An Evaluation of Recent Estimates of Fertility Trends in India

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India's first and second National Family Health Surveys (NFHS-1 and NFHS-2) were conducted in 1992–93 and 1998–99 under the auspices of the Ministry of Health and Family Welfare. The surveys provide national and state-level estimates of fertility, infant and child mortality, family planning practice, maternal and child health, and the utilization of services available to mothers and children. The International Institute for Population Sciences, Mumbai, coordinated the surveys in cooperation with selected population research centres in India, the East-West Center in Honolulu, Hawaii, and ORC Macro in Calverton, Maryland. The United States Agency for International Development, via a subcontract from ORC Macro to the East-West Center, provided support for the preparation and publication of this report.

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ABSTRACT

Comparison of fertility estimates from India's Sample Registration System (SRS) and two recent National Family Health Surveys (NFHS-1 in 1992–93 and NFHS-2 in 1998–99) indicates major discrepancies between the three sources. This subject report attempts to evaluate the reasons for these discrepancies and to assess the true trend of fertility in all India and 16 major states.

The analysis indicates that, for all India, the true total fertility rate (TFR) for 1990–92 was probably around 3.92, and the true TFR for 1996–98 was probably between 3.39 and 3.55, somewhat higher than the raw SRS estimates and considerably higher than the raw NFHS-1 and NFHS-2 estimates for the same time periods. The new estimates correct for displacement of births in NFHS-1 and NFHS-2 and for underregistration of births in the SRS. Although the new TFR estimates are higher, the decline in the TFR between 1990–92 and 1996–98 (0.4 or 0.5 child) derived from them is consistent with the declines calculated directly from the SRS (0.4 child) and from NFHS-1 and NFHS-2 (0.5 child).

Misreporting of women's ages in the two NFHS surveys does not have a large effect on the estimates of the TFR, for either India or major states. On the other hand, it does have a large effect on the estimates of ASFRs (age-specific fertility rates). Because the extent of age misreporting did not change much between the two surveys in India as a whole, our survey-based estimates of changes in ASFRs for all India are probably fairly accurate, insofar as errors in the estimates of ASFRs tend to cancel out when computing changes. In most individual states, however, the extent of age misreporting changed enough between the two surveys that we are unable to arrive at accurate estimates of changes in ASFRs. In the SRS, the pattern of change in ASFRs is distorted at both the national and state levels by changes in the pattern of age misreporting caused by the phasing in of a new SRS sample during the period 1993–95.

The analysis demonstrates that calculating TFR estimates for the 3-year period immediately preceding a survey does not work well in India. In NFHS-1 and NFHS-2, widespread ignorance of children's ages results in substantial displacement of births to earlier years in the birth histories and therefore to underestimation of the TFR for this 3-year period. Moreover, because the extent of displacement changed in many Indian states between NFHS-1 and NFHS-2, due to differences in the diligence of the survey organizations in collecting accurate age data, the TFR estimates for the 3-year period before each survey yield inaccurate estimates of the trend in the TFR in these states. In this situation, the own-children method of fertility estimation, applied to the household samples of NFHS-1 and NFHS-2, is a useful supplement to the birth-history method in that it yields TFR estimates for longer reference periods that minimize bias from displacement and provide more accurate indications of both level and trend in the TFR.

The analysis of bias in fertility estimates from the SRS could be improved further if the Sample Registration System were to publish unsmoothed single-year age-sex distributions of the SRS sample as well as sex ratios at birth on an annual basis.

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Published reports from India's 1992–93 and 1998–99 National Family Health Surveys (NFHS-1 and NFHS-2) have shown that estimates of the total fertility rate (TFR) for the 3-year period before each survey are consistently lower than corresponding estimates from India's Sample Registration System (SRS), for both all India and individual states (IIPS 1995; IIPS and ORC Macro 2000). In addition, discrepancies among the three sources in the TFR estimates for the state of Uttar Pradesh have been investigated in some depth in a recent study by Retherford et al. (2001). The present report extends Retherford et al.'s analysis for Uttar Pradesh to all India and an additional 15 major states. The goal of the analysis is to reconcile differences between the three sources of TFR estimates.

DATA

NFHS-1 and NFHS-2 were designed along the lines of the Demographic and Health Surveys (DHS) that have been conducted worldwide in many developing countries during the past two decades. Both NFHS-1 and NFHS-2 are nationally representative surveys that include both a household sample, covering everyone in the sampled households, and an individual sample, covering all ever-married women age 15–49 (13–49 in the case of NFHS-1) within those households. Corresponding to these two samples are a household questionnaire and an individual questionnaire. In the case of the household questionnaire, the household head or other knowledgeable adult in the household responded for the entire household. In the case of the individual questionnaire, each ever-married woman responded for herself and her children. NFHS-1 comprises 88,562 households and 89,777 ever-married women. NFHS-2 comprises 92,486 households and 90,303 ever-married women. Details of the sample design are contained in the basic survey reports for NFHS-1 and NFHS-2 (IIPS 1995; IIPS and ORC Macro 2000).

The International Institute for Population Sciences in Mumbai, which was the nodal agency for the two surveys, contracted with 7 survey organizations in NFHS-1 and 13 survey organizations in NFHS-2 to conduct the fieldwork in the various states. In some cases the survey organizations were private survey-research organizations, and in other cases they were population research centers or other organizations. Each contractor handled one or more states.

India's Sample Registration System (SRS) also provides national and state-level estimates of fertility, and it does so on an annual basis. The system includes both continuous registration of births and six-monthly surveys to catch missed births. The SRS is based on a nationally representative sample of villages and urban blocks. A new sample is selected every 10 years, following the decennial census. The most recent sample was phased in during 1993–95, using the 1991 Census as the sampling frame. In the SRS sample, the sampling unit in rural areas is an entire village or segment of any village with a population of 1,500 or more. In urban areas the sampling unit is a census enumeration block with a population ranging from about 750 to 1,000. The SRS sample currently includes 6,671 sampling units (4,436 in rural areas and 2,235 in urban areas), comprising about 1.1 million households and about 6 million population. The structure and procedures of the SRS have been described in more detail by Retherford et al. (2001).

DATA QUALITY

Data quality in NFHS-1 and NFHS-2

This section focuses on all India. Discussion of data quality in each of the 16 major states is deferred to the section of the report that analyzes state-level fertility estimates.

In NFHS-1, both the household response rate and the individual response rate for all India were 96 percent (IIPS 1995). In NFHS-2, the household response rate was 98 percent, and the individual response rate was 96 percent. Nonresponse is rare enough that it probably does not significantly bias the fertility estimates derived from NFHS-1 and NFHS-2.

Age misreporting is a more serious problem. Accuracy of age reporting is critical for calculating accurate estimates of fertility derived by either the birth-history method or the own-children method, which are the two methods used here to obtain fertility estimates from NFHS-1 and NFHS-2. In all India, only about one-fourth of ever-married women age 15–49 know their year of birth. For about three-fourths of the women, interviewers had to make educated guesses of age. In many cases, interviewers also had to make educated guesses of children’s ages, inasmuch as many mothers could not report these ages accurately. There is, accordingly, great potential for bias in the estimates of fertility derived from the two surveys.

Figures 1a and 1b show single-year age distributions of females in NFHS-1 and NFHS-2 for all India. These age distributions are based on the household sample (including persons of all ages), except that ages of ever-married women age 15–49 (13–49 in NFHS-1) are copied over from the individual sample. (This is done because women’s self-reports of their age tend to be more accurate than the reports of the household head or other knowledgeable person in the household who responded for the household in the household questionnaire). Both surveys show evidence of heaping on ages ending in 0 or 5, and the extent of such heaping is about the same in both surveys. This is also indicated by Myers’ Index of age heaping among women age

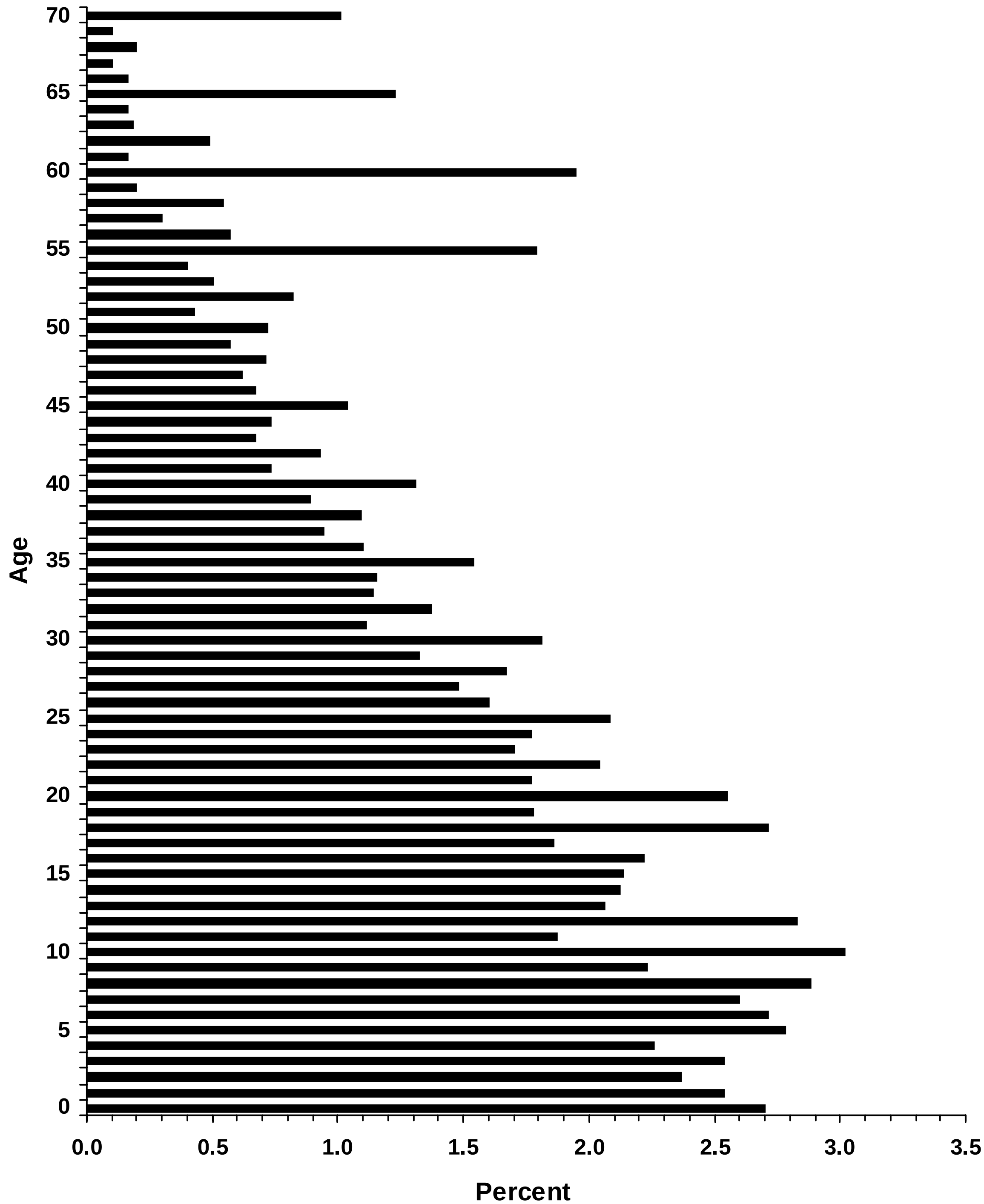

Figure 1a Female age distribution, with ages of ever-married women age 13–49 taken from the individual questionnaire and ages of other women taken from the household questionnaire: India, NFHS-1, 1992–93

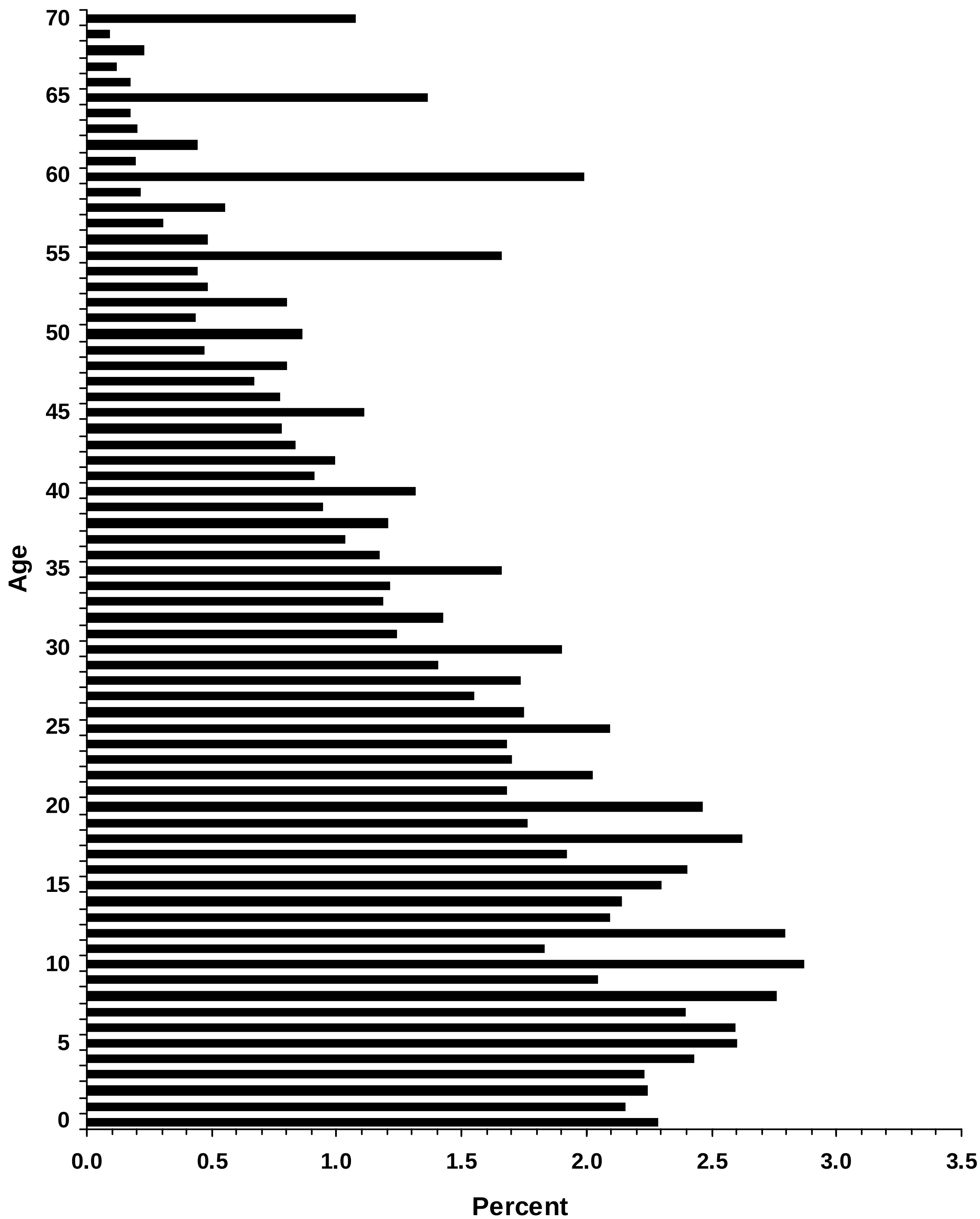

Figure 1b Female age distribution, with ages of ever-married women age 15–49 taken from the individual questionnaire and ages of other women taken from the household questionnaire: India, NFHS-2, 1998–99

10–69 (Shryock and Siegel 1973), which declined slightly from 10.4 to 10.0 between the two surveys. Although the extent of age misreporting for women age 10–69 did not change much between the two surveys at the all-India level, this is not true for many Indian states considered individually, as will be seen later. In some of states the quality of age reporting improved between the two surveys, while in others it worsened.

Figures 1a and 1b show considerable heaping on ages 8, 10, and 12, which translates into peaks in the fertility estimates derived from NFHS-1 and NFHS-2 in the 9th, 11th, and 13th years before the surveys. An additional problem contributing to misreporting of children's ages is that in both NFHS-1 and NFHS-2, young children who were reported as older than a cut-off age became ineligible for a large block of questions pertaining to children below this age, offering interviewers an opportunity to reduce their workload by exaggerating children's ages beyond the cut-off age. The cut-off age for the large block of questions pertaining to young children was approximately age 4.5 years in NFHS-1 and age 3.5 years in NFHS-2. (These cut-off ages are approximate because in the questionnaires the cut-off was specified as a date rather than an age.)

As shown in Figures 1a and 1b, in NFHS-1 there is a substantial jump between the proportion age 4 and the proportion age 5, and in NFHS-2 there is a substantial jump between the proportion age 3 and the proportion age 4, suggesting that some interviewers did indeed exaggerate children's ages in order to lighten their workload. This type of age exaggeration, which is equivalent to displacing births backward in time, has the effect of lowering fertility estimates for the 3-year period immediately preceding the survey, which is the period typically used for fertility estimates in demographic and health surveys, including NFHS-1 and NFHS-2. Because of the lower age cut-off in NFHS-2, there may be more displacement of births out of this 3-year period to earlier years in NFHS-2 than in NFHS-1. Some interviewers may also have intentionally omitted some births that occurred in the 3-year period before the survey in order to avoid having to ask the block of questions pertaining to young children.

Because of considerable preference for sons over daughters in India (mainly in the northern states), estimated sex ratios at birth provide another useful indicator of data quality. The sex ratio at birth is biologically determined for the most part and is usually close to 105 male births for every 100 female births, or a ratio of 1.05. In national populations with complete or near-complete vital registration, the sex ratio at birth rarely exceeds 1.06 (Keyfitz and Flieger 1968). If female births are omitted more than male births, this ratio will tend to be higher than 1.06. This occurs when women who prefer sons over daughters forget to mention children who have died or moved away, but more frequently daughters than sons. Such omissions are more likely for children born several years before the survey than for children born closer to the survey. If such omissions are common, one expects the sex ratio at birth, as ascertained from women's birth histories, to be higher in earlier years. In NFHS-1, the sex ratio at birth was 1.05, 1.07, and 1.06 in the first, second, and third 5-year periods before the survey. In NFHS-2, it was 1.07, 1.08, and 1.09 in these three periods. Overall, for the 15-year period before each survey, the sex ratio at birth was 1.06 in NFHS-1 and 1.08 in NFHS-2. These results suggest that both surveys omitted some births, and that omissions were more frequent in NFHS-2 than in NFHS-1. Sex-selective abortion has entered the picture since NFHS-1, however, so that the increase in the sex ratio at birth between NFHS-1 and NFHS-2 might be due mainly or even entirely to an emerging pattern of disproportionate abortion of female fetuses. Thus, the increase in the sex ratio at birth between the two surveys does not necessarily indicate a higher proportion of omitted births in NFHS-2.

