female fetuses, mainly after a first-born girl, has increased in India over the past few decades and has continued to unbalancing the child sex ratio (Jha *et. al.*, 2011). Unexpectedly, the child sex ratio is more skewed in the educated and well-off states because sex selective abortion is more common in educated and richer households as they can presumably afford ultrasound and abortion services more than the uneducated or poorer households (Jha *et al.,* 2011). Increasing education and incomes may also have contributed to the increasing selective abortion of girls.

Sex ratio is an indicator of the status of women in the society. In India, the sex ratio has been declining since 1901. The deep rooted patriarchal set-up together with certain socio-cultural practices, especially in some parts of the country, has led to an imbalance in the sex ratio. The factors responsible for this imbalance, resulting in such practices as female infanticide and sex selective abortion, have prevailed since ages and continue till date without much effort to stop them except for the PCPNDT Act 1994 and its amendments (Vella, 2005). In India, the urban areas show a lower SRB in comparison to the rural areas. Factors such as better medical infrastructure and availability of sex selective abortion technologies play a major role in such an imbalance (Vella, 2005). In the southern parts of the country, Kerala has a better sex ratio compared to the other southern states. The social development of the state has significantly led to a better status of women. In the case of Kerala, the role of migration also plays a major role in the context of sex ratio (Vella, 2005). The traditional value of sex ratio at birth is 105 males per 100 females (Raju and Premi, 1992). The scenario is the same in India, with the sex ratio at birth being in favor of males due to biological factors, pre-natal sex selection, and other factors. A number of recent studies have indicated an improvement in the overall sex ratio, but the child sex ratio has been worsening for the last two to three decades. The situation is becoming alarming in terms of long term consequences and needs to be investigated.

Method and data

We have taken sex ratio at birth from the Sample Registration System (SRS) for the period 1997–2011 and abridged life tables for India and major states of India. Sample Registration System (SRS) under the guidance of the Registrar General of India (RGI) is the primary and continuous source of data on life tables. The states included in the study are Punjab, Haryana, and Rajasthan (from the northern region); Uttar Pradesh and Madhya Pradesh (from the central region); West Bengal, Odisha, and Bihar (from the eastern region); Gujarat and Maharashtra (from the western region); and Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu (from the southern region). Two of the states, Himachal Pradesh and Assam, could not be included in the analysis due to deficiency of data for these states for the study period. So, we are restricting our analysis to only 14 states and India as a whole. These 14 states covered nearly 87% of India's population in the 2011 census.

In India, the assessment of the fertility and mortality levels in the population can be done using many sources of data like Civil Registration, Sample Registration System (SRS), etc. In the absence of good quality of civil registration statistics, the SRS is the most reliable source to develop these estimates. The SRS was started by the Registrar General of India as a scheme of "sample registration of births and deaths in India: rural" in 1964-65 on a pilot basis and was made fully effective in 1969-70. The SRS collects data from a sub-set of the population every year and calculates sex ratios at birth (prenatal factor) and infant and child mortality (postnatal factors) annually by the state; therefore, we can use this data separately for fertility and mortality factors. For the prenatal factor, sex ratio at birth (1998-2000) and the sex ratio at birth (2009-2010) data are taken from the SRS. Abridged life tables of the SRS 1996-2001 and 2006-2011 have been used for estimating survival probability (postnatal factor). For decomposing the child sex ratio by age and sex, we used data from two consecutive censuses of India conducted in the years 2001 and 2011 (ORG 2011). The Office of the Registrar General of India and Census Commissioner has been conducting the census every ten years since 1881, the latest one having been conducted in 2011. The present study is based on the last two Censuses of India, 2001 and 2011.

Methods

Decomposition analysis for prenatal and postnatal factors

A theoretical demographic relationship between child sex ratio and a number of male and female births and survival of these births by sex exists. A decomposition analysis was done to evaluate the impact of prenatal and postnatal factors on the child sex ratio over the 2001-2011 decade. The detailed expression is discussed below:

Child sex ratio (CSR^t) = Female population^t (0-4)/male population^t (0-4)

$$\text{CSR}^t = \frac{[\text{Female Birth}^{(t-4,\ t)}] * [\text{Female survival}_{0-4}^{(t-4,\ t)}]}{[\text{Male Birth}^{(t-4,\ t)}] * [\text{Male survival}_{0-4}^{(t-4,\ t)}]}$$

$= \left[\text{Sex ratio at birth}^{(t-4,\ t)}\right] * \left[\text{ ratio of survival rate }_{0-4}^{(t-4,\ t)}\right]$

= Prenatal factor* Postnatal factor

For the population at the time t

Child sex ratio (CSR^{t}) = $SRB^{t} * RS^{t}$

For the population at the time t+10

Child sex ratio (CSR^{t+10}) = $SRB^{t+10} * RS^{t+10}$

The ratio of child sex ratio for the population at time t to the population at time t+10

(CSR^{t+10}/ CSR^{t})= ($SRB^{t+10} * RS^{t+10}$/ $SRB^{t} * RS^{t}$)

Proportion change in child sex ratio during two-time periods

Proportion change in child sex ratio (PCSR) =1- (CSR^{t+10}/CSR^{t})

Proportion change in sex ratio at birth =1- (SRB^{t+10} /SRB^{t})

Proportion change in ratio of survival = 1- (RS^{t+10} /RS^{t})

Then 1- [CSR^{t+10}/CSR^{t}] = [1- (SRB^{t+10} /SRB^{t})] * [1- (RS^{t+10} /RS^{t})]

that is,

PCSR=PSRB+PRS-Interaction effects………………………………………………………… (1)

Where SRB is sex ratio at birth; RS is ratio of survival the rate of females and survival rate of males; and PCSR, PSRB, and PRS are proportion change in child sex ratio, sex ratio at birth, and ratio of survival the rate respectively.

