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

Data from the 2001 Census reveal that the sex ratio at birth may have increased by 6 percentage points in India since 1985, and in some parts by 20 percentage points. Data from the National Family Health Survey of 1998-99 show that while the use of prenatal diagnostic techniques has become fairly common only a minority misuses them for aborting female foetuses. The effect of PNDT use on the sex ratio at birth is found to be contingent on whether women are in the male-selection situation (i e, with at least one previous birth but have had no sons) or not. While income and education are found to increase the use of PNDT, their misuse is governed more by cultural factors and the sex composition of children already born.

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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 the 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 (SRB) owing to the increasing incidence of sex-selective abortion in regions where son preference remains strong [e g, Das Gupta and Bhat 1997; Sudha and Rajan 1999; Arnold, Kishor 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 SRB because of improvements in health status and midwifery practices and from the decline in the proportion of higher-order births [Bhat 2002].

Although it is well established that under normal circumstances, more males than females are born among all human populations, the SRB cannot be regarded as 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 SRB varies generally between 103 and 106. There is also some evidence of secular trends in the SRB, predating the invention of modern technologies of sex selection. Some western countries with reliable and long-standing registration data, such as Sweden and England, have recorded increase in the SRB of the order of 2-3 per cent over a period of one or two centuries [Klasen 1994]. The data for British India compiled by Visaria (1971) from the civil registration system showed that male-female ratio at birth increased from 107 in 1901-10 to 110 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 the registration system in British India. But fairly complete vital registration data available for four districts of Maharashtra (known as Berar during British rule) also showed a similar upward trend in the SRB during the first half of the 20th century [Dyson 1989; Bhat 2002].

The spatial and temporal variations in the SRB arise from social, demographic and biological factors affecting the SRB. Literature on the issue is replete with many speculations regarding the factors affecting the SRB. While a large number of factors are considered to be important, there are only a few studies that analysed the relationship in the multivariate context [Teitelbaum 1972; Chahnazarian 1988]. 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 (NFHS) provide an opportunity to analyse the effect of a larger set of factors from a fairly sizeable 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 analyse how socio-economic and demographic factors affect the SRB through the "misuse" of such techniques. Although some attempts have already been made to analyse this data set for this purpose [Arnold, Kishor and Roy 2002; Retherford and Roy 2003], its potential is yet to be fully exploited. An attempt in this direction is made in this paper. We also

take advantage of recently released data from the 2001 Census on fertility and age-sex distribution of the population in single years to study the influence of some key factors on the SRB in India.

Evidence from Census of 2001

Information on the sex ratio of children of age 0-six 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 also affected by sex differentials in child mortality, under-enumeration and age misreporting [Bhat 2002]. Recently, census data on population by single years of age have been released. This information can provide further clues to the nature of changes in the child sex ratio and its causes. In analysing this information, before computing sex ratios, we applied a three-point moving average formula to smooth the single year age data. In Figure 1, for all-India and the state of Punjab, we have plotted the difference in the sex ratio (males per 100 females) at the same single-year of age between 1991 and 1981, and between 2001 and 1981. However, the graph shows instead of age, the year of birth of children implied by their reported age in the census. For both Punjab and India, the increase in the sex ratio is more pronounced for more recently born children (i e, at younger ages). As per the 1991 Census data, the sex ratio steadily increased between 1985 and 1990 by 3 percentage points for India as a whole, and by 9 percentage points for Punjab. As per the 2001 Census data, the sex ratio steadily increased between 1995 and 2000 by another 3 percentage points at the all-India level, and by another 11 percentage points in Punjab.

The pattern of change observed in the census data discounts the possibility of this change arising from a rise in excess female child mortality in recent times. If it were the cause, owing to the cumulated impact of the mortality differential, sex ratios at ages three-four years would have shown greater change than at ages one-two years. The systematic age (or time) pattern in the sex ratio increase raises doubts whether it could be explained by more accurate reporting of children's age. However, the role of age misreporting in distorting the trend in sex ratios cannot be completely ruled out since for the overlapping period of 1988-90, the rise in the sex ratios indicated by the 1991 and 2001 Census are not identical – while the former census indicates significant increase, the latter indicates no change or a even a decline (in comparison to the sex ratios of 1981 Census at corresponding ages).

To a large extent, the systematic rise in the sex ratio in the years preceding the census must have been due to the rising trend in the SRB. If it were the only cause, the implication is that between 1985 and 2000 the sex ratio at birth increased by 6

Table 1: Sex Ratio for the Age Group 0-2 Years in 1981, 1991 and 2001 Censuses

State	Sex Ratio, 0-2 Age Group			Change
	1981	1991	2001	1981-01
All-India	102.7	105.4	108.3	5.6*
North-west				
Jammu and Kashmir	104.2	na	109.0	4.8*
Himachal Pradesh	103.2	107.1	113.9	10.7*
Punjab	107.3	116.2	127.2	20.0*
Haryana	107.8	114.7	124.2	16.3*
Delhi	106.1	109.1	116.5	10.4*
North-central				
Rajasthan	103.0	108.1	111.4	8.4*
Uttar Pradesh	103.1	105.9	108.8	5.6*
Bihar	100.5	103.5	105.3	4.8*
Madhya Pradesh	101.5	103.6	106.1	4.6*
East				
Assam	na	103.4	103.8	0.4
North-east@	101.6	101.8	103.3	1.7
West Bengal	101.9	103.4	104.3	2.5
Orissa	101.0	103.3	105.8	4.8
West				
Gujarat	104.6	107.4	114.3	9.7*
Maharashtra	105.1	107.0	111.3	6.2*
Goa	104.5	103.7	108.1	3.6
South				
Andhra Pradesh	100.5	102.5	103.6	3.2
Karnataka	102.3	104.4	106.0	3.7*
Kerala	102.7	104.8	104.1	1.4
Tamil Nadu	102.9	105.2	106.0	3.1

Notes: * Linear change with age statistically significant.
@ Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura.
Source: Census of India, 1981, 1991 and 2001.

