How Much Has Fertility Declined in Uttar Pradesh?

Robert D. Retherford, Vinod K. Mishra,
and G. Prakasam

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International Institute for Population Sciences
Mumbai, India

East-West Center, Population and Health Studies
Honolulu, Hawaii, U.S.A.

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 (USAID) provided funding for the NFHS, and United Nations Population Fund (UNFPA) provided support for the preparation and publication of this report.

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Correspondence addresses:
International Institute for Population Sciences
Govandi Station Road, Deonar, Mumbai - 400 088, India
Fax: 91-22-556-3257 • E-mail: iips.nfhs@axcess.net.in

East-West Center, Population and Health Studies
1601 East-West Road, Honolulu, Hawaii 96848-1601, U.S.A.
Fax: 1-808-944-7490 • E-mail: poppubs@eastwestcenter.org

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Abstract. *Based on a demographic analysis of fertility estimates from India's first and second National Family Health Surveys (NFHS-1 and NFHS-2), conducted in 1992–93 and 1998–99, and India's Sample Registration System (SRS), this report attempts to provide accurate estimates of fertility levels and trends in the state of Uttar Pradesh. The primary measure of fertility used in this analysis is the total fertility rate (TFR), which indicates the average number of children a woman would bear throughout her life at current age-specific fertility rates.*

According to the NFHS-2 report for Uttar Pradesh, a substantial decline in fertility occurred in the state during the six years between NFHS-1 and NFHS-2. Unadjusted estimates for the 3-year period preceding each survey indicate that the TFR declined from 4.82 children per woman in 1990–92 to 3.99 in 1996–98. Because there was greater displacement and omission of births in Uttar Pradesh in NFHS-2 than in NFHS-1, however, the unadjusted trend in the total fertility rate (TFR) estimated from the two surveys is too steeply downward. The trend estimated from the SRS, on the other hand, suffers from underregistration of births.

Correction for displacement and omission of births in NFHS-1 and NFHS-2 and underregistration of births in the SRS yields a 'best estimate' of the trend in the TFR in Uttar Pradesh that is described by the line, TFR = 11.0639 – .0603 t, where t denotes time measured in years since 1900. This line implies that the TFR in Uttar Pradesh fell from 5.55 in 1991 (the midpoint of the three-year period before NFHS-1) to 5.19 in 1997 (the midpoint of the three-year period before NFHS-2), a decline of about 0.4 child during the six years between the two surveys.

Estimates of changes in age-specific fertility rates (ASFRs) for 5-year age groups of women in Uttar Pradesh, as derived from NFHS-1 and NFHS-2, are severely distorted by differences between the two surveys in the extent of displacement of births. Estimates of changes in ASFRs derived from the SRS are also severely distorted, primarily because a new SRS sample was introduced in 1993–95. Because of these problems, neither data source yields accurate estimates of trends in age-specific fertility rates. On the other hand, we have a good deal of confidence in our final estimates of TFR, which are not much affected by misreporting of women's ages or displacement of births to earlier years.

Robert D. Retherford, Vinod K. Mishra, and G. Prakasam

Robert D. Retherford is Coordinator, and Vinod K. Mishra is a Fellow in Population and Health Studies at the East-West Center. G. Prakasam is Joint Director and State Demographer, Directorate of Health and Family Welfare Services, Karnataka, India.

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Assessment of the true trend of fertility in India has significant policy and programme implications. This is because the fertility trend is an important indicator of the degree of success of the government's family planning programme. Fertility estimates for the state of Uttar Pradesh are of particular interest because Uttar Pradesh has the largest population and the highest fertility of any Indian state. The population of Uttar Pradesh exceeds 160 million, and according to India's Sample Registration System (SRS), the state's total fertility rate (TFR—the average number of children a woman would bear throughout her life at current age-specific fertility rates) is about five children per woman. The Indian government, with support from the United States Agency for International Development (USAID), has a large project in Uttar Pradesh, called the Innovations in Family Planning Services (IFPS) project, aimed at bringing about a substantial fertility reduction.

Since the mid-1990s, the Ministry of Health and Family Welfare has been relying increasingly on the country's National Family Health Surveys (NFHS) to monitor and evaluate the success of its family planning and reproductive and child health programmes, both nationwide and in individual states, including Uttar Pradesh (MOHFW 1999). The first such survey (NFHS-1) was conducted in 1992–93, and the second (NFHS-2) was conducted six years later in 1998–99. The basic NFHS-1 and NFHS-2 reports provide fertility estimates for the 3-year period before each survey. This time period represents a compromise between the need to aggregate over calendar years in order to reduce bias due to displacement of births to earlier years and the need to obtain timely estimates close to the survey date.

As shown in Table 1, NFHS-1 estimated that the total fertility rate (TFR) in Uttar Pradesh was 4.82 children per woman in 1990–92, and NFHS-2 estimated that it was 3.99 in 1996–98, indicating a decline of 0.8 child between the two surveys. Comparable TFR estimates from the SRS, however, are higher than those from NFHS-1 and NFHS-2, and they indicate a much slower rate of fertility decline. The SRS

Table 1 Comparison of total fertility rate estimates from NFHS-1, NFHS-2, and the Sample Registration System (SRS), Uttar Pradesh

	1990–92	1996–98	(1996–98) – (1990–92)	(1996–98)/(1990–92)
NFHS	4.82	3.99	-0.83	0.83
SRS	5.17	4.78[a]	-0.39	0.93
NFHS/SRS	0.93	0.84	NA	NA

Sources: PRC Lucknow and IIPS (1994) 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 from NFHS-1, and NFHS estimates for 1996–98 are from NFHS-2. The SRS values are simple averages of annual estimates published by the SRS.

NA: Not applicable.

[a]Pertains to 1997. It was not possible to compute the average for 1996–98 because TFR estimates for 1998 were not available from the SRS at the time of writing.

estimates that the TFR in the state fell from 5.17 in 1990–92 to 4.78 in 1997, a decline of only 0.4 child. As shown in the last line of Table 1, the NFHS-1 estimate of the TFR for 1990–92 is 7 percent lower than the comparable SRS estimate, and the NFHS-2 estimate of the TFR for 1996–98 is 16 percent lower than the comparable SRS estimate.

The preliminary NFHS-2 report for Uttar Pradesh (ACNielsen and IIPS 1999) indicated that NFHS fertility estimates might be biased and promised an evaluation of their accuracy in a subsequent report. This Subject Report provides the promised evaluation. The objective is to analyze the discrepancies between the different sets of estimates in order to arrive at a more accurate assessment of true fertility levels and the true fertility trend in the state. The final set of fertility estimates presented here also uses information from the SRS. The analytical approach borrows considerably from earlier studies by Narasimhan et al. (1997) and Retherford and Thapa (2000).

DATA SOURCES

National Family Health Surveys

India's first National Family Health Survey (NFHS-1) was conducted during 1992-93. NFHS-1 is a nationally representative survey that includes both a household sample, covering everyone in the sampled households, and an individual sample, covering all ever-married women age 13–49 within those households. Corresponding to these two samples are a household questionnaire and an individual questionnaire. For the household questionnaire, the household head or any other knowledgeable adult in the household responded for the entire household. For the individual questionnaire, each ever-married woman between the ages of 13 and 49 responded for herself.

