Skewed Child Sex Ratios in India

A Revisit to Geographical Patterns and Socio-economic correlates

Abstract

This study revisits the regional and socio-economic pattern of masculinisation of Child Sex Ratios (CSR), Sex Ratio at Birth (SRB) and Sex Ratio at Last Birth (SRLB) by using the successive rounds of National Family Health Survey (NFHS). Although the masculinisation of CSR continues in many Indian states as well as in different socio-economic settings, a tremendous change in previously established patterns of CSR can be observed from the findings. District-level analysis presents an intra-state variation in CSR, SRB and SRLB, which helps in identifying the emerging ‘hotspots’ of the problem. The decline in preference for a son and rise in skewed CSR, SRB and SRLB invites the attention of researchers towards drawbacks in the method of measurement of preference for a son as people are now more aware of the legal consequences of sex-selective abortions and underreport the same.

Keywords: Child Sex Ratio, Sex Ratio at Birth, Sex Ratio at Last birth, Son preference, India.

Introduction

Historically, many communities have preferred sons over daughters. The lower perceived utility of girls over boys across the number of patriarchal, patrilineal and patrilocal cultures disadvantage girls in terms of their numbers in population (Das Gupta, 2009; Tafuro and Guilmoto 2020). John Graunt was the first to observe, in 1662, the difference between the number of males and females at birth, which made researchers curious to look into this disparity (Chahnazarian 1990; Campbell 2001).

Skewed Child Sex Ratios (CSRs) in geographies that traditionally prefer a son has attracted a great deal of attention since late 1980s and early 1990s (Keyfitz, 1977; Das Gupta 1987; Miller 1989; Sen 1990). Since then, gender preference at birth has been well documented in developing countries (Das Gupta 2005; Attané and Guilmoto 2007; Guilmoto 2009), especially in the Asian countries of Korea (Park and Cho 1995), China (Guilmoto 2012a), Indonesia (Guilmoto 2015), Vietnam (Guilmoto et al. 2009; Guilmoto 2012b) and India (Das Gupta and Bhat 1997; Sudha and Rajan 1999; Arnold, Kishor, and Roy 2002; Sekher and Hatti 2010; Diamond-Smith and Bishai, 2015; Kulkarni, 2020). Nevertheless, the topic continues to be a high priority research among the scholars across countries (Bongaarts and Guilmoto 2015; Guilmoto et al., 2018; Becquet, Guilmoto, and Dutreuilh, 2018; Sahoo and Nagarajan, 2020; Guilmoto, Chao, and Kulkarni, 2020; Chao et al. 2019; Tafuro and Guilmoto 2020). Moreover, a recent systematic assessment of sex ratio at birth (SRB) for all countries presents an evidence of SRB as further skewed in favour of males in Asia (Chao et al. 2019).

The Indian context

The traditional construct of preferences for sons at birth in India continues despite several initiatives from the government of India to balance the female-male populations in the country. Fewer females has been evident from the very first Indian decennial census in 1872 (Visaria, 2005). The overall sex ratio (females per thousand males) declined from 972 (1901) to 940 (2011) in 110 years (Figure 1). In the late 1990s, Amartya Sen put out the magnitude of the masculinisation and the number of ‘missing girls’ from the population of Asia. After that, a growing number of studies have also reported ‘missing women’ (Kulkarni 2007; Bongaarts and Guilmoto 2015; Guilmoto et al. 2020), a continuous decline in the CSR (Figure 2) and SRB (George 2006; Das Gupta 2010; Rajan et al. 1991; Raju and Premi 1992; Agnihotri 2000; Guilmoto and Depledge 2008; Arokiasamy and Goli 2012a). It has been more than two decades since the inception of the Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection) Act (PC-PNDT Act), but the impact of the initiative has been limited as the problem of sex-selective abortions continue to persist (Sekher and Hatti 2010; Sekher 2012; Nandi and Deolalikar 2013).

Previous literature and the need for study

In the past skewed CSRs and their geographical patterns and socio-economic correlates are well-documented in India. Several studies have reported that the disproportionate sex ratios stem from a strong preference for a son, combined with declining fertility and the availability of and access to sonography during pregnancy. In particular, access to health care and technologies has increased both pre- and postnatal bias against female children. Sex-selective abortions and excess female child mortality are considered to be proximate determinants of skewed CSR (Das Gupta 1987; Miller 1989; Raju and Premi 1992; Kishore 1993; Arnold et al. 2002; Visaria 2005; George 2006; Sekher and Hatti 2010; Myers 2012; Arokiasamy and Goli 2012a). A few studies have also attributed to under-enumeration of the female population (Bhat 2002; Bhat and Xavier 2007). The Government of India (2018) has also taken note of the behavioural pattern of Indian parents who continue to have children ‘until the desired number of sons is born’ and called it ‘meta son preference’, also called ‘stopping rule behaviour’ in the demographic literature (Clark, 2000; Government of India 2018).

Although there is a growing number of studies in India on CSR and SRB trends and patterns (Rajan et al. 1991; Sudha and Rajan 1999; Sen 2003; Diamond-Smith and Bishai, 2015; Kulkarni 2007, 2020) and their correlates (Das Gupta, 1987; Miller 1989; Raju and Premi, 1992; Visaria 2005; George, 2006; Sekher and Hatti, 2010; Myers 2012; Arokiasamy and Goli, 2012a) in the past, the recent National Family Health Survey 4 (NFHS-4) provides a unique opportunity to study them at least from five aspects: First, for the first time, we can look at the direct estimates of SRBs at district level, although some previous studies have made indirect estimations of SRBs at the district level using Census information (Kulkarni 2007; Kumar and Sathyanarayana 2012; Diamond-Smith and Bishai, 2015). Second, with a manifold increase in the sample size, NFHS-4 data allows reassessment of the preference for a son and the socio-economic correlates of CSRs and SRBs with greater precision and confidence levels. Third, for the first time in the Indian context, we use human fertility decision model to assess the effect of ‘stopping rule behaviour’ on Sex Ratio at Last Birth (SRLB) and present comprehensive empirical evidence as NFHS allows us to estimate district-level SRB and SRLB which helps to test above-said hypotheses with robust measures. Thus, this study tries to bring out the driving factors of SRB, CSR, and SRLB in the context of changing socio-economic scenario in the country. Fourth, we test how much the ‘north-west and south-east’ divide, ‘Bermuda triangle’ and ‘rice and wheat belt’ hypotheses previously used to explain the geographical pattern of sex ratio (Miller 1997; Atkins et al. 1997; Kishor 1993) are valid in the