Table 2: Child Sex Ratio and Sex Ratio at Birth by Selected Background Characteristics, All-India, 2001 Census

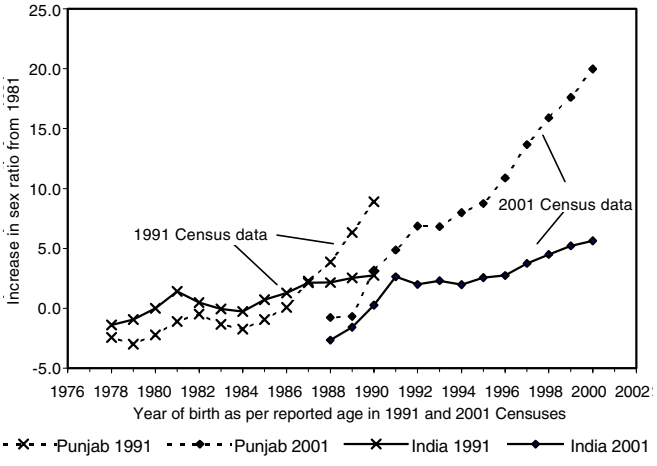
Background Characteristics	Sex Ratio of Children of Age 0-6 Years	Sex Ratio at Birth: Births during the Preceding Year	Sex Ratio at Birth: Children Ever-born to Women Aged 20-34
All	107.8	110.4	106.7
Residence			
Rural	107.1	110.4	106.3
Urban	110.3	110.6	108.3
Religion			
Hindu	108.2	110.9	106.9
Muslim	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)	1,63,820	19,887	2,37,622

na - not available/applicable.
Source: Census of India, 2001.

percentage points at the all-India level, and by as much as 20 percentage points in Punjab. Table 1 shows the sex ratio for the age group 0-two years from the censuses of 1981, 1991 and 2001 for the states of India. Between 1981 and 2001 the sex ratio in this age group has increased in all the states. The increase is particularly large in states in north and western India. To check whether the 2001 Census implies a steady increase in the sex ratio in the years before the census, the single-year sex ratios for the period 1995-2000 (i e, for ages one to five) were regressed on time (or age). In all states in north and western India, except in Goa, the observed rise in the sex ratio during this period was statistically significant. But in the states in south and eastern parts of India, except in Karnataka, the recorded rise during this period was not statistically significant. Thus in at least north and western parts of India there have been sharp increases in the SRB.

The data on fertility from the 2001 Census provide more direct information on the SRB. They also make it possible to study factors influencing the SRB in 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 2 shows the SRB by mother's background characteristics for the entire country.

Figure 1: Increase in Child Sex Ratios between 1981 and 1991 and between 1981 and 2001 by Single Year of Age, for India and Punjab



Source: Census of India, 1981, 1991 and 2001.

In all, nearly 20 million live births were reported during the year preceding the census. They imply a SRB of 110 males for 100 females. This sex ratio is higher than the sex ratio of 108 for children of age 0-six years at the time of the census. As child mortality is higher for girls than boys in India, the child sex ratio should have been higher than the SRB. The discrepancy could be indicating either a rise in the SRB during the years preceding the census, or underreporting of female births that occurred

Table 3: Sex Ratio at Birth by Residence and Mother's Educational Level, 2001 Census

Region and State	From Data on Births during the Year Preceding the Census					From Data on Children-ever Born to Women Age 20-34 Years				
	All Areas	Rural	Urban	Mother's Education		All Areas	Rural	Urban	Mother's Education	
				Illiterate	Matriculation or Higher				Illiterate	Matriculation or Higher
All-India	110	110	111	109	115	107	106	108	106	109
North-west										
Jammu and 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
Chhattisgarh	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
Maharashtra	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

Source: Census of India, 2001.

Figure 2: District-wise Sex Ratio at Birth among Children Ever Born to Women Aged 20-34 Years in 2001

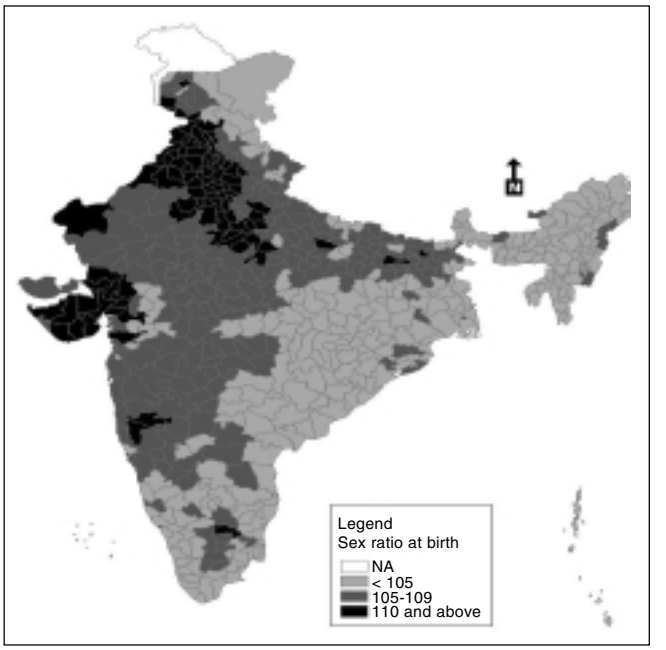
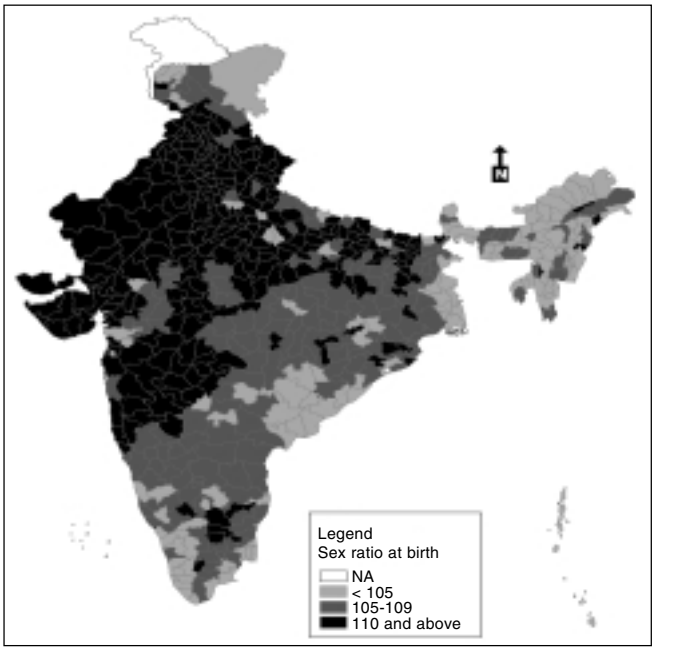


Figure 3: District-wise Sex Ratio at Birth among Those Born during the Year Preceding 2001 Census



during the year preceding the census, or greater exaggeration of age for boys than girls in the census. The foregoing analysis of child sex ratios by single years of age strongly supports the first possibility.