NFHS-1 used *de facto* samples, meaning that all persons who slept in the household during the night before the interview were included—both visitors and regular household members. Questions cover a range of topics in the areas of fertility, family planning, and maternal and child health. Within NFHS-1, the Uttar Pradesh sample comprises 11,438 completed interviews of ever-married women in 10,110 households for which a household questionnaire was completed.

The basic design of the second National Family Health Survey (NFHS-2), conducted in 1998–99, is similar to the design of NFHS-1 except that the individual sample in NFHS-2 includes ever-married women age 15–49 instead of 13–49. Within NFHS-2, the Uttar Pradesh sample comprises 9,292 completed interviews of ever-married women in 8,682 households.

Both NFHS-1 and NFHS-2 were designed to provide not only national estimates but also state-level estimates. In some states the sample was self-weighting, and in others it was weighted. A weighted sample design was used for Uttar Pradesh in both surveys, and the results reported here are based on the weighted data. The two survey reports for Uttar Pradesh (PRC Lucknow and IIPS 1994; IIPS and ORC Macro 2001) provide further details on the sample design.

Sample Registration System (SRS)

In the absence of a complete and reliable civil registration system in India, the Office of the Registrar General established a Sample Registration System (SRS) in 1964–65 on a pilot basis. This was expanded into a full-scale system in 1969–70. Since the early 1970s, the Sample Registration System has been the authoritative source of fertility estimates for the country.

The SRS is in essence a demographic sample survey that provides national and state-level estimates of fertility and mortality on an annual basis. The system includes both continuous registration and six-monthly surveys to catch missed events. It is based on a nationally representative sample of villages and urban blocks. The sampling unit in rural areas is an entire village or a 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 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 SRS sample for Uttar Pradesh includes 650 sampling units (450 rural and 200 urban), comprising about 650,000 population.

Estimates of fertility from the SRS are derived by a dual-record method. To understand how this method works, it is useful to consider the following basic characteristics of the SRS (Narasimhan et al. 1997):

- There is a local part-time enumerator for each sample unit.
- When a unit is first included in the system, staff from the state or district census directorate conduct a baseline survey with assistance from the local part-time enumerator. The baseline survey is a complete census of the sample unit. In principle all baseline surveys take place on 1 January, but in practice most baseline surveys take place in January or February, and a few take place in March. Household informants are asked to provide the ages of household members as of 1 January, even if the baseline survey is taken later. Ages in the household register are subsequently updated once a year on 1 January.
- The local part-time enumerator is responsible for continuous enumeration of births and deaths as they occur in the sample unit. In the case of births, the recorded age of the mother at childbirth is her age as of the last update on 1 January.
- Every six months, a full-time supervisor from state or district headquarters takes an independent survey to record births and deaths in the previous six months. These surveys are scheduled for 1 January and 1 July. At the time of the half-yearly

surveys, the supervisor also updates the house listing in the sample unit and the household registers.

- Age is recorded in the half-yearly surveys, but the procedure is simply to transfer updated ages from the household register to the survey schedule. When conducting the half-yearly survey at the beginning of the year, the supervisor updates the ages of all household members in the household register by adding one year as of 1 January (Registrar General, India 1998b; Deputy Registrar General S. K. Sinha, personal communication). Ages are not updated during the midyear survey.
- After a half-yearly survey, all births and deaths from the two sources (the continuous register and the half-yearly survey) are matched at state or district headquarters using information on house number, name of household head, name of mother (for births), name of deceased (for deaths), residence status of all household members (usual resident present, usual resident absent, in-migrant present, in-migrant absent, visitor), and month of occurrence and sex of the birth or death. All unmatched and partially matched events are verified in the field by a third person or by the supervisor and enumerator together, and a final list of births and deaths is prepared.
- Crude birth rates are calculated by pooling births from the final list of births for two half-yearly surveys covering January–December and dividing this estimated number of births by the estimated midyear population as obtained from the updated household registers. Crude death rates, age-specific fertility rates, and age-specific mortality rates are calculated similarly.
- The half-yearly survey collects information about births and deaths occurring to visitors as well as usual residents, but the information on visitors is not used in the calculation of fertility and mortality rates.

DATA QUALITY

National Family Health Surveys

Interview completion rates provide a useful first assessment of the quality of any survey data. Household interviews were completed for 96 percent of the households selected for the survey sample in NFHS-1 and for 90 percent in NFHS-2. Within households with completed household interviews, individual interviews were completed for 97 percent of eligible women in NFHS-1 and for 93 percent of women in NFHS-2. The number of eligible women with completed interviews per household declined from 1.13 to 1.07 between the two surveys. This decline is not explained by any change in the total number of eligible women per household, which went down marginally from 1.16 to 1.15, but rather by a decline in the proportion of eligible women for whom interviews were completed.

The relatively low completion rates in NFHS-2 are consistent with other evidence that the consulting organization hired to do the fieldwork in Uttar Pradesh cut short the number of days allotted to complete interviews in the primary sampling units (a village, a segment of a village, or an urban block) in order to conserve funds, with the result that interviewers often did not have enough time to complete their assignments, especially for callbacks in instances where a household informant or an eligible woman within the household was not at home the first time the interviewer visited the household (IIPS 1999).

Noncompletion rates would not bias fertility estimates if they were random. It is possible, however, that field staff trying to maximize the number of completed interviews would be more likely to leave out eligible women with larger numbers of children. This kind of selective noncompletion would bias fertility estimates downward.

The correct estimation of fertility from survey data requires accurate reporting of the ages of women and children. Only 8 percent of the women in Uttar Pradesh who were interviewed in either NFHS-1 or NFHS-2 knew their year of birth, even after probing. Every woman provided an age, however, or the interviewer estimated it, because interviewers were required to make an entry for age. Children's ages were recorded as reported by their mothers.

The first step in assessing the quality of age reporting in NFHS-1 and NFHS-2 is to examine the distribution of the population by age. Figures 1 and 2 show age distributions for females in the two surveys. Figures 1a and 1b give age distributions derived from the household samples. Both surveys show evidence of substantial heaping on ages ending in 0 or 5, but age heaping is much greater in NFHS-2 than in NFHS-1, indicating a decline in the quality of age reporting between the two surveys.

Figures 2a and 2b are similar to Figures 1a and 1b, except that the ages of ever-married women of reproductive age are derived from the individual sample. Ages of other females are derived from the household sample as in Figure 1. The ages from the individual sample, which were obtained from the women themselves after some probing for accuracy, are presumably more accurate than the ages from the household sample, which were obtained from household heads or other knowledgeable adults with little or no probing. As expected, Figures 2a and 2b show much less age heaping within the reproductive ages than do Figures 1a and 1b. The heaping that remains is still much greater in NFHS-2 than in NFHS-1, however, again indicating a decline in the quality of age reporting between the two surveys in Uttar Pradesh.