present context. Finally, with refined estimates, this study evaluates socio-economic and geographical pattern of SRB in India reported in factsheet based on IIPS and ICF (2017) and a few other studies that used the factsheets information such as Radkar (2018).

These two earlier studies hide much more than they reveal. Unlike NFHS (2015–16) factsheet, findings based on Sample Registration System (SRS) data do not support the logic of disappearance of excess female child mortality. The release of unit-level information allows re-examining the estimate of the NFHS 4 factsheet and studies based on them. The NFHS 4 factsheet show that CSRs has been improved and SRB is worsening (IIPS and ICF, 2017), which indicate the disappearance of excess female child mortality in India which is impossible by any logic and thus not true. This ambiguity shows that there is a need to recheck the estimates presented in the NFHS 4 factsheet by re-estimating it from the unit-level data.

Analytically, we have three-fold objectives for this study. First, to re-estimate CSR, SRB and SRLB by socio-economic groups, districts and states using unit-level information from NFHS (2015–16). Second, to present the trends in CSR and SRB with a uniform definition by states and socio-economic groups since the 1990s, using successive rounds of NFHS. Third, to estimate the recent changes in the correlates of skewed CSR, SRB, and SRLB in India using a more robust sample size. Thus, this study is meant to document the most recent socio-economic and geographical trends and patterns taking into account a uniform definition across successive rounds of NFHS.

Data

This study uses four successive rounds of the NFHS data (1992–93, 1998–99, 2005–06 and 2015–16) to investigate the emerging geographical and socio-economic pattern of CSR, SRB, and SRLB. Appropriate weights have been used to make the estimates representative and to account for a multistage sampling design. Details on design, data collection and its quality-related information are presented elsewhere (see IIPS, 1995, IIPS and ORC Macro, 2000; IIPS and ICF, 2007; IIPS and ICF, 2017).

Methods

As mentioned above, we use unit-level information of successive rounds of NFHS for a direct estimation of CSR, SRB and SRLB. CSR is estimated as the female/male ratio of the living child population 0 to 72 months old while the SRB and SRLB are calculated as the female/male ratio of total births in groups of five calendar years: 1987–1991 (NFHS I), 1993–1997 (NFHS II), 2000–2004 (NFHS III) and 2010–2014 (NFHS IV). To validate our estimates, we compare it with SRBs from SRS data. Figure 3 shows the correlation between the estimated SRBs based on NFHS (2015–16) and SRS (2013–15). The correlation (r) is as high as 0.80, which shows there is not much deviation of our estimate from the SRS estimates.

Sex preference is measured as the difference in preferred number of sons and daughters as reported by the women. Positive values are considered as son preference, negative ones are considered as daughter preference whereas zero means no preference. Further, the geographical pattern of CSR, SRB, and SRLB is represented at the district level through maps produced using Arc GIS.

Binary logistic regression is used to find out the drivers of skewed sex ratio in child population, at birth and at last birth. The advantage of logistic regression analysis is that it requires no assumption about the distribution of the independent variables, and the regression coefficient can be interpreted in terms of odds ratios. The binary logistic regression model is commonly estimated by the maximum likelihood function. In this model, the dependent variables are the number of males compare to females in the 0–6 years old age group and the number of males

compared to females at birth and at last birth. All background characteristics (sex preference, social groups, religion, educational status, wealth quintile, place of residence and region) are independent variables. The mathematical expressions of the models are given as below (see Retherford and Choe 1991).

Formally, the model may be written as:

$$\begin{aligned} \text{Log} \left(\frac{P_{(\text{no.males at birth})}}{1 - P_{(\text{no.females at birth})}} \right) \\ = \text{Exp} (\beta_0 + \beta_1 \text{ sex preference} + \beta_2 \text{ social groups} + \beta_3 \text{ religion} \\ + \beta_4 \text{ educational status} + \beta_5 \text{ Women's age at first birth} + \beta_6 \text{ place of residence} + \beta_7 \text{ region} \\ + e^k) \end{aligned}$$

where e^{β_0} are intercepts and $e^{\beta_1, \dots, \beta_7}$ represent the odds ratio of each of the predictor variables in the model including conflict exposers while e^k is an error term. We control for region to observe the unobservable heterogeneity across the regions and omitted variable bias.

Next, we used *human fertility decision model* to assess the effect of *stopping rule behaviour* on SRLB, which means that couple's parity progression continues until they achieve the desired sex composition. The model follows these assumptions:

If the woman has the child at parity i

- The probability of having a boy = p
- The probability of having a girl = $1-p$
- The probability of having all girls at parity $i = (1-p)^i$.

If women move to next parity $i+1$

- Probability of having all girls at parity $i+1 = (1-p)^{i+1}$. With this assumption, the probability of having all girls will decline and having all boys will have increased by moving to next parity $i+1$.