The census data on children ever born show a steady rise in the SRB from 105 for women aged 15-19 to 113 for women aged 45-49 in 2001. This is probably due to the failure of older women to report female children who died many years ago or who are married and living with their husbands. To minimise the effect of such recall errors, Table 2 shows the SRB implied by the data on children ever born to women aged 20-34 years. In all, these women reported 238 million live births in their lifetime, with a SRB of 107. As these children were born on average five-10 years before the survey, they would be indicating a SRB lower than that for the year preceding the census if the SRB has been rising.

Interestingly, the data on births for the year preceding the census shows negligible rural-urban difference in the SRB, whereas data on children ever born shows, as expected, higher SRB 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 under-reported more female births that occurred during the last year than urban women. But the analysis of child sex ratios by single years of age did not indicate a convergence of sex ratios in rural and urban areas. For example, the child sex ratio for the age group 0-two years in 2001 was 111 in urban areas compared with 108 in rural areas. The analysis of the increase in child sex ratios since 1981 by single-years of age (similar to the one shown in Figure 1) showed that the SRB may have increased by 8 percentage points in urban areas compared with 5 percentage points in rural areas. It is therefore likely that in the census data on current fertility, the under-reporting of female births was more in rural areas than in urban areas.

However, data on current as well as lifetime fertility show that the SRB increases with the mother's educational level. The data on births for the year preceding the census show that the SRB increases from 109 for illiterate women to 115 for women who have completed matriculation. But those graduated from college have reported a SRB of 114. The data on children ever born show that the SRB increases steadily from 106 for illiterate women to 110 for women with a college degree.

Religion is another variable that shows a systematic relationship with the SRB. As per both types of data, the SRB is 103-104 for Christians, indicating little practice of sex-selective abortions. But the SRB is much higher than the normal range among Sikhs and Jains. As per the data on births during last year, 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 SRB of 111 and 107, as per the two types of data. The data on scheduled tribes indicate no evidence of sex-selective abortions (sex ratio being 106 and 103, respectively). As per both types of data, the SRB for scheduled castes is 2 percentage points higher than that for scheduled tribes.

The data on births for the year preceding the census have been tabulated by the mother's age at the time of the census. As in this case the time lapsed since the birth is less than a year, the mother's age is essentially her age at the time of birth. The SRB calculated from these data shows a curvilinear relationship with her age. It 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. Many studies have reported such a curvilinear relationship [e g, James 1987; Chahnazarian 1988], which could be due to the relationship of maternal age with stillbirth rate and coital frequency. Such a pattern may be accentuated in a situation where sex-selective

abortion is practised because this practice peaks around the third birth order.

Table 3 shows the SRB 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 SRB 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 SRB is 127 for Punjab and Haryana and 120 for Gujarat. The SRB 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 SRB reported by women who had passed matriculation is higher than 106. In Punjab and Haryana, the SRB 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.

The existence of strong regional pattern in the SRB becomes even more evident when it is mapped for the districts of India. Figure 2 shows such a map drawn using the data on lifetime births for women aged 20-34, while Figure 3 shows the map drawn using the data on births during the year before the census. As the former map is based on more number of births per district, it may be more reliable than the latter but refers to an earlier period than the map in Figure 3. In Figure 2, a line drawn diagonally separating south and eastern India from north and western India would neatly demark the two regions of low and high SRB. Except for some isolated pockets (such as around Salem district in Tamil Nadu), the SRB was less than 105 in east and south India. In much of north and western India, the SRB was more than 105, and was in excess of 110 in Punjab, Haryana and Gujarat. The map drawn using the data on births during the year preceding the census (Figure 3) shows that the region with the SRB in excess of 110 has expanded considerably to cover virtually the entire area above the diagonal line that had SRB higher than 105. Also, the area with SRB less than 105 has shrunk considerably in south India, as many districts in Karnataka, Andhra Pradesh and Tamil Nadu have crossed the threshold. But north-east India has remained relatively untouched by this change.

Evidence from National Family Health Surveys

The NFHS conducted in 1992-93 (NFHS-1) and 1998-99 (NFHS-2) were designed on the lines of Demographic and Health Surveys (DHS) carried out 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 micro data from the surveys are available in electronic form, they provide greater scope than the census data for the analysis of determinants of the SRB as well as the use of prenatal diagnostic techniques (PNDT). But, 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 factor that has recently emerged and has a strong influence on the SRB is the use of sex determination tests during pregnancy followed by abortion of foetuses of the unwanted sex. Although conducting abortions became legal in India in 1971, it is only recently that prenatal 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 per cent of 32,000 live births that occurred during the three-year period before the survey. The SRB 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 foetuses, since if sex-selective abortions were not practised, the SRB would have been close to 105. Even the reported SRB 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 rough estimates of the misuse of PNDT for sex selection and the true extent of the use of PNDT. To do this, we assume that abortion after PNDT is done only when the fetus is detected to be female. Although some couples may abort male foetuses when all previous births are male, we shall later show that this tendency is pretty weak in India. Also male foetuses may get aborted because of wrong diagnosis; we shall assume that such failures of PNDT are rare.