Age-wise decomposition analysis for sex ratio

Sex ratio among under-5 for 2011 census population

${}_{2011}P^{m}_{0\text{-}4} = {}_{2006\text{-}2011}B^{m} * {}_{2006\text{-}2011}SR^{m}_{0\text{-}4}$

${}_{2011}P^{f}_{0\text{-}4} = {}_{2006\text{-}2011}B^{f} * {}_{2006\text{-}2011}SR^{f}_{0\text{-}4}$

${}_{2011}P^{f}_{0\text{-}4} / {}_{2011}P^{m}_{0\text{-}4} = ({}_{2006\text{-}2011}B^{f} * {}_{2006\text{-}2011}SR^{f}_{0\text{-}4}) / ({}_{2006\text{-}2011}B^{m} * {}_{2006\text{-}2011}SR^{m}_{0\text{-}4})$

$= [SRB_{2006\text{-}11}] * [(L^{f}_{0\text{-}4}/5*l_0)/ (L^{m}_{0\text{-}4}/5*l_0)]$

$= [SRB_{2006\text{-}11}] * [(L^{f}_{0\text{-}4}/L^{m}_{0\text{-}4})]$ ……………………………………… (2)

Values for $L^{f}_{0\text{-}4}$ and $L^{m}_{0\text{-}4}$ were taken from the Sample Registration System (SRS) life table for the respective population in the quinquennial year 2006-11.

Sex ratio among under-5 for 2001 census population

${}_{2001}P^{m}_{0\text{-}4} = {}_{1996\text{-}01}B^{m} * {}_{1996\text{-}01}SR^{m}_{0\text{-}4}$

${}_{2001}P^{f}_{0\text{-}4} = {}_{1996\text{-}01}B^{f} * {}_{1996\text{-}01}SR^{f}_{0\text{-}4}$

${}_{2001}P^{f}_{0\text{-}4} / {}_{2001}P^{m}_{0\text{-}4} = ({}_{1996\text{-}01}B^{f} * {}_{1996\text{-}01}SR^{f}_{0\text{-}4}) / ({}_{1996\text{-}01}B^{m} * {}_{1996\text{-}01}SR^{m}_{0\text{-}4})$

$= [SRB_{1996\text{-}01}] * [({}_{1996\text{-}01}L^{f}_{0\text{-}4}/5*l_0)/ ({}_{1996\text{-}01}L^{m}_{0\text{-}4}/5*l_0)]$

$= [SRB_{1996\text{-}01}] * [({}_{1996\text{-}01}L^{f}_{0\text{-}4}/{}_{1996\text{-}01}L^{m}_{0\text{-}4})]$ ………………………… (3)

Values for L^{f}_{0-4} and L^{m}_{0-4} were taken from the Sample Registration System (SRS) life table for the respective population in the quinquennial year 1996-2001.

Results

********************************table 1 here********************************

The decomposition of changes in the total population of under 5 child population

For India and major states, the periods 2001 and 2011 have been presented in table 1. It is evident that the prenatal factor made a major contribution (72%) to the declining child sex ratio during the 2001-11 period (child sex ratio declined from 934 to 924 during this period). The corresponding figure for the postnatal factor is 28% only. The highest decline in the child sex ratio was seen in Andhra Pradesh (23 absolute numbers per 1000), followed by Rajasthan (21 absolute numbers per 1000), Maharashtra (18 absolute numbers per 1000), Uttar Pradesh (18 absolute numbers per 1000), Bihar (16 absolute numbers per 1000), Odisha (10 absolute numbers per 1000), and Madhya Pradesh (10 absolute numbers per 1000). This decline means that in all these states, except Rajasthan and Madhya Pradesh, sex-selective abortion (prenatal factor) was the main contributing factor (more than 75%). In Rajasthan, there was a large decline in CSR in 10 years. However, while sex selection increased this gap during the given period, the postnatal factor reduced it (21 points per 1000). In Rajasthan, the proportion of the prenatal factor is positive, which implies an increase in the fertility component in the direction of increased masculinity of the birth cohort (positive greater than one). On the other hand, the proportion of the postnatal factor (mortality component) is negative, meaning a faster improvement in girls' survival. In other words, if the female child mortality status was the same in 2006-11 as it was in 1996-2001, the child sex ratio would have declined by 87.6 points instead of by only 21 points. In other words, Rajasthan's CSR would have been 804 per 1000 instead of 892 in the year 2011. This shows that the postnatal factor, that is, female child survival improved much faster than male child survival during the study period, helping reduce the impact of the prenatal factor on CSR. In Madhya Pradesh, the child sex ratio declined by 10 points between 2001and 2011.

However, the case of Madhya Pradesh is totally opposite to that of Rajasthan; here sex-selective abortion reduced this gap, whereas the postnatal factor expanded it. In Madhya Pradesh, the proportion of the prenatal factor is negative, implying a decline in the fertility component in the direction of declined masculinity of the birth cohort (negative). On the other hand, the proportion of the postnatal factor (mortality component) is positive, meaning a faster improvement in boys' survival in the study period. In the states of Haryana and Punjab, the child sex ratio increased by 23 and 61 points per 1000 respectively because both sex-selective abortions and female child mortality declined during 2001 and 2011. At the state level, an unexpectedly huge variation was observed in terms of the contribution of prenatal (sex-selective abortion) and postnatal (mortality) factors during 2001-11. The prenatal factor is a proxy estimate for sex-selective abortions, which remained the sole contributing factor to the declining child sex ratio in many states during the period 2001-2011.