If the sex ratio is 952 (biological or normal sex ratio)

- Then $p = 0.512$
- $1-p = 0.488$

Using above parameters, the model can be written as

$$PSR_{mi} = \text{Male births at parity } i / \text{Male births at parity } i+1$$

$$PSR_{fi} = \text{Female births at parity } i / \text{Male births at parity } i+1$$

Then, we estimate SRLB with normality and without normality assumption as follows

$$\text{SRLB with normality assumption} = \left(\frac{PSR_{mi}}{PSR_{fi}} \right) * 952$$

$$\text{SRLB without normality assumption} = \left(\frac{PSR_{mi}}{PSR_{fi}} \right) * SRB_i$$

where PSR_{mi} is probability of male sample ratio from parity i to parity $i+1$ and similarly, PSR_{fi} is probability of female sample ratio from parity i to parity $i+1$.

Findings

Trends in sex preference, CSR, SRB, and SRLB

Estimates based on the four rounds of NFHS indicate that CSR is continuously masculinised

(Table 1). There was a strong preference for a son in 1992–93 but it has been decreasing. By 2015–16, it decreased by half compared to what it was in 1992–93 (46.25% in 1992–93 to 26.43% in 2015–16). Nevertheless, CSR, SRB, and SRLB have not shown a remarkable improvement. The proportion of women preferring for a girl child has been very small throughout the period studied: it was only 2.86% in 1992–93 and 3.63% in 2015–16. SRB shows a declining trend from 1992–93 to 2015–16, which is largely driven by the escalation of sex-selective abortions in an economically progressive society. SRLB is adverse compared to all other indicators of sex ratio. It was 873 in 1992–93, which declined to 803 in 2015–16. The rate of decline in CSR is also alarming. It is decreased to 916 in 2015–16 from 944 in 1992–93.

The decline in the preference for a son and the rise in skewed CSR and SRB draw the attention of researchers towards the method of measurement of the preference for a son as people are now more aware of legal consequences of sex-selective abortions and under-report them. This is clear if we look at the evidence of skewed SRB among women with no pregnancy terminations. In a normal condition, no pregnancy termination means no chance of sex-selective abortions, thus no chance for a skewed SRB (Keyfitz, 1977; Dreze, 2012). However, a skewed SRB among women with no pregnancy termination means that the respondents underreport son preference, sex detection tests and pregnancy terminations.

The socio-economic pattern of CSR

Akin to evidence based on the previous rounds of NFHS (Bhat and Zavier 2007; Sekher and Hatti 2010; Arokiasamy and Goli 2012a), the evidence based on the latest NFHS suggests that CSR continues to vary considerably by socio-economic background characteristics (Table 2). Among women with son preference, the CSR is as low as 776 in 2015–16 compared to those with no the preference for a son (941). The estimates of CSR by social groups shows that, in 1992–93, Scheduled Castes (SCs) had a lower CSR (895) than all other social groups but the situation has changed in the last 20 years; SCs have shown a remarkable progress in terms of CSR while other social groups are getting worse than before. Over the period from 1992 to 2016, Scheduled Tribes (STs) are also started exposing to the culture of eliminating female child or limiting the family size after attainment of the required number of sons, which indirectly restrain the female birth in the presence of sex-selective abortions or ‘natality discrimination’. Muslims (956) and Christian (978) had a better CSR in 1992–93, and they continue to be on top in 2015–16 with 965 and 1067 girls in 0–6 years old age group. Sikhs had the lowest number of girls in child population with CSR of 878 in 1992–93, which declined to 807 in 1998–99 but improved to 872 in 2015–16. Although this improvement is appreciable in Sikhs, there is a long way to reach biological normal sex ratios of 952 girls per 1000 boys.

Table 2 also shows that women with no education had the lowest CSR (929) in 1992–93 but improved to the highest (949) in 2015–16. The results thus suggest that lower the educational level, better is the CSR, which shows that the regressive movement of eliminating girl child cannot be stopped through the strengthening of the women’s education alone. This pattern can also be attributed to the high fertility or non-exposure to the sex determination techniques among women with no or less education in comparison to their higher-educated counterparts (Bhat and Zavier 2007; Sekher and Hatti 2010; Arokiasamy and Goli 2012a; Dreze and Sen 2013).

The general notion of ‘higher the wealth, better the women's position’ seems to be a myth. From 1992–93 (1057) to 2015–16 (951) the poorest population have consistently a better CSR than the richer or richest. In 1992–93, the urban and rural settings had the same CSR (945 each), but in 2015–16 it declined more in the urban India and currently stands at 899 in the 0–6 years old age group, whereas their rural counterparts have 924 girls per a thousand boys.

These results are in tune with previous studies which argued that the growth of urbanisation made greater access available to health technologies that facilitated sex determination and discrimination against girls (Mealey and Mackey, 1990; Bhat, 1997; Arnold et al. 2002; Bhat and Xavier, 2007; Myers, 2012).

The socio-economic pattern of SRB

Akin to CSR, SRB is also worsening (794 in 1992–93 to 756 in 2015–16) over the period among the women with the preference for a son (Table 3). Except SCs, the number of girls born per thousand boys has reduced in all social groups from 1992–93 to 2015–16. Even among the STs, who are believed to be having better SRBs in the past as noted by Arokiasamy and Goli (2012a), show a declining trend (from 973 in 1992–93 to 953 in 2015–16). Such a trend suggests that STs are gradually getting exposed to advanced technology and communication which facilitates their interaction with the mainstream cultures and practices of natality discrimination. Among members of all religions, Sikhs are eliminating a larger number of girls at birth, which is in tune with the previous arguments by Das Gupta (1987). The SRB among Sikhs is getting slightly better from its previous values of 835 in 1992–93 to 861 in 2015–16, although such smaller improvement in a span of 20 years could not help in balancing the SRB. Despite a greater fall in SRB during 1992–2016 (1017 in 1992–93 and 956 in 2015–16), Christians show a better SRB throughout the period in comparison to other religions in India.