During the six years between the two surveys, respondents' knowledge of their ages would have changed very little. Rather, the amount of age heaping in the final survey results depends a great deal on the extent to which interviewers probe to get accurate information on age. Vigilant supervision in the field is crucial to ensure that interviewers do indeed probe and that they adhere to survey guidelines on how to obtain accurate information on age, as emphasized during the three weeks of training

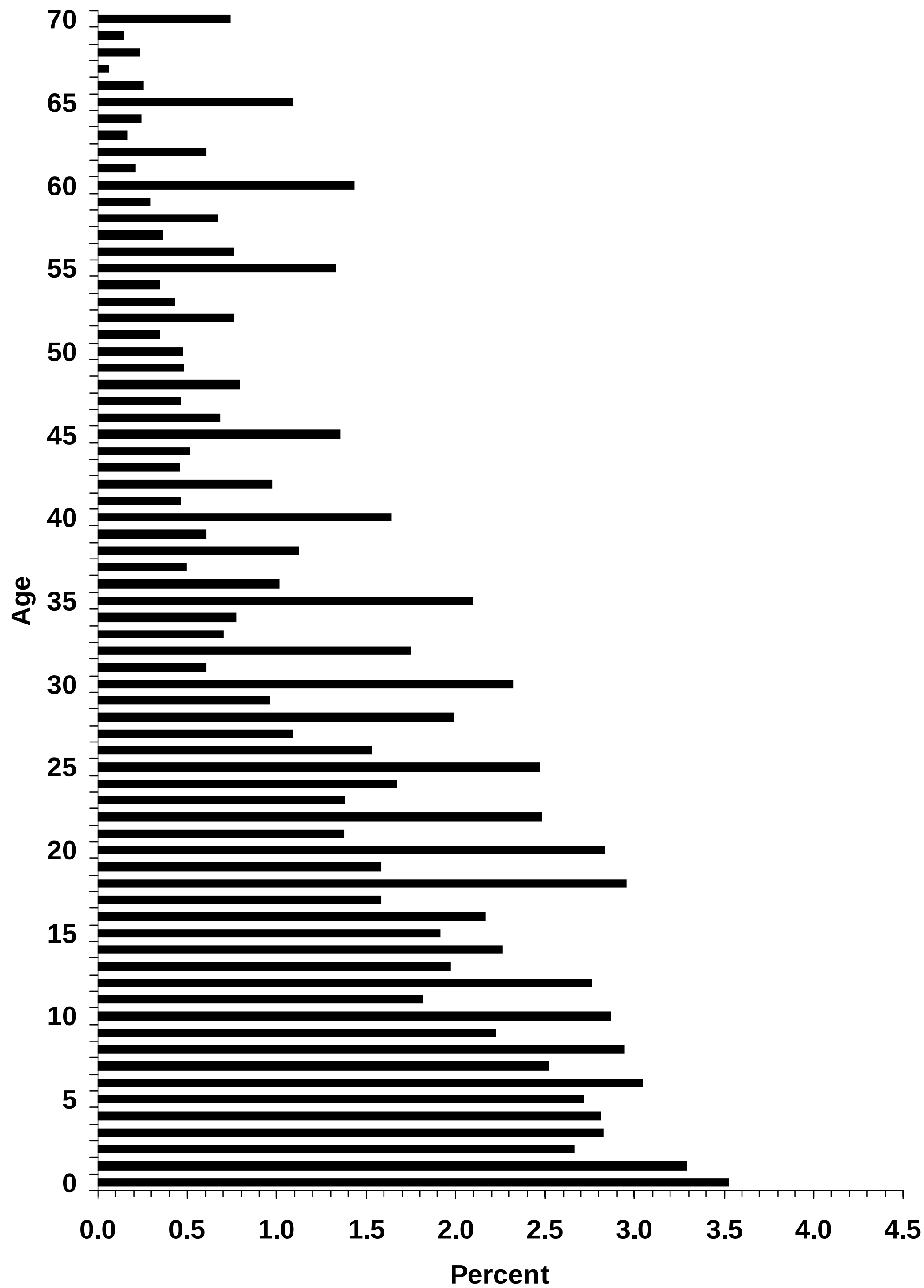

Figure 1a Female age distribution, with ages taken solely from the household questionnaire: Uttar Pradesh, NFHS-1, 1992–93

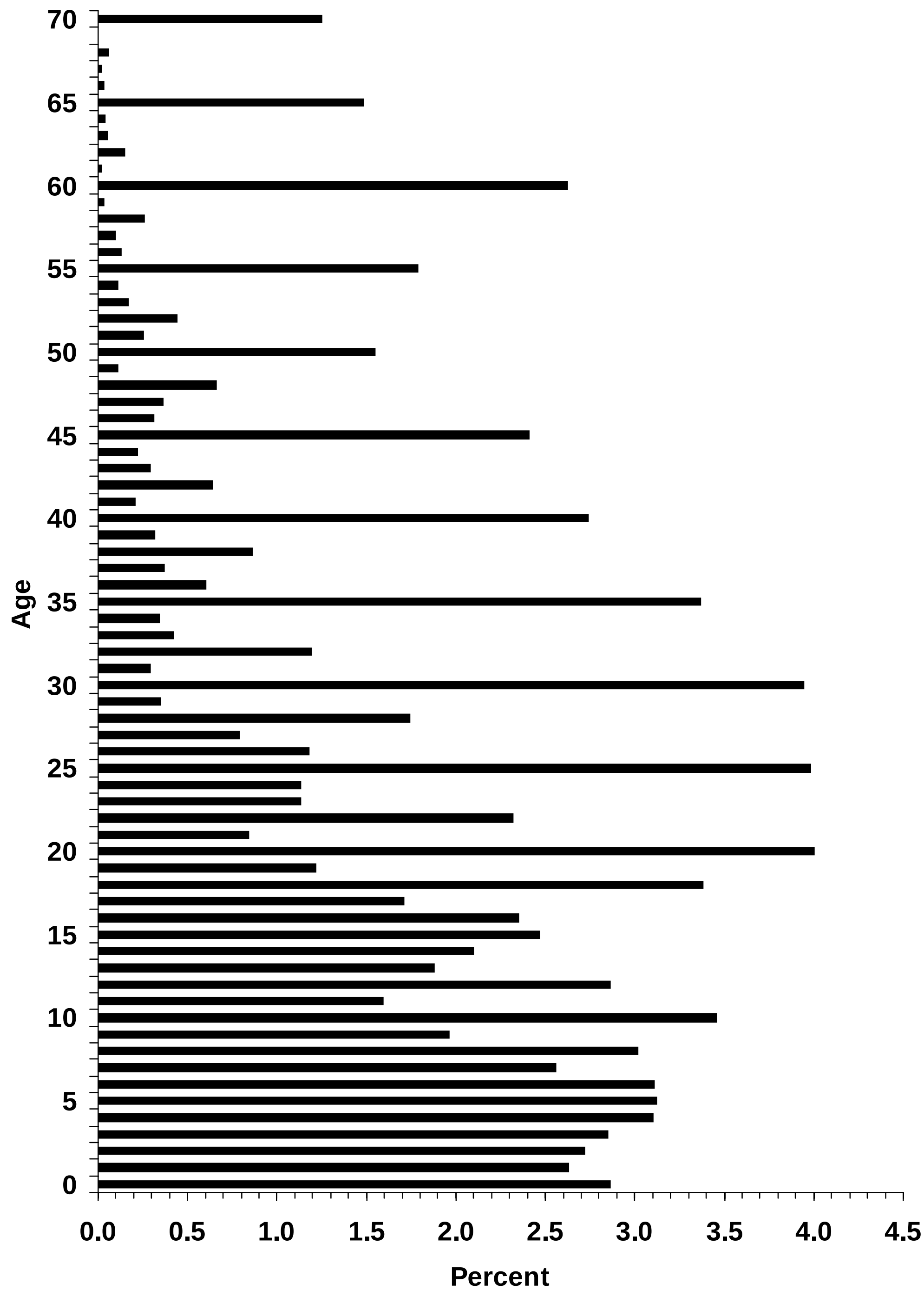

Figure 1b Female age distribution, with ages taken solely from the household questionnaire: Uttar Pradesh, NFHS-2, 1998–99