The trend of gender differentials in the probability of dying for the age-group 0-4 years from SRS 1971-75 to 2011-15 in the total population

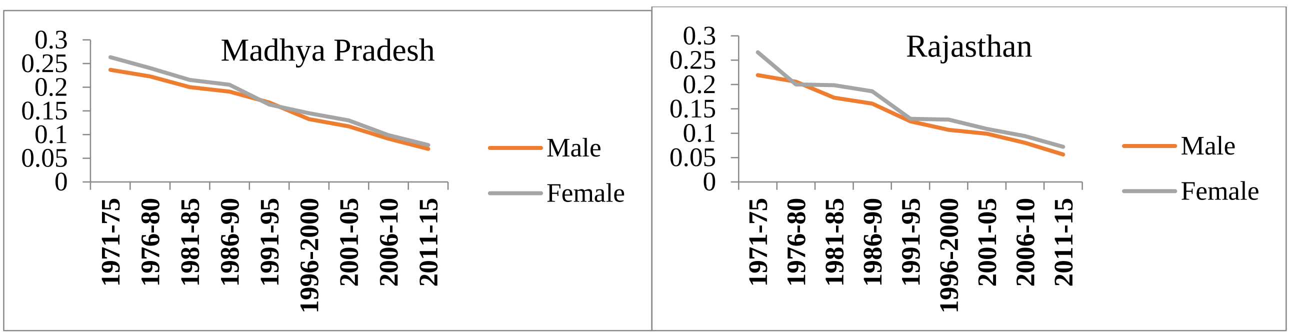


Table1: Decomposition analysis showing changes in the under-five child population by prenatal, postnatal factors in India and major states by total population in India and major states

Regions/ India	2001 CSR	2011 CSR	Diff	Pre F (proportion)	Post F (proportion)	Pre F (absolute values)	Post F (absolute values)
North							
Punjab	794	855	61	0.93	0.07	57	4
Rajasthan	913	892	-21	4.19	-3.19	88	-67
Haryana	817	840	23	0.83	0.17	19	4
Central							
Uttar Pradesh	929	911	-18	0.78	0.22	14	4
Madhya Pradesh	938	928	-10	-1.40	2.40	-14	24
East							
Bihar	957	941	-16	0.88	0.13	14	2
West Bengal	966	959	-7	0.86	0.14	6	1
Odisha	959	945	-14	1.00	0.00	14	0
West							
Maharashtra	913	895	-18	1.11	-0.11	20	-2
Gujarat	888	901	13	1.00	0.00	13	0
South							
Karnataka	948	955	7	1.14	-0.14	8	-1
Kerala	962	966	4	1.25	-0.25	5	-1
Andhra Pradesh	965	942	-23	1.04	-0.04	24	-1
Tamil Nadu	946	945	1	0.00	1.00	0	1
India	934	924	-10	0.70	0.30	7	3

***Note**: CSR: Child sex ratio, Diff: Difference between CSR in 2001 and 2011, Pre F: Prenatal Factor and Post F: Postnatal Factor*

********************************table 2 here***********************************

Prenatal and postnatal factor contributions to changes in the rural sex ratio among under 5 child population

In rural India, the decline in the child sex ratio (941 to 928 females per 1000 males) between 2001 and 2011 can be explained mainly (that is, 10 points) on account of the prenatal factor and only 3 points on account of postnatal factor (Table 2). The highest decline in the child sex ratio was observed in Maharashtra (25 absolute numbers per 1000), followed by Rajasthan (23 absolute numbers), Andhra Pradesh (22 absolute numbers), Bihar (16 absolute numbers), Odisha, and Madhya Pradesh (12 absolute numbers). The prenatal factor contributed heavily (93%) across the states which implies an increase in the fertility component in the direction of increased masculinity of the birth cohort (positive greater than one). On the other hand, the proportion of the postnatal factor (mortality component) is negative, meaning a faster improvement in girls' survival for the decline in the child sex ratio between 2001 and 2011. In states like Rajasthan, Odisha, and Madhya Pradesh, the results of the contribution of the prenatal and postnatal factors to the decline in the child sex ratio showed a negative value. In Rajasthan, the decline in the CSR (23 points per 1000) was mainly caused by differentials in the female child mortality (postnatal factor).

By contrast, the prenatal factor (sex selective abortions) became weak and thus helped in improving the CSR during 2001-11. This means that if the extent of sex selective abortion in 2011 was the same as in 2001, the child sex ratio would have declined by 40.7 points instead of by 23 points. In other words, the CSR would have been 854 females per 1000 males instead of 895 females per 1000 males. Similarly, Madhya Pradesh showed a 12-point decline in the CSR from 2001 to 2011, predominately on account of unfavorable mortality of the girl children (postnatal factor). This means that if the level of sex selective abortions in 2011 had remained the same as in 2001, then the CSR would have declined by 385 points instead of by 12 points. A similar decline was observed in Odisha, except that the role of the two factors was just the opposite to what was observed in the case of Madhya Pradesh. Sex-selective abortions in Odisha increased during 2001-11. However, gender differentials in mortality reduced during the same period, making the decline in the CSR from 2001 to 2011 less pronounced. Had the female child mortality in 2011 remained the same as in 2001, the child sex ratio would have declined by 37 points instead of by 12 points. In that case, the CSR for Odisha in the year 2011 would have declined to 913 females per 1000 males instead of to 950 females per 1000 males.