In 1992–93 the SRB was found to be better among primary (968) and secondary educated women (965) in comparison to the highly educated women (934), but in 2015–16 it gets worse among the former than the latter. This is a noticeable contrast to what is previously reported by Clark (2000) and Arokiasamy and Goli (2012a). SRB is found to be the lowest among the women with secondary education in 2015–16. Households in the low income quintile had the highest number of girls (1031) born per thousand boys in 1992–93, but this reduced to 939 in 2015–16. Among all income groups, the middle (892) and richest (845) have the lowest SRB in 2015–16. Both rural and urban India exhibit the evidences of persistent missing of girls at birth in the last two decades (Table 3), but, comparatively, urban India (895) has significantly fewer girls born to every thousand boys than rural India (917) according to the 2015–16 estimates.

The socio-economic pattern of SRLB

Among women with son preference, SRLB is as low as 638 girls per one thousand boys in 2015–16 (Table 4). Among social groups, SRLB was lowest in SCs (866) in 1992–93 but in 2015–16, the lowest was in OBCs (786) and other castes (779). Hindus and Sikhs had the lowest SRLB in 1992–93, and it continues to be the worse after two decades with respective reduction to 793 and 663 in 2015–16. In 1992–93, among all educational groups, women with primary education had a better SRLB in comparison to highly educated women but from 1998–99 onwards, the figures of SRLB are declining among women in all educational categories except it has seen some improvement among women with higher education. SRLB was better among poorest (950) in 1992–93 but it started worsening and lowered to 821 in 2015–16. In 1992–93, SRLB was lower among the poor (866) and richest (899) population, while in 2015–16, it is lowest among the richest (765) population. In contrast to the CSR and SRB pattern, SRLB is worse in rural India (791) compared to urban (814) in 2015–16. Lower SRLB and higher CSR and SRB in rural areas suggest that they have higher fertility rates compared to urban areas. The relationship between fertility and CSR is well-documented in previous studies (Das Gupta and Bhat, 1997). However, we empirically test the stopping rule hypothesis using human fertility model as below.

Stopping rule behaviour and SRLB

Previously, Clark (2000) established that last order births have a significant higher proportion of sons than other births, mainly noticeable among the socially and economically disadvantaged couples of north India. Clark (2001), Van Bavel (2004) and Pham et al. (2009) have empirically showed that the stopping rule plays a critical role in the sex ratio of last births. The impact of 'stopping rule behaviour' on SRLB is assayed through human fertility model (Table 8). As parents wish to have at least one boy and they keep having children until this happens and often stop childbearing when a son is born. Stopping rule behaviour may not affect the overall CSR and SRB in the absence of sex-selective abortions (Keyfitz and Caswell 2005), but it is a mirror of the level of the preference for a son in a population. Thus, it can't be sidelined during the study of sex ratio, especially in the backdrop of continuous masculinisation of the population in early ages. Here in Table 8, it is shown how the SRLB is being affected by the stopping rule behaviour coupled with termination of pregnancy. The result shows that where there is no stopping rule behaviour, the sex ratio ranges from 730 to 1000 over different parities. But in the presence of termination of pregnancy and stopping rule behaviour, the sex ratio is highly in favour of males and varies between 510 to 680 girls per a thousand boys. In the absence of differential in stopping rule behaviour and termination of pregnancy, the women with parity 1 have 950 girls per thousand boys at last birth but in the presence of both, there are only 510 girls per thousand boys at last birth. The same happens in women with higher parity, i.e., in the presence of termination of pregnancy and differential in the stopping rule behaviour, women bear very few girls at last birth in comparison to their absence.

The geographical pattern of CSR, SRB, and SRLB

The variation in terms of sex ratio among Indian states is not a new phenomenon, and this regional inconsistency is revealed time to time from different data sources like the Census, vital statistics and sample surveys (Kulkarni, 2007; Arokiasamy 2007; Guilimoto and Depledge 2008; Kumar and Sathyanarayana 2012). As per the sex ratio scenario, a north-south divide has been noticed, which is also described as rice-and-wheat-belt divide where rice belt includes all the southern and eastern parts of the country and the wheat-producing areas are mainly concentrated in western parts (Kishor 1993; Miller 1997; Atkins et al. 1997). Agnihotri in 1996 found that the dearth of females in the primary age group is prevalent in north and north-western parts of India and termed this region as a 'Bermuda triangle' which includes districts of Haryana, the ravine area of Madhya Pradesh, Rajasthan and western Uttar Pradesh. Dreze and Sen (2013) also found that the northern and western states show clear evidence of the stronghold of natality discrimination, which is not common in eastern and southern India. Here, in this paper, the analysis of the recent data shows an emerging geographical pattern of sex ratio in the 0–6 years old age group and at birth. Although, the most recent Census (2011) continues to support the fact that the north, west, and central India mainly contribute to the decline in CSRs at the national level, it also hints at the decline of CSR in several districts of south and eastern India (Arokiasamy and Goli, 2012b). Now it has been ten years after the last Census was conducted, the analyses based on 2015–16 data shows an emerging pattern in CSR and SRB (see table 5, 6 and Table 7).

Table 5 shows that south Indian states like Tamil Nadu (1051), Andhra Pradesh (1006), Kerala (969) and Karnataka (949) had a higher CSR than many north Indian states in 1992–93. In states like Andhra Pradesh and Tamil Nadu, female outnumbered the male in child (0–6 years' age group) population in 1992–93. However, from 1992–93 to 2015–16, the CSR deteriorated in every south Indian state except Kerala (1025). Despite being one of the southern and rice-cultivating Indian states, Telangana (912) has a relatively low CSR in 2015–16. In 1992–93, the northern states, Delhi (904), Punjab (887), Rajasthan (877) and Haryana (859) have a very

low CSR, and these states continue to be at the bottom in 2015–16 as well. In 2015–16, the north-eastern states like Manipur (982), Meghalaya (1014), Mizoram (946) and Nagaland (949) had a better CSR in comparison to many north Indian states like Delhi (835), Uttar Pradesh (904), Bihar (935) and Jammu & Kashmir (911). Overall, a majority of the Indian states have experienced a declining trend in the CSR. From 1992–92 to 2015–15–16, the states which have shown an improvement in CSR are Kerala (+56), Himachal Pradesh (+44), Meghalaya (+40), Arunachal Pradesh (+30), Mizoram (+13), Rajasthan (+6) and Odisha (+1). Although it has been widely discussed and documented about north-south or east-west divide in CSR patterns by previous studies, our trend analysis suggests that CSR is undoubtedly declining in almost all part of India and leading to unevenness in geographical patterns of CSR imbalance in the country.

