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Factors Influencing the Use of Prenatal Diagnostic Techniques and Sex Ratio at Birth in India

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Abstract:

In recent years the use of prenatal diagnostic techniques (PNDT), followed by sex-selective abortion has emerged as the most powerful determinant of sex ratio at birth in India. In this paper we have used the recently released data on fertility from the 2001 Census as well as from the National Family Health Surveys (NFHS) to analyse the factors influencing the use of PNDT as well as sex ratio at birth. We find that, though the use of PNDT is now fairly widespread in India, only a minority of couples misuse it for aborting female fetuses. While income and education do increase the use of PNDT, its misuse is governed more by cultural factors and sex composition of children already born. The paternal age is found to reduce the probability of male birth while trained birth attendance is found to increase this probability. Maternal anaemia and obesity are found to decrease the sex ratio at birth. The sex ratio at birth is found to be lower at higher altitudes. In spite of controlling many socio-economic and demographic factors, the sex ratio at birth is higher in north India, especially in north-western parts, indicating that women in these regions misuse the technology more than others.

Introduction

The Indian subcontinent is one of the few regions in the world where there are more males than females in the population. Before the landmark study of Pravin Visaria on the sex ratio of India's population, several hypotheses were in circulation to account for this unusual occurrence. Visaria (1971) persuasively argued that excess female mortality is the main reason for this anomaly and laid at rest other competing explanations. But India's sex ratio (males per females) has shown a more or less steady increase since 1901, even though the data from India's Sample Registration System suggest narrowing of the sex differentials in mortality in recent years. The latest census in 2001 has recorded a significant increase in the sex ratio of children age 0-6 while registering a decline in the overall male-female ratio from the previous census in 1991. Many attribute the increase in the child sex ratio to a possible rise in the sex ratio at birth owing to the increasing incidence of female foeticide in regions where son preference remains strong (e.g., Das Gupta and Bhat 1997, Sudha and Rajan 1999, Arnold, Kishore and Roy 2002). But it has also been pointed out that there could be other factors at work such as changing pattern of age misstatements by sex, and increase in the sex ratio at birth because of improvements in health status and midwifery practices or from the decline in the proportion of higher-order births (see Bhat 2002).

Although it is well established that under normal circumstances, more males than females are born among all human populations, the sex ratio at birth is not a universal constant. But often the observed variations are due to smallness of the sample of births from which the ratio is calculated or incomplete coverage of births of particular sex. From an analysis of data for countries with relatively complete registration, Visaria (1971) concluded that the sex ratio at birth varies generally between 103 and 106. There also is some evidence of secular trends in the sex ratio at birth, predating the invention of modern technologies of sex selection. Some western countries with reliable and longstanding registration data, such as Sweden and England, have recorded declines in the female-male ratio of the order of 2-3 percent over a period of one or two centuries (see Klasen 1994). The data for British India complied by Visaria (1971) from the civil registration system showed that female-male ratio at birth declined from 936 in 1901-10 to 912 in 1940-46. The decline was seen in all the major provinces of British India except Bombay and Assam. However, Visaria was of the view that the observed trend was a spurious result of deterioration in the completeness of registration system in British India. But fairly complete vital registration data available for four districts of Maharashtra (known as of Berar during British rule) also showed a similar downward trend in the sex ratio at birth during the first half of twentieth century (see Dyson 1989, Bhat 2002).

The spatial and temporal variations in sex ratio at birth arise from social, demographic and biological factors affecting the sex ratio at birth. The literature on the issue is replete with many speculations regarding the factors affecting the sex ratio at birth. The review of literature on this subject has shown that while a large number of factors are considered to be important, there are few studies that analyzed the relationship in the multivariate context (Teitelbaum 1972, Chahnazarian 1988, Waldron 1998). One of the main reasons for the paucity of such studies is because, national vital statistic systems, which provide data on large sample of births required for such an analysis have information only for limited set of associated factors. The data from India's National Family Health surveys provide an opportunity to analyze the effect of a larger set of factors from a fairly large sample of births using multivariate techniques. Also, as the second round of the survey (NFHS-2) had collected data on the use of ultrasound and amniocentesis during pregnancies of live births born during the three-year period preceding the survey, they additionally make it possible to analyze how socioeconomic and demographic factors affect the sex ratio at birth through the 'misuse' such technologies. Although some attempts have already been made to analyze this data set for this purpose (Arnold, Kishore and Roy 2002; Retherford and Roy 2003), its full potential remains to be exploited. An attempt in this direction is made in this paper. We also take advantage of recently released data on fertility from the 2001 Census to study the influence of some key factors on sex ratio at birth in India.