Data quality in the SRS

In the SRS, the extent of age misreporting cannot be ascertained easily, because the SRS does not publish age distributions by single years of age. Thus, one cannot examine heaping on ages ending in 0 and 5 or compute a value of Myers' Index. With the exception of children below ten years of age whose births were registered, however, age misreporting is likely to be much worse in the SRS than in NFHS-1 and NFHS-2, because in the training and supervision of interviewers, the two surveys devoted much more effort to obtaining accurate information on age than is typically done in the SRS.

Despite the lack of published single-year age data from the SRS, it is possible to infer that the pattern of age misreporting in the SRS changes over time, due to the phasing in of a new sample of registration areas (villages and urban blocks) every ten years. Since the early 1980s, the SRS sample has been replaced twice, once during 1983–85 using the 1981 Census as the sampling frame and again during 1993–95 using the 1991 Census as the sampling frame. The impact of the 1993–95 changeover on age misreporting and on SRS fertility estimates will be analyzed later.

The SRS does not normally report sex ratios at birth, but a special report did release, on a one-time basis, national and state-level sex ratios at birth from the SRS for the period 1981–90 (Registrar General, India 1996). The SRS sex ratio at birth for all India for this 10-year period was 1.10, indicating substantial underregistration of female births and undoubtedly a good deal of underregistration of male births as well, implying that the SRS estimates of the TFR for all-India are too low. Sex-selective abortion was probably negligible in India during the period 1981–90 and therefore cannot explain the high sex ratio at birth during that period. Because this is the only reported sex ratio at birth ever released by the SRS for all India, it is not possible to ascertain the trend in the sex ratio at birth in the SRS.

Although the SRS suffers from underregistration of births, it does not suffer from displacement of births to earlier years, because births are registered in the year in which they occur. Later in this report we estimate that, in all India, the proportion of births that are not registered in the SRS is in the range of 7 to 10 percent.

THE BIRTH-HISTORY METHOD AND THE OWN-CHILDREN METHOD

The fertility measures estimated in this report are age-specific fertility rates (ASFRs), the general fertility rate (GFR), and the total fertility rate (TFR). For a particular calendar year, an ASFR for a 5-year age group is calculated as the number of births to women in the age group during the year divided by the mid-year number of women in the age group. Such a rate has the dimensions of births per woman per year. The GFR is defined as births during the year to women age 15–49 divided by the mid-year population of women age 15–49. The GFR also has the dimensions of births per woman per year. The TFR is defined as the number of children a woman would have if she lived through her reproductive years experiencing current age-specific birth rates. It is calculated by adding ASFRs in 5-year age groups from 15–19 to 45–49 and multiplying the sum by five. The TFR has the dimensions of births per woman over her entire reproductive lifetime.

In this report, annual fertility estimates from the SRS are taken from published SRS reports. Fertility estimates from NFHS-1 and NFHS-2 are derived using two methods: (1) the birth-history method and (2) the own-children method. In the present analysis, the own-children method is preferred over the birth-history method, for reasons explained below.

The birth-history method of estimating fertility

The birth-history method is straightforward. One simply counts births by age of mother as reported in the birth histories for each year up to the 15th year before the survey. One similarly counts woman-years of exposure to the risk of birth by woman's age. Births by age of mother are then divided by woman-years of exposure in each age group in each calendar year or group of calendar years to obtain estimates of ASFRs for the same period. TFRs are derived from the ASFRs, by summing the ASFRs in five-year age groups from 15–19 to 45–49 and multiplying the sum by five. In the calculation of these various fertility rates, which pertain to all women, not just ever-married women, it is assumed that never-married women have had no births.

In the present context, the principal disadvantage of the birth-history method is that it cannot be used to calculate TFRs for each of the 15 years before the survey (either NFHS-1 or NFHS-2). This is so because, following usual practice, NFHS-1 and NFHS-2 collected birth histories from ever-married women only up to age 50. Thus, the oldest women covered were only 44 years old five years before each survey, so that an age-specific fertility rate (ASFR) for women age 45–49 cannot be calculated for years earlier than five years before the survey. Similarly, 15 years before each survey, the oldest women in the sample were only 34 years old. Thus, comparable measures of overall fertility for each of the 15 years before the two surveys can be based only on fertility up to age 35. A suitable summary measure of fertility that is comparable over the entire period is CFR(35), the cumulative fertility rate up to age 35. This measure is calculated by adding ASFRs in 5-year age groups from 15–19 to 30–34 and multiplying the sum by five.

The own-children method of estimating fertility

Because the own-children method (Cho et al. 1986) is applied to the household sample (with ages of ever-married women of reproductive age copied over from the individual sample), covering all persons in the household with no age restrictions, it allows computation of ASFRs and the TFR for each of the 15 years before each survey. For that reason it is our preferred fertility estimation method.

In the own-children method, enumerated children are first matched to mothers within households, based on answers to questions on age, sex, marital status, and relation to head of household. A computer algorithm is used for matching. The matched (i.e., own) children, classified by their own age and mother's age, are then reverse-survived to estimate numbers of births by age of mother in previous years. Reverse-survival is similarly used to estimate numbers of women by age in previous years. After adjustments are made for unmatched (i.e., non-own) children, ASFRs are calculated by dividing the number of reverse-survived births by the number of reverse-survived women. TFRs are then calculated from the ASFRs.

The own-children method may be viewed as fertility estimation from incomplete birth histories, where the missing births correspond to children under age 15 who are either dead or no longer living in the household at the time of the survey. The own-children method uses reverse-survival and other approximation procedures to add these missing births back in. Life tables for the reverse-survival calculations are taken from the SRS (Registrar General, India 1986; 1990; 1995; 1998).

In applying the own-children method, calculations are initially done by single years of age and time. Estimates of ASFRs for grouped ages or grouped calendar years or both are obtained by aggregating single-year numerators (births) and single-year denominators (women) separately over the appropriate ages and calendar years and then dividing the aggregated numerator by the aggregated denominator. Such aggregation is useful for minimizing the distorting effects of age misreporting on the fertility estimates. Because numerators and denominators are aggregated separately before dividing to get ASFRs, the ASFRs take into account population growth over the estimation period and are therefore implicitly weighted by population size. Further details of the calculations have been described by Retherford et al. (2001).

In order to validate the use of the own-children method instead of the birth-history method for deriving fertility estimates for all India, we compare fertility estimates derived by the two methods. Because of the problem of age truncation in the birth-history method as one goes back in time, comparable estimates of fertility for each of the 15 years preceding NFHS-1 or NFHS-2 can be generated only up to age 35. For this reason, an appropriate summary measure for comparing the two methods is cumulative fertility up to age 35, or CFR(35). Figure 2 shows 15-year trends in CFR(35) for all India derived from the birth-history and own-children methods for each of the two surveys. Figure 2a compares fertility trends derived by the own-children method and the birth-history method applied to NFHS-1, and Figure 2b compares trends derived by the two methods applied to NFHS-2. In each case, the two sets of estimates are in close agreement, justifying the use of the own-children method in the remainder of this report.

EARLIER WORK ON FERTILITY ESTIMATES FOR UTTAR PRADESH

In the case of the state of Uttar Pradesh, discrepancies in TFR estimates between NFHS-1, NFHS-2, and the SRS have been investigated in some depth in a recent study by Retherford et al. (2001). NFHS-1 and NFHS-2 indicate that in Uttar Pradesh the TFR for the 3-year period before each survey fell from 4.82 children per woman in 1992–93 to 3.99 children per woman in 1996–98 (IIPS and ORC Macro 2000). In contrast, the SRS indicates that the TFR fell from 5.17 to 4.78 over the same period. Retherford et al. find that, because of underregistration of births in the SRS, the true level of fertility is even higher. They estimate that the TFR in Uttar Pradesh fell from 5.55 to 5.19 between 1990–92 and 1996–98.

Briefly, the methodology used by Retherford et al. is the following: In order to minimize bias from displacement of births to earlier years before NFHS-2, the authors first calculated a TFR for the 15-year period before the survey— i.e., for 1984–98—using the own-children method. Based on a post-enumeration survey that was conducted for NFHS-2 in Uttar Pradesh (but not in other states), this 15-year TFR was adjusted upward by 4.72 percent to adjust for births that were missed in the main survey, yielding a TFR value of 5.5503. Next the authors calculated a correction factor for TFRs from the SRS as the ratio of 5.5503 (from NFHS-2, adjusted) to the unweighted average of annual TFRs published by the SRS for the same 15-year time period. The value of this ratio is 1.0639. Under the somewhat heroic assumption that

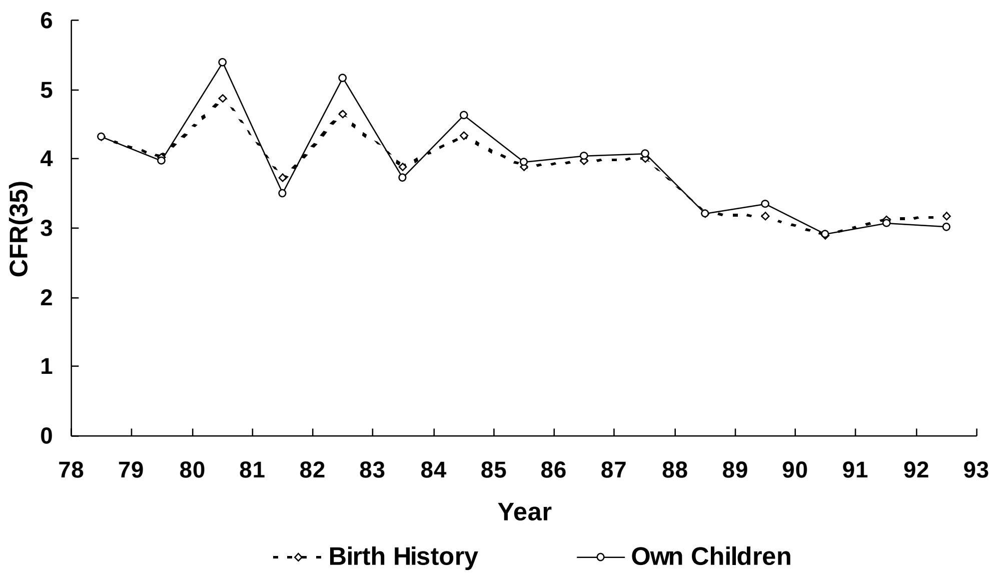

Figure 2a Birth-history and own-children estimates of cumulative fertility rates, CFR(35), from NFHS-1: India, 1978–92

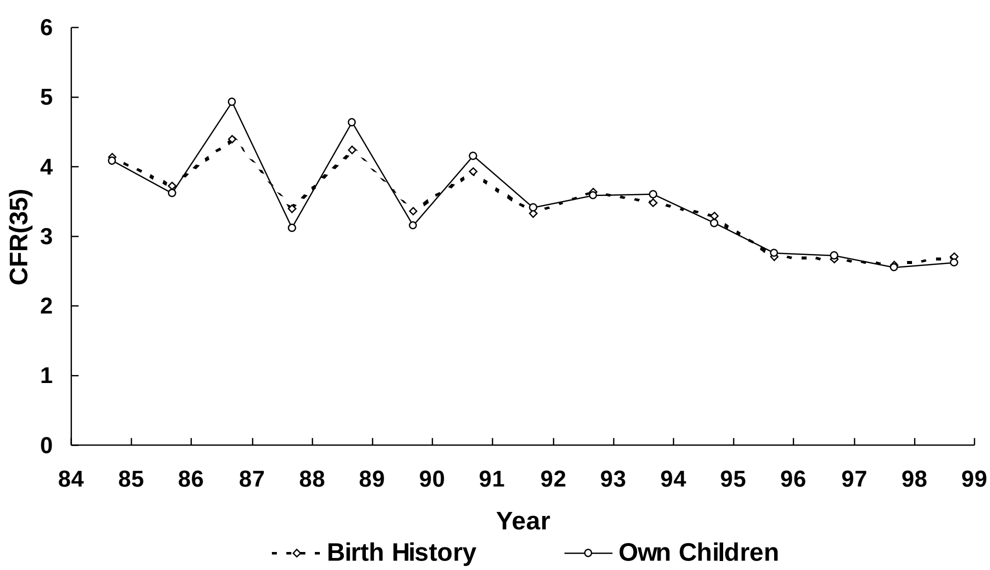

Figure 2b Birth-history and own-children estimates of cumulative fertility rates, CFR(35), from NFHS-2: India, 1984–98

the degree of completeness of birth registration in the SRS did not change in Uttar Pradesh between 1978 and 1998, the correction factor of 1.0639 was then used to correct each annual SRS estimate of the TFR between 1978 and 1998. This was done by multiplying each unadjusted annual SRS estimate of the TFR by 1.0639 to yield a set of adjusted annual estimates. A line was then fitted through the adjusted annual estimates. The equation of the line is TFR = 11.0639 – .0603 t, where t is years since 1900. Estimates of the TFR for the 3-year period preceding each survey were then obtained by substituting t = 91.5 and t = 97.5 into the right side of this equation, yielding TFRs of 5.55 and 5.19.

This procedure cannot be used for all India and other major states because a post-enumeration survey was conducted in NFHS-2 only in Uttar Pradesh and not in other states. In the present analysis for all-India and other major states, the methodology used for Uttar Pradesh must therefore be modified, as explained in the next section.

FERTILITY ESTIMATES FOR ALL INDIA

Table 1 shows the discrepancies in TFR estimates for all India that we wish to explain. The NFHS estimate of 3.39 for 1990–92 is from the NFHS-1 report for all India (IIPS 1995), and the NFHS estimate of 2.85 for 1996–98 is from the NFHS-2 report for all India (IIPS and ORC Macro 2000). These estimates are derived by the birth-history method. The estimates from the SRS are simple 3-year averages of values of the TFR published by the SRS for single calendar years. The SRS TFRs are one-third to one-half child higher than the NFHS TFRs. The discrepancy is greater for NFHS-2 (1996–98) than for NFHS-1 (1990–92). The two NFHS surveys indicate a larger absolute decline and percentage decline in the TFR than does the SRS.

The problem of displacement in NFHS-1 and NFHS-2

As a first step in understanding the source of the discrepancies between the two surveys and the SRS, Figure 3 shows three overlapping trends in the TFR, derived from the three data sources. In Figure 3, the trends from NFHS-1 and NFHS-2, which are derived by the own-children method, each show sharp peaks in the 9^{th}, 11^{th}, and 13^{th} years before the survey, reflecting heaping of children's ages on 8, 10, and 12 years, as explained earlier. The trend based on the SRS is much smoother because in the SRS births are recorded in the year in which they occur so that children's ages do not enter into the calculation of the fertility estimates. The trends derived from the two NFHS surveys show evidence of displacement of births out of the first three years before each survey to earlier years, suggesting that displacement is a major

Table 1 Comparison of total fertility rates (TFR) estimated from NFHS-1, NFHS-2, and the Sample Registration System: India

	1990–92	1996–98	(1996–98) – (1990–92)	(1996–98)/(1990–92)
NFHS	3.39	2.85	-0.54	0.84
SRS	3.68	3.32	-0.35	0.90
NFHS/SRS	0.92	0.86	NA	NA

Sources: IIPS (1995) for NFHS-1; IIPS and ORC Macro (2000) for NFHS-2; Registrar General, India (various years) for the SRS.

Note: NFHS estimates for 1990–92 are birth-history estimates from NFHS-1, and NFHS estimates for 1996–98 are birth-history estimates from NFHS-2. The SRS values are simple averages of annual estimates published by the SRS. Time periods are calendar years for the SRS and years before the survey for NFHS-1 and NFHS-2, so time periods differ slightly for each data source.

NA: Not applicable.

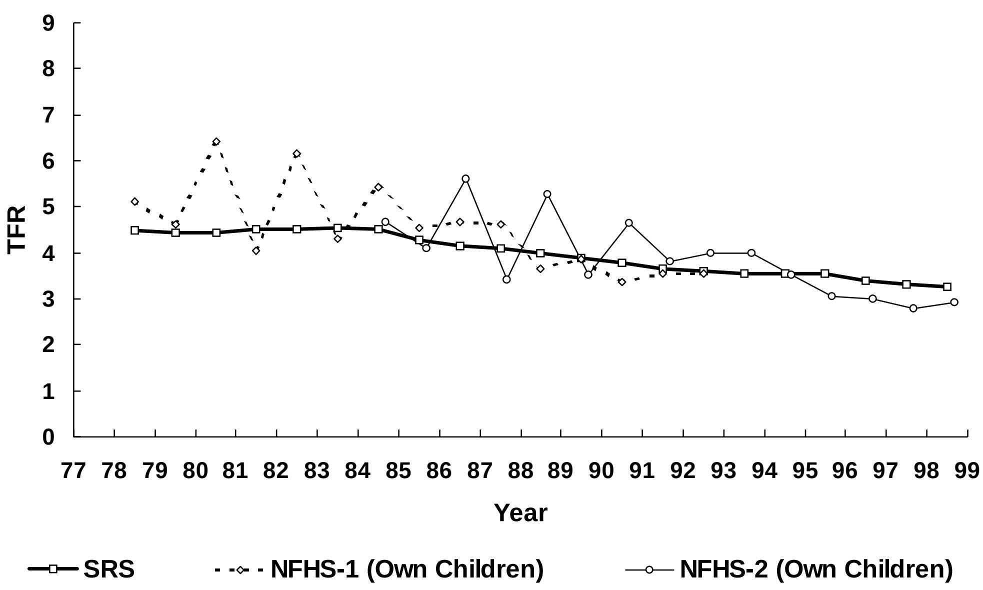

Figure 3 Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: India

Table 2 Trends in age-specific fertility rates (ASFRs) and total fertility rates (TFRs) from NFHS-1, NFHS-2, and the SRS: India

Fertility measure	NFHS-1				NFHS-2				SRS			
	1978–82	1983–87	1988–92	**1978–92**	1984–88	1989–93	1994–98	**1984–98**	1978–82	1983–87	1988–92	1993–97
ASFRs												
15–19	173	158	110	**143**	176	152	104	**140**	90	89	81	60
20–24	301	282	219	**262**	288	261	206	**247**	246	255	240	234
25–29	255	235	182	**220**	222	195	159	**188**	231	223	198	190
30–34	167	143	111	**137**	132	109	84	**105**	165	150	122	115
35–39	95	79	58	**75**	67	53	38	**51**	99	86	71	58
40–44	47	33	28	**36**	29	21	14	**21**	45	42	32	28
45–49	18	12	12	**14**	12	7	6	**8**	20	19	12	9
TFR	5.28	4.71	3.60	**4.44**	4.62	3.99	3.05	**3.81**	4.48	4.31	3.78	3.47

Note: The NFHS-1 and NFHS-2 fertility estimates are derived by the own-children method. The SRS estimates for 5-year time periods are simple averages of estimates for single calendar years published in annual SRS reports. For all India, the 15-year aggregations pertain approximately to 1978–92 and 1984–98. Because the surveys were taken at different times in different states, these reference periods are offset by a year in some states.

part of the explanation of why the TFR estimates from the two NFHS surveys are lower than the TFR estimates from the SRS for the 3-year period preceding each survey in Table 1. Figure 3 also suggests that displacement out of the 3-year period preceding the survey may be worse in NFHS-2 than in NFHS-1, a possibility that was discussed earlier in connection with the large block of questions asked of children below a cut-off age, which was younger in NFHS-2 than in NFHS-1.