Let M_U and F_U be the number of male and female live births to reported users of PNDT during the pregnancy of these births. Also let M_N and F_N be the number of male and female live births to reported non-users of PNDT. Let S be the ratio of male-to-female live births when no sex-selective abortion is practised. Using these notations, the SRB among reported users of PNDT can be written as

$$S_U = \frac{M_U}{F_U}.$$

Similarly, the SRB among reported non-users of PNDT can be written as

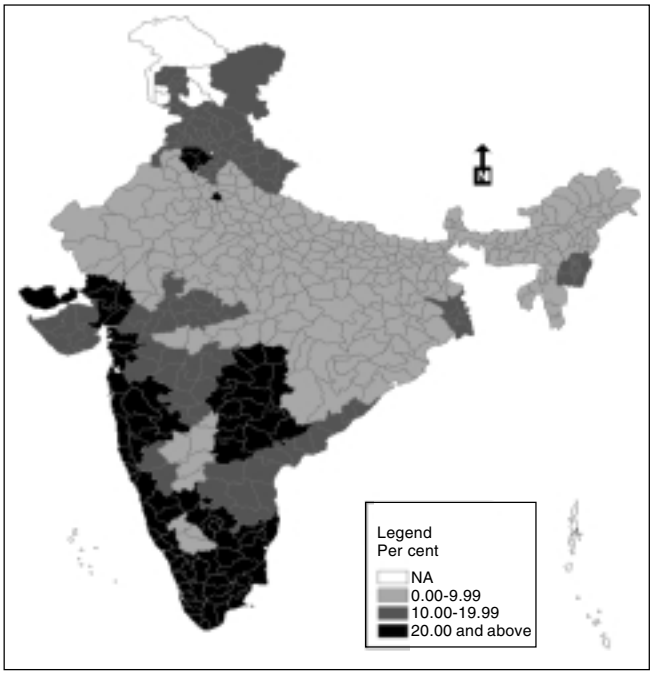
$$S_N = \frac{M_N}{F_N}.$$

If it is assumed that only female foetuses are aborted after PNDT, the number of abortion of female foetuses after PNDT can be computed as

$$A_U = \frac{M_U}{S} - F_U = M_U\left(\frac{1}{S} - \frac{1}{S_U}\right).$$

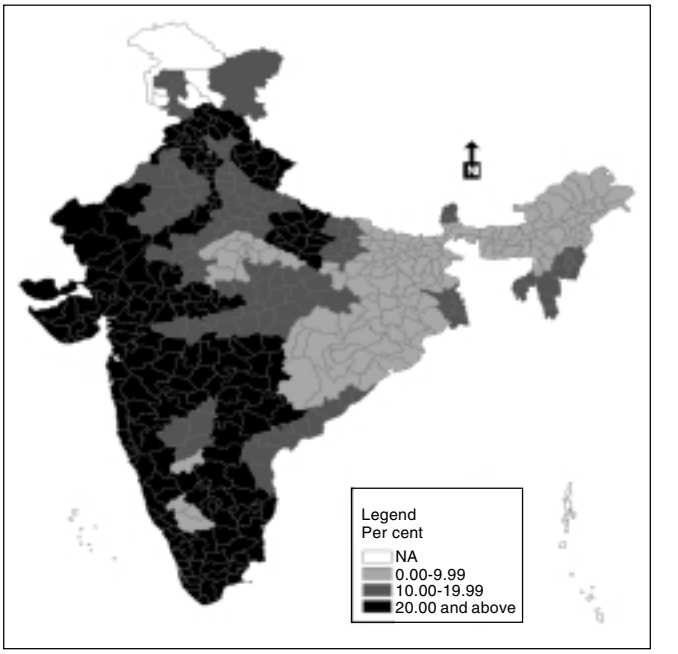
It may be noted that for A_U to be positive, $S_U > S$. If it is not the case, it will be assumed that $A_U = 0$.

Figure 4: Reported Use of Prenatal Diagnostic Techniques in 77 Natural Regions of India, NFHS-2, 1998-99



Source: NFHS-2 micro data.

Figure 5: Reported Use of Prenatal Diagnostic Techniques When Doctor Is the ANC Provider, 77 Natural Regions of India, NFHS-2, 1998-99



Source: NFHS-2 micro data.

We define the index of the misuse of PNDT as the proportion of female foetuses aborted after the use of PNDT. If all women correctly reported the use of PNDT, then this index is given by

$$\frac{A_U}{F_U + A_U} = 1 - F_U \frac{S}{M_U} = 1 - \frac{S}{S_U}.$$

However, not all users may disclose the use of PNDT. This is indicated by S_N being significantly higher than S. The number of abortion of female foetuses done by reported non-users of PNDT can be computed as

$$A_N = \frac{M_N}{S} - F_N = M_N \left(\frac{1}{S} - \frac{1}{S_N} \right).$$

As before, for A_N to be positive, $S_N > S$. If it is not the case, it will be assumed that $A_N = 0$

Thus the adjusted proportion of female foetuses aborted after PNDT can be computed as

$$\frac{A_U + A_N}{F_U + A_U + A_N}$$

We can also estimate the proportion of foetuses actually subjected to PNDT as

$$\frac{M_U + F_U + A_U + A_N}{M_U + F_U + M_N + F_N + A_U + A_N}$$

In making actual computations, there is the practical problem of assuming a value for S, the SRB in the absence of sex-selective abortions. Although it is thought to be close to 105 males for 100 females, as the census data reviewed earlier show, it could be as low as 103 in India. In order to study the sensitivity of the estimates to the assumed value of S, Table 4 shows estimates of the misuse of PNDT and corrected estimates of PNDT use obtained from the NFHS data using the values of S ranging from 103 to 106. As can be seen from the table, the corrected estimate of PNDT use for all-India is not sensitive to the assumed value of the sex ratio. It varies from 13.5 to 14.7 per cent (against the uncorrected value of 12.8 per cent) when the normal SRB is varied from 106 to 103. The estimate of misuse of the technology by those who reported the use of PNDT is also not very sensitive to the assumption on the normal SRB. It varies from 5 to 8 per cent when the normal SRB is varied from 106 to 103. However, if the observed higher SRB (107) among those who did not report the PNDT use is because of undisclosed use, the estimated misuse of the technology increases from 11 to 27 per cent when the normal SRB is varied from 106 to 103. Nonetheless, these results amply show that majority of the users of PNDT in India do not misuse it to abort female foetuses.