Evidence from Census of 2001

Information on the sex ratio of children of age 0-6 years was one of the first data to be released from the 2001 Census. It caused widespread anguish as it showed significant fall in the proportion of females in this age group, indicating dramatic increase in the incidence of pre-birth elimination of females (Registrar General, India 2003). But data on child sex ratios are affected also by sex differentials in child mortality, underenumeration and age misreporting (Bhat 2002). The recently released data on fertility from the 2001 Census provide more direct information on the sex ratio at birth. They also make it possible study factors influencing the sex ratio at birth at greater detail as they have been cross-tabulated by more variables than the child sex ratios. Two types of data on fertility were colleted in the Census of 2001: (i) live births during the one-year period preceding the census for all currently married women (i.e., current fertility) and (ii) number of children ever born for all ever-married women (i.e., lifetime fertility). In both cases, data have been collected on the sex of the child. These data have been tabulated by mother's age, religion, and educational level for rural and urban areas of all states. Table 1 shows for all- India the sex ratio at birth by mother's background characteristics.

In all, nearly 20 million live births were reported during the year preceding the census. They imply a sex ratio at birth of 110 males for 100 females. This sex ratio is higher than the sex ratio of 108 for children of age 0-6 years at the time of the census. As in India child mortality is higher for girls than boys, the child sex ratio should have been higher than the sex ratio at birth. The discrepancy could be indicating the rise in the sex ratio at birth during the years preceding the census, or underreporting of female births that occurred during the year preceding the census, or greater exaggeration of age for boys than girls in the census. The census data on children-ever born showed a steady rise in the sex ratio at birth from 105 for women aged 15-19 to 113 for women aged 45-49 in 2001. This is probably due the failure of older women to report female children who died or married off. To minimize the effect of recall errors, Table 1 shows the sex ratio at birth implied by the data on children ever born to women age 20-34 years. In all, these women reported 238 million live births in their lifetime, with sex ratio at birth of 107. As these children were born on average 5-10 years before the survey, they would be indicating a sex ratio at birth lower than that for the year preceding the census if the sex ratio at birth has been rising.

Interestingly, the data on births for the year preceding the census shows negligible rural-urban difference in the sex ratio at birth, whereas data on children ever born shows, as expected, higher sex ratio at birth in urban areas (108) than in rural areas (106). This may be indicating either that the rural-urban difference has disappeared in more recent years or that rural women have underreported more female births that occurred during the last year than urban women. However, both types of data show that the sex ratio at birth increases with mother's educational level. The data on births for the year preceding the census show that sex ratio at birth increases from 109 for illiterate women to 115 for women who have completed matriculation. But those graduated from college have reported a sex ratio at birth of 114. The data on children ever born show that the sex ratio at birth steadily increases from 106 for illiterate women to 110 for women with a college degree.

Religion is another variable that shows a systematic relationship with sex ratio at birth. As per both types of data, sex ratio at birth is 103-104 for Christians, indicating little practice of sex-selective abortions. But the sex ratio at birth is much higher than the normal range among Sikhs and Jains. As per the data on last birth, it is 129 for Sikhs and 118 for Jains while as per the data on children ever born it is, respectively, 119 and 111. Hindus, the main community, have a sex ratio at birth of 111 and 107, as per the two types of data. The data on scheduled tribes indicate no evidence of female feticide (sex ratio being 106 and 103, respectively). As per both types of data, the sex ratio at birth for scheduled castes is two percentage points higher than that for scheduled tribes.

The data on births for the year preceding the census have been tabulated by mother's age at the time of the census. As in this case the time lapsed since the birth is less than a year, mother's age is essentially her age at the time of birth. The sex ratio at birth calculated from these data shows a curvilinear relationship with mother's age. The sex ratio at birth increases from 106 for mothers aged less than 15 to 113 for mothers aged 20-29 and then decreases steadily to 75 for women aged more than 50 years. Very young mothers apparently do not resort to female feticide as most of their births are of first order. Women of age more than 40 years also apparently do not resort to female infanticide but their sex ratio at birth is lower than 100 because under normal circumstances order of birth and paternal age are inversely related to sex ratio at birth (e.g., Chahnazarian 1988).

Table 2 shows the sex ratio at birth computed from the two types of census fertility data for the states of India. None of the states in the south and eastern parts of India show any evidence of sex selective abortions, as the computed sex ratios at birth from both types of data are well within the normal range. In these states, births born even to women who completed matriculation show no evidence of female feticide. But there is a strong evidence of sex-selective abortions in north and western parts of the country, especially in the states of Punjab, Haryana and Gujarat. For the year preceding the survey, the sex ratio at birth is 127 for Punjab and Haryana and 120 for Gujarat. The sex ratio at birth computed from the data on children ever born to women aged 20-34 is 118 for Punjab, 116 for Haryana and 112 for Gujarat. In all the states of north and western India (except Goa), the sex ratio at birth reported by women who had passed matriculation is higher than 106. In Punjab and Haryana, the sex ratio at birth for this group of women is as high as 139-141, as per the data on births during last year and 122-125, as per the data on children ever born.