Table 2 demonstrates displacement in another way. The table shows fertility estimates for the three 5-year periods and for the entire 15-year period before NFHS-1 and NFHS-2. Estimates for the 15-year periods are shown in boldface. In the case of the SRS, the table shows estimates for four 5-year periods. The fertility estimates from NFHS-1 and NFHS-2 are generated by the own-children method, while the estimates for 5-year periods from the SRS are unweighted averages of annual estimates.

Because of displacement of births out of the first five years before each survey and a bunching of births in the second and third five years before each survey, the within-survey trend of the TFR derived from each survey separately is more steeply downward than the between-survey trend based on the boldfaced 15-year-aggregated TFRs. The average annual within-survey decline in the TFR between the third and first 5-year periods before the survey is 0.17 child per year in NFHS-1 and 0.16 child per year in NFHS-2, compared with an average annual between-survey decline of 0.10 child per year. The average annual decline in the SRS estimates between 1983–87 and 1993–97 was lower yet, at 0.08 child per year. Quite clearly, each of the within-survey estimates of trend in the TFR, based on 5-year time periods, starts too high and ends too low. The between-survey estimate of trend, based on two 15-year time periods, looks much more reasonable and is much closer to the trend estimated from the SRS. The even slower rate of TFR decline in the SRS could be due to improvements in birth registration completeness over time (although we do not know whether completeness actually did improve over this period) or to greater omission of births in NFHS-2 than in NFHS-1.

Estimating underregistration of births in the SRS

Our strategy for obtaining a more accurate set of TFR estimates for 1990–92 and 1996–98 is to adjust the SRS estimates of the TFR in Table 1 for underregistration of births by making use of the 15-year-aggregated estimates of the TFR derived by the own-children method from NFHS-1 and NFHS-2. Fifteen-year-aggregated estimates of the TFR are used because they minimize bias due to displacement of births to earlier years. The first step is to estimate the extent of underregistration of births in the SRS.

To estimate underregistration of births in the SRS, we use the GFR rather than the TFR. The GFR, it will be recalled, is defined as births to women age 15–49 during the time period under consideration divided by woman-years of exposure during that period. A 15-year-aggregated estimate of the GFR for 1978–92 is calculated by applying the own-children method to NFHS-1, and a roughly comparable estimate from the SRS is calculated by taking a weighted average of annual estimates of the GFR published by the SRS for 1978, 1979, ..., 1992, where the weights are based on the estimated number of women age 15–49 in each calendar year during the 15-year period.[1] A correction factor for underregistration is then calculated by dividing the NFHS-1 estimate of the GFR for 1978–92 by the comparable SRS estimate for the same period. In the division, the denominators of the two GFRs cancel out inasmuch as the proportion of females who are age 15–49 is close to the same in the NFHS

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[1]Weights must be used, because the own-children fertility estimates for the 15-year period are implicitly weighted by virtue of the way they are calculated. In the calculation of 15-year weighted averages of GFRs and TFRs from the SRS, weights were calculated as the estimated number of women age 15–49 at the midpoint of a particular calendar year divided by the sum of the midpoint values over 15 calendar years. Thus the weights sum to unity. The number of women age 15–49 at the midpoint of each calendar year was estimated by linear interpolation of values from the 1971, 1981, 1991, and 2001 censuses. A value for Assam is not available from the 1981 Census, requiring interpolation between the 1971, 1991, and 2001 censuses. Preliminary estimates of total female population by state were available from the 2001 Census, but estimates of female population by age were not yet available. To obtain female population age 15–49 for calendar years between 1991 and 1998, we first interpolated total female population between 1991 and 2001 to estimate total female population at the time of NFHS-2 (taken as 1999.17, the average date of interview in NFHS-2). We then multiplied this value by the proportion of females in the NFHS-2 household sample who were age 15–49 to estimate the number of women age 15–49 in the general population in 1999.17. We then interpolated between this value and the number of women age 15–49 in the 1991 Census to obtain estimates of the number of women age 15–49 at the midpoints of intermediate calendar years.

surveys and the SRS, so that the correction factor specifies the ratio of NFHS-1 births to SRS births over the 15-year time period. This correction factor assumes that no births were missed in NFHS-1. A correction factor for the period 1984–98 is similarly calculated by dividing the NFHS-2 estimate of the GFR for this 15-year period by the comparable SRS estimate of the GFR for the same period.

The correction factors calculated in this way for all India are 1.107 for the 15-year period preceding NFHS-1 and 1.073 for the 15-year period preceding NFHS-2. These values probably are underestimates, because some births are undoubtedly missed in NFHS-1 and NFHS-2.

The correction factors of 1.107 and 1.073 are not the same as rates of underregistration of births in the SRS, which may be calculated from a correction factor k (1.107 or 1.073) as $1–1/k$. The rates of underregistration so calculated are 9.6 percent for the period 1978–92 and 6.8 percent for the period 1984–98.

Correcting the SRS TFRs for underregistration of births

One might think that the GFR ratios could be used to adjust upward the SRS TFRs, but actually 15-year-aggregated TFR ratios (calculated in the same way as the 15-year-aggregated GFR ratios) are more appropriate, because TFRs are what are being corrected. The 15-year-aggregated TFR ratios for all India are 1.067 for NFHS-1 and 1.020 for NFHS-2, which are considerably lower than the corresponding GFR ratios of 1.107 and 1.073. The reason why the TFR ratios are lower than the GFR ratios will be explained later, when estimates of ASFRs are discussed. In what follows, we use the TFR ratios to correct the SRS estimates of the TFR.

Table 3 shows the NFHS and SRS raw estimates of the TFR, taken from Table 1, as well as two alternative sets of adjusted estimates of the TFR. The first set of adjusted estimates adjusts the SRS estimate for 1990–92 upward by multiplying it by the 15-year NFHS-1/SRS ratio of TFRs, and it adjusts the SRS estimate for 1996–98 upward by multiplying it by the 15-year NFHS-2/SRS ratio of TFRs. With these adjustments, the TFR is estimated to have declined from 3.92 in 1990–92 to 3.39 in 1996–98. In the second set of adjusted estimates, the SRS TFRs for both 1990–92 and 1996–98 are adjusted upward by the higher of the two 15-year NFHS/SRS ratios of TFRs, namely the NFHS-1/SRS ratio of TFRs. The rationale is that the extent of birth underregistration in the SRS probably did not change much between 1978–92 and 1984–98 (periods that overlap by nine years), so that the higher of the two 15-year NFHS/SRS ratios of TFRs probably does a better job of capturing missed births. Thus the second set of adjusted estimates assumes that omission of births is greater in NFHS-2 than in NFHS-1. With this adjustment, the TFR declines from 3.92 in 1990–92 to 3.55 in 1996–98.

Table 3 Estimates of the total fertility rate (TFR) for 1990–92 and 1996–98: India

Data source and method	1990–92	1996–98	Estimated decline
NFHS raw values[a]	3.39	2.85	0.54
SRS raw values[b]	3.68	3.32	0.35
SRS TFRs adjusted upward by the two 15-year NFHS/SRS ratios of TFRs[c]	3.92	3.39	0.53
SRS TFRs adjusted upward by the higher of the two 15-year NFHS/SRS ratios of TFRs[d]	3.92	3.55	0.37
International regression line estimates of TFR[e]	4.44	3.92	0.52

[a]The values for 1990–92 are birth-history estimates from NFHS-1, and the values for 1996–98 are birth-history estimates from NFHS-2 (published reports).
[b]The 1990–92 SRS value is a simple average of published estimates of the TFR for 1990, 1991, and 1992, and the 1996–98 SRS value is a simple average of published estimates of the TFR for 1996, 1997, and 1998.
[c]The 1990–92 SRS TFR is adjusted upward by the 15-year NFHS-1/SRS ratio of TFRs, and the 1996–98 SRS TFR is adjusted upward by the 15-year NFHS-2/SRS ratio of TFRs.
[d]The higher of the two 15-year NFHS/SRS ratios of TFRs is used to adjust the SRS TFRs for both 1990–92 and 1996–98.
[e]The equation of the international regression line is TFR = 7.2931 – 0.0700 CPR, where CPR denotes the contraceptive prevalence rate (the percentage of currently married women age 15–49 who are currently using any contraceptive method, including traditional methods).

In applying each 15-year-aggregated adjustment factor to a 3-year period at the end of the 15-year period, we assume that birth registration completeness in the SRS did not change during the 15-year period. If it improved during the 15-year period, then the adjustment for the three most recent years of the period may be too large. On the other hand, since NFHS-1 and NFHS-2 both missed some births, the adjustment factors may be too small. These offsetting errors probably cancel each other to some extent.

Another approach for estimating the TFR is based on the widely used "international regression line" that relates the TFR to the contraceptive prevalence rate (CPR). The CPR is calculated as the percentage of currently married women age 15–49 who are currently using any method of contraception. The international regression line is based on data on national-level TFRs and CPRs from more than 90 countries around the world (Ross and Frankenberg 1993). The equation of this line is:

$$\text{TFR} = 7.2931 - 0.0700\ \text{CPR} \qquad (1)$$

Despite the fact that other variables known to affect fertility are omitted from the right side of this equation, the equation fits the data rather well. $R^2 = 0.88$, indicating that the regression line explains 88 percent of the variation in the TFR.[2] There is still a good deal of scatter around the fitted line, however.

Results from NFHS-1 and NFHS-2 indicate that the CPR in all India increased from 40.6 to 48.2 percent between the two surveys. Age misreporting has little or no effect on these estimates, which we consider to be reasonably accurate. Substitution of these values into equation (1) yields predicted TFRs of 4.44 for 1990–92 and 3.92 for 1996–98. These estimates are higher than any of the other estimates in Table 3, but they are also less reliable, based as they are in part on a regression line that reflects the experience of countries other than India. Moreover, because Indian women rely heavily on female sterilization, which is a very effective method, and because sterilization often occurs at a young age in India, the international regression line may overestimate India's TFR. Nevertheless, the estimates based on the international regression line establish that even the higher of our two alternative sets of adjusted estimates is plausible.

Overall, the analysis embodied in Table 3 shows that both the NFHS and the SRS estimates of the TFR for 1990–92 and 1996–98 for all India are too low, although by exactly how much is difficult to say. The true TFR for 1990–92 is probably around 3.92, and the true TFR for 1996–98 is probably between 3.39 and 3.55.

Age-specific fertility rates (ASFRs)

Fertility rates calculated for 5-year age groups of women are much more susceptible to bias from misreporting of women's ages and displacement of births than are total fertility rates. Figure 4 shows estimates of ASFRs for women in 5-year age groups during the 3-year periods before NFHS-1 and NFHS-2 along with comparable SRS estimates for the whole country. None of the estimates in the figure incorporate any correction factors. The estimates from NFHS-1 and NFHS-2 are derived by the own-children method. The estimates from the SRS are simple averages of published ASFRs for single calendar years, averaged over three years.

Figure 4a suggests that the comparatively small fertility decline between 1990–92 and 1996–98 estimated from the SRS stemmed from fertility reduction at all reproductive ages, but especially 15–19. Inasmuch as the proportion currently using contraception among currently married women age 15–19 increased only marginally between 1990–92 and 1996–98 (from 7 to 8 percent, as estimated from the two NFHS surveys), most of the fertility decline in this age group, if real, would have to have occurred because of a decline in the proportion currently married at 15–19. According to the SRS, the proportion currently married at 15–19 for all India de-

[2]Other versions of the international regression line yield almost identical results to those shown here.

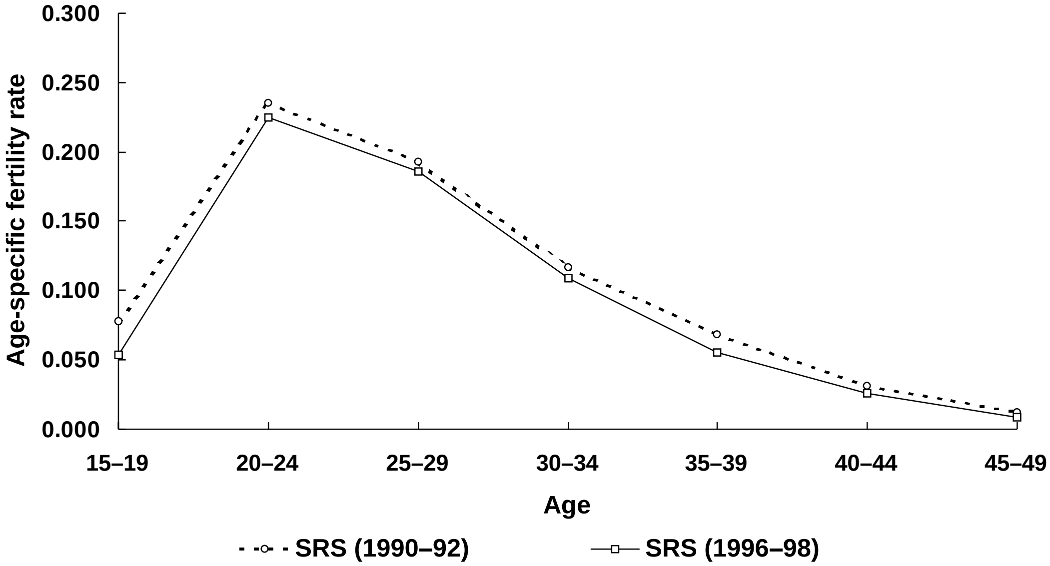

Figure 4a Age-specific fertility rates from the SRS for 1990–92 and 1996–98: India

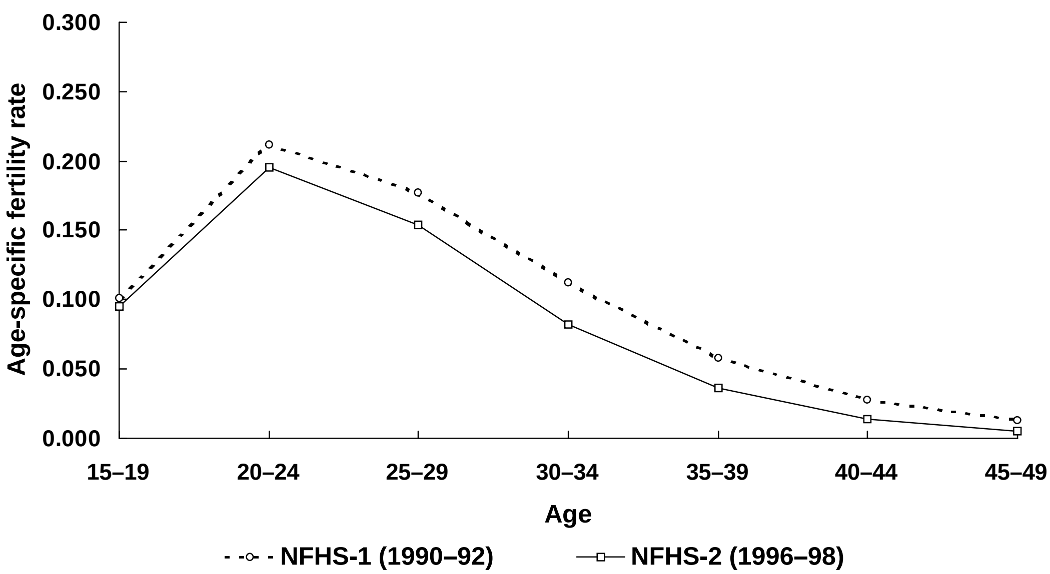

Figure 4b Age-specific fertility rates from NFHS-1 (1990–92) and NFHS-2 (1996–98): India

creased from 31 to 25 percent between 1991 and 1997,[3] not enough to explain the approximately one-third decline in the ASFR at 15–19 shown in Figure 4a. In reality, much of the apparent decline in ASFR(15–19) as estimated by the SRS is not real. As will be explained shortly, it results from changes in the pattern of age misreporting caused by the phasing in of a new SRS sample over the period 1993–95.

In contrast to the ASFR estimates from the SRS, the ASFR estimates for 1990–92 from NFHS-1 and 1996–98 from NFHS-2, shown in Figure 4b, indicate virtually no fertility decline at age 15–19 but substantial declines at older ages. The age pattern of fertility decline shown in Figure 4b, based on NFHS-1 and NFHS-2, may be fairly accurate, given that age misreporting, as indicated by Myers' Index, is about the same in the two surveys, so that the biasing effects of age misreporting on ASFRs may mostly cancel out when calculating changes over time. Myers' Index, however, only covers ages 10–69. The extent of misreporting of children's ages below 10, which can also bias estimates of ASFRs from the two surveys, is not necessarily the same in the two surveys.

In NFHS-1 and NFHS-2, children's ages tend to be moved up for various reasons. One reason, discussed earlier, is that some interviewers may wish to lighten their workload by recording a child's age above the cut-off age for a large block of questions asked about young children. Another reason is simple rounding. For example, a child age 2 years 9 months might be reported as age 3, in which case it is not reported in the birth histories as a birth during the first three years before the survey. Such exaggeration of children's ages—equivalent to displacement of births to earlier years—does not affect all ASFRs equally. The effect is unequal because displacement of births to earlier years tends to shift the entire age curve of fertility to the left (i.e., to younger ages of women), raising estimated fertility among younger women and lowering estimated fertility among older women. This shift occurs because a birth that is displaced further into the past is erroneously reported to have occurred when the mother was younger. As a consequence of this mechanism, ASFRs below the peak age of fertility are overestimated, and ASFRs above the peak age of fertility are underestimated. At the same time, the net displacement of births out of the 3-year period before the survey to earlier years tends to lower ASFRs at all ages. These two effects on the estimated ASFR at 15–19 are offsetting to some extent, and the net

[3]According to NFHS-1 and NFHS-2, the proportion currently married at 15–19 decreased from 38 to 33 percent between the two surveys. The higher estimates of the proportion currently married at 15–19 in the two surveys than in the SRS stem from greater misreporting of women's ages in the SRS, leading to more moving up of married women from age 15–19 to age 20–24. (When calculating the proportion currently married at 15–19 from NFHS-2, we first copied over the ages of ever-married women from the individual file to the household file. This was already done in the NFHS-1 published reports, but it was not done in the NFHS-2 published reports.)

effect is not clear. Above the peak age of fertility, the two effects are in the same direction, so that the net effect on estimated ASFRs in this age range is clearly to bias them downward.