SRB is deteriorating in almost all states of India (Table 6). Southern India, which is known for its better demographic indicators, has not remained untouched by this demographic constraint. From 1992–93 to 2015–16, the states which have shown an improvement in SRB are Himachal Pradesh (+78), Kerala (+38), Jammu & Kashmir (+30), Punjab (+17), Mizoram (+6) and Nagaland (+12). The rest show a declining trend in the last two decades. The newly formed Telangana also has fewer girls (875) per thousand boys at birth.

In 2015–16, among the major Indian states, Haryana (846) and Punjab (845) continuously display the lowest SRB. Since 1992–93, the north-eastern states like Mizoram (+6), Tripura (+28) Nagaland (+12) have shown a positive growth in the number of girls at birth. But states like Meghalaya and Manipur show a very low SRB in the last two decades. The top five states where the SRB is better in 2015–16 are Kerala (1028), Meghalaya (992), Mizoram (986), Manipur (964) and Chhattisgarh (958) and the bottom five with worst SRB are Sikkim (802), Delhi (820), Punjab (845), Haryana (846) and Rajasthan (869).

Table 7 shows the trend of SRLB in all Indian states from 1992–93 to 2015–16. The top states where the SRLB is comparatively better in 2015–16 are Kerala (921), Meghalaya (918), Mizoram (916), Tamil Nadu (927), and Manipur (915) and the states in the bottom are Gujarat (660), Delhi (671), Punjab (674), Rajasthan (675) and Haryana (697). Northern states like Himachal Pradesh (709), Uttarakhand (755) and Uttar Pradesh (755) have fewer girls at last birth in 2015–16 in comparison to many south Indian and north-eastern states. The SRLB is very low in almost all parts of the country.

From 1992–93 to 2015–16, the states which have added more girls at last birth from earlier are Goa (+15) Karnataka (+20) Kerala (+38) Mizoram (+33) and Nagaland (+3). Except these five states, all remaining states have fewer girls at last birth in 2015–16 in comparison to 1992–93. The sex ratio at last birth shows the level of the preference for a son and stopping rule behaviour of couples, as the people stop childbearing once they have achieved the desired number of sons.

As mentioned above, for the first time the design and sample size in the NFHS 4 allows for estimating CSR, SRB and SRLB at district levels. District-level assessment depicts better regionalisation of sex ratio imbalance in the country. Also, it helps to evaluate the regionalisation proposed in the previous studies. The estimate of CSR over districts shows a huge variation not only across the country but also within states across the districts. The states like Kerala, Meghalaya, Maharashtra, and Chhattisgarh, which have comparatively better CSR figures in terms of state averages, also have districts with a low CSR. Most of the districts with better CSR are clustered in the southern part of the country. Map 1 clearly shows the districts with better CSR in any state clustered together, while the districts with worse CSR also share geographical boundaries. Across many districts of north India, the range of CSR varies between 500–900 girls per thousand boys. The whole eastern tribal belt of Madhya Pradesh, Odisha, Chhattisgarh and north-eastern states have better CSR levels. In contrast, most of the western

districts have less than 900 girls per thousand boys. In many districts of India, there are less than 800 girls per thousand boys in the 0–6 years old age group. The north-eastern districts are better than western districts in terms of CSR. In Haryana, most of the districts have less than 800 girls per thousand boys in the 0–6 years old age group.

Akin to the pattern of CSR across the districts, the states having better SRB also have some parts (districts) with worse sex ratio. Thus, Map 2 shows that there is not only an interstate diversity but also an intrastate diversity in SRB. Although the SRB levels are better in the south, also an emerging masculinisation process is going on across several districts in the region. In western India, except for a few districts, most of the districts have worse SRB. The districts of east-central India have better SRB than western India. Most of the districts of Jammu & Kashmir and Himachal Pradesh have less than 900 girls per thousand boys at birth.

As said previously, SRLB does not play any role in determining the overall sex ratio of the population in the absence of sex-selective abortions, but it depicts the level of preference for a son existing in the society. Map 3 shows that north and northwestern India display a high meta son preference. The SRLB in western and northern India is between 400 to 800 girls per thousand births. Although, southern India has more districts with better SRLB, it also has a cluster of districts with SRLB skewed towards males. In the north-east, we found there were only a few districts with a balanced SRLB. The SRLB is overall skewed in every part of India except a few geographical pockets in south and north-east.

Multivariate regression analyses: Socio-economic factors of CSR, SRB and SRLB

Previously Das Gupta (1987, 2009), Kishor (1993), Agnihotri (2000), Sekher and Hatti (2010), and Arokiasamy and Goli (2012) examined the socio-economic factors of childhood sex ratios in India. We re-examined the factors in order to observe the changes in the association of socio-economic factors and all three different measures of CSRs. Table 7 shows the effect of socio-economic factors on CSR, SRB, and SRLB. Model I represents the likelihood of males and females in the 0–6 years old age group. Results in model 1 clearly showed that among women with the preference for a son, there is a high probability of having more sons than daughters after adjusting to all other socio-economic variables. The likelihood of having more males than females in the 0–6 years old age group is less in all other groups (SC, OBC and Others) in comparison to STs. The likelihood of having more male children among women with a primary or secondary level of education is higher than among the women with no education. The odds of having more males in the 0–6 years old age group is higher in the middle, rich and richest population than poor.