It is useful to investigate whether the use of PNDT and its misuse vary according to background characteristics of women. Table 5 presents information on them. The estimates presented in this table are computed assuming a normal SRB of 105. For

Table 4: Effect of Assumed Value of Normal Sex Ratio at Birth on Estimates of Use and Misuse of Prenatal Diagnostic Techniques

Assumed Normal Sex Ratio at Birth	Estimated Per Cent of Female Foetuses Aborted after PNDT		Adjusted Per Cent of Births Subjected to PNDT
	Est 1	Est 2	
103	7.9	26.6	14.7
104	7.0	22.0	14.3
105	6.1	16.9	13.9
106	5.2	11.3	13.5

Source: NFHS-2 micro data.

India as whole, the SRB of 112 among those who used PNDT indicates that 6 per cent of female foetuses were aborted after PNDT. But if it is assumed that some of those who did not use PNDT may have actually used it, the estimated percentage of female foetuses aborted rises to 17 per cent, and the adjusted use of PNDT is 14 instead of 13 per cent. Those who did not avail antenatal care (ANC) services clearly could not have used PNDT and resorted to female feticide. Their SRB of 102 also testifies to this. But the SRB among those who availed ANC from a doctor is 112. Twenty-five per cent of them had reported PNDT, which rises to 27 per cent if adjustment is made for the suspected non-disclosure of its use. If the normal sex ratio is 105, the SRB of 111 among PNDT users indicates that 6 per cent of the users may have used the technology to abort female foetuses. But this estimate rises to 23 per cent if an adjustment is made for the possibility that some of the reported non-users of PNDT users did not disclose its use (since the SRB among this group is 113). Among women who availed PNDT from providers other than the doctor, 5 per cent had reported the use of PNDT, and it is estimated that 24 per cent of them had misused it. In this group, among those who did not report the use of PNDT, the SRB is 104, indicating no misreporting of the PNDT status.

In urban areas, 31 per cent of live births were reportedly subjected to PNDT compared with only 8 per cent in rural areas. On the assumption that reported PNDT use is correct, 8 per cent of those who used PNDT misused it in urban areas while

Table 5: Reported and Adjusted Use of Prenatal Diagnostic Technologies and Estimated Percentage of Females Foetuses Aborted After the Use of These Technologies by Selected Background Characteristics, NFHS-2, 1998-99

Variables	Total Births in the Sample	Per Cent of Births Subjected to PNDT		Sex Ratio at Birth			Per Cent of Female Foetuses 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
ANC status at pregnancy								
No ANC	10,987	0.0	0.0	102.4	102.4	0.0	0.0	0.0
ANC by doctor	15,745	24.5	27.0	112.6	113.1	111.1	5.5	22.8
ANC by others	5,395	5.0	5.3	104.7	104.0	119.5	12.1	12.1
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	21.8	106.9	108.3	101.8	0.0	10.3
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
Sex composition of sibling								
All sisters, no brother	7,874	13.9	18.9	119.1	116.2	138.7	24.3	51.2
All brothers, no sister	7,176	11.7	11.7	100.5	100.3	102.2	0.0	0.0
Other combinations	17,182	12.8	13.2	105.9	106.2	104.0	0.0	7.2
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
Caste								
Scheduled caste/tribe	9,491	6.3	7.8	108.7	108.8	107.7	2.5	35.8
Other backward caste	10,358	14.0	14.1	105.4	105.3	106.6	1.5	2.9
Others	12,000	17.4	19.2	110.0	108.7	116.5	9.9	22.0
Parents' educational level								
Both parents illiterate	8,922	2.7	2.8	105.1	105.3	96.7	0.0	10.2
Only father literate	9,890	5.3	5.7	104.3	103.4	121.5	13.6	13.6
Mother less than middle	5,821	14.2	14.2	103.2	103.3	102.5	0.0	0.0
Mother middle or more	7,510	33.8	37.6	119.0	121.4	114.2	8.1	27.8
Standard of living								
Low SLI	11,638	3.8	4.5	105.9	106.5	93.9	0.0	24.6
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	9.4
Regular exposure	16,885	22.0	23.7	110.0	109.7	111.3	5.7	18.0
Mother's work status								
Not working	22,282	14.9	16.7	109.8	108.6	116.3	9.7	23.9
Working, not for wage	5,135	9.1	9.1	104.1	104.7	97.9	0.0	0.0
Working for wage	4,804	7.4	7.4	102.4	103.2	91.9	0.0	0.0
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

Source: NFHS-2 micro data.

4 per cent did so in rural areas. But the sex ratio of those who did not report the use of PNDT shows that 32 per cent in urban areas and 9 per cent in rural areas may actually have used it, and among them 9 per cent in urban areas and 24 per cent in rural areas may have misused 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 per cent. The reported use is less than 5 per cent 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 per cent). The strong regional pattern in the reported use is clearly seen in Figure 4 where we have mapped the use-rate for 77 for natural regions of the country. One reason for the relatively high use of PNDT in south and western parts of the country could be that there the use of ANC services, especially from a doctor, is high. However, as the map in Figure 5 shows, even when only cases with ANC by a doctor are considered, the regional pattern in the use of PNDT does not disappear. Reported use of ultrasound or amniocentesis is rare in east and north-central India, even when ANC is availed from a doctor.

Although south India shows the highest use rate of PNDT, misuse of the technology is rare; as a consequence, the SRB is less than 105 in this region among both users and non-users (Table 5). In the north-central region, though the use of PNDT is rare, misuse among those who use it is high (17-24 per cent). But it is in the north-western region, where the misuse of PNDT is most frequent (27-47 per cent). For north-western India, when the reported use is adjusted for its possible under-reporting, the implied use rate increases from 17 to 22 per cent. In other regions, the implied corrections for underreporting are small. Although east India shows the highest percentage of misuse if the high SRB for non-users is taken into account, it is most probably due to sampling errors in the data than the actual misreporting of PNDT status.

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 per cent for the first birth order but the estimated misuse, at the maximum, is only 10 per cent. On the other hand, when the birth order is four or more, only 4 per cent report the use of PNDT but nearly 40 per cent 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 of the fetus, while at higher orders the main reason for the use is to detect the sex of the child. The reported use of PNDT doesn't show significant variations with sex composition of previous children born to the woman. But the misuse of the technology is highest when the woman had no son, but had one or more daughters. Among such women, the misuse is estimated to be 24-51 per cent. When women had no daughter but had one or more sons, the SRB is 101, and 102 for women reporting PNDT use. While this may be suggesting abortion of male foetuses by such women, the difference from the normal sex ratio can also be due to sampling errors. On the other hand, the SRB for women who had no sons but had two or more daughters is substantially high to be attributed to sampling errors (119 for all births and 139 for births with reported use of PNDT).