Misreporting of women's ages also tends to distort the age pattern of fertility. In India as well as elsewhere in South Asia (except Sri Lanka), most women do not know their age precisely, so that there is considerable potential for misreporting of age. Ages tend to be shifted upward in the case of women who are married and who have more than the typical number of children for their age (Retherford and Mirza 1982; Narasimhan et al. 1997; Retherford and Thapa 2000; Retherford et al. 2001). Conversely, ages tend to be shifted downward in the case of never-married women and married women with fewer than the typical number of children for their age. The net effect of this age misreporting is to shift the age curve of fertility to the right, increasing fertility among older women and decreasing fertility among younger women. The extent to which the leftward shift associated with displacement of births and the rightward shift associated with misreporting of women's ages cancel each other is not clear.

In the SRS there is no displacement of births because births are recorded in the year in which they occur. There is every reason to believe, however, that women's ages are misreported to an even greater extent in the SRS than in NFHS-1 and NFHS-2, because the two surveys devoted considerably more effort to collecting accurate age data than does the SRS (Narasimhan et al. 1997). This means that the ASFR curve in the SRS is undoubtedly shifted to the right. Because of this rightward shift, the absolute levels of ASFRs estimated from the SRS are biased downward at ages below the peak age of fertility and biased upward at ages above the peak age of fertility. The downward bias at younger ages is aggravated by underregistration of births, and the upward bias at older ages is offset to some extent by underregistration of births. However, most underregistration of births in the SRS probably occurs at younger ages of women in newly formed marital unions that have not yet been captured by the SRS, as well as among the substantial numbers of recently married women who return to their parental home (usually outside the registration area) for the birth of their first child.[4] Thus the SRS estimate of fertility at 15–19 is biased downward both by misreporting of women's ages and by underregistration of births.

As noted by Retherford et al. (2001), the rightward shift of the age curve of fertility in the SRS is reduced to some extent by an offsetting effect that stems from

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[4]In NFHS-1 in Uttar Pradesh, for example, the proportion of births that occurred in the home of the mother's parents during the four years immediately preceding the survey was 21 percent for women below age 20, 10 percent for women age 20–34, and 2 percent for women age 35 and above (Narasimhan et al. 1997). It is possible that a substantial proportion of births occurring in the mother's parents' home, which occur mainly at age 15–19, are missed by the SRS.

the way that the SRS records ages. The SRS tabulates ASFRs by age at the beginning of the calendar year. This means that a reported ASFR for a given 5-year age group of women actually pertains to a 5-year age group that is on average six months older. Thus the age groups that the SRS reports as 15–19, 20–24, ..., 45–49 are in reality age groups 15.5–20.4, 20.5–24.4, ..., 45.5–50.4. This feature of the SRS has the effect of shifting the age curve of fertility one-half year to the left (Narasimhan et al. 1997). Retherford et al.'s (2001) results for Uttar Pradesh suggest that this leftward shift is more than offset by the rightward shift just described.

Figure 4b indicates that, for all India, ASFR(15–19) hardly changed between NFHS-1 and NFHS-2. Given that the proportion currently married at 15–19 fell from 38 to 33 percent[5] between the two surveys, the constancy of ASFR(15–19) suggests that marital fertility at 15–19 may have increased slightly. This is possible, inasmuch as age at marriage rose slightly between the two surveys (so that average fecundability within the 15–19 age group increased) while contraceptive use at 15–19 hardly changed, from 7 percent in NFHS-1 to 8 percent in NFHS-2.

Figure 5 depicts the same data as Figure 4 but arranged somewhat differently. Figure 5a compares the age curves of fertility for 1990–92 derived from the SRS and from NFHS-1, and Figure 5b compares the age curves of fertility for 1996–98 derived from the SRS and from NFHS-2. In Figure 5a, for the period 1990–92, NFHS-1 yields somewhat higher fertility than the SRS at age 15–19 and lower fertility than the SRS at older ages. The discrepancies reflect errors in the SRS (the rightward shift of the SRS-derived curve) as well as errors in NFHS-1 (a leftward shift and a rightward shift, the net effect being unclear).

The discrepancies in Figure 5b (for 1996–98) are much larger than those in Figure 5a (for 1990–92). Indeed, in Figure 5b the estimate of ASFR(15–19) is twice as high in NFHS-2 as in the SRS. As explained below, the larger discrepancies in Figure 5b probably occur because of greater age misreporting in 1996–98 than in 1990–92 in the SRS as result of the phasing in of a new SRS sample during 1993–95. The period 1990–92 immediately precedes the sample changeover, whereas the period 1996–98 immediately follows the changeover. The urban sample of urban blocks was replaced in 1993, half of the rural sample of villages was replaced in 1994, and the other half of the rural sample of villages was replaced in 1995.

The increase in age misreporting that occurs as a result of sample changeover causes the age curve of fertility to be shifted more to the right. To see how the phasing in of the new sample during 1993–95 creates this additional bias, consider women age 15–19 in the SRS sample in 1993, just before the phasing in of the new sample. Some of these women were recent brides from outside the registration area

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[5]See footnote 3.

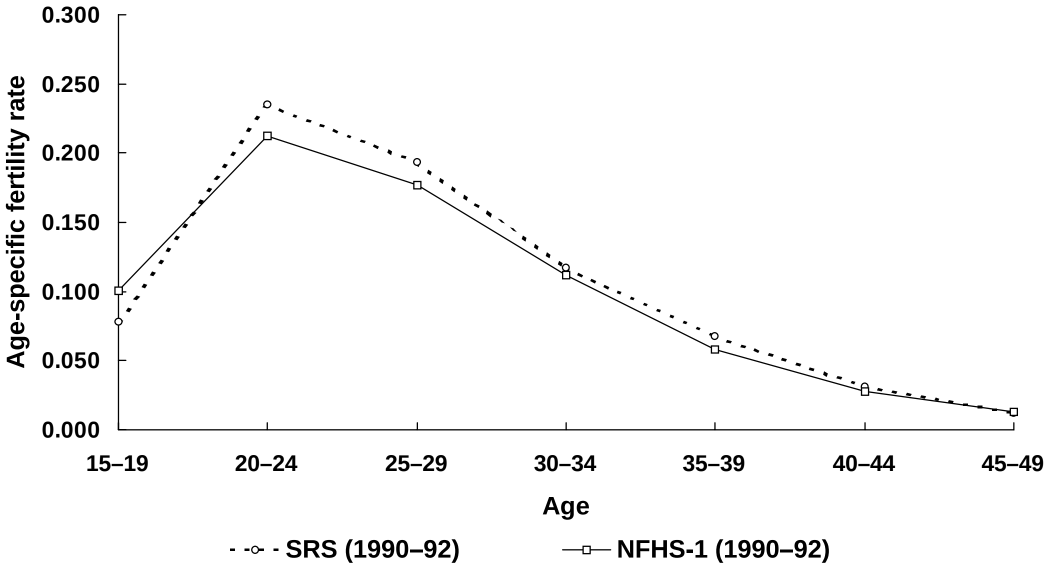

Figure 5a Age-specific fertility rates from the SRS (1990–92) and NFHS-1 (1990–92): India

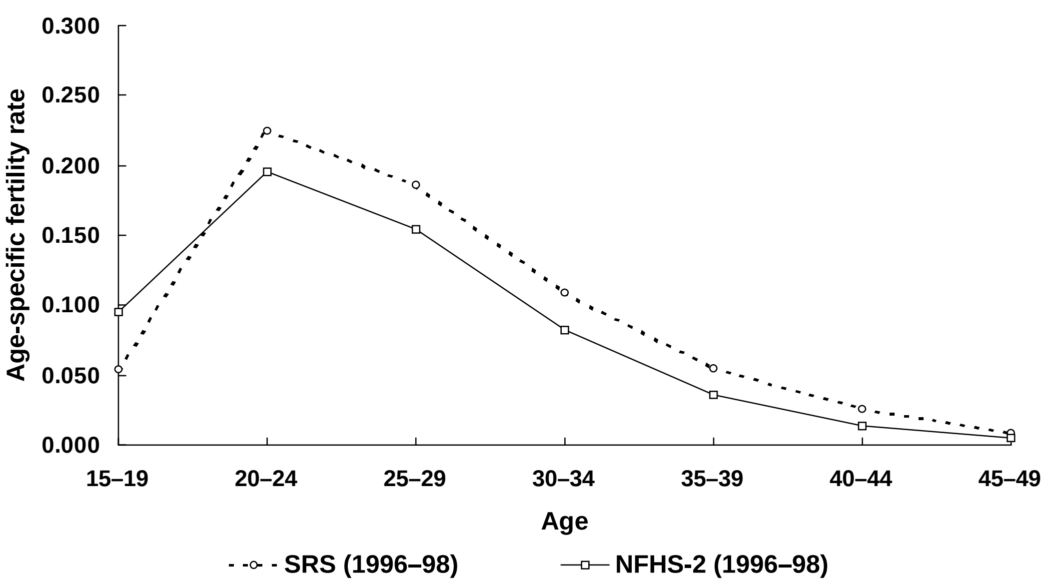

Figure 5b Age-specific fertility rates from the SRS (1996–98) and NFHS-2 (1996–98): India

(rural village or urban block) whose ages had to be estimated by the local part-time SRS enumerator when they moved into the registration area. Among these women, many who did not know their ages were undoubtedly shifted upward into the 20–24 age group by virtue of being married. Most other women age 15–19 in 1993, whether single or married, had resided in the registration area since 1983–85 and were enumerated in the age group 5–9 (approximately) in the baseline survey that was taken at the time of the 1983–85 sample changeover. In the 1983–85 baseline survey, no one in the 5–9 age group was shifted upward or downward by virtue of marital status because everyone was still single. In each subsequent year between 1984 and 1993, the local enumerator simply increased the ages of these girls, as initially ascertained in the baseline survey, by one year. By 1993, the single girls and some of the married girls in the registration area constituted a large group of young women age 15–19 whose ages had been recorded earlier and could not be shifted.

During 1993–95, the situation changed with the phasing in of a new sample. By 1996, all women age 15–19 were new in the sample. Their ages had just been determined by the new baseline survey, and all of those who were married—and especially those who were both married and had children—were at risk of being shifted upward in age. Since many (and in many areas of India, most) married women age 15–19 come from outside the village or urban block, however, the proportion at risk of being rounded up to 20–24 by virtue of being married may not have increased much during the 3-year changeover. Perhaps a more important factor is that the proportion of single women age 20–24 who were at risk of being shifted downward into the 15–19 age group increased greatly over the three years, the reason being that parents anxious to marry off older single daughters tend to minimize their age. No doubt both types of shifts occurred and help to explain the substantial decline in fertility at 15–19 and increases at 20–24 and older ages that occurred in the SRS between 1993 and 1996. It is also possible that underregistration of births temporarily increased with the phasing in of a new sample.

According to the SRS, between 1993 and 1996 the age-specific proportion currently married at age 15–19, or ASPM(15–19), fell from 29 to 27 percent,[6] ASFR(15–19) fell from 70 to 55 births per 1,000 women per year, and the age-specific marital fertility rate, or ASMFR(15–19), fell from 236 to 209 births per 1,000 currently married women per year in the country as a whole. If our reasoning is correct, the declines in ASFR(15–19) and ASMFR(15–19) in the SRS are partly spurious, especially the decline in ASMFR(15–19), which is probably entirely spurious, given that contraceptive use at 15–19 increased by only one percentage point, from 7 to 8 per-

[6]Proportions married from the SRS were calculated by dividing ASFR(15–19) from the SRS by ASMFR(15–19) from the SRS.

cent, between NFHS-1 and NFHS-2. Contrary to expectation, however, ASPM(15–19) did not decline much between 1993 and 1996 in the SRS, suggesting that downward shifting of 20–24-year-old single women to 15–19 is not an important mechanism.

If the reasoning about the effect of phasing in a new SRS sample is correct, one should see even steeper declines in SRS estimates of ASMFR(15–19) between 1993 and 1996 in India's high-fertility states, where the proportion of women who do not know their year of birth is even higher than in India as a whole. Retherford et al. (2001) report relevant findings for the states of Uttar Pradesh, Madhya Pradesh, Bihar, and Rajasthan. The SRS indicates that , between 1993 and 1996, ASMFR(15–19) fell from 214 to 161 births per 1,000 currently married women per year in Uttar Pradesh, from 256 to 228 in Madhya Pradesh, from 196 to 139 in Bihar, and from 212 to 136 in Rajasthan.[7] Yet, between 1992–93 and 1998–99, NFHS-1 and NFHS-2 indicate that the proportion of currently married women age 15–19 who were currently using contraception changed from 3 to 5 percent in Uttar Pradesh, from 7 to 5 percent in Madhya Pradesh, from 3 to 2 percent in Bihar, and from 2 to 4 percent in Rajasthan. The large but highly implausible declines in ASMFR(15–19) in all four states provide additional evidence for the argument that the large decline in ASFR(15–19) in the SRS for all India, as shown in Figures 4 and 5, is partly an artifact of the phasing in of a new SRS sample during 1993–95.

As in the case of all India, however, ASPM(15–19) did not fall as much as expected in these four states, except in Uttar Pradesh. Between 1993 and 1996, ASPM(15–19) fell from 34 to 25 percent in Uttar Pradesh, from 41 to 39 percent in Madhya Pradesh, from 39 to 37 percent in Bihar, and from 43 to 40 percent in Rajasthan. The large declines in ASMFR(15–19) together with the rather small declines in ASPM(15–19) suggest that the main effect of the SRS sample changeover, in terms of its effect on fertility, was to increase the likelihood of shifting 15–19-year-old married women with children into the 20–24 age group. As already mentioned, it is also possible that underregistration of births temporarily increased with the phasing in of a new sample.

To minimize bias from displacement of births and misreporting of women's ages in NFHS-1 and NFHS-2 and from the phasing in of a new SRS sample during 1993–95, Figure 6 shows the age curves of fertility for 15-year periods instead of 3-year periods before NFHS-1 and NFHS-2. Figure 6a compares SRS estimates of the age curve of fertility for 1978–92 and 1984–98. In contrast with Figure 4a, Figure 6a shows more fertility decline at the older ages than at the younger ages. Figure 6b, which compares the NFHS-1 estimate of the age curve of fertility for 1978–92 with

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[7]Marital fertility changed little between 1991 and 1993. Almost all of the decline in ASMFR(15–19) that occurred in these four states between 1991 and 1996 occurred between 1993 and 1996.

Figure 6a Age-specific fertility rates from the SRS for 1978–92 and 1984–98: India

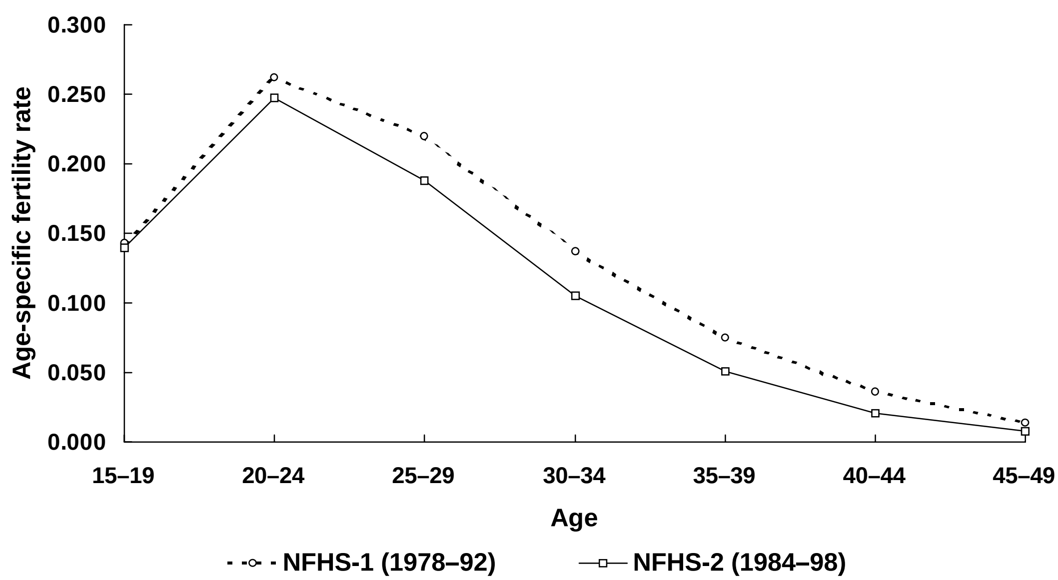

Figure 6b Age-specific fertility rates from NFHS-1 (1978–92) and NFHS-2 (1984–98): India

the NFHS-2 estimate of the age curve of fertility for 1984–98, shows a rather similar pattern, but with less fertility decline at 15–19 and more fertility decline at older ages. Overall, the two NFHS surveys indicate a larger overall fertility decline than does the SRS in Figure 6, again suggesting more omission of births in NFHS-2 than in NFHS-1 or some improvement in birth registration completeness in the SRS between 1978–92 and 1984–98.

Figure 7 depicts the same data as Figure 6 but arranged differently. Figure 7a compares the age curves of fertility for 1978–92 derived from the SRS and from NFHS-1, and Figure 7b compares the age curves of fertility for 1984–98 derived from the SRS and from NFHS-2. The NFHS curves are higher, relative to the SRS curves, in Figure 7 than in Figure 5, reflecting the smaller proportion of NFHS births displaced out of the 15-year estimation period used in Figure 7 than the 3-year estimation period used in Figure 5. The upward shift in Figure 7 is especially marked at age 15–19. Because of the near-elimination of displacement (displacement shifts the NFHS curves to the left), the NFHS curves are now more shifted to the right, at the same time that their overall levels are shifted upward. As in the SRS, the rightward shift in the two NFHS curves occurs because of a tendency to exaggerate the ages of women who are married and who have more than the number of children than is typical for their age and to reduce the ages of women who are single or who are married with fewer than the number of children than is typical for their age. Fifteen-year aggregations do not eliminate these latter sources of distortion.