The trend of gender differentials in the probability of dying for the age-group 0-4 years from SRS 1971-75 to 2011-15 in the rural population

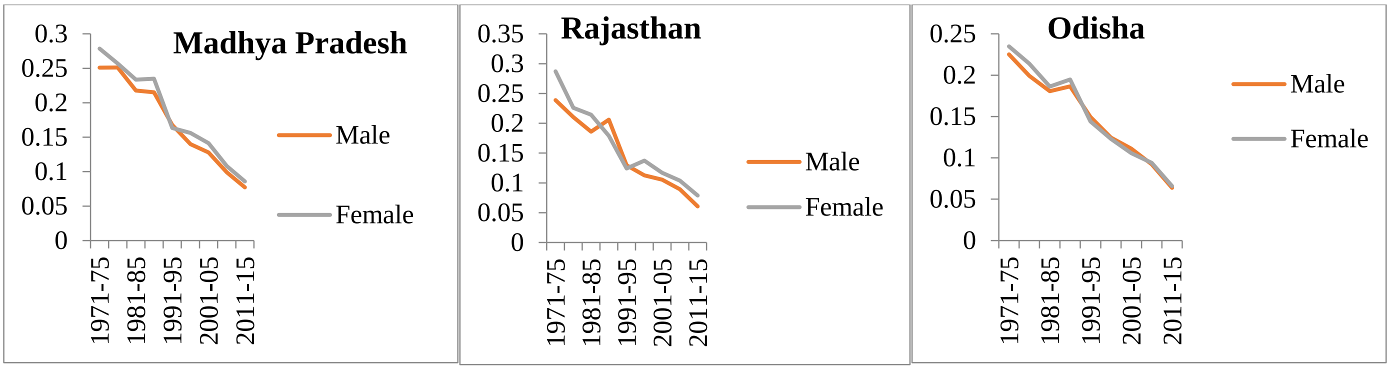


Table2: Decomposition analysis showing changes in the under-five child population by prenatal, postnatal factors in India and major states by rural population in India and its regions

Regions/ India	2001 CSR	2011 CSR	Diff	Pre F (proportion)	Post F (proportion)	Pre F (absolute values)	Post F (absolute values)
North							
Punjab	793	851	58	0.84	0.16	49	9
Rajasthan	918	895	-23	-0.78	1.78	-18	41
Haryana	821	841	19	0.80	0.20	15	4
Central							
Uttar Pradesh	916	916	Constant			0	0
Madhya Pradesh	945	933	-12	-31.08	32.08	-373	385
East							
Bihar	959	943	-16	0.94	0.06	15	1
West Bengal	968	961	-7	0.71	0.29	5	2
Odisha	962	950	-12	3.08	-2.08	37	-25
West							
Maharashtra	914	889	-25	0.92	0.08	23	2
Gujarat	911	923	12	0.92	0.08	11	1
South							
Karnataka	950	956	6	0.67	0.33	4	2
Kerala	963	967	4	0.00	1.00	0	4
Andhra Pradesh	967	945	-22	0.05	0.95	1	21
Tamil Nadu	937	936	-1	2.00	-1.00	2	-1
India	941	928	-13	0.77	0.23	10	3

***Note**: CSR: Child sex ratio, Diff: Difference between CSR in 2001 and 2011, Pre F: Prenatal Factor and Post F: Postnatal Factor*

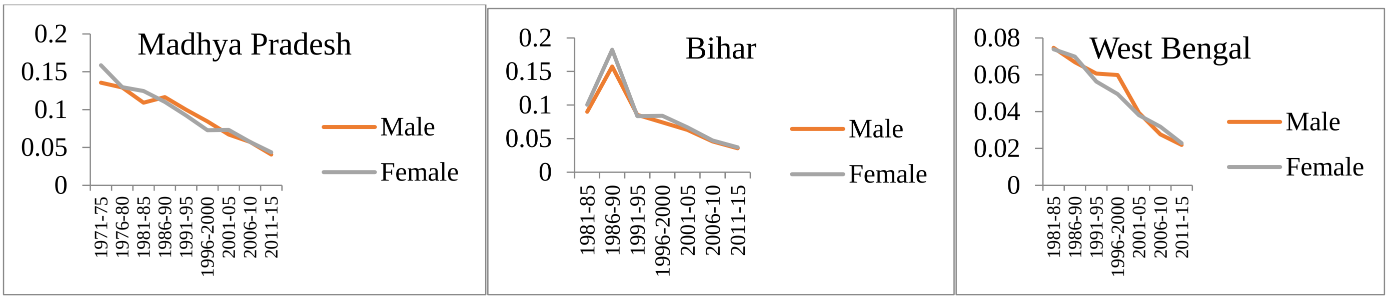
There have been unexpectedly huge variations across states in the one decade (2001-11) in the rural areas too. The prenatal factor seems to have contributed more than 92% to the decline in the child sex ratio in rural Maharashtra and Bihar and in rural West Bengal contributed more than 70% to the decline in the child sex ratio.