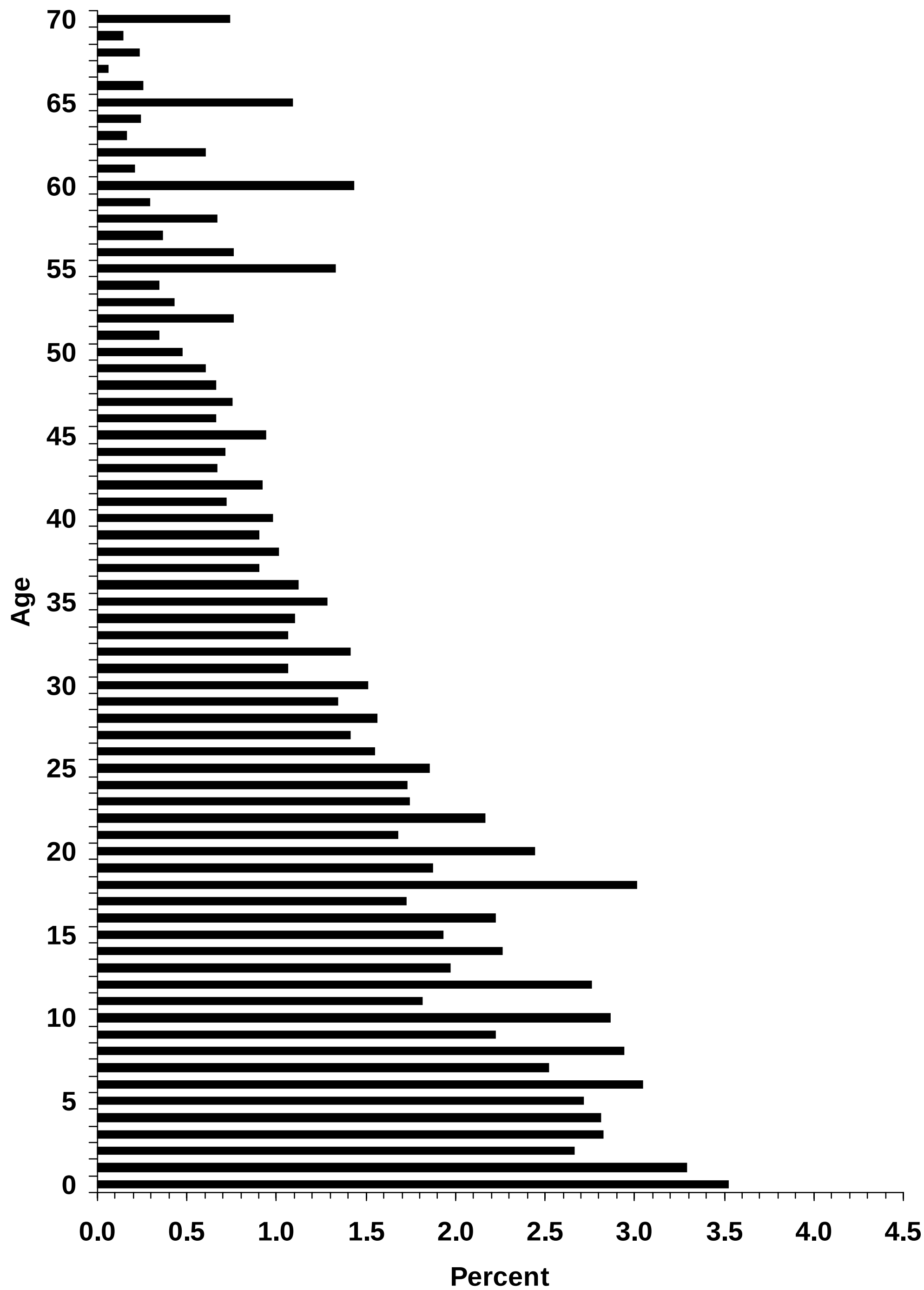

Figure 2a Female age distribution, with ages of ever-married women age 13–49 taken from the individual questionnaire and ages of other women taken from the household questionnaire: Uttar Pradesh, NFHS-1, 1992–93