The discrepancies in Figure 7 are especially large at age 15–19. In Figure 7b, the NFHS-2 estimate of ASFR(15–19) is again almost twice as high as the SRS estimate. The discrepancies in Figure 7b may be somewhat greater than in Figure 7a because the two extremes of the period 1984–98 in Figure 7b both occur either in the latter stages of an SRS sample changeover (1983–85) or right after an SRS sample changeover (1993–95), resulting in more age misreporting and therefore more shifting of the SRS curve of fertility to the right. The period 1978–92, in contrast, encompasses only one SRS sample changeover that occurred during 1983–85.

Figure 7 also clarifies why the 15-year GFR ratio is higher than the 15-year TFR ratio, as seen earlier. The GFR is a weighted sum of ASFRs, where the weights are the proportion of women age 15–49 falling in each 5-year age group within the 15–49 age range, whereas the TFR is an unweighted sum of ASFRs in which each ASFR is weighted equally. In the case of the GFR, the weight is larger at 15–19 than at older ages. At 15–19 the NFHS ASFR is higher than the SRS ASFR, whereas the reverse is true at older ages, as seen in Figure 7. Because of the difference in weighting, the 15-year GFR ratio (which is the ratio of the NFHS GFR to the SRS GFR) is higher than the corresponding 15-year TFR ratio.

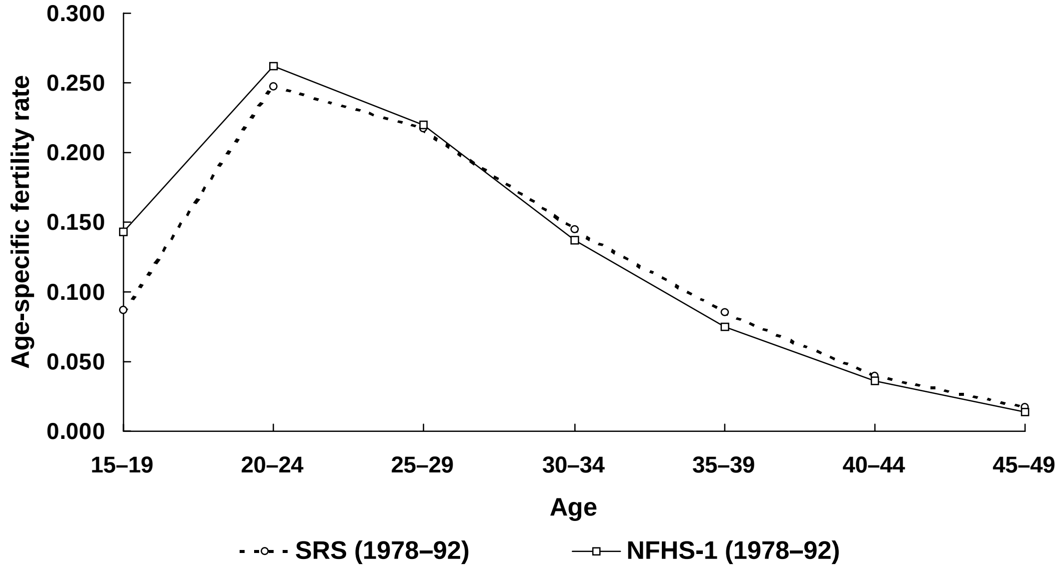

Figure 7a Age-specific fertility rates from the SRS (1978–92) and NFHS-1 (1978–92): India

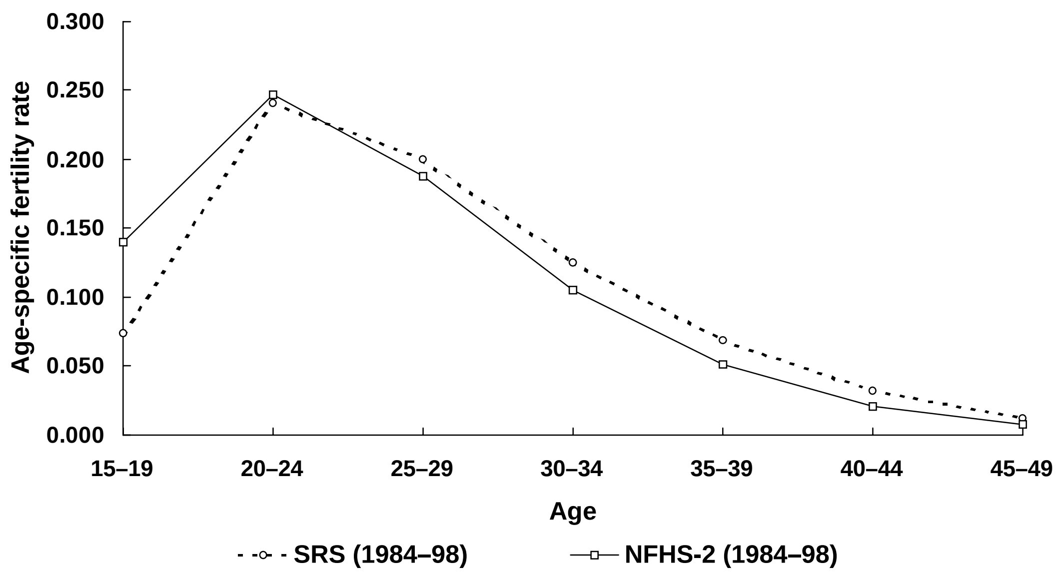

Figure 7b Age-specific fertility rates from the SRS (1984–98) and NFHS-2 (1984–98): India

Although the age pattern of fertility is substantially distorted by age misreporting in both NFHS surveys and in the SRS (although in different ways), the shifting of ages and the displacement of births should not make nearly so much difference in estimates of the TFR, because fertility is low at the lower and upper tails of the reproductive age range, so that very few births are shifted outside this range. Thus the shifted births get picked up one way or another when summing ASFRs over the entire reproductive age range when calculating to the TFR. We therefore consider the 15-year TFR estimates to be considerably more accurate than the 15-year ASFR estimates.

Despite some loose ends requiring further investigation, it is fairly clear that, because age misreporting did not change much at the all-India level between NFHS-1 and NFHS-2, 15-year-aggregated estimates from these two surveys probably provide a fairly accurate picture of how age-specific fertility changed in the country as a whole between the two surveys, even though the estimates of ASFRs for specific 5-year age groups in each survey are likely to be substantially biased by misreporting of women's ages and by displacement of births. The pattern of age-specific fertility change over the same period derived from the SRS, on the other hand, is substantially distorted by changes in the extent of age misreporting caused by the phasing in of a new SRS sample over the period 1993–95.

FERTILITY ESTIMATES FOR MAJOR STATES

Our analysis of fertility estimates is necessarily briefer for major states than for all India. Table 4 shows how values of Myers' Index of age heaping changed for major states between NFHS-1 and NFHS-2, with and without ever-married women's ages copied over from the individual questionnaire to the household questionnaire. Copying over ages reduces Myers' Index considerably, because the ages of ever-married women age 15–49 (13–49 in NFHS-1) were probed extensively in the individual interview but not in the household interview. Moreover, the ever-married woman herself reported her age in the individual interview, whereas in the household interview the household head (or other household respondent in the absence of the head) reported it on her behalf. As noted earlier, in all India Myers' Index changed little between the two surveys. The lack of change is to be expected, because there is little reason to believe that knowledge of age among respondents changed much in the approximately six years between the two surveys. In most individual states, however, Myers' Index differs between the two surveys. Large changes in Myers' Index—as in Uttar Pradesh (where Myers' Index doubled) and Andhra Pradesh (where it declined by half)—are due to differences between the two surveys in interviewer training and supervision relating to the recording of age in a context where most respondents do not know their age accurately.

Table 4 Myers' Index for females from NFHS-1 and NFHS-2: India and selected states

	With ages copied over from the individual questionnaire[a]		With ages taken from the household questionnaire	
India or state	NFHS-1	NFHS-2	NFHS-1	NFHS-2
India	10.4	10.0	18.0	18.4
Andhra Pradesh	14.2	6.9	25.5	10.0
Assam	10.0	13.5	27.8	28.1
Bihar	6.3	5.4	11.8	11.4
Gujarat	11.1	6.6	17.3	10.5
Haryana	9.4	11.1	27.4	25.1
Himachal Pradesh	9.9	8.1	19.8	18.5
Karnataka	7.1	10.6	11.3	19.0
Kerala	8.6	7.9	9.7	11.1
Madhya Pradesh	16.1	9.7	24.4	30.9
Maharashtra	8.8	7.6	14.5	14.4
Orissa	11.9	8.0	25.0	20.6
Punjab	11.3	10.1	25.4	20.9
Rajasthan	24.3	25.3	31.4	27.4
Tamil Nadu	8.1	5.0	11.1	5.3
Uttar Pradesh	7.5	15.3	16.3	31.8
West Bengal	10.7	12.9	16.9	16.3

[a]Ages 15–49 (13–49 for NFHS-1) for ever-married women are copied over from the individual (ever-married woman) file to the household file. The ages of all other women are from the household file. Myers' Index is calculated for all women age 10–69, irrespective of marital status.

It is also of interest to look at the proportions of women who know their year of birth. If women with inconsistent age and year of birth are counted as not knowing year of birth, the proportion knowing year of birth increases from 17 to 29 percent for all India (Table 5). The near-doubling of this proportion in only six years seems implausible, however. Although instructions on how to collect age data were the same in both surveys and in all states, it appears that the survey organizations (which in most states were not the same in the two surveys) did not always follow these instructions to the letter. According to the instructions, an age had to be entered by the interviewer, even if it required an educated guess. But this was not so with the earlier question on year of birth, which was supposed to be coded "don't know" if the woman did not know her year of birth. It is clear that in some states, such as Andhra Pradesh, where the proportion who know year of birth increased from 12 to 70 percent between the two surveys (from 13 to 100 percent, if one counts women with inconsistent age and year of birth as knowing year of birth), interviewers in NFHS-2 calculated year of birth from age and entered it when the woman could not initially provide a year of birth. Rajasthan shows a similar pattern. Kerala, on the other hand, shows the opposite pattern, where the proportion knowing year of birth declined between the two surveys, from 75 to 50 percent, which is even more implausible. These inconsistencies in responses to the question on year of birth probably do not affect the ulti-

Table 5 Percentage of ever-married women of reproductive age who know their year of birth in NFHS-1 and NFHS-2: India and selected states

	Women with inconsistent age and year of birth counted as knowing year of birth		Women with inconsistent age and year of birth counted as not knowing year of birth	
India or state	NFHS-1	NFHS-2	NFHS-1	NFHS-2
India	18.3	33.9	17.1	29.4
Andhra Pradesh	12.9	99.8	12.3	69.9
Assam	6.6	13.8	6.4	11.3
Bihar	8.8	7.3	8.5	6.8
Gujarat	21.5	27.3	20.8	25.7
Haryana	18.1	17.6	17.8	17.2
Himachal Pradesh	22.7	25.5	22.0	25.4
Karnataka	17.1	22.5	16.6	22.3
Kerala	80.4	50.9	75.4	49.5
Madhya Pradesh	14.6	13.0	12.5	12.7
Maharashtra	25.4	36.1	23.2	32.3
Orissa	6.7	11.0	6.6	11.0
Punjab	20.2	26.5	18.5	24.5
Rajasthan	23.6	99.2	20.7	85.4
Tamil Nadu	31.9	39.6	29.8	37.9
Uttar Pradesh	7.9	8.5	7.6	8.0
West Bengal	10.1	35.6	10.0	33.5

mate reporting of age, but they do illustrate how crucial interviewer training and supervision are in the collection of accurate information on year of birth.

Table 6 shows sex ratios at birth, which vary greatly by state. The boldfaced sex ratios pertaining to the 15-year period before each of the two NFHS surveys are of particular interest, because they minimize the distorting effect of sex differentials in displacement of births between successive 5-year periods before each survey. In NFHS-1, these 15-year sex ratios at birth range from 1.02 in Andhra Pradesh and Tamil Nadu to 1.15 in Punjab. In NFHS-2, they range from 1.04 in Tamil Nadu to 1.20 in Punjab. Sex ratios increased between the two surveys in every state except Karnataka, Madhya Pradesh, Orissa, and Rajasthan. The declines in Karnataka, Madhya Pradesh, and Rajasthan may reflect greater omission of births in NFHS-1 than in NFHS-2 in these states. In most states the sex ratio at birth did not increase or decrease much between the two surveys. However, it increased from 1.09 to 1.14 in Haryana, from 1.04 to 1.10 in Maharashtra, and from 1.15 to 1.20 in Punjab, perhaps reflecting increases in sex-selective abortion in these states. The sex ratio at birth increased from 1.01 to 1.06 in West Bengal, but the value of 1.06 is still close to the expected value of about 1.05 and is not abnormally high.

The state-level sex ratios at birth from the two NFHS surveys suggest that the rate of omission of births may differ between the two surveys, and that the extent of

Table 6 Sex ratio at birth from NFHS-1, NFHS-2, and the SRS: India and selected states

	NFHS-1				NFHS-2				SRS
India or state	1978–82	1983–87	1988–92	**1978–92**	1984–88	1989–93	1994–98	**1984–98**	1981–90
India	1.06	1.07	1.05	**1.06**	1.09	1.08	1.07	**1.08**	1.10
Andhra Pradesh	1.05	1.00	1.04	**1.02**	1.03	1.14	1.02	**1.07**	1.05
Assam	1.08	1.14	0.98	**1.07**	1.05	1.08	1.11	**1.08**	1.06
Bihar	1.08	1.02	1.03	**1.04**	1.02	1.06	1.06	**1.05**	1.12
Gujarat	1.13	1.03	1.02	**1.06**	1.09	1.05	1.06	**1.07**	1.11
Haryana	1.05	1.10	1.12	**1.09**	1.08	1.19	1.17	**1.14**	1.15
Himachal Pradesh	1.09	1.06	1.09	**1.08**	0.98	1.13	1.16	**1.09**	NA
Karnataka	1.02	1.08	1.06	**1.06**	1.06	1.06	1.04	**1.05**	1.07
Kerala	0.96	1.13	0.99	**1.03**	0.97	1.10	1.11	**1.05**	1.06
Madhya Pradesh	1.04	1.11	1.08	**1.08**	1.05	1.08	1.06	**1.06**	1.08
Maharashtra	1.03	1.04	1.07	**1.04**	1.17	1.02	1.10	**1.10**	1.09
Orissa	1.06	1.01	1.11	**1.06**	1.11	1.02	1.05	**1.06**	1.06
Punjab	1.10	1.19	1.16	**1.15**	1.20	1.23	1.16	**1.20**	1.13
Rajasthan	1.14	1.14	1.11	**1.13**	1.14	1.10	1.08	**1.10**	1.14
Tamil Nadu	0.99	1.11	0.96	**1.02**	1.04	1.04	1.05	**1.04**	1.05
Uttar Pradesh	1.08	1.10	1.05	**1.08**	1.16	1.10	1.04	**1.09**	1.12
West Bengal	1.02	0.96	1.05	**1.01**	1.08	1.02	1.08	**1.06**	1.06

Note: The sex ratio at birth is defined as the ratio of male births to female births. For all India, the 15-year aggregations pertain approximately to 1978–92 and 1984–98. Because the surveys were taken at different times in different states, these reference periods are offset by a year in some states.

differential omission varies by state. This is not surprising, given the number of different survey organizations involved in data collection in the two surveys. Because of the growth of sex-selective abortion between the two surveys, however, the trend in the sex ratio at birth between the two surveys is not necessarily a good indicator of the trend in omissions.

In the SRS for the period 1981–90 (the only period for which a sex ratio at birth is available from the SRS), the sex ratio at birth ranges from 1.05 in Andhra Pradesh and Tamil Nadu to 1.15 in Haryana. During this earlier period there was little or no sex-selective abortion, so that the high values of 1.11 in Gujarat, 1.12 in Bihar and Uttar Pradesh, 1.13 in Punjab, 1.14 in Rajasthan, and 1.15 in Haryana probably reflect underregistration of births that is greater for females than for males, reflecting the strong preference for sons in these states. (There may also have been some sex-selective infanticide that was undetected by the SRS, but it seems unlikely that it could account for such high sex ratios at birth.) Overall, the high state-level sex ratios at birth from the SRS suggest that underregistration of births in the SRS is substantial, that it varies considerably from state to state, and that in most states it exceeds the rate of omission of births in NFHS-1 and NFHS-2.