Evidence from National Family Health Survey

The National Family Health Surveys conducted in 1992-93 (NFHS-1) and 1998-99 (NFHS-2) were designed on the lines of Demographic Health Surveys (DHS) conduced in many developing countries with the financial assistance of USAID. They provide valuable information on birth histories of women, their background characteristics, including antenatal and delivery care during the pregnancy of most recently born children (during the four-year period preceding the survey in NFHS-1 and three-year period preceding the survey in NFHS-2). From NFHS-2, data on anthropometrical indicators and anaemia for all women, and the use of ultrasound and amniocentesis during the pregnancy of the recently born children are also available. As the unit-record data from the surveys are available in electronic form, they provide greater scope than the census data for the analysis of determinants of sex ratio at birth as well as the use of prenatal diagnostic techniques (PNDT). However, as the data on number of births available from the NFHS are relatively small compared to that from the census, the results tend to be more suggestive than confirmatory.

Use and Misuse of Prenatal Diagnostic Techniques

A recently emerged factor that has a strong influence on the sex ratio at birth is the use of sex determination tests during pregnancy followed by abortion of fetuses of unwanted sex. Although conducting abortion became legal in India in 1971, it is only recently that pre-natal diagnostic techniques became widely available. Because of its relative rarity, information on the use of these techniques was not collected in NFHS-1. But in NFHS-2, this information was collected from the mothers who gave birth during the three-year period before the survey. In this survey, the use of PNDT (mainly ultrasound) was reported by mothers in 13 percent of 32 thousand live births that occurred during the three-year period before the survey. The sex ratio at birth in the reported cases of PNDT was 112 compared with 107 among live births to women who did not report the use of PNDT. Clearly, in a significant percentage of cases, PNDT was misused to abort female fetuses, since if sex-selective abortions were not practiced, the sex ratio at birth would have been close to 105. Even the reported sex ratio at birth for non-PNDT cases is relatively high indicating that some women may not have disclosed its use.

From the survey data, it is possible to arrive at a rough estimate of the misuse of PNDT for sex selection and the true extent of the use of PNDT. To do this, we assume that (i) sex ratio at birth in the absence of sex-selective abortion is 105 males for 100 females, and (ii) abortion after PNDT is done only when the fetus is detected to be female. Although some male fetuses may get aborted because of wrong diagnosis, it is assumed that such failures of PNDT are rare. We define the index of misuse of PNDT as

$$\frac{\text{Number of missing female live births}}{\text{Female live births to reported users of PNDT + Missing female live births}} \times 100$$

The number of missing female live births is computed as

$$\frac{\text{Reported number of male live births} \times 100}{105} - \text{Reported number of female live births.}$$

If however, the sex ratio for reported live births is lower than 105 for a group of women, it assumed that it is due to sampling errors and there are no missing live births, either male or female. Also, two estimates of missing female live births are made: (i) by assuming that the reported use of PNDT is correct, and any deviation in the sex ratio at birth from 105 among sub groups of those who did not use the PNDT is due to sampling errors; (ii) women who did not report the use of PNDT may have actually used it if the sex at birth for the group they belong to is more than 105. In the latter case, the adjusted percentage of pregnancies subjected to PNDT is computed as:

$$\frac{\text{Total live births to reported users of PNDT + Missing female live births}}{\text{Reported total live births by all women + Missing female live births}} \times 100$$

Table 3 presents data on the reported use of PNDT and the estimated misuse of these technologies according to background characteristics. For India as whole, the sex ratio at birth of 112 among those who used PNDT indicates that 6 percent of female fetuses were aborted after PNDT (i.e. those who misused PNDT). But if it is assumed that some of those who did not use PNDT may have actually used it (since their sex ratio at birth is 107), the estimated percentage of female fetuses aborted rises to 17 percent, and the adjusted use of PNDT is 14 instead of 13 percent. In urban areas, 31 percent of live births were reportedly subjected to PNDT compared with only 8 percent in rural areas. On the assumption that reported PNDT use is correct, 8 percent of those who used PNDT missed it in urban areas while 4 percent did so in rural areas. But the sex ratio of those who did not report the use of PNDT shows that 32 percent in rural areas and 9 percent in urban areas may actually have used it, and among them 9 percent in urban areas and 24 percent in rural areas may have miss used it. Thus the use of PNDT is certainly much higher in urban areas than in rural areas, but it is not altogether clear as to where the misuse is higher.

The use of PNDT is relatively high in south and western regions of India where the reported use is 27-28 percent. The reported use is less than 5 percent in east and north-central regions of India. In north-western parts of the country where the child sex ratios are high, the reported use is moderate (17 percent). The strong regional pattern in the reported use is clearly seen Figure 1 where we have mapped the use rate for 72 for natural regions of the country. Although south India shows the highest use rates, misuse of the technology is rare; as a consequence, sex ratio at birth is less than 105 in this region among both users and non-users (see Table 3). In north-central region, though the use of PNDT is rare, misuse among those who use it is high (17-24 percent). But it is in the north-western region, where the misuse of PNDT is most frequent (27-47 percent). Although East shows the highest percentage of misuse if the high sex ratio at birth for non-users is taken into account, it is more probably due to sampling errors than misreporting. For north-western India, when the reported use is adjusted for its possible underreporting, the implied use rate increases from 17 to 22 percent. In other regions, the implied corrections for underreporting are small.