**********************************table 3 here************************************

Prenatal and postnatal factor contributions to changes in the urban sex ratio among under 5 child population

Table 3 shows that the highest decline in the child sex ratio was observed in Madhya Pradesh (24 absolute numbers per 1000), followed by Odisha (23 absolute numbers per 1000), Andhra Pradesh (21 absolute numbers per 1000), Bihar (17 absolute numbers per 1000), Rajasthan (8 absolute numbers per 1000), Maharashtra (7 absolute numbers per 1000), and West Bengal (6 absolute numbers per 1000). In Andhra Pradesh the decline was mainly caused by prenatal factors and as such it was the highest among all the states. This means that sex selective abortion became worse during 2001-2011 and had its effects on the declining child sex ratio in the urban areas of these states. In urban Madhya Pradesh, Bihar, and West Bengal, the gender differentials in child mortality reduced during 2001-11. Therefore, the contribution of the postnatal factor was negative (female child mortality improving much). In other words, had the gender differentials in child mortality in 2011 remained the same as in 2001, the child sex ratio in urban Madhya Pradesh, Bihar, and West Bengal would have been even lower due to the upward trend of sex selection in the urban areas in these states. Had child mortality differentials in 2011 remained the same as in 2001, the CSR would have declined to 907 instead of 914 in Madhya Pradesh, to 899 in Bihar instead of 919, and to 941 instead of 952 per 1000 in West Bengal. By contrast, the CSR in Kerala went up during this period, but the increase would have been higher (11 points) if child mortality had remained unchanged between 2001 and 2011. Despite males having an advantage in child mortality differentials in several states, the slow improvement in the probability of child survival, particularly of urban males, is a matter of concern that requires further comprehensive scrutiny (Chaurasia, A. R 2017).

The trend of gender differentials in the probability of dying for age-group 0-4 years from SRS 1971-75 to 2011-15 in the urban population



In the urban areas of Bihar, Madhya Pradesh, Uttar Pradesh, and West Bengal, the prenatal factor has been solely responsible for the declining child sex ratio during the last intercensal period. In the states of Andhra Pradesh, Odisha, and Tamil Nadu, the prenatal factor contributed more than 70% to the declining child sex ratio in the urban areas in the given period. Contrary to it, the postnatal factor contributed 33% to the total decline in the child sex ratio of the urban areas of Rajasthan and 83% to the total decline in the child sex ratio in urban Maharashtra that is the highest.

Table3: Decomposition analysis showing changes in the under-five child population by prenatal, postnatal factors in India and major states by urban population in India and its regions

Regions/ India	**2001 CSR**	**2011 CSR**	**Diff**	**Pre F (proportion)**	**Post F (proportion)**	**Pre F (absolute values)**	**Post F (absolute values)**
North							
Punjab	797	862	65	1.06	-0.06	69	-4
Rajasthan	892	884	-8	0.63	0.38	5	3
Haryana	805	838	33	0.97	0.03	32	1
Central							
Uttar Pradesh	894	891	-3	1.00	0.00	3	0
Madhya Pradesh	938	914	-24	1.29	-0.29	31	-7
East							
Bihar	936	919	-17	1.18	-0.18	20	-3
West Bengal	958	952	-6	1.83	-0.83	11	-5
Odisha	940	917	-23	0.87	0.13	20	3
West							
Maharashtra	911	904	-7	0.14	0.86	1	6
Gujarat	843	867	24	1.00	0.00	24	0
South							
Karnataka	943	953	10	0.90	0.10	9	1
Kerala	957	965	8	1.38	-0.38	11	-3
Andhra Pradesh	958	937	-21	0.95	0.05	20	1
Tamil Nadu	959	954	-5	1.00	0.00	5	0
India	911	912	-1	1.00	0.00	1	0

***Note**: CSR: Child sex ratio, Diff: Difference between CSR in 2001 and 2011, Pre F: Prenatal Factor and Post F: Postnatal Factor*

Discussion

This study is an attempt to shed light on the contribution of prenatal and postnatal factors to the declining child sex ratio (CRS) in India between censuses 2001 and 2011. It assesses the geographical variations in sex selective abortion as the prenatal factor on the one hand, and gender differentials in mortality during infancy and childhood as the postnatal factor on the other hand. By taking the state as a unit of analysis, the study demonstrated that presenting the intra-state variations will have great value for demographers, social scientists and policy makers. Our findings clearly show that most of the selected states are experiencing a declining child sex ratio (CSR). Mortality factors have very little to contribute to this decline in most of the states. In states such as Maharashtra, Andhra Pradesh, Uttar Pradesh, Bihar, Odisha, Madhya Pradesh, Tamil Nadu, and West Bengal, the prenatal factor, that is, sex selective abortion has made a major contribution to the declining child sex ratio during 2001-11. However, in states like Rajasthan and Odisha, the gender differentials in child morality contributed majorly to the declining child sex ratio (Chaurasia, A. R, 2017). In the urban areas of states like Madhya Pradesh, Bihar, and West Bengal, sex selection before birth has predominantly contributed to the decline in the child sex ratio. These are demographically important states (SRS states) since they collectively account for nearly 90% of all of India's population as per census 2011. Thus, any change in these states is bound to change the national average of the child sex ratio.

Omission/misreporting clearly indicates that the male-female undercount has decreased over the years. The female undercount was higher till the year 1991, but after that, the scenario changed, with the male undercount increasing to 23.2 per 1000 from 22.8 per 1000 females in the 2001 census. By age group, the undercount of females in the 0-4 and 5-9 age groups has not been very different from the male undercount and, thus, cannot explain the reason for the decline in the child sex ratio from census 1981 to census 2011. The post-enumeration results show that in census 2001, the female undercount in the age group 0-4 was 32.7 per 1000, whereas the male undercount was 31.5 per 1000 in the same age group. In the same census, in the age group 5-9, the female undercount was 23.5 per 1000, whereas the male undercount was 21.8. There is also no significant differential by sex in the omission rates in the country in the 2011 census, which could have affected the decline in the child sex ratio. Visaria (1971), taking evidence from the post enumeration survey of census tasks, had concluded that the large imbalance in the child sex ratio in India and major states cannot be explained by more undercount for females than males. The construction of the child sex ratio by the state may be affected by internal migration, but no reliable data exists for this (Guillot, 2002). No evidence has been found for female selective emigration or male selective in-migration of a magnitude which can affect the sex ratio (Premi, 1991). So, in this analysis migration and omission were not considered.