As mentioned earlier, we do not have any data on sex ratios at birth at more than one time point that would indicate how the extent of underregistration of births in the SRS has changed over time. However, several earlier studies based on SRS evaluation

Table 7 Unadjusted estimates of trend in the TFR from NFHS-1, NFHS-2, and the SRS: India and selected states

	NFHS-1 (own children)				NFHS-2 (own children)				SRS			
India or state	1978–82	1983–87	1988–92	**1978–92**	1984–88	1989–93	1994–98	**1984–98**	1978–82	1983–87	1988–92	1993–97
India	5.28	4.71	3.60	**4.44**	4.62	3.99	3.05	**3.81**	4.48	4.31	3.78	3.47
Andhra Pradesh	4.26	3.91	2.79	**3.57**	3.70	3.23	2.37	**3.04**	4.00	3.82	3.04	2.62
Assam	5.91	5.64	3.82	**4.99**	5.05	4.16	2.68	**3.81**	4.12	4.15	3.51	3.40
Bihar	6.11	5.72	4.17	**5.22**	5.90	5.54	3.81	**4.96**	5.65	5.48	4.86	4.50
Gujarat	4.79	4.05	3.04	**3.86**	3.83	3.30	2.78	**3.25**	4.52	3.89	3.34	3.10
Haryana	5.61	4.76	4.25	**4.79**	5.00	4.08	3.11	**3.97**	5.00	4.61	4.01	3.61
Himachal Pradesh	4.57	3.79	3.20	**3.78**	4.04	3.09	2.42	**3.11**	3.81	3.75	3.24	2.65
Karnataka	4.72	4.14	3.40	**4.00**	4.06	3.13	2.39	**3.10**	3.62	3.60	3.19	2.70
Kerala	3.50	2.56	2.19	**2.68**	2.77	2.06	2.02	**2.26**	2.93	2.36	1.89	1.78
Madhya Pradesh	5.98	5.43	3.96	**5.00**	5.60	5.03	3.66	**4.66**	4.79	5.06	4.62	4.13
Maharashtra	4.47	3.81	3.05	**3.70**	4.02	3.05	2.54	**3.13**	3.64	3.74	3.21	2.86
Orissa	5.01	4.57	2.97	**4.08**	4.22	3.80	2.73	**3.50**	4.24	4.10	3.47	3.17
Punjab	4.80	4.01	2.87	**3.79**	4.01	3.26	2.52	**3.19**	3.95	3.61	3.22	2.86
Rajasthan	6.29	5.80	3.93	**5.23**	5.38	5.10	4.02	**4.75**	5.28	5.37	4.58	4.37
Tamil Nadu	3.88	3.29	2.47	**3.15**	3.03	2.54	2.27	**2.58**	3.45	2.95	2.36	2.08
Uttar Pradesh	6.74	6.03	5.00	**5.84**	6.27	5.66	4.32	**5.30**	5.82	5.63	5.22	5.01
West Bengal	4.76	4.25	3.12	**3.95**	4.05	3.38	2.43	**3.20**	4.19	3.83	3.26	2.80

Note: For all India, the 15-year aggregations pertain approximately to 1978–92 and 1984–98. Because the surveys were taken at different times in different states, these reference periods are offset by a year in some states. In the SRS in Bihar and West Bengal, TFRs are not available for 1977, 1978, 1979, and 1980. In each of these two states, the 1981 SRS TFRs were used for 1977, 1978, 1979, and 1980. In the SRS in Himachal Pradesh, the estimate of the TFR is not available for 1990. In this case, the average of the 1989 and 1991 SRS TFRs was used for 1990. In cases where an SRS TFR for 1999 was needed, the SRS TFR for 1998 was used for 1999.

checks of subsamples of the SRS sample units indicate that birth registration in the SRS has improved over time. One study, based on the 1972 Fertility Survey conducted in a 25-percent subsample of the SRS, concluded that the SRS underregistered births in 1972 by about 8 percent (Mishra 1988; see also Registrar General, India 1976; 1983). Two subsequent studies concluded that the SRS underregistered births by 3.2 percent in 1980–81 and by 1.8 percent in 1985 (Registrar General, India 1984; 1988). The analysis in the present report suggests much higher levels of underregistration of births.

Table 7 shows state-level estimates of within-survey and between-survey trends in the TFR derived from the two NFHS surveys, as well as trends estimated by the SRS. In all states the within-survey declines in the TFR based on the trend over three 5-year time periods are steeper than the between-survey declines based on the trend over two 15-year time periods, reflecting displacement of births backward in time when 5-year periods from a single survey are used. In all states except Kerala and Tamil Nadu, the SRS estimate of the TFR for 1993–97 is substantially higher than the NFHS-2 estimate for 1994–98, reflecting displacement of births in NFHS-2 from 1994–98 to earlier years as well as some real decline in fertility between 1993–97 and 1994–98. The results for Kerala and Tamil Nadu suggest substantial underregistration of births in the SRS in these two states.

Table 8 Fifteen-year-aggregated NFHS-1/SRS and NFHS-2/SRS ratios of the GFR: India and selected states

	15-year GFRs for 1978–92			15-year GFRs for 1984–98		
India or state	NFHS-1	SRS	NFHS-1/SRS	NFHS-2	SRS	NFHS-2/SRS
India	147.85	133.62	1.107	131.53	122.54	1.073
Andhra Pradesh	124.79	120.77	1.033	108.97	103.21	1.056
Assam	171.86	128.18	1.341	136.94	121.30	1.129
Bihar	172.89	161.88	1.068	166.58	149.56	1.114
Gujarat	130.37	129.79	1.004	112.23	113.36	0.990
Haryana	164.25	151.10	1.087	140.53	136.55	1.029
Himachal Pradesh	125.29	121.27	1.033	105.31	105.35	1.000
Karnataka	135.76	114.35	1.187	110.35	103.24	1.069
Kerala	89.05	81.79	1.089	75.39	68.36	1.103
Madhya Pradesh	168.48	161.16	1.045	161.68	148.62	1.088
Maharashtra	129.29	114.94	1.125	115.95	105.70	1.097
Orissa	135.36	125.24	1.081	121.91	114.19	1.068
Punjab	129.99	117.38	1.107	109.27	106.44	1.027
Rajasthan	167.46	160.50	1.043	160.21	150.23	1.066
Tamil Nadu	105.43	98.35	1.072	88.78	80.41	1.104
Uttar Pradesh	185.34	169.13	1.096	175.25	160.73	1.090
West Bengal	133.18	126.22	1.055	113.96	105.42	1.081

Notes: For all India, the 15-year aggregations pertain approximately to 1978–92 and 1984–98. Because the surveys were taken at different times in different states, these reference periods are offset by a year in some states. In the SRS in Bihar and West Bengal, GFRs are not available for 1977, 1978, 1979, and 1980. In each of these two states, the 1981 SRS GFRs were used for 1977, 1978, 1979, and 1980 when calculating 15-year-aggregated GFRs from the SRS. In the SRS in Himachal Pradesh, an estimate of the GFR is not available for 1990. In this case, the average of the 1989 and 1991 SRS GFRs was used for 1990. In cases where an SRS GFR for 1999 was needed, the SRS GFR for 1998 was used for 1999.

Table 8 shows state-level 15-year-aggregated NFHS/SRS ratios of the GFR. The NFHS-1/SRS ratios of the GFR range from 1.00 in Gujarat to 1.34 in Assam. The NFHS-2/SRS ratios of the GFR range from 0.99 in Gujarat to 1.13 in Assam. As already explained, underregistration of births is more accurately reflected in the GFR ratios than in the TFR ratios. Rates of underregistration of births, derived from the GFR ratios, are shown in Table 9. The states of Gujarat and Himachal Pradesh stand out as states with very low GFR ratios and rates of underregistration in both surveys, and the states of Assam, Karnataka, Kerala, Maharashtra, Punjab, Tamil Nadu, and Uttar Pradesh are states with relatively high GFR ratios and rates of underregistration in at least one of the two surveys.

The GFR ratios in Table 8 and the derived estimates of underregistration in Table 9 assume that no births were missed in NFHS-1 and NFHS-2. Because the two surveys undoubtedly did miss some births, the estimates of underregistration of births in the SRS in Table 9 are probably underestimates. (In the case of Uttar Pradesh, the one state where there was a post-enumeration check in NFHS-2, it is estimated that 5 percent of births were missed, so that the estimate of underregistration of births for Uttar Pradesh in Table 9 is definitely an underestimate. See Retherford et al. (2001).)

Table 9 Estimates of underregistration of births in the SRS: India and selected states

India or state	Rate of underregistration for 1978–92	Rate of underregistration for 1984–98
India	0.09630	0.06838
Andhra Pradesh	0.03221	0.05292
Assam	0.25415	0.11423
Bihar	0.06369	0.10215
Gujarat	0.00442	-0.01006
Haryana	0.08004	0.02833
Himachal Pradesh	0.03205	-0.00047
Karnataka	0.15770	0.06445
Kerala	0.08149	0.09324
Madhya Pradesh	0.04349	0.08077
Maharashtra	0.11096	0.08837
Orissa	0.07470	0.06336
Punjab	0.09699	0.02585
Rajasthan	0.04161	0.06226
Tamil Nadu	0.06711	0.09426
Uttar Pradesh	0.08745	0.08283
West Bengal	0.05223	0.07496

Note: Rates of underregistration of births in the SRS are calculated from the GFR ratios in Table 8. The rates of underregistration for 1978–92 are calculated from the NFHS-1/SRS ratios, and the rates of underregistration for 1984–88 are cacluated from the NFHS-2/SRS ratios. Denoting a GFR ratio by *k*, the rate of underregistration is calculated as 1–1/*k*.

The pattern of variation by state in the NFHS/SRS ratios of the TFR in Table 10 is rather similar to the pattern for GFR ratios in Table 8, but the TFR ratios are usually somewhat lower than the GFR ratios, for reasons explained earlier. In Himachal Pradesh and Kerala, however, they are higher. The reason for this reversal is that, because of previous fertility decline, the proportion of women age 15–49 who are 15–19 is relatively low in Himachal Pradesh and Kerala, so that ASFR(15–19) is weighted relatively little compared with ASFR(20–24) and ASFR(25–29) in the calculation of the 15-year GFR ratio.

Table 11 shows state-level estimates of the TFR for 1990–92 and 1996–98 derived by various methods. The raw NFHS and SRS values are shown, as well as two sets of adjusted SRS estimates that use 15-year-aggregated TFR ratios in different ways, plus estimates derived from contraceptive prevalence rates using the international regression line discussed earlier. The contraceptive prevalence rates from NFHS-1 and NFHS-2 are shown in Table 12. In Table 11, Gujarat is the only state requiring no adjustment of the SRS TFRs, inasmuch as the TFR ratios for Gujarat are either one or slightly less than one and then reset to one. In all other states, the SRS estimates of the TFR have been adjusted upward to varying degrees, depending on the size of the TFR ratios in Table 10. In most cases the TFR estimates derived using the international regression line are higher than the other TFR estimates, but not always.

Table 10 Fifteen-year-aggregated NFHS-1/SRS and NFHS-2/SRS ratios of the TFR: India and selected states

	15-year TFRs for 1978–92			15-year TFRs for 1984–98		
India or state	NFHS-1	SRS	NFHS-1/SRS	NFHS-2	SRS	NFHS-2/SRS
India	4.438	4.159	1.067	3.807	3.732	1.020
Andhra Pradesh	3.572	3.670	0.973	3.037	3.020	1.006
Assam	4.991	3.897	1.281	3.809	3.574	1.066
Bihar	5.224	5.278	0.990	4.960	4.810	1.031
Gujarat	3.864	3.864	1.000	3.252	3.335	0.975
Haryana	4.790	4.491	1.067	3.968	3.925	1.011
Himachal Pradesh	3.780	3.576	1.057	3.110	3.056	1.018
Karnataka	3.998	3.448	1.160	3.101	3.037	1.021
Kerala	2.681	2.358	1.137	2.257	1.950	1.157
Madhya Pradesh	4.997	4.885	1.023	4.660	4.475	1.041
Maharashtra	3.696	3.508	1.054	3.130	3.155	0.992
Orissa	4.076	3.904	1.044	3.503	3.444	1.017
Punjab	3.788	3.494	1.084	3.188	3.104	1.027
Rajasthan	5.233	5.041	1.038	4.751	4.611	1.030
Tamil Nadu	3.151	2.991	1.053	2.576	2.354	1.095
Uttar Pradesh	5.838	5.529	1.056	5.300	5.174	1.024
West Bengal	3.955	3.804	1.040	3.202	3.136	1.021

Notes: For all India, the 15-year aggregations pertain approximately to 1978–92 and 1984–98. Because the surveys were taken at different times in different states, these reference periods are offset by a year in some states. In the SRS in Bihar and West Bengal, TFRs are not available for 1977, 1978, 1979, and 1980. In each of these two states, the 1981 SRS TFRs were used for 1977, 1978, 1979, and 1980 when calculating 15-year-aggregated TFRs from the SRS. In the SRS in Himachal Pradesh, an estimate of the TFR is not available for 1990. In this case, the average of the 1989 and 1991 SRS TFRs was used for 1990. In cases where an SRS TFR for 1999 was needed, the SRS TFR for 1998 was used for 1999.

It is of interest in this regard to compare TFR estimates in the last two columns of Table 11, based on the international regression line, with the previous two columns, in which the higher of the two TFR ratios (NFHS-1/SRS or NFHS-2/SRS) was used to adjust the SRS estimates for both 1990–92 and 1996–98. The two sets of estimates agree quite well for Assam, Himachal Pradesh, Madhya Pradesh, and West Bengal. The agreement is also fairly close in the case of Punjab. The two sets of estimates are quite different, however, for Andhra Pradesh, Bihar, Kerala, Orissa, Tamil Nadu, and for the country as a whole. In these cases, the TFRs derived from the international regression line are much higher than the TFRs obtained by using the higher of the two 15-year TFR ratios to adjust the SRS estimates. The reasons for this state-level variation are not clear. In the case of Assam, the results suggest high rates of omission of births, especially in NFHS-2.

In Andhra Pradesh and Gujarat, the raw NFHS-1 and NFHS-2 estimates are less than the corresponding SRS estimates for the 3-year period before each survey (because of displacement of births in the two NFHS surveys but not in the SRS), whereas the 15-year-aggregated TFR ratios are either exactly one or very close to one, indicating close agreement between each of the two NFHS surveys and the SRS when the effects of displacement are minimized.

Table 11 Estimates of the total fertility rate (TFR) for 1990–92 and 1996–98 derived by various methods: India and selected states

India or state	NFHS raw values[a]		SRS raw values		SRS TFRs adjusted upward by the two 15-year NFHS/SRS ratios of TFRs[d]		SRS TFRs adjusted upward by the higher of the two NFHS/SRS ratios of TFRs[e]		TFRs estimated from international regression line[f]	
	1990–92	1996–98	1990–92[b]	1996–98[c]	1990–92	1996–98	1990–92	1996–98	1990–92	1996–98
India	3.39	2.85	3.68	3.32	3.92	3.39	3.92	3.55	4.44	3.92
Andhra Pradesh	2.59	2.25	2.95	2.49	2.95	2.50	2.97	2.50	3.97	3.12
Assam	3.53	2.31	3.44	3.22	4.40	3.43	4.40	4.13	4.28	4.26
Bihar	4.00	3.49	4.61	4.38	4.61	4.51	4.75	4.51	5.67	5.58
Gujarat	2.99	2.72	3.23	3.00	3.23	3.00	3.23	3.00	3.84	3.16
Haryana	3.99	2.88	3.85	3.42	4.11	3.45	4.11	3.64	3.81	2.93
Himachal Pradesh	2.97	2.14	3.11	2.39	3.29	2.43	3.29	2.53	3.21	2.55
Karnataka	2.85	2.13	3.08	2.48	3.57	2.53	3.57	2.88	3.84	3.21
Kerala	2.00	1.96	1.81	1.83	2.05	2.12	2.09	2.12	2.86	2.83
Madhya Pradesh	3.90	3.31	4.58	3.98	4.68	4.14	4.76	4.14	4.72	4.19
Maharashtra	2.86	2.52	3.07	2.74	3.23	2.74	3.23	2.89	3.50	3.03
Orissa	2.92	2.46	3.32	3.03	3.46	3.08	3.46	3.17	4.75	4.02
Punjab	2.92	2.21	3.13	2.68	3.39	2.75	3.39	2.91	3.18	2.63
Rajasthan	3.63	3.77	4.56	4.17	4.73	4.30	4.73	4.33	5.06	4.47
Tamil Nadu	2.48	2.19	2.26	2.01	2.38	2.20	2.47	2.20	3.81	3.64
Uttar Pradesh	4.82	3.99	5.17	4.77	5.45[g]	4.88[g]	5.45[g]	5.03[g]	5.91	5.33
West Bengal	2.92	2.29	3.18	2.53	3.30	2.59	3.30	2.64	3.25	2.63

[a]Derived by the birth-history method. Estimates for 1990–92 are from the published NFHS-1 report for all India, and estimates for 1996–98 are from the published NFHS-2 report for all India.

[b]Simple average of published estimates of the TFR for 1990, 1991, and 1992.

[c]Simple average of published estimates of the TFR for 1996, 1997, and 1998.

[d]The 1990–92 SRS TFR is adjusted upward by the 15-year NFHS-1/SRS ratio of TFRs, and the 1996–98 SRS TFR is adjusted upward by the 15-year NFHS-2/SRS ratio of TFRs. However, if the adjustment factor is less than one, it is reset to one (i.e., no adjustment).

[e]The higher of the two 15-year NFHS/SRS ratios of TFRs is used to adjust the SRS TFRs for both 1990–92 and 1996–98.

[f]The equation of the international regression line is TFR = 7.2931 – 0.0700 CPR, where CPR denotes the contraceptive prevalence rate (the percentage of currently married women age 15–49 who are currently using any contraceptive method, including traditional methods).

[g]In an earlier study, when omission of births in NFHS-2 in Uttar Pradesh was taken into account (estimated from a post-enumeration survey that was conducted in Uttar Pradesh but not in other states), the TFR for Uttar Pradesh was estimated to be 5.55 in 1990–92 and 5.19 in 1996–98 (Retherford et al. 2001). This earlier study did not, however, use population weights to calculate the 15-year SRS TFR that was used in turn to calculate the 15-year NFHS-2/SRS ratio of TFRs. When weights are used, the corrected TFR estimates are still 5.55 for 1990–92 and 5.19 for 1996–98. Also in the earlier study, because SRS estimates of the TFR for 1998 were not yet available, the 1998 value of the TFR was assumed to be the same as the 1997 value when calculating the average 15-year SRS TFR for 1984–98. SRS estimates for 1998 have since become available. When, in addition to using weights, the actual SRS TFR for 1998 is used in the calculations, the corrected TFR estimates for Uttar Pradesh are 5.55 for 1990–92 and 5.18 for 1996–98. The estimates of 5.55 for 1990–92 and 5.18 for 1996–98, rather than any of the values shown in the body of Table 11 for Uttar Pradesh, are our best estimates for Uttar Pradesh.

Table 12 Contraceptive prevalence rates from NFHS-1 and NFHS-2: India and selected states

	Contraceptive prevalence rate	
India or state	**NFHS-1**	**NFHS-2**
India	41	48
Andhra Pradesh	47	60
Assam	43	43
Bihar	23	25
Gujarat	49	59
Haryana	50	62
Himachal Pradesh	58	68
Karnataka	49	58
Kerala	63	64
Madhya Pradesh	37	44
Maharashtra	54	61
Orissa	36	47
Punjab	59	67
Rajasthan	32	40
Tamil Nadu	50	52
Uttar Pradesh	20	28
West Bengal	58	67

Note: The contraceptive prevalence rate (CPR) is defined as the percentage of currently married women age 15–49 who are currently using any contraceptive method, includingtraditional methods. More exact (i.e., less rounded) estimates of the CPR than shown here were used to estimate the TFRs from the international regression line in Table 11.

It is also of interest to compare Uttar Pradesh, where Myers' Index doubled between the two surveys, and Andhra Pradesh, where Myers' Index was halved between the two surveys. In Uttar Pradesh, because of greater displacement in the second survey than in the first, the raw NFHS estimates show too great a fertility decline, compared with the SRS estimates. In Andhra Pradesh, because of less displacement in the second survey than in the first, the raw NFHS estimates show too small a fertility decline, compared with the SRS estimates. In each case, the SRS estimates provide a more accurate estimate of change over the six years between the two surveys, assuming that the rate of underregistration of births in the SRS did not change much in the approximately six years between the two surveys. We do not know, however, how much the phasing in of a new SRS sample during 1993–95 affected the rate of underregistration of births.