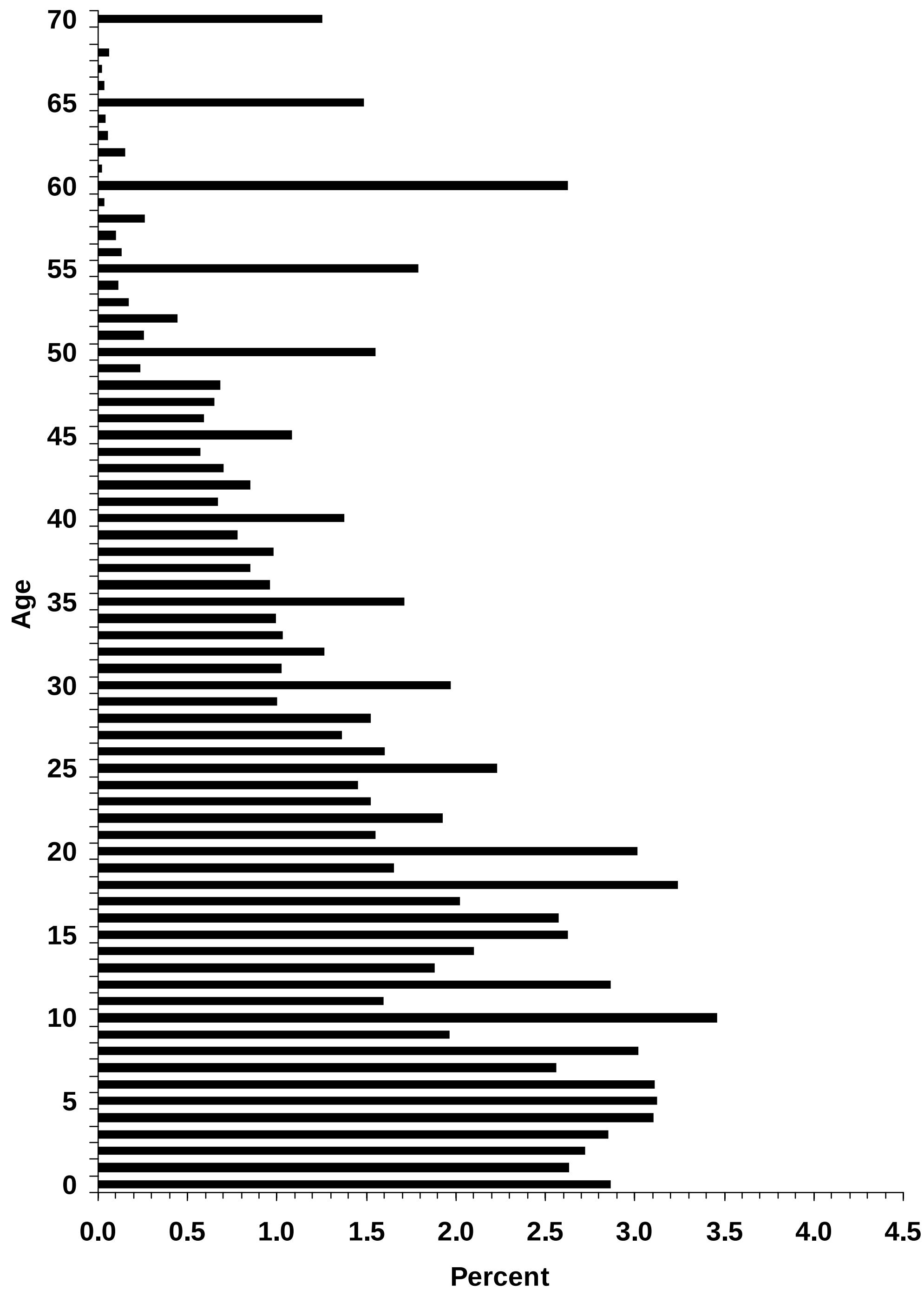

Figure 2b Female age distribution, with ages of ever-married women age 15–49 taken from the individual questionnaire and ages of other women taken from the household questionnaire: Uttar Pradesh, NFHS-2, 1998–99

for interviewers and supervisors. The greater age heaping in NFHS-2 than in NFHS-1 suggests that interviewers and their supervisors made less effort to obtain accurate information on age during the second survey.

A common measure of age heaping is Myers' Index, which provides an overall summary of preferences for, or avoidance of, ages ending in specific digits. Table 2 shows values of Myers' Index for the age range 10–69 in the household samples for both surveys. The table consistently shows less digit preference for females than for males, indicating that interviewers made an extra effort to get accurate ages of women in the household questionnaire. In both surveys, the value of Myers' Index for females is reduced by slightly more than half when the ages of ever-married women of reproductive age are taken from the individual questionnaire instead of the household questionnaire. Regardless of which set of ages is used, however, the value of the index approximately doubles between NFHS-1 and NFHS-2, indicating major deterioration in the quality of age reporting between the two surveys.

At age 50, there is no heaping in NFHS-1 but major heaping in NFHS-2. During training, interviewers were instructed to exercise special care in assigning age 50 to a woman because women age 49 were eligible for the individual interview, but women age 50 were not. In Uttar Pradesh, this problem was clearly addressed much more conscientiously in NFHS-1 than in NFHS-2. Some interviewers may even have rounded up the ages of some women to 50 intentionally in order to reduce the number of women they would have to interview. They may have been particularly motivated to round up the ages of women with large numbers of children, all of whom would have had to be recorded in a lengthy birth history. Rendering high-fertility women ineligible for the individual interview by rounding their ages up to 50 would contribute to an underestimation of fertility.

At the higher childhood ages, there is considerable heaping on ages 8, 10, and 12 in both surveys, but more so in NFHS-2 than in NFHS-1. Heaping on ages 8, 10, and 12 is commonly observed in south Asian countries (Retherford and Alam 1985). In this respect, the two surveys are typical.

In both NFHS-1 and NFHS-2, young children who were reported as older than they were became ineligible for a large block of questions. Interviewers could thus reduce their workload by this type of age exaggeration, which is equivalent to displacement of births to earlier years. The cutoff age for the large block of questions pertaining to young children was approximately 5 years in NFHS-1 and 4 years in NFHS-2. (These cutoff ages are approximate because the cutoff actually was specified in terms of a date of birth rather than an age.)

Figure 2a shows no heaping on age 5 in NFHS-1. There is, however, considerable heaping on age 6, some of which may reflect intentional exaggeration of children's ages. In Figure 2b, the proportion of girls age 4 in NFHS-2 is considerably larger than the proportion age 3, suggesting that some interviewers exaggerated children's ages

Table 2 Myers' Index for NFHS-1 and NFHS-2, Uttar Pradesh

Survey	Males	Females	Females (with ages copied over from individual questionnaire)
NFHS-1	23.6	16.3	7.5
NFHS-2	36.0	31.8	15.3

in order to lighten their workload. This type of age exaggeration, which is equivalent to displacing births backward in time, also has the effect of lowering fertility estimates for the years immediately preceding a survey.

Because of considerable preference for sons over daughters in Uttar Pradesh, 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. If female births are omitted more often than male births, this ratio will be higher than 1.05. Women who forget to mention children who have died or moved away are more likely to omit girls than boys. They are also more likely to omit children born several years before the survey than children born more recently. If such omissions are common, then the sex ratio at birth, as ascertained from women's birth histories, will become progressively higher (more males than females) in earlier years before the survey.

Table 3 shows that the sex ratio at birth is close to 1.05 for births in the first five years before both NFHS-1 and NFHS-2. In NFHS-1, the ratio increases to 1.10 and 1.08 in the second and third five years before the survey, while in NFHS-2, the ratio increases to 1.10 and 1.16. These results support the hypothesis that respondents are more likely to omit female births and births that occurred in the more distant past. They also suggest more omission of births in NFHS-2 than in NFHS-1.

The pattern of sex ratios at birth shown in Table 3 could occur, however, if female births during the first five years before the survey were more likely than male births to be omitted but male births were more likely to be displaced backward in time. The possible distorting effects of differential displacement by sex can be minimized by considering the sex ratio at birth for the entire 15-year period before the survey.

Table 3 shows that, for the 15-year period before each survey, the sex ratio at birth was 1.08 in NFHS-1 and 1.09 in NFHS-2. The nearly equal values of 1.08 and 1.09 do indeed suggest that the higher sex ratios at birth in the second and third five years before each survey stem partly from differential displacement by sex, with male births during the first five years before each survey more likely than female births to be displaced to earlier years. The finding that the sex ratio at birth is at or close to the expected value of 1.05 during the first five years before each survey also suggests that greater omission of female births in the most recent five years is counterbalanced by greater displacement of male births to earlier periods.

Table 3 Male births, female births, and the sex ratio at birth: NFHS-1, NFHS-2, and the SRS, Uttar Pradesh

Data source and time period	Male births	Female births	Sex ratio at birth (M/F) x 100
NFHS-1			
1978–82	4,443	4,104	108
1983–87	5,300	4,815	110
1988–92	5,145	4,888	105
1978–92	**14,888**	**13,807**	**108**
NFHS-2			
1984–88	3,824	3,307	116
1989–93	4,339	3,951	110
1994–98	3,906	3,774	104
1984–98	**12,069**	**11,032**	**109**
SRS			
1981–90	—	—	112

In sum, there is evidence of misreporting of women's and children's ages, omission of eligible women, and omission and displacement of births in both NFHS-1 and NFHS-2 results for Uttar Pradesh. These problems are all more prevalent in NFHS-2 than in NFHS-1.

Sample Registration System

In the SRS in Uttar Pradesh, there is evidence of considerable underregistration of births. Later in this report, we estimate that TFRs from the SRS must be upwardly adjusted by about 6 percent to allow for underregistration.