In Punjab (61 points) and Haryana (23 points), age made a big improvement in CSR (0-4 years) during the considered period by the census, and both sex selective abortion (prenatal) and female child mortality (postnatal factor) were favorable to it. National Family Health Survey (NFHS) -4 data also shows Punjab recorded the maximum improvement (126 points) in the child sex ratio (0-6) from 734 in 2005 to 860 in 2015, whereas Haryana came in second with an improvement of 74 points. Haryana's child sex ratio rose from 762 girls in 2005 to 836 in 2015 (International Institute for Population Sciences [IIPS] & ORC Macro, 2015-16). Except for Delhi and Uttarakhand, which recorded a decline in the child sex ratio over the past decade, the situation has improved in all other northern states. Child sex ratio in Himachal Pradesh improved by 23 points (913 to 936) and in Jammu and Kashmir by 20 points (902 to 922). Census 2011 had shown that while India's overall sex ratio improved from 933 to 940 between 2001 and 2011, the child sex ratio fell from 927 to 914. "Infant Mortality Rate (IMR) declined from 57 to 41 per 1,000 live births between NFHS-3 (2005-06) and NFHS-4. IMR has declined substantially in almost all the states during the last decade. It dropped by more than 20 percentage points in Tripura, West Bengal, Jharkhand, Arunachal Pradesh, Rajasthan, and Odisha. NFHS (2015-16) also showed that sex ratio at birth (number of females per 1,000 males) improved from 914 to 919 at the national level, with Kerala recording the highest sex ratio at birth (1,047 female per 1000 male), followed by Meghalaya (1,009 female per 1000 male) and Chhattisgarh (977 female per 1000 male). Some scientific evidence suggests that a targeted approach to improving child survival through the Janani Suraksha

Yojana (JSY) has paid off (http://www.huffingtonpost.in/2017/03/01/india) sees-improved-sex-ratio-decline-in-infant-mortality-rate_a_21864344/).

As an effort to improve the child sex ratio, different state governments have made different efforts to address the problem of skewed child sex ratio since the early 1990s. Rajasthan started the *Rajalakshmi* scheme to improve the number of the girl children in the state (Sharma *et al.,* 2003; Sekher, 2010) in 1992. In 1994, Haryana started the "*Apni Beti, Apna Dhan*" (Our Daughter, Our Wealth) program. The Government of India runs the *Dhana Lakshmi* scheme. Karnataka launched the *Bhagyalakshmi* scheme to increase the number of the girl child (Sekher, 2012). Under this program, cash grants are provided to the poor households upon the birth of a girl child. The money is saved in a bank account in the girl's name and handed over to her on her eighteenth birthday provided she remains unmarried till this legal age of marriage, with additional incentives for increasing educational attainment (Sinha and Yoong, 2009). "*Beti Bachao, Beti Padhao*" is meant to save the daughter and educate the girl child. It addresses the gender imbalance and discrimination against the girl child in the Indian society. This scheme was launched by Prime Minister of India on 22nd of January 2015 at Panipat, Haryana as the state is one of the poorest performing states in sex ratio at birth and child sex ratio (https://www.youtube.com/user/BetiBachaoBetiPadhao). The Pre-Natal Diagnostic Techniques Act and its amendment were meant to check the practice of determining the sex of the fetus to stop sex selective abortions. However, governments have been unable to tackle this problem because there is no proper implementation of the Act. The poor status of women in the society is actually the root cause of the problem. Media outreach can be very effective in changing the societal norms and behaviors, including reducing son preference. Reducing the demand for sex-selection may offer the most effective long-term solution (Guo *et al.,* 2016). The majority of countries evaluated in the report have never had a female head of state. In comparison, India has had two female heads of state – Prime Minister Indira Gandhi and Present Pratibha Patil – whose terms jointly add up to 21 years of being ruled by women (http://time.com/money/4362191/female-heads-of-state/). On this sub-index, India's rank is 2nd, after Bangladesh. But on the participation of women in Parliament, India lags behind Bangladesh, Pakistan, Syria, Egypt, and more than a hundred other countries, with a rank of 112.

Conclusion

Sex selection is a serious cause for concern in India. In addition, there is an excess incidence of female deaths during the postnatal period at young ages, especially below the age of five years, in some of the Indian states. The contribution of the prenatal factor has been high in most of the states. Focusing on both prenatal and postnatal factors can arrest the large imbalance in the child sex ratio in the states. A large extent of missing girls is clearly evident from this paper. Further research is needed to inform the development of policy actions to prevent sex-selective abortions and to prevent the child sex ratio becoming more skewed in India. While other studies have shown that a serious effort towards improving the sex ratio at birth or the child sex ratio is being made at different levels and has also been effective, this paper shows that the effective implementation of such efforts and a wide-enough coverage of them is still lacking in most of the states to attain a balanced child sex ratio. This study concludes that the contribution of the prenatal factors in the declining child sex ratio has been high in India and most of the states. By focusing on both pre- and postnatal factors, the imbalance in the child sex ratio in the country can be checked to a large extent. The prenatal factor is a proxy estimate of sex-selective abortions, which remained the sole contributing factor to the declining child sex ratio in many states during the period 2001-2011.