Figure 8 rounds out the picture by showing overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS, without any adjustments. The three sets of estimates are fairly consistent in the case of Andhra Pradesh, Gujarat, Haryana, Himachal Pradesh, Tamil Nadu, and West Bengal. Discrepancies are greatest in Assam, and other states are in between.

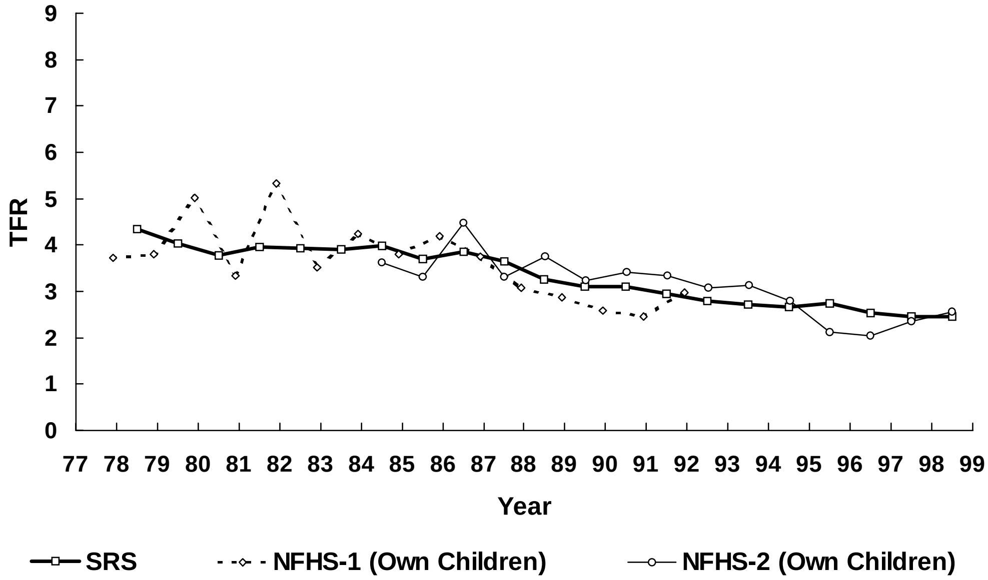

Figure 8a Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Andhra Pradesh

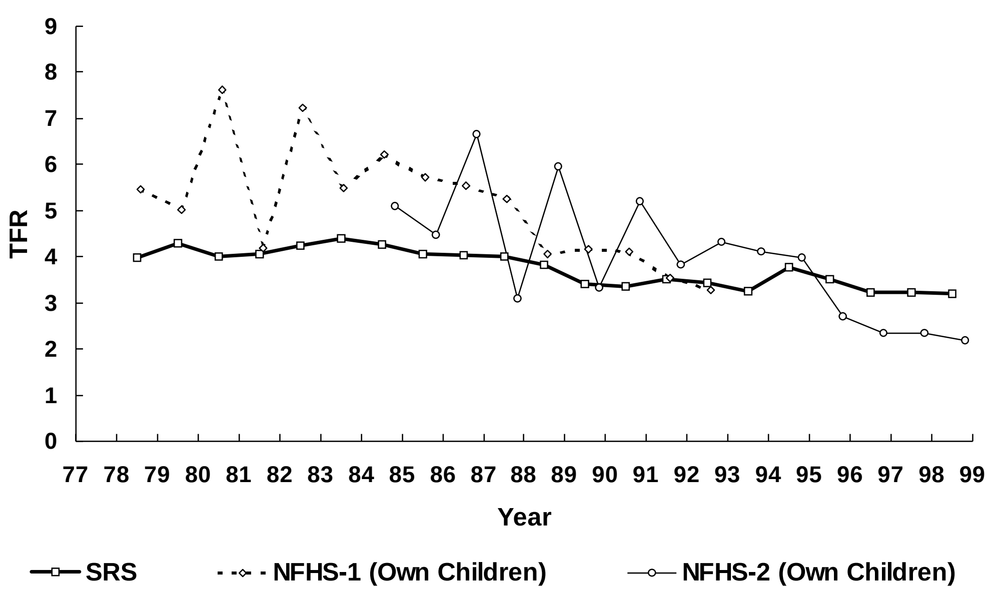

Figure 8b Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Assam

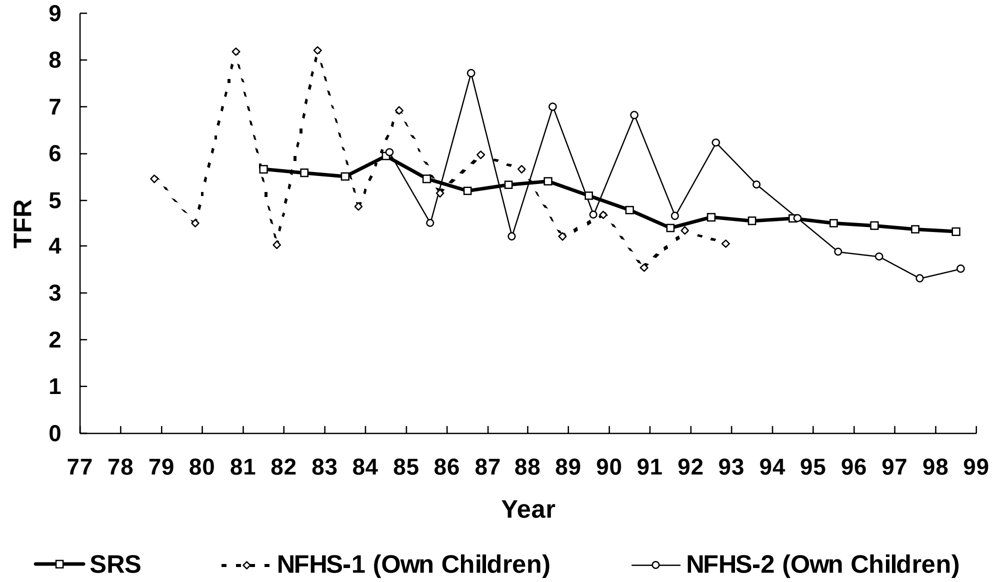

Figure 8c Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Bihar

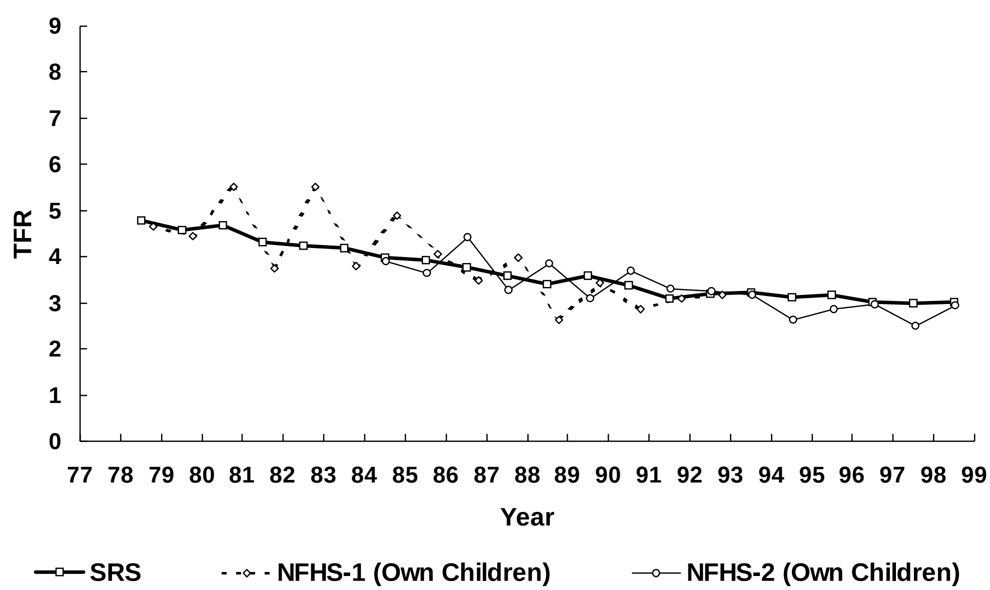

Figure 8d Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Gujarat

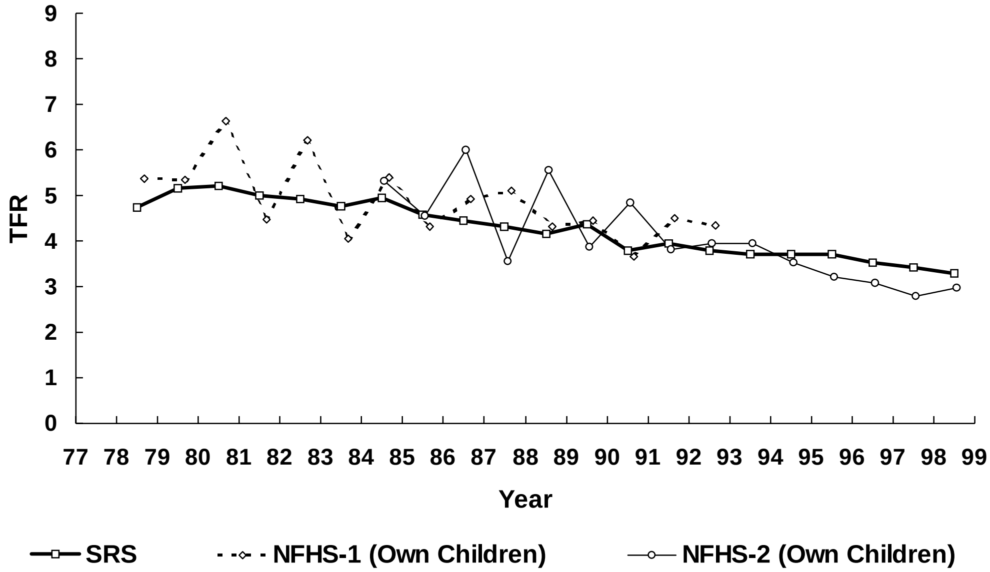

Figure 8e Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Haryana

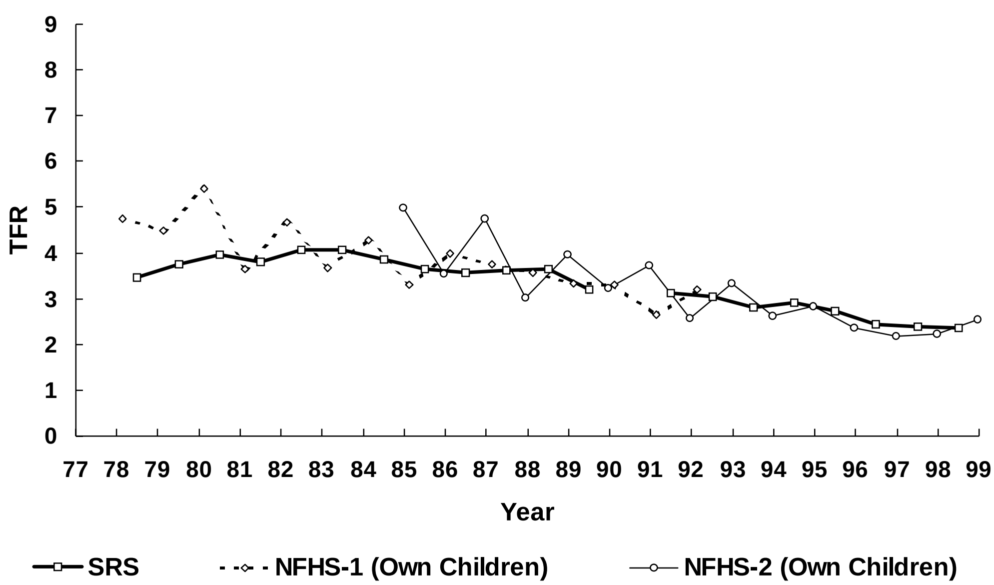

Figure 8f Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Himachal Pradesh

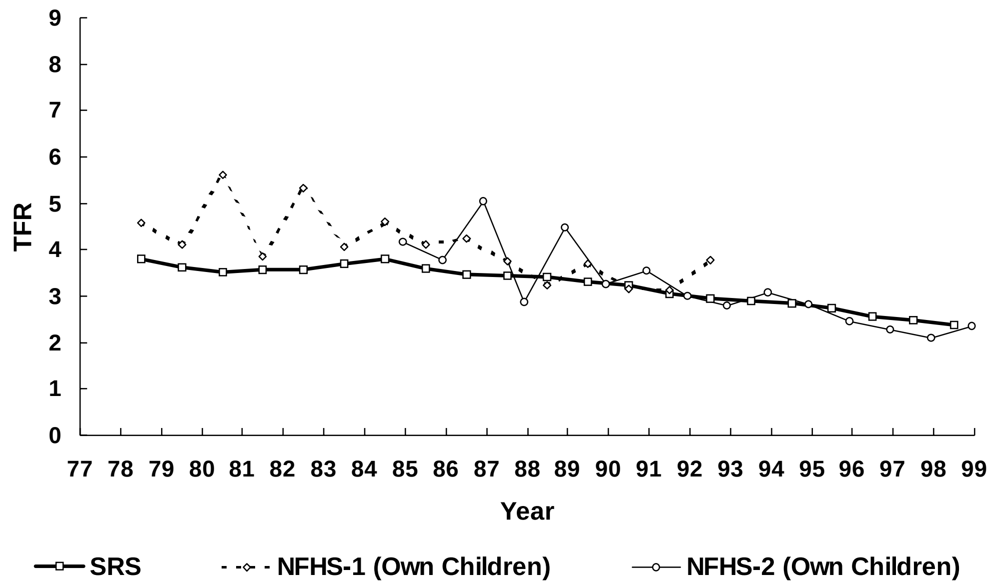

Figure 8g Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Karnataka

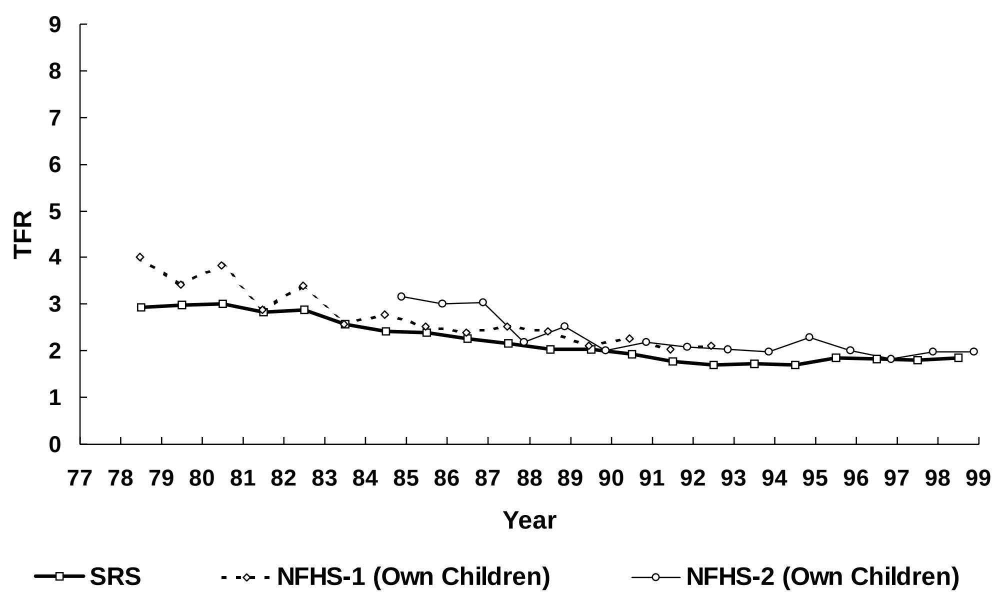

Figure 8h Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Kerala

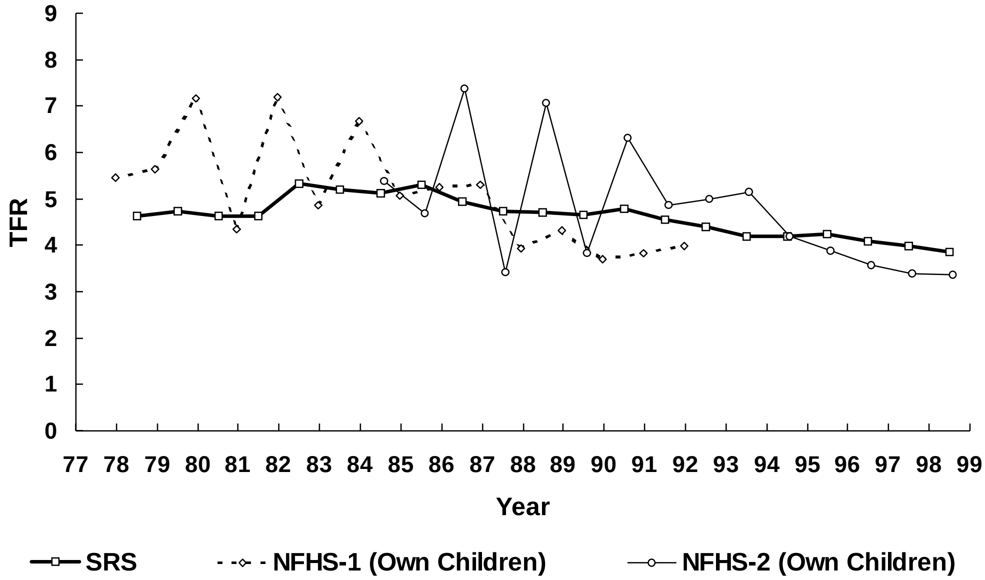

Figure 8i Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Madhya Pradesh

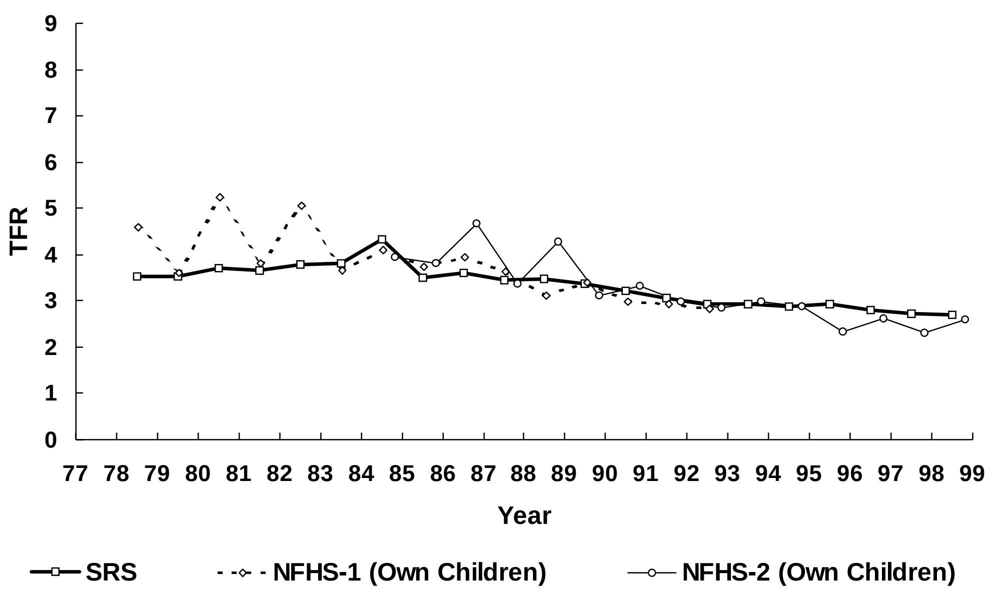

Figure 8j Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Maharashtra

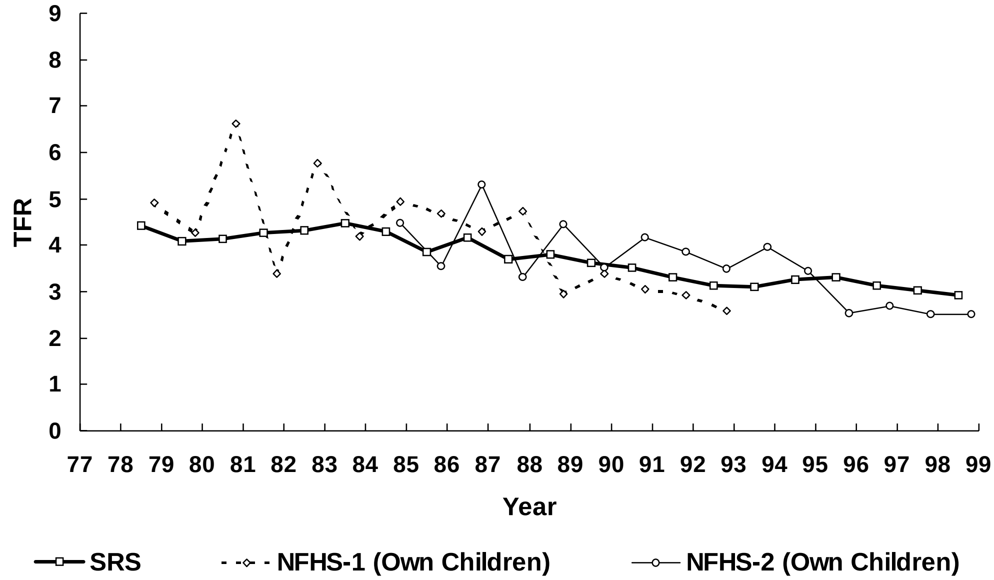

Figure 8k Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Orissa

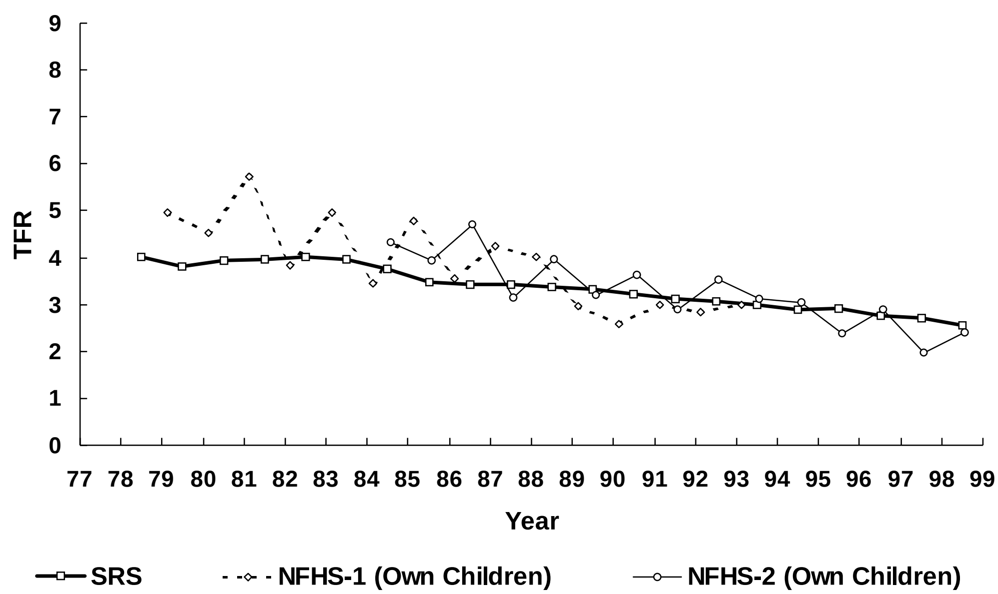

Figure 8l Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Punjab

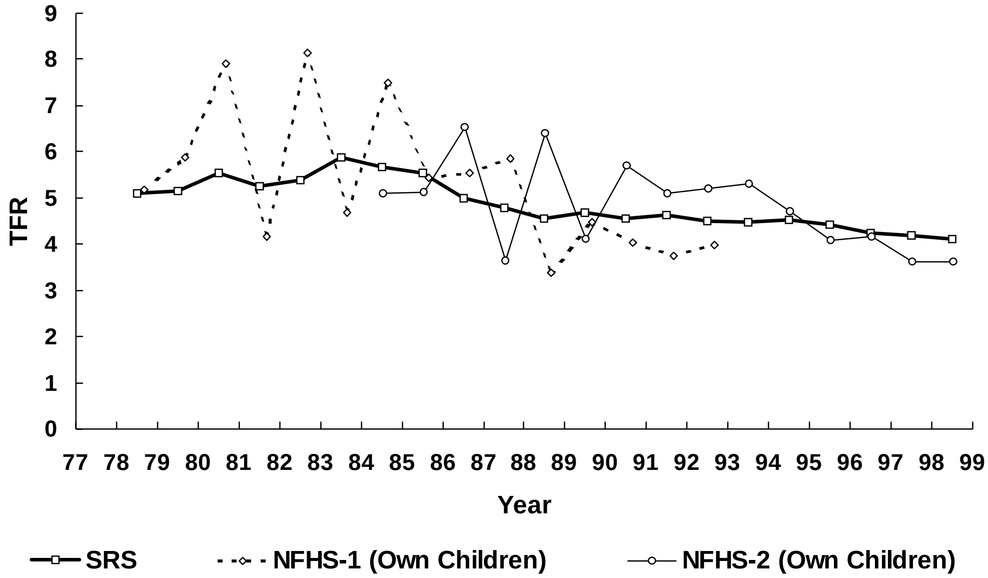

Figure 8m Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Rajasthan

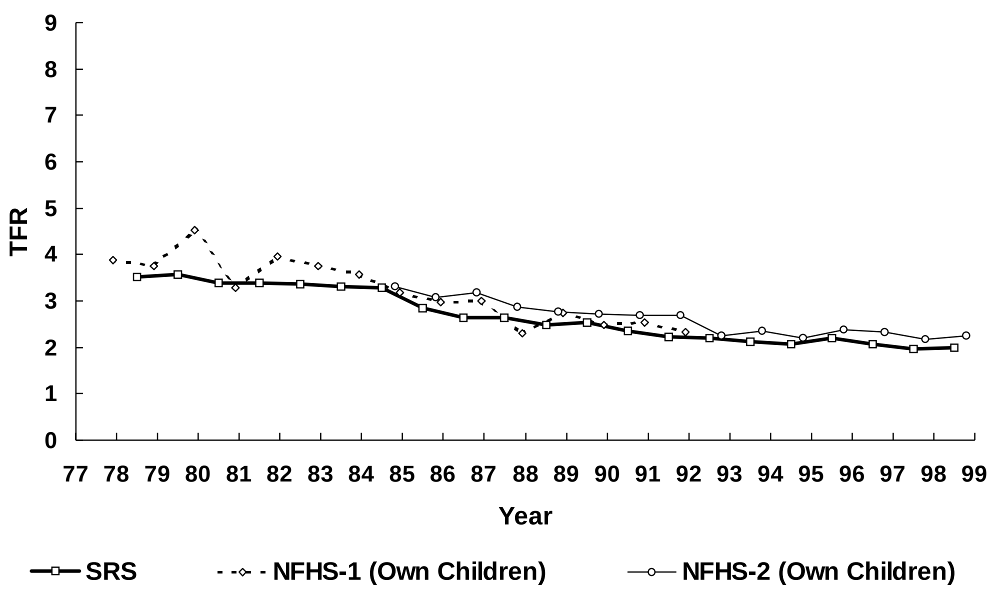

Figure 8n Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Tamil Nadu

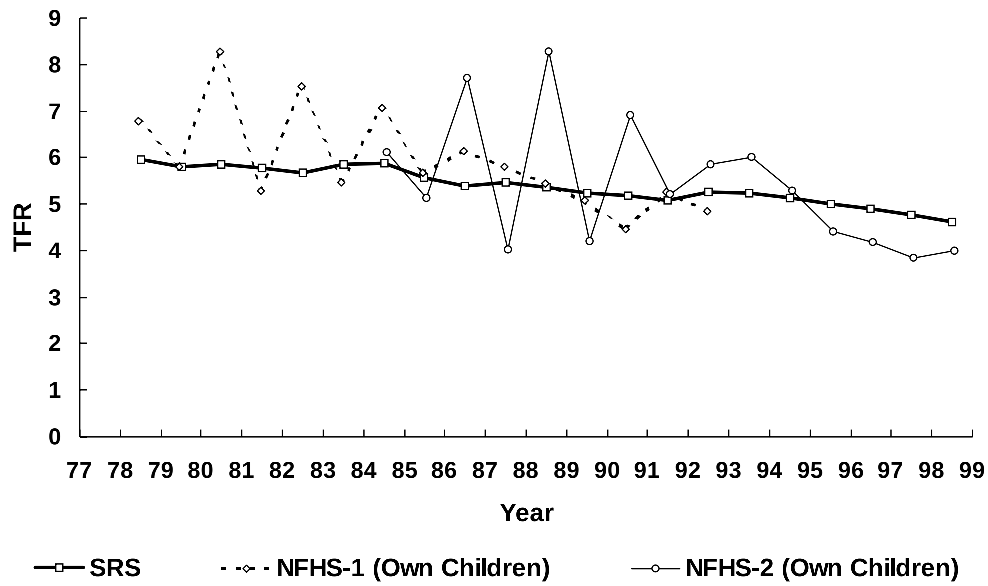

Figure 8o Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

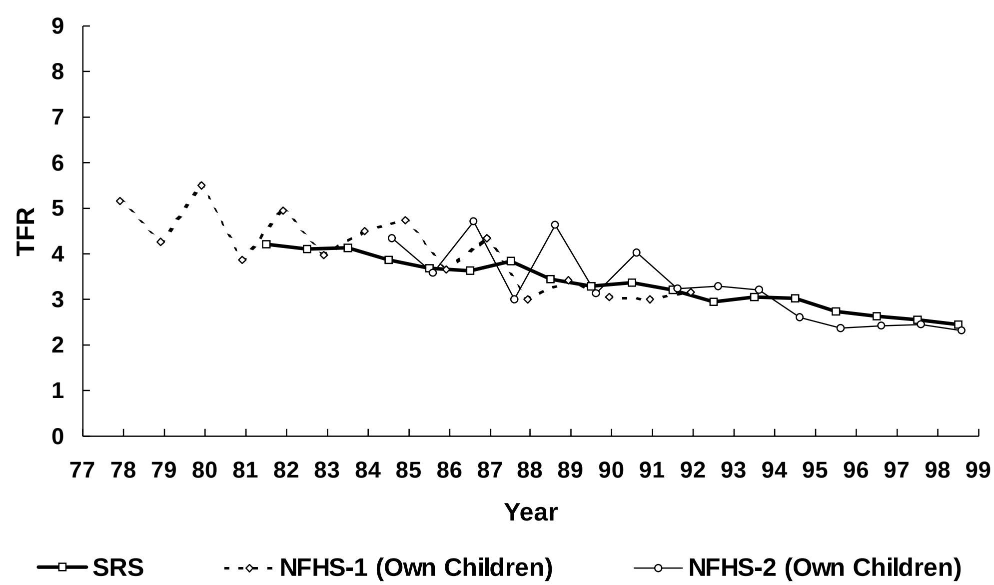

Figure 8p Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: West Bengal

CONCLUSION

The analysis indicates that, for all India, the true TFR for 1990–92 was probably around 3.92, and the true TFR for 1996–98 was probably between 3.39 and 3.55, somewhat higher than the raw SRS estimates and considerably higher than the raw NFHS-1 and NFHS-2 estimates for the same time periods. Even these new estimates may be a bit low, however, because we have no estimates of omitted births in NFHS-1 and NFHS-2, except for Uttar Pradesh in NFHS-2, where a post-enumeration survey indicated that about 5 percent of births were missed. The raw NFHS estimates are too low primarily because of displacement of births out of the 3-year period preceding each survey to earlier years, and the raw SRS estimates are too low because of underregistration of births. The extent of displacement in NFHS-1 and NFHS-2 and the extent of underregistration of births in the SRS vary considerably by state.

Because the extent of age misreporting did not change much between the two surveys in India as a whole, our estimates of change in age-specific fertility rates in all India, based on the own-children estimates of ASFRs from NFHS-1 and NFHS-2, are probably fairly accurate, even though the estimated levels of the ASFRs are biased. In most individual states, however, the extent of age misreporting changed enough between the two surveys that we are unable to arrive at accurate estimates of the age pattern of fertility change between the two surveys. In the case of the SRS, the age pattern of fertility change is distorted both at the national level and the state level by changes in the pattern of age misreporting caused by the phasing in of a new SRS sample during the period 1993–95.

The analysis also illustrates that the standard strategy in demographic and health surveys of providing TFR estimates for the 3-year period immediately preceding the survey does not work very well in India, where there is widespread ignorance of age, resulting in substantial displacement of births to earlier years and therefore to underestimation of the TFR for this 3-year period. The analysis also shows that application of the own-children method of fertility estimation to the household samples of DHS surveys can usefully supplement the usual birth-history approach and contribute to deriving more accurate fertility estimates. For such analyses, the ages of ever-married women in the individual sample should be copied over to the household sample. This was done in NFHS-1 but not in NFHS-2, and it is generally not done in demographic and health surveys in other countries.