The extent of age misreporting in the SRS 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. Age misreporting is likely to be even more serious in the SRS than in NFHS-1 and NFHS-2, however, because the two surveys devoted much more effort to obtaining accurate information on age than is typically done in the SRS.

As will be discussed in more detail later, changes in the pattern of age misreporting also occur in the SRS related to changeovers in the sample of registration areas (villages and urban blocks). Since the early 1980s, the SRS sample has been replaced twice, once in 1983–85 using the 1981 Census as the sampling frame and again in 1993–95 using the 1991 Census as the sampling frame.

The SRS does not normally report sex ratios at birth, but a special report did release state-level sex ratios at birth from the SRS for the period 1981–90 (Registrar General, India 1996). As shown in Table 3, the SRS sex ratio at birth in Uttar Pradesh for this 10-year period is 1.12, indicating substantial underregistration of female births and undoubtedly some underregistration of male births as well. Because this is the only reported sex ratio at birth ever released by the SRS for Uttar Pradesh, it is not possible to discern whether birth registration has become more complete over time.

METHODS

In this Subject Report, annual fertility estimates from the SRS are taken from published SRS reports. Fertility estimates for periods of more than one year are calculated as simple unweighted averages of annual estimates. Estimates of fertility 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 for reasons that will be explained.

Birth-history method

The birth-history method is one of two methods we use to derive fertility estimates from NFHS-1 and NFHS-2. The method is straightforward. One simply counts births by age of mother as reported in the birth histories for each calendar year up to the 15th year before the survey. Similarly, one counts woman-years of exposure to the risk of birth by woman's age, also for each calendar year up to the 15th year before the survey. Then, for each calendar year or group of calendar years, one divides the number of births to women in each 5-year age group by the number of woman-years of exposure among women in the same 5-year age group to obtain an age-specific fertility rate (ASFR).

A total fertility rate (TFR), defined as the average number of children a woman would bear throughout her life at current age-specific fertility rates, can then be calculated by summing ASFRs in 5-year age groups from 15–19 to 45–49 and multiplying the sum by five. Base calculations are actually done in months, and rates are converted to a yearly basis at the end of the calculations. In the calculation of these various fertility rates, which pertain to all women and not just to ever-married women, it is assumed that never-married women (for whom birth histories are not collected but who are included in the NFHS household samples) have had no births.

We cannot calculate a complete set of ASFRs for each of the 15 years before each survey because the birth-history method is subject to problems of age truncation. Following usual practice, NFHS-1 and NFHS-2 collected birth histories from ever-married women up to age 50. The oldest women covered were thus only 44 years old five years before each respective survey, so we cannot calculate an ASFR for women age 45–49 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 only be based 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.

Own-children method

The own-children method is a reverse-survival method for estimating age-specific fertility rates (ASFRs) and other fertility measures for years before a census or household survey. Because the household samples from NFHS-1 and NFHS-2 include women of all ages, a full set of ASFRs—and, therefore, a TFR—out to age 45–49 can be calculated using this method for each of the 15 years before each survey.

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 or line number of mother in the household listing, if available. 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 adjusting for unmatched (i.e., non-own) children, age-specific fertility rates are calculated by dividing the number of reverse-survived births by the number of reverse-survived women.

Estimates are normally computed for each of the 15 years before a survey or census. Initial calculations are by single years of age and time. Estimates for grouped ages or grouped calendar years are obtained by aggregating single-year numerators (births) and denominators (women) and dividing the aggregated numerator by the aggregated denominator. As we shall see, such aggregation is useful for minimizing the distorting effects of age misreporting on fertility estimates (Cho, Retherford, and Choe 1986).

The reverse-survival calculations require life tables. These were derived from SRS life tables for 1976–80, 1981–85, 1988–92, and 1991–95 (Registrar General, India 1986; 1990; 1995; 1998a). To obtain life tables for each year within the 15-year period 1978–92 before NFHS-1, we used the SRS life tables for the periods 1976–80 and 1988–92. For purposes of interpolation and extrapolation, we considered the life tables to be located at the midpoints of the two periods, namely at 1978.5 and 1990.5, and assumed linear change in between. Each of the two life tables specifies a set of age-specific probabilities of dying. We linearly interpolated or extrapolated these two sets of probabilities to obtain a set of age-specific probabilities for each year within the 15-year period 1978–92. We then calculated a complete life table from each set of age-specific probabilities of dying. This was done separately for males and females.

We used a similar procedure to obtain life tables for each of the 15 years preceding NFHS-2. In this case, we used the SRS life tables for 1981–85 and 1991–95 as the basis for interpolation and extrapolation.

It should be noted that the own-children fertility estimates are not affected much by errors in the mortality estimates used for reverse-survival. One reason is that the reverse-survival ratios used to back-project children and women are both fairly close to 1.00, and the other reason is that errors in the reverse-survival ratios used to back-project births from children in the numerators of age-specific fertility rates cancel to some extent errors in the reverse-survival ratios used to back-project women in the denominators (Cho, Retherford, and Choe 1986).

We prefer the own-children method for generating fertility estimates from NFHS-1 and NFHS-2 because, unlike the birth-history method, it yields a complete set of age-specific fertility rates between 15–19 and 45–49 for each of the 15 years before each survey. This makes it possible to calculate a TFR for each of the 15 years as well as a TFR for the 15-year period as a whole.

In order to validate the use of the own-children method for deriving fertility estimates, however, we first compared fertility estimates derived by this method with estimates derived by the birth-history method. 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 of fertility for comparing the two methods is cumulative fertility up to age 35, or CFR(35).

Figure 3 shows 15-year trends in CFR(35) derived from each of the two surveys. Figure 3a compares fertility trends derived by the own-children method and the birth-history method for NFHS-1, and Figure 3b compares trends for 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.

FINDINGS

Trends in the total fertility rate (TFR)

Figure 4 shows overlapping trends in the TFR from NFHS-1, NFHS-2, and the SRS in Uttar Pradesh, based on annual estimates of the TFR. The trends based on NFHS-1 and NFHS-2 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. This type of age misreporting is more severe in NFHS-2 than in NFHS-1. The trends based on the SRS are much smoother because births are recorded in the year in which they occur so that children's ages do not enter into the calculation of fertility estimates. The