Policy implications

There is a need to review program and social interventions aimed at reducing the gender gap in child and adolescent mortality and develop a strategic plan for effective implementation and monitoring of all integrated interventions. The PCPNDT Act is a well-intentioned piece of social legislation that strengthens the practice of medical ethics by providing a legal incentive for Indian physicians to uphold their obligations. While the PCPNDT Act succeeds in acknowledging and drawing attention to a grave societal problem, its failure to curb female selective abortion cannot be overlooked. There is a need to develop a mechanism for real time monitoring of pregnancy without affecting access to services of abortion to women who have an unintended pregnancy.

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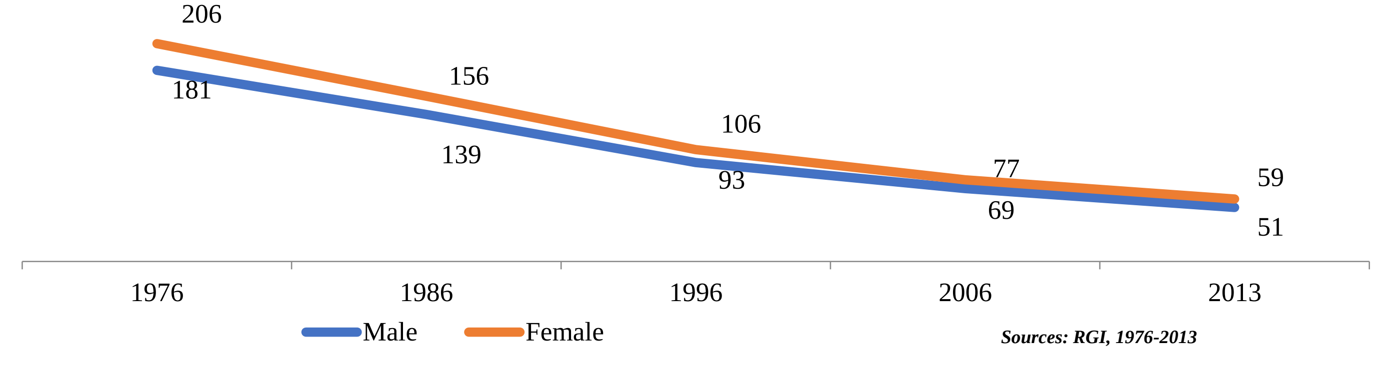

Figure 1: U5MR per 1000 live birth in India by gender

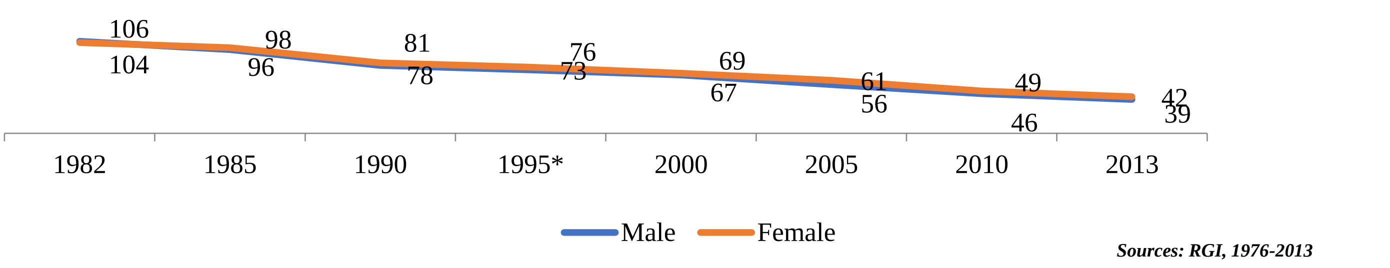

Figure 2: IMR per 1000 live birth in India by gender

Figure 3. The trend in gender differential in under five probabilities of dying by SRS from 1971-75 to 2011-15 in India

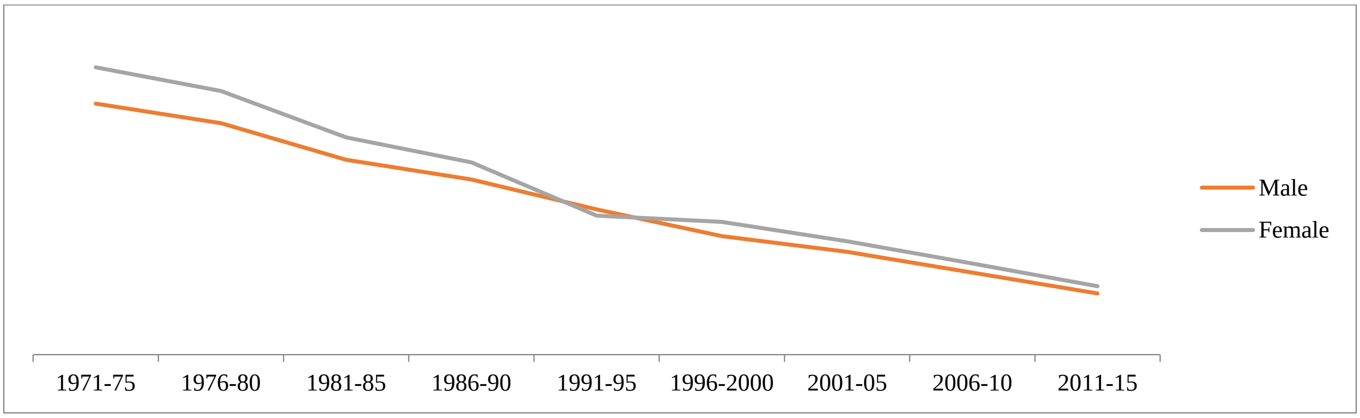

Figure 4 Trend in sex ratio at birth in the Sample Registration System, three year moving average, states of India 1998-2011