Attainment of the goal of more accurate fertility estimates from the SRS would be greatly enhanced if the Sample Registration System would publish single-year age-sex distributions of the SRS sample as well as sex ratios at birth on an annual basis. Such information would be useful for demographic analyses of quality of data and bias in fertility estimates derived from the SRS.

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REFERENCES

Cho, L.-J., R. D. Retherford, and M. K. Choe. 1986. *The Own-Children Method of Fertility Estimation.* An East-West Center Book. Honolulu: East-West Center.

IIPS (International Institute for Population Sciences). 1995. *National Family Health Survey (MCH and Family Planning): India, 1992-93*. Bombay: International Institute for Population Sciences.

IIPS (International Institute for Population Sciences) and ORC Macro. 2000. *National Family Health Survey (NFHS-2): India*. Mumbai: IIPS.

Keyfitz, N., and W. Flieger. 1968. *World Population: An Analysis of Vital Data.* Chicago: University of Chicago Press.

Mishra, V. K. 1988. *India's stagnated birth rate: A matter of serious concern*. Unpublished paper. Delhi: Institute of Economic Growth.

Narasimhan, R. L., R. D. Retherford, V. Mishra, F. Arnold, and T. K. Roy. 1997. *Comparison of Fertility Estimates from India's Sample Registration System and National Family Health Survey*. National Family Health Survey Subject Reports No. 4. Mumbai: International Institute for Population Sciences. Honolulu: East-West Center.

Registrar General, India. Various years. Sample Registration System annual reports. New Delhi: Office of the Registrar General.

Registrar General, India. 1976. *Fertility Differentials in India, 1972: Results of the Fertility Survey in a Sub-sample of SRS (1972)*. New Delhi: Office of the Registrar General.

Registrar General, India. 1983. *Sample Registration System, 1976–78*. New Delhi: Office of the Registrar General.

Registrar General, India. 1984. *Report on the Intensive Enquiry Conducted in a Sub-sample of Sample Registration System Units (1980–81)*. Occasional Paper No. 2 of 1983. New Delhi: Office of the Registrar General.

Registrar General, India. 1986. *SRS Based Abridged Life-Tables 1976–80*. Occasional Paper No. 1 of 1985. New Delhi: Office of the Registrar General.

Registrar General, India. 1988. *Report on the Intensive Enquiry Conducted in a*

Sub-sample of Sample Registration System Units (1985). Occasional Paper No. 1 of 1988. New Delhi: Office of the Registrar General.

Registrar General, India. 1990. *SRS Based Abridged Life-Tables 1981–85*. Occasional Paper No. 1 of 1989. New Delhi: Office of the Registrar General.

Registrar General, India. 1995. *SRS Based Abridged Life-Tables 1988-92*. Occasional Paper No. 4 of 1995. New Delhi: Office of the Registrar General.

Registrar General, India. 1998. *SRS Based Abridged Life Tables 1990–94 and 1991–95*. SRS Analytical Studies Report No. 1 of 1998. New Delhi: Office of the Registrar General.

Registrar General, India. 1996. *Report of the Technical Group on Population Projections*. New Delhi: Office of the Registrar General.

Registrar General, India. 1999. *Compendium of India's Fertility and Mortality Indicators, 1971–1997: Based on the Sample Registration System (SRS)*. New Delhi: Office of the Registrar General.

Retherford, R. D., and M. Mirza. 1982. Evidence of age exaggeration in demographic estimates for Pakistan. *Population Studies* 36: 257–70.

Retherford, R. D., V. K. Mishra, and G. Prakasam. 2001. *How Much Has Fertility Declined in Uttar Pradesh?* National Family Health Survey Subject Reports, No. 17. Mumbai: International Institute for Population Sciences; Honolulu: East-West Center.

Retherford, R. D., and S. Thapa. 2000. The trend of fertility in Nepal, 1961-95. *Genus* 55: 61–98.

Shryock, H. S., and J. S. Siegel. 1973. *The Methods and Materials of Demography.* 2 volumes. Washington, D. C.: U. S. Bureau of the Census.