The reported use of PNDT declines as the order of birth increases. But the misuse of the technology increases with the birth order. The reported use is 21 percent for the first birth order but the estimated misuse, at the maximum, is only 8 percent. On the other hand, when the birth order is 4 or more, only 4 percent report the use of PNDT but nearly 40 percent resort to abortion if the fetus is female. Thus in the case of first birth, the predominant reason for the use of PNDT is to detect abnormalities, while at higher orders the main reason for the use is to detect the sex of the child. In particular, the misuse of the technology is highest when the woman has no son, but has two or more daughters. Among such women, the misuse is estimated to be 46-63 percent.

The reported use of PNDT is 12 percent among Hindus and Muslims, and 26 percent among other religions (mainly Christians and Sikhs). While those who misuse the technology are negligible among Muslims, it is 8-12 percent among Hindus and 5-20 percent among other religions. The use of the technology increases with the level of education of parents. When both the mother and father are illiterate, only 2 percent use PNDT. When only the father is literate, this increases to 5 percent. When the mother has completed high school or gone to college, the reported use is 42 percent. The misuse is least when both the mother and father are illiterate (0-3 percent), but relatively high when the mother has competed high school or gone to college (9-25 percent). The reported use also rises with standard of living (SLI) of parents and with mother's exposure to media. The estimated misuse is higher among those who have high SLI than those with low or moderate levels of SLI. The exposure to media however does not show a clear relationship with misuse.

The reported as well as the adjusted use rates increase with mother's ideal family size. When the ideal family size is one or two, 22-24 percent had PNDT. When the ideal family size is 4 or more, only 4 percent use PNDT. The misuse is highest when the ideal family size is three (13-44 percent), moderate when it is one or two (6-28 percent) and negligible when it is four or more.

The foregoing analysis shows that the use of PNDT tends to be systematically related to socio-economic factors, and the adjustment needed for the possible underreporting of PNDT use is relative small. Therefore, without significantly biasing the results, one can apply the multivariate techniques to the reported data on PNDT use to study the independent effects of key socio-economic variables on the use of PNDT. Accordingly, Table 4 shows the results of logistic regression of the determinants of PNDT use. As the table shows, most of the variables used in the regression have statistically significant effects on the use of PNDT. Maternal and paternal age show a non-linear relationship with the use of PNDT. The use increases initially with age but later tends decrease with age. The use of this technology is lower if the order of birth is three or more, but it is significantly higher if there are no surviving male siblings. That is, couples without sons tend to use the technology more in order to have sons.

Urban residence, educational level, exposure to media and standard of living show strong, independent and positive effects on the use of PNDT. Its use is higher among Christians, and if the religion is other than Hindu, Muslim or Sikh. The use is lower among members of scheduled tribes and scheduled castes, even after controlling for standard of living and educational level. The use of PNDT is lower among mothers having larger ideal family sizes and among those who gave non-numeric answer to the question on ideal family size. Women who were visited by health workers during the pregnancy report lower use of PNDT. This finding directly contradicts the claim of some activists that health workers act as promoters of this technology in rural India. Even after controlling these variables, eastern, north-central and north-western parts of India show lower use of PNDT than southern states. In other words, the geographical pattern seen in the PNDT use cannot fully be explained by the observed socio-economic variations.

Determinates of sex ratio at birth

In recent years the use of PNDT has emerged as the key intervening variable through which other factors influence the sex ratio at birth in India. There are, however, a number of factors that independently affect the sex ratio at birth. Teittelbaum (1972) provides an early review of the literature on this subject. Waldren (1998) provides a more recent review of the literature. Chahnazarian (1988) has applied multivariate techniques to test the independent effects of some of these variables using vital statistics data for several countries. For India, Retherford and Roy (2003) have used the NFHS data to test the significance of a limited set of factors. Here, using the same data set, an attempt is made to test the significance of far more variables on the sex ratio at birth.

Accordingly, Table 5 shows results of the logit analysis of the determinants of sex ratio at birth using the data from NFHS-1 and NFHS-2. The results presented are with respect to the probability of having a male birth. Two sets of regression results are presented, one using data on births that occurred during the 0-14 years before the survey, and another using data on births that occurred 0-4 years (for NFHS-1) and 0-3 years (for NFHS-2) before the survey. While the first set of regressions is based on larger sample of births, the latter set takes advantage of having information on more variables for the more recent births. However, it can be seen that in the regressions the estimated effects of only a few variables employed are statistically significant. The results of regressions suggest that the sex ratio at birth increases with the paternal age, a finding also reported by Chahnazarian (1988). As indicated by the census data reviewed earlier, maternal age shows a non-linear relationship but its effect is significant only in one of the regressions (NFHS-1, for births 0-14 years before the survey) that too at ten percent level. Although order of birth doesn't show statistically significant relationship in any of the regressions, regressions using the NFHS-2 data set show that if the birth order is higher than two and there are living sons, the probability of next birth being a male is higher and the effect is strongly significant. This shows that in recent years such women are resorting to female feticides.