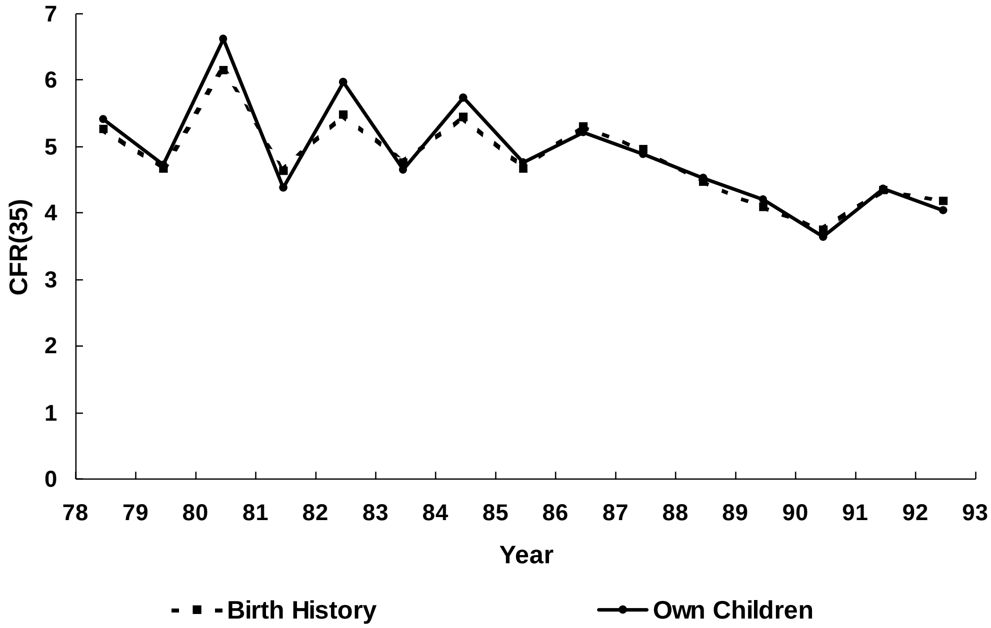

Figure 3a Birth-history and own-children estimates of cumulative fertility rates, CFR(35): Uttar Pradesh, NFHS-1, 1978–92

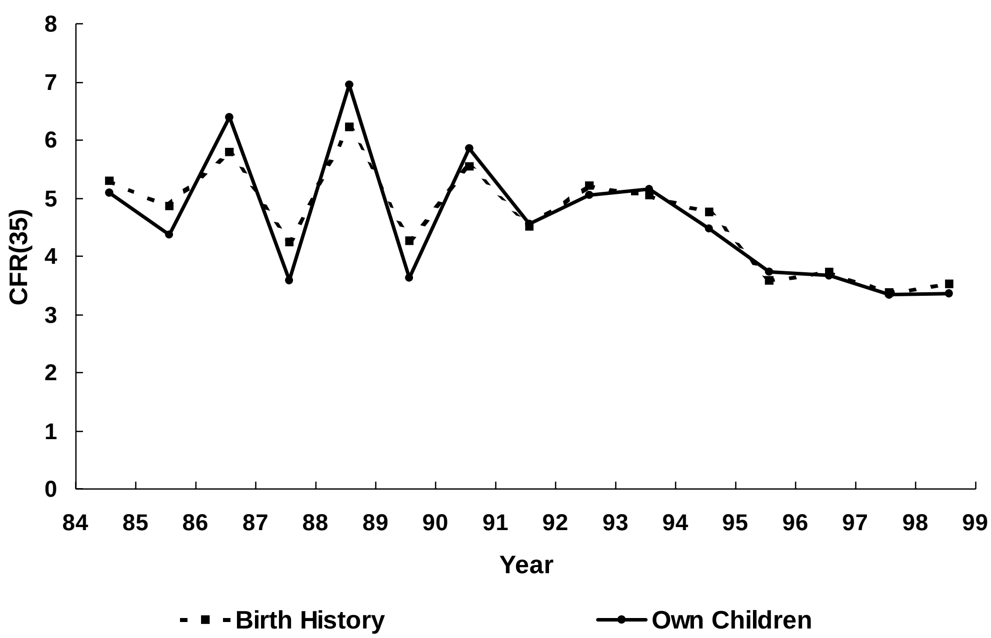

Figure 3b Birth- history and own-children estimates of cumulative fertility rates, CFR(35): Uttar Pradesh, NFHS-2, 1984–98

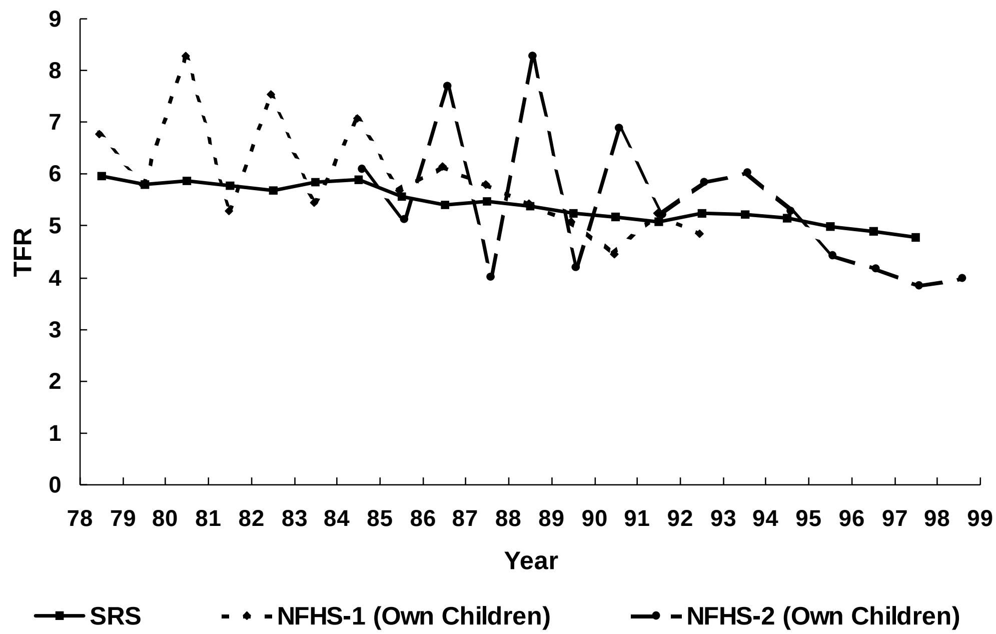

Figure 4 Overlapping trends in the TFR, estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

trends derived from the two NFHS surveys show clear evidence of displacement of births out of the first four years before each survey to earlier years.

Table 4 shows fertility estimates for 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. For the SRS, the table shows estimates for four 5-year periods that overlap the periods covered by NFHS-1 and NFHS-2. The fertility estimates from NFHS-1 and NFHS-2 are generated by the own-children method, while 5-year estimates from the SRS are simple unweighted averages of annual estimates. As is already apparent from Figure 4, aggregation into three 5-year time periods does not give an accurate picture of fertility trends for NFHS-1 and NFHS-2 because displacement of births to earlier years produces an underestimate of the TFR for the first 5-year period before each survey. In addition, severe heaping on age 10 produces an overestimate of the TFR for the period 10–14 years before each survey.

A comparison of the various estimates in Table 4 indicates a number of inconsistencies. Looking first at the within-survey estimates for 5-year time periods derived from NFHS-1 and NFHS-2, we see a steep decline in TFR during the 15 years preceding each survey. These two within-survey trends are, however, quite inconsistent with each other. The within-survey trend estimated from NFHS-1 shows a drop from 6.74 children per woman in 1978–82 to 5.00 in 1988–92, whereas the within-survey trend from NFHS-2 shows a drop from 6.27 in 1984–88 to 4.32 in 1994–98. Within the period of overlap, the estimate for 1989–93 from NFHS-2 and the estimate for 1988–

Table 4 Trends in age-specific fertility rates (ASFRs) and total fertility rates (TFRs) from NFHS-1, NFHS-2, and the SRS, Uttar Pradesh

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	170	145	106	**136**	190	174	110	**152**	97	90	78	49
20–24	340	320	263	**302**	340	311	238	**290**	271	280	272	262
25–29	334	315	267	**301**	309	288	234	**273**	281	280	262	268
30–34	242	231	194	**219**	222	201	157	**189**	235	218	201	203
35–39	154	132	109	**129**	112	102	82	**97**	157	144	136	124
40–44	79	47	46	**58**	57	39	31	**41**	81	76	68	67
45–49	29	17	16	**21**	23	17	13	**18**	41	37	29	28
TFR	6.74	6.03	5.00	**5.84**	6.27	5.66	4.32	**5.30**	5.82	5.63	5.22	5.01

92 from NFHS-1 should agree rather closely, but they do not. Indeed, the two estimates—at 5.66 and 5.00—differ by two-thirds of a child.