North India shows the high probability of having a more male child in comparison to the rest of India. Model II presents the likelihood of having more males than females at birth. The results of model II depicts that there is a higher likelihood of having more males than females at birth in the presence of son preference. SCs and OBCs have a less probability of having a son in comparison to STs. The probability of having more sons is high among women with a primary or secondary level of education. The probability of having more male children is highest among the richest women. Model III represents the likelihood of having more males than females at last birth. It is clear from the result that there is a higher likelihood of having a male child at the last birth if the previous two births were female. In the presence of son preference, there is a high probability of having males at last birth. Among all religions, Sikhs are more likely to have a male child at last birth. All economic classes are more likely to have a male child at last birth in comparison to the poor class. The probability of having males at last birth is higher in urban areas than in rural areas.

Conclusion

Beside PC-PNDT Act, recently India has initiated new programmes for combating the issues related to gender imbalance out of which one key programme is *Beti Bachao, Beti Padhao* (BBBP). Although, the NFHS 4 data does not allow the evaluation of the impact of BBBP as the launching of survey and BBBP programme was at the same time, but it does allow prioritising the key challenges in front of fulfilling BBBP targets and for identifying the changing ‘hot spots’ of the problem by analysing the trends and patterns of the sex ratio imbalance and key factors associated with it. This study based on 2015–16 data shows the most recent trends of masculinisation of the population by estimating SRB, CSR, and SRLB. Given that NFHS 4 factsheet and report unjustifiably represent the trends in SRB and CSR, the study presents the correct estimates of SRB and CSR by using unit-level data. A high correlation between NFHS- and SRS-based estimates show faith in our estimates (Figure 3).

The estimation across four rounds of NFHS data (1992–2016) shows that there is a declining trend in CSR, SRB, and SRLB as opposed to what has been reported in the factsheets of NFHS. A more surprising fact is that despite the decline in the preference for a son almost by half, the masculinisation of the population at the early ages continues. Over the period, except a slight improvement of CSR in SCs and SRB in STs, the overall CSR, SRB, and SRLB worsened across all social groups. Masculinisation continues across the population in all religious, educational, and wealth groups. Despite a slight improvement in SRB and SRLB among all religious groups, Sikhs are at the bottom in all three indicators: CSR, SRB, and SRLB. The decline is significant among females with higher education, rich wealth quintile and urban residents than their counterparts. Meta preference for a son is a significant factor for the highly skewed SRLB. The sex of previous births is also a critical determinant of the sex of the subsequent child. Although states from the north and north-west India continue to show a greater masculinisation of the child population, the district-level assessment shows assimilation of the culture of elimination of girl child in several districts of east and south India. Therefore, the previous notion of rice-and-wheat-belt divide or north-west and south-east divide in CSR imbalance (Miller 1997; Dyson and Moore 1983) cannot be strictly valid now as the intra-regional variation is a new emerging pattern in all three indicators of CSR. The culture of elimination of girl child is spreading to tribal populations in the eastern and remote areas of central India with the development of communication and increasing technological access. However, worsening of CSR and SRB in certain parts of the southern region of India needs a further exploration as none of the existing evidence or theoretical framework is able to explain the cause.

From a policy perspective, we put forward that acts like PC-PNDT and recent initiatives such as BBBP and other conditional cash transfers, which mainly target the legal surveillance of births, behaviour and attitude changes and state-specific conditional cash transfers needs to be strictly evaluated for their impact on improving childhood sex ratios. We especially recommend not to target only the below-poverty line families or marginalised communities in these programmes because the problem of skewed CSR is more in the wealthiest, urban and educated families. We also doubt how much awareness programmes, mostly driven by advertisements, work as the problem lies with most educated, wealthiest and urban communities who are well aware of the legal consequences of elimination of the girl child. The state-specific trends suggest that a strict implementation and monitoring of PC-PNDT Act is having some impact regarding improving the scenario of the sex ratio in highly focused states like Punjab, Haryana, and Rajasthan where the problem continues to be severe. The problem of sex ratio imbalance has roots in patriarchy and overvaluing of sons over daughters. We are promoting girl child education through programmes like BBBP but on the other side, we are reducing expenditure on public education and health programmes (Government of India 2018).

The catastrophic expenditures in education, health and marriages are the key factors which affect the girls more than it does boys and undermine the value of daughters in the society. By providing good education, better health care, employment opportunities and strengthening actions against the elimination of dowry can improve the value of daughters and parents' trust on daughters for old age security. The continuous religious divide in the sex ratio imbalance shows that interventions in religious culture and norms are must for improving the value of daughters in the society. As reported in previous studied as well (Attané and Guilmoto, 2007; Sekher and Hatti, 2010), there must be a change in the tendency of thinking that 'raising daughters is like a watering neighbour's garden'. As long as patrilineal and patrilocal societies continue, the parents' insecurity of lineage and old-age social security continues, which will keep undermining the value of daughters. Unless we raise the value of daughters in the Indian society and culture, the problem cannot be eliminated through only legal measures or advertisements.