The reported use of PNDT is 12 per cent among Hindus and Muslims, and 26 per cent among other religions (mainly Christians and Sikhs). While those who misuse the technology are negligible among Muslims, it is 8-21 per cent among Hindus and 5-20 per cent among other religions. As would be expected, the reported use of PNDT increases from 6 per cent among scheduled castes/tribes to 14 per cent among other backward classes (OBCs) and 17 per cent among others. But the misuse of the technology is least among OBCs (2-3 per cent) while it is relatively high among other castes (10-22 per cent).

The use of the technology increases with the level of education of parents. When both the mother and father are illiterate, only 2 per cent use PNDT. When only the father is literate, this increases to 5 per cent. When the mother has completed high school or gone to college, the reported use is 42 per cent. The misuse does not show a consistent relationship with education. It is low when both the mother and father are illiterate (0-10 per cent), but relatively high when the father is literate but the mother is not (14 per cent) and when the mother has competed high school or gone to college (9-28 per cent). Interestingly, misuse is almost negligible among mothers who are literate but have not completed middle school. To study the relationship of use and misuse of PNDT with the prosperity of households we use an index of

Table 6: Results of Logit Analysis of Determinants of the Use of Prenatal Diagnostic Technologies, NFHS-2, 1998-99

Explanatory Variables	Coefficient
Maternal age	0.105 **
Maternal age squared	-0.0008
Paternal age	0.134 ***
Paternal age squared	-0.0017 ***
Order of birth 3+ (no = 0)	-0.260 ***
No surviving male sibling and order 2 or higher (yes = 0)	0.082
No surviving female sibling and order 2 or higher (yes = 0)	-0.206 ***
Urban residence (rural = 0)	0.743 ***
Educational level (mother and father illiterate =0)	
Mother illiterate, father literate	0.360 ***
Mother less than primary	0.683 ***
Mother middle school	0.819 ***
Mother high school +	1.189 ***
Regular exposure to mass media (no = 0)	0.661 ***
Standard of living (low = 0)	
Moderate	0.415 ***
High	1.107 ***
Religion (Hindu = 0)	
Muslim	0.101
Christian	0.485 ***
Sikh	0.094
Others	0.374 **
Caste/tribe (others = 0)	
Scheduled tribe	-0.589 ***
Scheduled caste	-0.308 ***
Other backward castes	-0.086
Female work status (not working=0)	
Working for wages	-0.015
Others	-0.199 **
Ideal number of children reported by mother	-0.449 ***
Ideal number of children squared	0.0278 ***
Non-numeric ideal children (numeric = 0)	-1.000 ***
Health worker visit during pregnancy (no = 0)	-0.275 ***
Region (south=0)	
East	-1.755 ***
West	0.060
North-west	-1.225 ***
North-central	-1.529 ***
Constant	-5.697 ***
Number of births	31,481
-2 Log-likelihood	16,671
Pseudo R^2	0.231

Note: * p<0.05, ** p<0.01, *** p<0.001.
Source: NFHS-2 micro data.

standard of living (SLI) computed from household amenities and assets [IIPS and ORC Macro 2000]. The reported use of PNDT increases from 3 per cent in low SLI households to 38 per cent in high SLI households. The estimated misuse among reported PNDT users also increases from zero per cent in the low SLI group to 2 per cent in the medium SLI group and 13 per cent in the high SLI group. But when adjusted for the possible misreporting of PNDT status, the estimated misuse of PNDT in the low SLI group (24 per cent) turns out to be as high as in the high SLI group (23 per cent) and substantially higher than the medium SLI group (8 per cent).

The reported uses of PNDT increases with the mother's exposure to media. But it does not show a clear relationship with misuse. When only the reported use of PNDT is considered, misuse is marginally lower among women regularly exposed to media. But when adjusted for possible underreporting of PNDT, the estimated misuse is higher among women regularly exposed to media. Women's work status however has a clear relationship with both use and misuse of PNDT. Both use and misuse are higher among non-working women compared with women working for wage or those who are self-employed or working in the family farm or business. 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 per cent had PNDT. When the ideal family size is four or more, only 4 per cent use PNDT. The misuse is highest when the ideal family size is three (13-44 per cent), moderate when it is one or two (6-28 per cent) 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 adjustments needed for possible under-reporting of its use are relatively minor. 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 6 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 significant, independent effects on the use of PNDT. The use of PNDT increases with maternal as well as paternal age. But the use of this technology is lower if the order of birth is three or more. It is particularly low if the mother has already given birth to a son.

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. When compared with non-workers, the use is lower among mothers who work but not for wage. 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 is directly in contradiction with the claim of some activists that public health workers act as conduits of this technology in rural areas. 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. This indicates the influence of neighbourhood on the use of technology.

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 SRB in India. There are, however, a number of factors that independently affect the SRB. Teitelbaum (1972) provides an early review of the literature on this subject. James (1987) and Waldren (1998) provide 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 SRB.

Accordingly, Table 7 shows the results of the logit analysis of determinants of the SRB 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 for each of the surveys, 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. Nonetheless, none of the regressions is able to account for more than 1 per cent of the variation in the probability of male birth (as indicated by values of pseudo R^2), which underscores the random nature of sex determination at birth. Since in such a situation statistically significant effects could be detected only in large samples, we have checked whether some additional variables become significant when 10 per cent probability level is employed for rejection of null hypothesis.

The most notable results from these regressions are with respect to the effects of sex composition of previously born children and the use of PNDT on the probability of male birth. 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 mother had at least one previous birth but had no son at the time of current birth, the probability of the birth being a male is higher and this effect is strongly significant. This suggests that such women were not resorting to sex-selective abortion in the 1980s but had begun to do so in the 1990s. The female-selection situation, characterised by women who had at least one previous child but had no daughter, reduces the probability of male birth, but its effect in the regressions is only mildly significant at 10 per cent level.