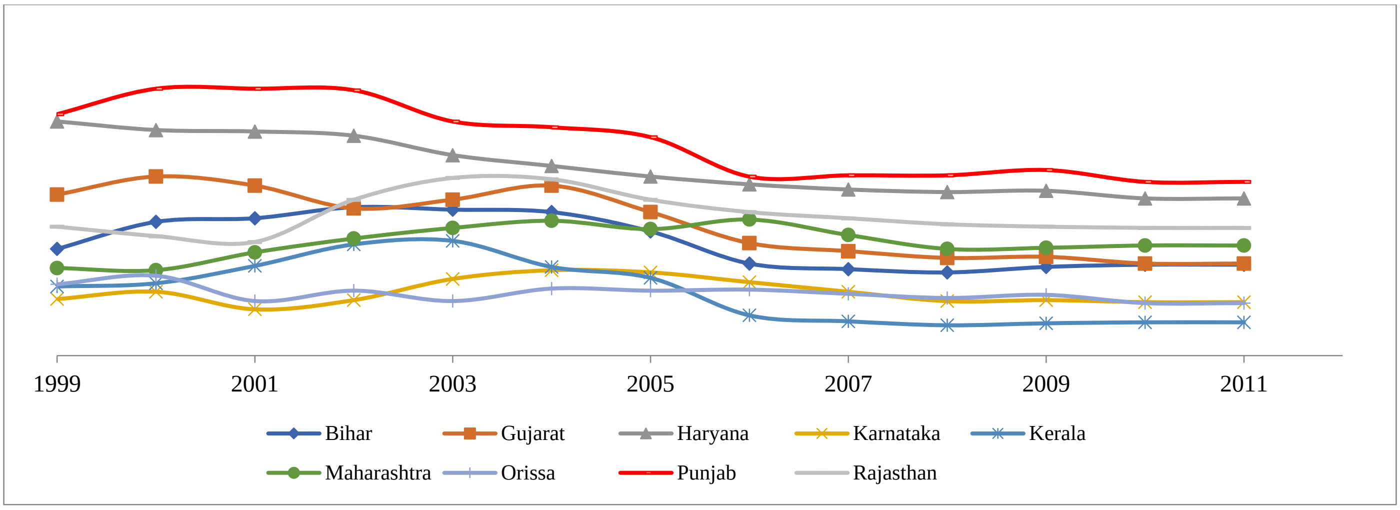

Figure 5. The trend in sex ratio at birth in the Sample Registration System, three year moving average, states of India 1998-2011

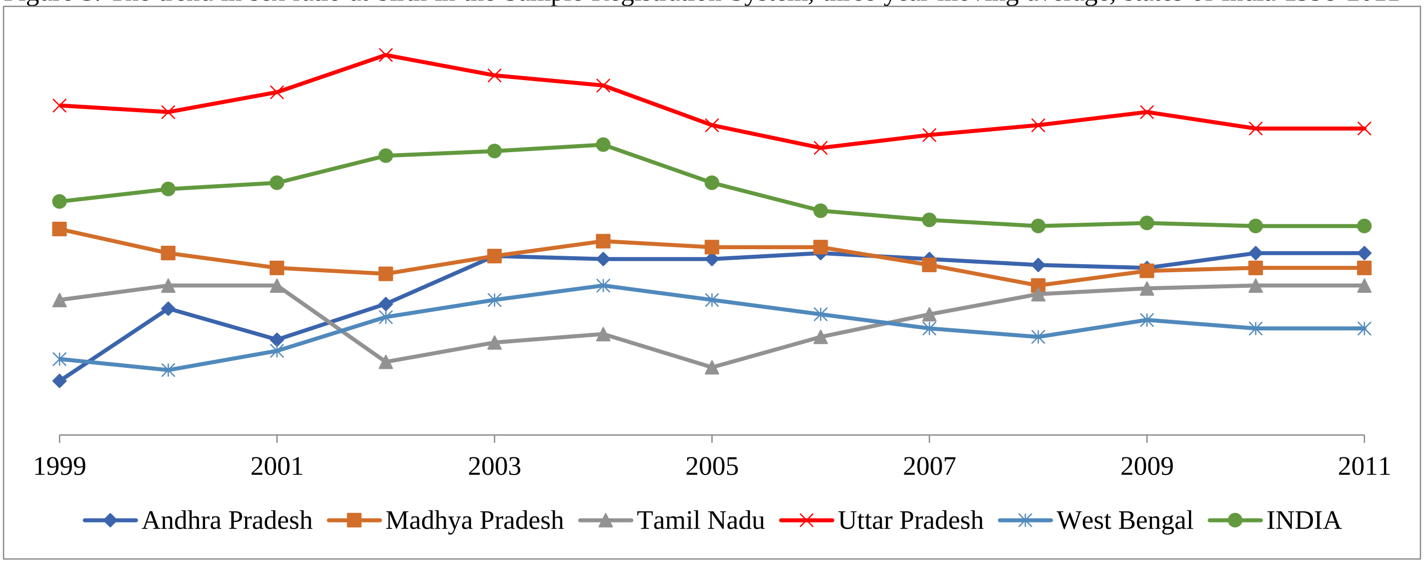

Figure 6 Child sex ratio (0-4), no. of females per 1000 males by place of residence by the census of India 2001& 2011