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Tables

Table 1: Trends in Sex Preference, Sex Ratio at Birth and Child Sex Ratio (0–6 age) in India, 1992–93 to 2015–15–16

Indicator	1992–93	1998–99–99	2005–06	2015–15–16
	Percent/ Ratio	Percent/ Ratio	Percent / Ratio	Percent/ Ratio
Son Preference	46.25	35.2	35.2	26.43
Daughter Preference	2.86	2.14	2.14	3.63
No Preference	50.87	62.65	62.65	69.92
Sex Ratio at Birth per 1000†	941	938	919	911
Sex Ratio at Last Birth per 1000†	873	791	805	803
Sex Ratio at Last Birth per 1000† when last two births were male	992	977	1003	1014
Sex Ratio at Last Birth per 1000† when Last Two Births were Female	717	649	590	517
Sex Ratio at Last Birth per 1000† when Last Two Births were One Male and One Female	784	742	725	681
Child Sex Ratio per 1000 in 0–6 Age†	944	923	913	916

Table 2: Child Sex Ratio (0–6 years old age group) by Socio-economic background characteristics in India, 1992–93 to 2015–15–16

Background Characteristics	1992–93	1998–99–99	2005–06	2015–15–16
Sex Preference				
The preference for a son	782	786	762	776
No Preference	1057	979	955	941
Social Groups				
Schedule Caste	895	906	938	931
Schedule Tribe	994	953	947	968
OBC	-	931	902	906
Others	947	912	896	896
Religion				
Hindu	945	918	908	914
Muslim	956	963	939	928
Christian	978	903	968	951
Sikh	878	807	740	872
Other	843	916	975	931
Education				
No Education	929	932	921	949
Primary	989	943	902	900
Secondary	959	901	910	901
Higher	974	873	873	917
Wealth Quintile*				
Poorest	1057	921	913	951
Poor	908	959	935	942
Middle	935	932	916	887
Rich	1005	895	885	916
Richest	957	851	857	866
Place of Residence				
Urban	945	931	895	899
Rural	945	920	919	924

*Wealth Quintile for NFHS 1 (1992–93) and NFHS 2 (1998–99–99) are calculated by authors.

Table 3: Sex Ratio at Birth by socio-economic background characteristics in India, 1992–93–93 to 2015–15–16

Background Characteristics	1992–93	1998–99–99	2005–06	2015–15–16
Sex Preference				
The preference for a son	794	800	795	756
No Preference	1042	997	953	929
Social Groups				
schedule Caste	901	944	941	927
schedule Tribe	973	941	997	953
OBC	-	941	903	900
Others	945	925	897	888
Religion				
Hindu	941	936	914	907
Muslim	954	963	944	924
Christian	1017	944	1018	956
Sikh	835	832	719	861
Other	887	849	897	912
Education				
No Education	930	954	940	939
Primary	968	930	884	900
Secondary	965	923	904	896
Higher	934	862	889	904
Wealth Quintile				
Poorest	1031	852	965	939
Poor	950	947	930	939
Middle	923	992	922	892
Rich	1006	927	887	912
Richest	943	947	857	845
Place of Residence				
Urban	948	942	897	895
Rural	939	937	926	917

Table 4: Sex Ratio at Last Birth by Socio-economic background characteristics in India, 1992–93–93 to 2015–15–16

Background Characteristics	1992–93	1998–99–99	2005–06	2015–15–16
Sex Preference				
The preference for a son	741	722	715	638
No Preference	957	885	821	824
Social Groups				
schedule Caste	866	838	831	829
schedule Tribe	909	829	922	839
OBC	-	864	790	786
Others	871	815	769	779
Religion				
Hindu	867	835	791	793
Muslim	936	914	883	850
Christian	1034	935	1008	954
Sikh	612	596	494	663
Other	781	654	820	818
Education				
No Education	866	866	835	807
Primary	904	809	776	769
Secondary	885	815	775	801
Higher	835	810	800	845
Wealth Quintile				
Poorest	950	798	889	821
Poor	866	965	788	811
Middle	924	874	808	796
Rich	948	974	769	817
Richest	899	796	757	765
Place of Residence				
Urban	879	849	802	814
Rural	872	840	806	798

Table 5: Child Sex Ratios for all States of India, 1992–93 to 2015–15–16

States	1992–93	1998–99–99	2005–06	2015–15–16
Andhra Pradesh	1006	920	891	894
Arunachal Pradesh	894	867	1020	924
Assam	1022	915	988	921
Bihar	941	939	887	935
Goa	954	847	960	902
Gujarat	966	922	902	881
Haryana	859	857	759	826
Himachal Pradesh	900	934	893	944
Jammu and Kashmir	863	878	911	911
Karnataka	949	957	945	922
Kerala	969	942	925	1025
Madhya Pradesh	921	910	975	919
Maharashtra	956	931	882	923
Manipur	1060	992	1012	982
Meghalaya	974	898	974	1014
Mizoram	933	871	1025	946
Nagaland	950	922	975	949
Delhi	904	833	855	835
Odisha	934	955	924	935
Punjab	887	830	725	840
Rajasthan	877	883	860	883
Tamil Nadu	1051	967	933	944
Tripura	961	983	972	953
Uttar Pradesh	919	936	906	904
West Bengal	969	898	975	953
Sikkim	-	920	1003	891
Chhattisgarh	-	-	927	966
Jharkhand	-	-	1085	921
Uttarakhand	-	-	911	891
Telangana	-	-	-	912

Table 6: Sex Ratio at Birth for all States of India, 1992–93 to 2015–15–16

States	1992–93	1998–99–99	2005–06	2015–15–16
Andhra Pradesh	1005	950	872	899
Arunachal Pradesh	971	820	1001	910
Assam	962	909	982	901
Bihar	955	944	921	931
Goa	965	878	945	949
Gujarat	980	901	897	873
Haryana	904	877	726	846
Himachal Pradesh	852	903	901	930
Jammu and Kashmir	880	911	908	910
Karnataka	929	964	970	909
Kerala	961	892	934	1028
Madhya Pradesh	930	915	1014	913
Maharashtra	961	926	865	911
Manipur	1057	1068	1010	964
Meghalaya	1021	849	929	992
Mizoram	980	936	1032	986
Nagaland	943	884	902	955
Delhi	884	847	859	820
Odisha	948	992	886	941
Punjab	828	874	742	845
Rajasthan	893	896	897	869
Tamil Nadu	1018	1000	991	950
Tripura	908	981	978	936
Uttar Pradesh	909	972	915	896
West Bengal	963	927	947	947
Sikkim	-	896	986	802
Chhattisgarh	-	-	890	958
Jharkhand	-	-	1062	930
Uttarakhand	-	-	873	878
Telangana	-	-	-	875

Table 7: Results from logistic regression models: Socio-economic Correlates of Child Sex Ratio (0–6 years), Sex Ratio at Birth and Sex ratio at Last Birth.