Urban residence, educational level, exposure to mass media, religion and caste generally do not show statistically significant or consistent relationships in all the regressions. However, mothers with high school education or higher have reported lower proportion of males in their births in NFHS-1. But in NFHS-2 they have reported more males in their births, and the effect is mildly significant in the regression using data for births during the 0-14 years before the survey. This is consistent with the census results showing higher sex ratio at birth among well-educated women. The regression results show that the sex ratio at birth increases as the mothers' ideal number of children decreases, though in a non-linear fashion. This effect is strongly significant in all the regressions. Also, those who gave non-numeric response to the question on ideal family size had fewer sons. This may seem consistent with the contention of some female activists that incidence of female feticide increases with the decrease in family size. However, the fact that this effect is also found in NFHS-1 data set (i.e., in births that occurred during the 1970s and 1980s) indicates that the observed relationship is spurious: It may be that those who had more female children by chance, may have reported higher ideal family size in order to justify the non-use of contraception.

Data on mother's nutritional status and anaemia are available only from NFHS-2. When data on births during 0-14 years are used (i.e., larger sample of births), moderate and sever anaemia show strong negative effect on the sex ratio at birth. Mother's height does not show any effect on the sex ratio at birth, but the results strongly suggest that obese women tend to have fewer sons. Data on altitude are available only from NFHS-2. When births during the 0-14 years before the survey is considered, there is an indication that higher altitudes reduce the chance male birth, possibly through higher male fetal mortality. In both NFHS-1 and NFHS-2, data on antenatal and natal care is available only for the recent births (for the last 4 years in NFHS-1 and last 3 years in NFHS-2). Both data sets show that sex ratio at birth is higher when trained personnel attend the birth. This is could be due to the reduction in stillbirths when they attend the birth. Antenatal care however appears to have no effect on sex ratio at birth.

In all the regressions, even after controlling for the foregoing factors, the sex ratio at birth is significantly higher in north-western and north-central regions. This is could be because of greater misuse of PNDT in these parts, or because of the tendency to underreport of female births in northern India.

Summary and Conclusions

In recent years the use of prenatal diagnostic techniques (PNDT), followed by sex-selective abortion has emerged as the most powerful determinant of sex ratio at birth in India. In this paper we have analysed the factors influencing the use of PNDT as well as sex ratio at birth. We present evidence from the recently released data on fertility from the 2001 census as well as from the National Family Health Surveys (NFHS). The census fertility data suggest that sex ratio at birth in India may have increased to 110, and in some areas as high as 130. But this data may have been affected by underreporting of female births. But even this data show that the sex ratio at birth in south and eastern India is well within the range observed under normal circumstances, thus discount the possibility of widespread use of sex selective abortions in these areas. The census data also show that though there may be little rural-urban difference in the sex ratio at birth, among the educated class the sex ratio at birth is abnormally high.

The data collected in NFHS-2 (1998-99) show that 13 percent of live births were subjected to PNDT, and 6 percent of female fetuses may have been aborted after PNDT. However, if possible underreporting is taken into account, PNDT may have been used in 14 percent of the cases, and 17 percent of female fetuses may have been aborted. The use of PNDT is higher in southern and western regions of India while its misuse for selectively aborting female fetuses is higher in north, especially in north-western parts of the country. Also, the use of these techniques is higher at lower parities but their misuse is more at higher parities, especially if women had daughters only.

As would be expected, the use of PNDT is much higher in urban areas, among educated women, those with higher levels of standard of living, and regularly exposed to media. The multivariate analysis applied to the data shows that these factors have independent effects of the use of PNDT. But they do not show a clear-cut relationship with its misuse. This may be because the sample of users of PNDT in the NFHS is not large enough to infer the patterns unambiguously. Interestingly, the analysis shows that those who reported the visit of health workers during pregnancy of the index birth have used the PNDT less than others. This contradicts the allegation of some activists who claim that government health workers are often hired by private agencies to promote the use of this technology in rural India.

The analysis of NFHS data show that beyond the use of PNDT, several other factors influence the sex ratio at birth. The paternal age is found to reduce the probability of male birth while trained birth attendance is found to increase this probability (possibly by reducing incidence of still births). Maternal anaemia and obesity are found to decrease the sex ratio at birth. The sex ratio at birth is found to be lower at higher altitudes. Urban residence, educational level, standard of living, religion and cast/tribe failed to show significant or consistent relationships with sex ratio at birth. The sex ratio at birth was significantly higher among women who had earlier given birth to three or more children but all were daughters, indicating that such women misused the technology more than others. In spite of controlling many socio-economic and demographic factors, the sex ratio at birth was higher in north India, especially in north-western parts, indicating that women in these regions misused the technology more than others.

In conclusion, although the use of PNDT is now fairly widespread in India, only a minority of couples misuse it for aborting female fetuses. While income and education do increase the use of PNDT, its misuse is governed more by cultural factors and sex composition of children already born.