Information on the use of PNDT is available only for the recent births from NFHS-2. The regression using this data shows that PNDT use does not have a direct effect on the SRB. To test whether its effect depends on the sex-selection situation, we have interacted its use with dummy variables for male- and female-selection situations. As the results show, when women in male-selection situation (at least one previous birth and no sons) use PNDT, it has strong positive effect on the probability of male birth. Its effect in the case of women with female-selection situation is not in the expected direction (i e, negative), and also not statistically significant. It may be noted that male-selection

Table 7: 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	0.015 **	-0.004	0.013	0.012
Maternal age squared	-0.0003 **	0.0002	-0.0003	-0.0002
Paternal age	-0.009 *	-0.006	-0.005	-0.030 **
Paternal age squared	0.0001 *	0.0001	0.0001	0.0005 ***
Paternal age not reported (reported = 0)	0.027	-0.070	na	na
Order of birth	0.002	0.000	0.011	0.011
No surviving male sibling and order 2 or higher (yes = 0)	-0.002	0.043 ***	0.004	0.110 ***
No surviving female sibling and order 2 or higher (yes = 0)	-0.025 *	-0.022 *	-0.035 *	-0.041
Urban residence (rural = 0)	0.024 **	-0.017	0.016	-0.039
Educational level (mother and father illiterate =0)				
Mother illiterate, father literate	-0.014	-0.007	-0.010	-0.025
Mother less than primary	-0.016	0.011	-0.073 **	-0.017
Mother middle school	0.005	0.020	0.009	0.090 *
Mother high school +	-0.064 ***	0.038 *	-0.127 ***	0.068
Regular exposure to mass media (no = 0)	0.000	0.020	-0.020	-0.009
Standard of living (low = 0)				
Moderate	-0.018	-0.026 **	-0.014	-0.005
High	0.007	-0.020	0.029	0.044
Religion (Hindu = 0)				
Muslim	-0.028 *	0.013	-0.035	0.020
Christian	0.013	0.045 *	0.012	0.031
Sikh	0.043	0.033	-0.014	-0.092
Buddhist	0.028	0.055	0.197 *	-0.107
Others	0.040	0.057	-0.001	0.064
Caste/tribe (others = 0)				
Scheduled tribe	0.015	0.016	0.027	0.006
Scheduled caste	0.020	0.010	0.025	0.060 *
Other backward class		0.011		-0.006
Female work status (Not working=0)				
Working for wages	-0.013	-0.010	-0.059 **	-0.051
Others	0.004	-0.002	0.014	-0.014
Ideal number of children reported by mother	-0.043 ***	-0.070 ***	-0.043 **	-0.064 *
Ideal number of children squared	0.0018 **	0.0046 ***	0.0016	0.0003
Non-numeric ideal children (numeric = 0)	-0.134 ***	-0.156 ***	-0.076	-0.232 ***
Consanguinity (no = 0)	-0.016	na	0.012	na
Health worker visited during pregnancy (no = 0)	na	na	0.032	-0.017
Birth attendance (untrained birth attendant=0)	na	na		
Trained birth attendant at home	na	na	0.085 ***	0.076 *
Trained birth attendant at institution	na	na	0.040	0.070 **
Iron and folic acid supplementation (no = 0)				
Received tablets/syrup	na	na	0.016	0.022
Fully consumed	na	na	na	-0.041
Number of antenatal check-ups	na	na	0.008 *	0.000
Maternal anaemia at survey				
Mild	na	-0.015	na	0.002
Moderate/severe	na	-0.044 ***	na	0.002
Not tested	na	-0.025	na	-0.113 **
Mother's body-mass index at survey (normal = 0)				
Low (below 18.5 kg/m2)	na	0.005	na	0.032
High (25 kg/m2 or more)	na	-0.048 **	na	-0.109 *
Not measured	na	-0.202 ***	na	-0.119 ***
Mother's height at survey	na	0.007	na	-0.001
Mother's height not measured (measured = 0)	na	-0.029	na	0.029
Use of PNDT (no=0)	na	na	na	-0.056
Interaction with PNDT use				
No surviving male sibling and order 2 or higher	na	na	na	0.228 ***
No surviving female sibling and order 2 or higher	na	na	na	0.015
Altitude more than 1,000 metres (lower = 0)	na	-0.035 *	na	0.029
Region (south = 0)				
East	0.023	0.043 **	0.079 **	0.078 *
West	-0.002	0.041 *	0.040	0.060
North-west	0.043 **	0.090 ***	0.129 ***	0.147 ***
North-central	0.051 ***	0.082 ***	0.090 ***	0.090 **
Constant	0.110	0.317 ***	-0.051	0.550
Number of live births	1,75,815	1,58,840	53,591	31,353
-2 Log-likelihood	2,43,431	2,19,726	74,163	43,234
Pseudo R^2	0.001	0.002	0.002	0.005

Notes: * p<0.10, ** p<0.05, *** p<0.01.
na - not available/applicable.
Source: NFHS-2 micro data.

situation shows positive effect on the probability of having a male birth even in the absence of PNDT use, indicating that some women must have suppressed its use.

Another important result is with respect to the effects of antenatal and delivery care. In both NFHS-1 and NFHS-2, data on antenatal and natal care are available only for the recent births (for the last four years in NFHS-1 and last three years in NFHS-2). Both data sets show that the SRB is higher when trained personnel attend the birth. This could be due to the reduction in stillbirths when they attend the birth. But number of antenatal care check-ups and consumption of iron and folic acid tablets or syrup during pregnancy appear to have no effect on the SRB.

Urban residence, educational level, standard of living, exposure to mass media, religion and caste generally do not show statistically significant or consistent relationship in all the regressions. 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 0-14 years before the survey. Mothers working for wage report lower probability of male births in all the regressions but the effect is statistically significant only in data on births during 0-14 years before NFHS-2. The regression results show that the SRB 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 would seem consistent with the contention of some female activists that incidence of sex-selective abortions increases with the decrease in family size. However, the fact that this effect is also found in NFHS-1 data for the period when the incidence of female feticides were rare (as indicated by the insignificance of the variable representing the male-selection situation) suggests that the observed relationship is spurious: Those who had sons tend to use contraception more than those who had daughters; in order to justify their non-use of contraception, the latter group has the tendency to report higher ideal family size.