Factors	Exp.β (Odds Ratio)		
	Model I Likelihood of having more males than females in 0–6 age group children	Model II Likelihood of having more males than females at birth	Model III Probability of having male compare to female at last birth
Sex of Previous Two Birth			
Both male®	-	-	1.00
Both female	-	-	2.021*** (1.972–2.072)
One Male and One Female	-	-	1.504*** (1.473–1.536)
Sex Preference			
Others®	1.00	1.00	1.00
Son Preference	1.292*** (1.270–1.315)	1.283*** (1.260–1.308)	1.232*** (1.209–1.256)
Caste			
SC®	1.00	1.00	1.00
ST	0.955*** (0.931–0.979)	0.946*** (0.921–0.972)	0.914*** (0.888–0.942)
OBC	0.962** (0.936–0.990)	0.960** (0.932–0.989)	0.894*** (0.866–0.925)
Others	0.992 (0.972–1.014)	0.987 (0.965–1.010)	0.974* (0.950–1.000)
Religion			
Hindu®	1.00	1.00	1.00
Muslim	0.954*** (0.933–0.976)	0.947*** (0.924–0.971)	0.821*** (0.799–0.844)
Christian	0.954* (0.918–0.991)	0.936*** (0.898–0.974)	0.917*** (0.876–0.961)
Sikh	0.995 (0.937–1.058)	1.004 (0.940–1.072)	1.111** (1.030–1.198)
Others	0.975 (0.928–1.026)	0.964 (0.914–1.017)	0.885*** (0.835–0.940)
Education			
No Education®	1.00	1.00	1.00
Primary	1.048*** (1.025–1.072)	1.047*** (1.022–1.072)	1.001 (0.978–1.025)
Secondary	1.054*** (1.034–1.076)	1.054*** (1.031–1.077)	1.024** (1.000–1.049)
Higher	1.029 (0.996–1.064)	1.023 (0.987–1.061)	1.078** (1.009–1.153)
Wealth Quintile*			
Poorest®	1.00	1.00	1.00
Poor	1.009 (0.988–1.032)	1.001 (0.978–1.024)	1.064*** (1.038–1.091)
Middle	1.059*** (1.034–1.086)	1.048*** (1.021–1.076)	1.103*** (1.073–1.135)
Rich	1.042** (1.013–1.072)	1.031* (1.001–1.063)	1.152*** (1.116–1.190)
Richest	1.110*** (1.073–1.148)	1.115*** (1.075–1.156)	1.197*** (1.152–1.246)
Place of Residence			
Urban®	1.00	1.00	1.00
Rural	0.995(0.975–1.015)	1.003 (0.981–1.024)	1.080*** (1.055–1.106)
Region			
North®	1.00	1.00	1.00
central	0.961*** (0.940–0.984)	0.966** (0.942–0.990)	0.907*** (0.883–0.932)
East	0.948*** (0.924–0.973)	0.944*** (0.919–0.971)	0.861*** (0.835–0.888)
North-east	0.961* (0.930–0.995)	0.980 (0.945–1.016)	0.769*** (0.738–0.801)
South	0.940*** (0.913–0.969)	0.948*** (0.918–0.979)	0.747*** (0.720–0.775)
West	0.978 (0.947–1.012)	0.984 (0.949–1.019)	1.014 (0.976–1.056)
Constant	1.019 (0.982–1.059)	1.029 (0.989–1.072)	0.960 (0.916–1.006)

® - Reference category; Level of significance: * p < 0.05; ** p < 0.01; *** p < 0.001.

Table 8: Quantification of the impact of stopping rule on Sex Ratio of Last Births by parity, India (2015–15–16)

Birth	SRB of parity i			SRLB of parity i				PSR at parity i (%)			Estimation of SRLB			
Parity	Male	Female	Total	Actual	Male	Female	Total	Actual	PSR	PSR f i	PSR t	PSR mi /	SRBL*	SRBL*
	Births	Births	Births	SRBs	Births	Births	Births	SRBL	mi		i	PSR f i		*
1	292	149	441	510	290	148	438	510	99.2	99.2	99.2	1.00	952	510
2	15010	9710	24720	645	10062	6860	16923	680	67.0	70.7	68.5	0.95	1000	680
3	8866	5838	14704	658	5919	3279	9198	552	66.8	56.2	62.6	1.19	800	552
4	3607	2619	6226	725	2496	1389	3885	556	69.2	53.1	62.4	1.30	730	556
5+	2757	2182	4939	794	1851	1249	3100	676	67.1	57.2	62.8	1.17	813	676

Note: * SRLB when the differential in stopping rule behaviour and termination of pregnancy not present or when assumed normal SRB

** SRLB when the differential in stopping rule behaviour and termination of pregnancy present or when considered actual SRB

Figure 1: Trends in Sex Ratio of the overall population in major states of India, 1901–2011

Figure 2: Trends in Child Sex Ratios in the Major States of India, 1961 to 2011

Source: Calculated by using 0-6 population in single year age group by sex from Socio- economic tables (1961-1981).

Office of the Registrar General and Census Commissioner, India.

Figure 3: Correlation between the estimates of SRB from SRS (2013–15) and NFHS (2015–15–16)

Map 1: District Pattern of Child Sex Ratio in India, 2015–16

Map 2: District Pattern of Sex Ratio at Birth in India, 2015–16

Map 3: District Pattern of Sex Ratio at Last Birth in India, 2015–16