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Figure 1: Reported use of prenatal diagnostic techniques in 76 natural regions of India, NFHS-2, 1998-99

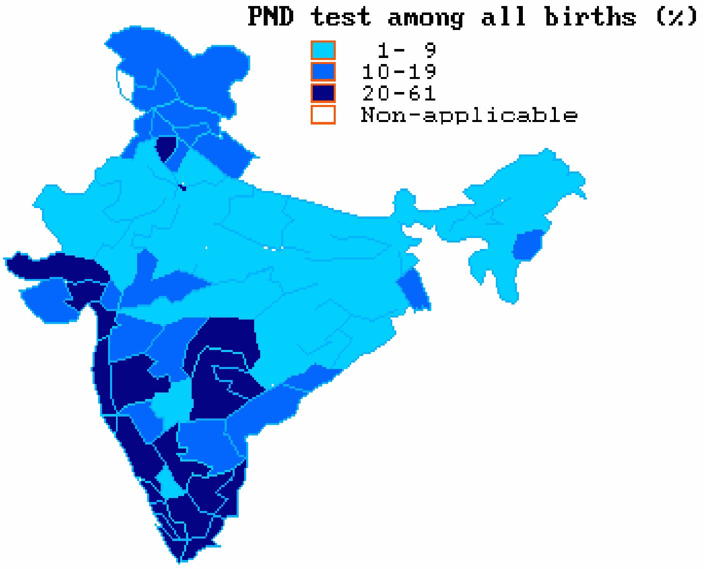

Table 1. Child sex ratio and sex ratio at birth by selected background characteristics, All India, 2001 Census

Background characteristics	Sex ratio of children of age 0-6 years	Sex ratio at birth: Births during the preceding year	Sex ratio at birth: Children ever-born to women aged 20-34
All	107.8	110.4	106.7
Residence			
Rural	107.1	110.4	106.3
Urban	110.3	110.6	108.3
Religion			
Hindu	108.2	110.9	106.9
Muslim	105.3	107.4	105.3
Christian	103.7	103.8	103.0
Sikh	127.3	129.8	119.1
Buddhist	106.2	108.4	105.2
Jain	115.0	118.0	110.5
Other religious communities	102.5	106.5	102.3
Caste/Tribe			
Scheduled tribe	102.8	106.4	103.1
Scheduled caste	106.6	108.6	105.8
Others	108.8	111.5	107.4
Mother's age			
< 15	na	105.9	na
15-19	na	108.2	na
20-24	na	111.4	na
25-29	na	113.2	na
30-34	na	112.1	na
35-39	na	109.1	na
40-44	na	103.7	na
45-49	na	99.7	na
50+	na	75.7	na
Mother's educational level			
Illiterate	na	108.7	106.0
Literate but below primary	na	110.0	106.3
Primary but below middle	na	111.8	107.1
Middle but below matric or secondary	na	113.0	107.5
Matric or secondary but below graduate	na	115.3	109.4
Graduate and above	na	114.1	109.7
Total births/children (in thousands)	163,820	19,887	237,622

na - not available/applicable.

Table 2. Sex ratio at birth by residence and mother's educational level, 2001 Census

Region & State	From data on births during the year preceding the census					From data on children-ever born to women age 20-34 years				
				Mother's education					Mother's education	
	All areas	Rural	Urban	Iliterate	Matriculation or higher	All areas	Rural	Urban	Iliterate	Matriculation or higher
All-India	110	110	111	109	115	107	106	108	106	109
North-West										
Jammu & Kashmir	105	105	103	102	114	109	108	113	107	116
Himachal Pradesh	118	119	117	112	127	109	109	114	105	115
Punjab	127	127	126	118	139	118	118	119	114	125
Haryana	127	127	127	120	141	116	115	117	113	122
Delhi	117	121	117	110	125	112	114	112	109	116
North-Central										
Rajasthan	116	115	119	113	124	109	108	111	108	113
Uttaranchal	117	117	117	114	124	107	106	110	105	112
Uttar Pradesh	111	111	109	110	119	107	107	110	107	111
Bihar	109	109	109	107	118	107	107	109	107	110
Jharkhand	110	110	114	109	116	104	104	107	104	107
Chattisgarh	108	107	109	107	112	102	102	104	101	107
Madhya Pradesh	111	110	113	109	116	106	106	109	105	109
East										
Assam	106	106	102	105	106	104	104	106	104	104
North-East*	103	103	101	102	101	102	103	102	103	103
West Bengal	103	103	99	102	102	104	104	105	104	104
Orissa	108	108	105	106	111	104	103	105	103	105
West										
Gujarat	120	118	125	114	134	112	110	115	109	119
Maharashta	114	115	112	110	118	108	107	108	106	111
Goa	109	106	112	105	109	105	104	106	105	105
South										
Andhra Pradesh	105	106	103	105	106	104	104	104	104	104
Karnataka	103	103	104	102	104	105	105	105	105	105
Kerala	103	103	104	102	104	104	104	104	105	104
Tamil Nadu	107	109	104	108	106	105	105	104	106	104

* Arunachal Pradesh, Nagaland, Manipur, Meghalaya, Mizoram, Sikkim and Tripura.