Maternal and paternal ages show statistically significant relationship with the SRB in some of the regressions. In births that occurred during 0-14 years before NFHS-1, maternal age shows statistically significant non-linear relationship, indicating initially a rise in the SRB with maternal age and then a fall at older ages. This may be attributed to a similar relationship of maternal age with stillbirth rate. But this relationship is not seen in the data from NFHS-2. As the role of men in sex determination of the fetus is well established, their age could have a bearing on the SRB. Some researchers have found that the SRB decreases with paternal age and speculated that it is due to the decrease in coital frequency with age [e g, Chahnazarian 1988]. All of our regressions indicate that the SRB initially decreases with paternal age and then rises at advanced ages. This effect is strongly significant in births that occurred 0-3 years before NFHS-2 and mildly significant in the regression that used births during 0-14 years before NFHS-1. While the initial decrease is as expected, the suggested rise after age 30 or so needs further investigation. The significance of the quadratic term in the regressions may simply be indicating that the rate of decrement diminishes with age.

The possibility of maternal malnutrition influencing the SRB has been discussed in the literature on this subject. Andersson and Bergstrom (1998) had found that short maternal stature and obesity were independently related to low SRB in Africa. 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 effects on the SRB. Mother's height does not show any effect on the SRB, but the results strongly suggest that obese women tend to have fewer sons. But it should be noted that NFHS data on maternal anaemia and body-mass index refer to the time of the survey rather than to the time of birth. Also to be noted is that women for whom data on body-mass index were not available had significantly lower SRB. This index was not calculated for pregnant women and those who had given birth during the two months before the survey. Such women were likely to have had more female births in the past because in societies with strong son preference, those who had sons are more likely to use contraception and stop childbearing.

Data on altitude are available only from NFHS-2. When births during the 0-14 years before the survey are considered, there is a weak indication that higher altitudes reduce the chance of male birth. This may be because of lower temperature and higher male fetal mortality at higher altitudes. It is also possible that people living at higher altitudes are genetically different from those living in low-lying areas. The information on consanguinity was collected only in NFHS-1. It shows no statistically significant relationship with the SRB. But owing to the limitations of the information on consanguinity collected in NFHS-1, it served as a poor proxy for the level of inbreeding. In all the regressions, even after controlling for the foregoing factors, the SRB is significantly higher in north-western and north-central regions. This could be because of greater misuse of PNDT in these parts. However, as these regional differences are also significant (but smaller) in the regressions that use NFHS-1 data, they may be indicating the presence of some genetic factors such as levels of circulating gonadotrophin, or a tendency to under-report female births in northern India.

Summary and Conclusions

In recent years the use of PNDT, followed by sex-selective abortion has emerged as a powerful determinant of SRB in India. In this paper we have analysed the factors influencing the use of PNDT as well as SRB. We present evidence from the recently released data on fertility from the 2001 Census as well as from the NFHS. The census fertility data suggest that SRB in India may have increased to 110, and in some areas, to as high as 130. But this data may have been affected by under-reporting of female births. However, even this data show that the SRB in south and eastern India is well within the range observed under normal circumstances, and 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 SRB, among the educated class the SRB is abnormally high.

The data collected in NFHS-2 (1998-99) show that 13 per cent of live births were subjected to PNDT, and 6 per cent of female foetuses may have been aborted after PNDT. But, if possible under-reporting is taken into account, PNDT may have been used in 14 per cent of the cases, and in 17 per cent of such cases female foetuses may have been aborted. The use of PNDT is higher in southern and western regions of India while its misuse for

selectively aborting female foetuses is higher in the north, especially in the 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 only daughters.

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, non-working women and those regularly exposed to media. The multivariate analysis applied to the data shows that these factors have independent effects on the use of PNDT. But they do not show a clear-cut relationship with its misuse. This may be because users of PNDT in the NFHS sample are 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 used as conduits by private agencies to promote the use of this technology in rural India.

The analysis of determinants of SRB shows that PNDT use does not have a direct effect on the SRB because it is not generally misused. But the analysis shows that when women in male-selection situation (i e, with at least one previous birth but had no sons) use PNDT, it has a strong positive effect on the probability of male birth. It was found that women in male-selection situation have higher SRB even in the absence of PNDT use, indicating that some women must have suppressed its use in the survey.

Beyond the use of PNDT and sex composition of previously born children, several other factors are also found to influence the SRB. The SRB was higher when a skilled person attended the delivery. There was evidence suggesting that the SRB initially increases and then deceases with maternal age. On the other hand, there was even stronger evidence indicating that the SRB decreases with paternal age initially and then increases with it. Maternal anaemia and obesity are found to decrease the SRB. There was evidence, albeit weak, that SRB is lower at higher altitudes. Urban residence, educational level, standard of living, religion and caste/tribe failed to show significant or consistent relationship with the SRB. However, regressions suggested that probability of male birth was lower for wage-earning women. In spite of controlling for many socio-economic and demographic factors, the SRB was higher in north India, especially in north-western parts, indicating that women in these regions misused the technology more than others. But the role of some genetic factors or under-reporting of female births in explaining a part of the remaining regional variations cannot be completely ruled out.

Although, the study focused on the characteristics of women in analysing the determinants of use and misuse of PNDT, we do not mean to suggest that their husbands had no part to play. Indeed, it is likely that women went for PNDT on the coaxing of their husbands and other family members. But the differentials in the use and misuse are likely to be governed more by women's characteristics because: in a culture of silence, the woman's involvement in decision-making would be more to do with her own characteristics (education, occupation, income, etc) than that of her husband's. Also, as the NFHS had collected data from women, it was more appropriate to study the determinants in terms of their own characteristics or those they share with their husbands (religion, caste, standard of living, parity, etc).

In conclusion, although the use of PNDT is now fairly common in many parts of India, only a minority of couples who use these techniques misuses it for aborting female foetuses. While income and education do increase the use of PNDT, their misuse is governed more by cultural factors and sex composition of children already born. The higher SRB observed among more educated and higher income groups is mainly because of their better access to these techniques rather than from their greater misuse. EPW

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[We wish to acknowledge with gratitude the assistance of K C Das in drawing the maps included in the paper. Comments of Fred Arnold, Marcus Feldman and participants of the seminar on "Female Deficit in Asia: Trends and Perspectives" held at Singapore during December 5-7, 2005 were helpful in revising the paper.]

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