Table 3. Reported and adjusted use of prenatal diagnostic technologies and estimated percentage of females fetuses aborted after the use of these technologies by selected background characteristics, NFHS-2, 1998-99

Variable	Total Births in sample	Percent of births with PNDT		Sex ratio at birth			Female fetuses aborted after PNDT(%)	
		Reported	Adjusted	All births	PNDT not reported	PNDT reported	Est. 1	Est. 2
Total	32,228	12.8	13.9	107.7	107.1	111.8	6.1	16.9
Residence								
Rural	25,064	7.7	8.8	107.6	107.4	109.8	4.4	24.4
Urban	7,164	30.8	31.8	108.1	105.7	113.6	7.5	8.9
Region								
East	4,421	5.0	8.7	114.2	114.6	106.5	1.4	62.8
South	6,132	27.9	27.9	102.0	102.7	100.2	0.0	0.0
West	4,421	26.0	27.3	108.8	107.1	113.9	7.8	12.6
North West	2,047	17.2	22.0	119.2	114.6	144.4	27.3	46.7
North-Central	15,211	4.6	5.2	106.4	105.5	126.4	16.9	24.3
Birth order								
1	9,299	20.8	20.8	106.9	108.3	101.8	0.0	7.7
2	8,333	15.5	16.9	108.9	108.8	109.3	3.9	19.4
3	5,708	9.3	10.5	108.0	106.3	126.1	16.7	25.2
4+	8,892	4.3	5.3	107.3	105.3	166.9	37.1	40.0
Sibling composition								
No brother, No sister	9,299	20.8	20.8	106.9	108.3	101.8	0.0	7.7
No brother, 1 sister	4,469	16.0	20.5	118.1	118.3	117.3	10.5	43.7
No brother, 2+ sister	3,406	11.3	16.8	120.3	113.6	193.1	45.6	63.2
No brother	17,174	17.7	20.3	112.3	112.0	113.8	7.7	28.3
Religion								
Hindus	25,534	12.2	13.5	108.3	107.4	114.7	8.5	21.1
Muslims	5,042	12.0	12.0	101.4	101.8	98.0	0.0	0.0
Others	1,570	26.1	28.3	111.9	112.5	110.2	4.8	19.9
Parents' education								
Both parents illiterate	8,922	2.7	2.7	105.1	105.3	96.7	0.0	3.4
Mother illiterate but father literate	9,890	5.3	5.3	104.3	103.4	121.5	13.6	13.6
Mother middle school complete or lower	8922	16.4	17.4	107.6	107.8	106.5	1.4	13.1
Mother high school complete or higher	4,574	42.2	45.8	120.2	124.3	114.9	8.6	25.1
Standard of living								
Low SLI	11,638	3.8	4.3	105.9	106.5	93.9	0.0	18.1
Medium SLI	15,068	11.8	12.2	106.1	106.0	107.4	2.2	8.4
High SLI	5,125	35.8	38.8	116.2	114.2	120.0	12.5	23.3
Mother's media exposure								
No exposure	15,314	2.7	2.9	105.2	104.9	115.9	9.4	7.6
Regular exposure	16,885	22.0	23.7	110.0	109.7	111.3	5.7	18.0
Mother's ideal family size								
1-2	15,480	21.5	24.4	113.8	114.3	112.1	6.4	28.0
3	8,675	5.8	7.7	109.5	108.8	120.7	13.0	43.8
4+ or non-numeric	8,073	3.9	3.9	95.1	95.1	96.2	0.0	0.0

Table 4. Results of logit analysis of determinants of the use of prenatal diagnostic technologies, NFHS-2, 1998-99

Explanatory variables	Coefficient	Significance
Maternal age	0.1437	***
Maternal age squared	-0.0018	**
Paternal age	0.1378	***
Paternal age squared	-0.0018	***
Order of birth 3+ (no = 0)	-0.2853	***
No surviving male sibling (yes = 0)	0.5360	**
Urban residence (rural = 0)	0.7680	***
Educational level (mother & father illiterate =0)		
Mother illiterate, father literate	0.3816	***
Mother less than primary	0.7365	***
Mother middle school	0.8911	***
Mother high school +	1.2771	***
Regular exposure to mass media (no = 0)	0.6802	***
Standard of living (low = 0)		
Moderate	0.4148	***
High	1.1174	***
Religion (Hindu = 0)		
Muslim	0.0960	
Christian	0.5158	***
Sikh	0.0966	
Others	0.3938	**
Caste/tribe (others = 0)		
Scheduled tribe	-0.6194	***
Scheduled caste	-0.3086	***
Other backward castes	-0.0853	*
Ideal number of children reported by mother	-0.4593	***
Ideal number of children squared	0.0271	***
Non-numeric ideal children (numeric = 0)	-1.0871	***
Health worker visit during pregnancy (no = 0)	-0.2826	***
Region (south=0)		
East	-1.7630	***
West	0.0392	
North-west	-1.2379	***
North-central	-1.5635	***
Constant	-7.0019	***
Number of births	31,487	
-2 Log-likelihood	16,673	
Pseudo R^2	0.231	

* p<10 percent, ** p<5 percent, *** p<1 percent

Table 5. Results of logit analysis of determinates of probability of having a male birth NFHS-1, 1992-93 and NFHS-2, 1998-99

Explanatory variables	Births during 0-14 years before survey		Births during	
			1989-92	1996-98
	NFHS-1	NFHS-2	NFHS-1	NFHS-2
Maternal age	0.0135 *	-0.0057	0.0097	0.0094
Maternal age squared	-0.0002 *	0.0002	-0.0002	-0.0002
Paternal age	-0.0091 *	-0.0059	-0.0058	-0.0305 **
Paternal age squared	0.0001 *	0.0001	0.0001	0.0005 ***
Paternal age not reported (reported = 0)	0.0037	-0.0704	---	---
Order of birth	0.0026	-0.0016	0.0105	0.0070
No surviving male sibling and order 3 or higher (yes = 0)	0.0103	0.0612 ***	0.0332	0.1755 ***
Urban residence (rural = 0)	0.0223 *	-0.0166	0.0137	-0.0397
Educational level (mother & father illiterate =0)				
Mother illiterate, father literate	-0.0143	-0.0069	-0.0067	-0.0209
Mother less than primary	-0.0154	0.0118	-0.0668 **	-0.0074
Mother middle school	0.0057	0.0228	0.0162	0.1016 **
Mother high school +	-0.0645 ***	0.0405 *	-0.1237 ***	0.0775
Regular exposure to mass media (no = 0)	0.0000	0.0200	-0.0190	-0.0092
Standard of living (low = 0)				
Moderate	-0.0163	-0.0242 *	-0.0066	-0.0003
High	0.0097	-0.0185	0.0372	0.0516
Religion (Hindu = 0)				
Muslim	-0.0269 *	0.0145	-0.0304	0.0222
Christian	0.0127	0.0436 *	0.0126	0.0250
Sikh	0.0268	0.0350	-0.0150	-0.0817
Buddhist	0.0395	0.0559	0.1873	0.2089 *
Others	0.0398	0.0565	0.0049	0.0670
Caste/tribe (others = 0)				
Scheduled tribe	0.0151	0.0146	0.0263	-0.0008
Scheduled caste	0.0179	0.0088	0.0218	0.0562
Other backward castes	---	0.0112	---	-0.0061
Ideal number of children reported by mother	-0.0426 ***	-0.0695 ***	-0.0422 **	-0.0643 **
Ideal number of children squared	0.0018 **	0.0046 ***	0.0016	0.0004
Non-numeric ideal children (numeric = 0)	-0.1315 ***	-0.1533 ***	-0.0685	-0.2299 ***
Health worker visited during pregnancy (no = 0)	---	---	0.0322	-0.0193
Birth attendance (untrained birth attendant=0)				
Trained birth attendant at home	---	---	0.0841 ***	0.0763 *
Trained birth attendant at institution	---	---	0.0429 *	0.0696 **
Iron and folic acid supplementation (no = 0)				
Received tablets/syrup	---	---	0.0171	0.0212
Fully consumed	---	---		-0.0420
Number of antenatal check-ups	---	---	0.0080 *	0.0001
Maternal anaemia at survey				
Mild	---	-0.0154	---	0.0035
Moderate/severe	---	-0.0439 ***	---	0.0008
Not tested	---	-0.0249	---	-0.1172 **
Mother's body-mass index at survey (normal = 0)				
Low (below 18.5 kg/m2)	---	0.0050	---	0.0323
High (25 kg/m2 or more)	---	-0.0478 **	---	-0.0996 *
Not measured	---	-0.2006 ***	---	-0.1179 ***
Mother's height at survey	---	0.0060	---	-0.0008
Mother's height not measured (measured = 0)	---	-0.0272	---	0.0426
Altitude more than 1,000 meters (lower = 0)	---	-0.0354 *	---	0.0310
Consanguinity (no = 0)	-0.0157	---	0.0105	---
Region (south = 0)				
East	0.0257	0.0448 **	0.0857 **	0.0829 *
West	-0.0002	0.0409 *	0.0425	0.0578

North-west	0.0472 **	0.0924 ***	0.1397 ***	0.1527 ***
North-central	0.0544 ***	0.0840 ***	0.1004 ***	0.0934 **
Constant	0.1270	0.3340 ***	-0.0282	0.5717
Number of births	176,115	158,897	53,676	31,384
-2 Log-likelihood	243,853	219,811	74,287	43,297
Pseudo R^2	0.001	0.002	0.001	0.005

* p<10 percent, ** p<5 percent, *** p<1 percent