Based on within-survey estimates for the first and third 5-year periods before each survey, the annual rates of decline in the TFR average 0.174 child per woman per year in NFHS-1 and 0.195 child per woman per year in NFHS-2. In contrast, a comparison between the two surveys, computed using the two 15-year estimates of the TFR, indicates a much more gradual between-survey decline from 5.84 for the period 1978–92 to 5.30 for the period 1984–98, averaging 0.088 child per woman per year. (In the calculation of average rates of decline, TFRs are dated at the midpoints of the time periods to which they pertain.) The SRS estimates in Table 4 indicate a downward trend that is even more gradual than the between-survey trend derived from NFHS-1 and NFHS-2. SRS estimates of the TFR decline from 5.82 in 1978–82 to 5.01 in 1993–97, implying an average rate of decline of 0.054 child per woman per year.

Quite clearly, each of the two within-survey estimates of the trend in TFR, based on 5-year time periods, starts too high and ends too low. The between-survey estimate, based on two 15-year time periods, looks much more reasonable and is much closer to the trend estimated from the SRS. Aggregation over 15-year time periods does a rather good job of minimizing the distorting effects of displacement of births in the two surveys. In this regard it helps that there is no heaping at all on age 15 in NFHS-1 and only a modest amount of heaping on age 15 in NFHS-2 (Figure 2). To be sure, even when there is no heaping on age 15, there can still be a net displacement of births across the 15-year boundary. The number of displaced births is, however, a very small proportion of the total number of births during the 15 years before the survey so that any remaining bias from displacement is very small.

It is clear from this analysis that fertility trends derived from NFHS-1 and NFHS-2 are more accurate if calculated for the two 15-year periods preceding the surveys than if calculated for shorter periods. This is mainly because aggregation over 15-year periods minimizes bias from displacement of births to earlier years. To refine our earlier estimate of the fertility trend between NFHS-1 and NFHS-2 (Table 4), we calculate TFRs for the 15-year periods before the two surveys, date the two TFRs at the midpoints of their respective 15-year periods, plot the two dated TFRs on a graph of TFR against time, and draw a line between the two points. The two-point formula for this line yields an equation that can then be used to compute a predicted value of TFR at any given point in time. This calculation procedure seems reasonable inasmuch as the true fertility trend in Uttar Pradesh appears to be approximately linear, judging from the nearly linear year-by-year sequence of TFR estimates from the SRS in Figure 4. The equation of the line constructed in this way is:

$$\text{TFR} = 13.3623 - .0880\, t \qquad (1)$$

Table 5 Estimates of the total fertility rate for 1990–92 and 1996–98, Uttar Pradesh

Data source and method	1990–92	1996–98	Estimated decline
NFHS			
Raw values	4.82	3.99	0.83
Linear model with no upward adjustment to either of the two 15-year TFRs from the two surveys[a]	5.31	4.78	0.53
Linear model with NFHS-1 TFR not adjusted and NFHS-2 TFR adjusted upward by 4.72% for omission of births[b]	5.55	5.27	0.28
SRS			
Raw values	5.17	4.78[e]	0.39
NFHS and SRS (combined data)			
Linear model with NFHS-1 TFR adjusted upward by 1.24% and NFHS-2 TFR adjusted upward by 4.72% (best estimate)[c]	**5.55**	**5.19**	**0.36**
International regression line[d]	5.91	5.33	0.58

Note: The NFHS raw values are from the basic NFHS-1 and NFHS-2 survey reports. The SRS raw value for 1990–92 is a simple average of annual TFRs published by the SRS for 1990–1992, but the SRS raw value for 1996–1998 pertains to 1997 only. It was not possible to compute the average for 1996–98 because TFR estimates for 1998 were not available from the SRS at the time of writing. Our 'best estimates' are highlighted in boldface. Differences in the last column are calculated from more exact values than shown in the first two columns.

[a]A linear trend is derived using the 2-point formula for a line, based on two TFRs, estimated for the 15-year period before each survey and dated 7.5 years before the survey. The equation of the line is TFR = 13.3623 – .0880 *t*. The TFRs shown are generated by substituting 91.5 and 97.5 for *t*.

[b]Before fitting a line using the procedure described in footnote a, the TFR is adjusted upward by 4.72 percent to correct for omitted births in NFHS-2. The equation of the line is TFR = 9.8665 – .0471 *t*.

[c]The procedure for fitting this line is somewhat involved and described in the text. In effect, the TFR for the 15-year period preceding NFHS-1 is adjusted upward by 1.24 percent to correct for omitted births in NFHS-1, the TFR for the 15-year period preceding NFHS-2 is adjusted upward by 4.72 percent to correct for omitted births in NFHS-2, and a line is drawn using the 2-point formula for a line, based on the two upwardly adjusted TFRs, each dated 7.5 years before the survey. The equation of the line is TFR = 11.0639 – .0603 *t*.

[d]The equation of the international regression line is TFR = 7.2931 – 0.0700 CPR, where CPR denotes the contraceptive prevalence rate. Estimates shown pertain to the time of each survey rather than the 3-year period before the survey.

[e]Pertains to 1997.

where *t* denotes time measured in years since 1900. The annual rate of decline in the TFR is given by the coefficient of *t*, which indicates a rate of decline of 0.088 births per woman per year. As shown in Table 5, predicted TFRs for 1991.5 and 1997.5 (obtained by substituting 91.5 and 97.5 for *t* in the equation), corresponding to the midpoints of the three-year periods before NFHS-1 and NFHS-2, are 5.31 and 4.78.

This estimated decline is too steep, however, because omission of births is greater in NFHS-2 than in NFHS-1. We can improve the procedure by adjusting the TFR for the 15-year period before NFHS-2 to account for the greater omission of births in NFHS-2 before applying the two-point formula for a line. The rate of omission of births in NFHS-2 is available from the special post-survey evaluation check that was conducted in Uttar Pradesh about six months after the main survey (IIPS 1999). In 19 selected PSUs, women interviewed in NFHS-2 were re-interviewed, and the two accounts of their birth histories were compared. Altogether, 1,314 births were reported in the original survey, and 1,376 births were reported for the same women in the evaluation check, indicating that the TFR for the 15-year period before NFHS-2 should be adjusted upward by a factor of 1.0472. (This correction factor actually pertains to all children ever born to eligible women, but here we apply it specifically to those births that occurred during the 15-year period before the survey.)

We cannot adjust the TFR in Uttar Pradesh for the 15-year period before NFHS-1 in the same way because no evaluation check was conducted after NFHS-1 that would allow the calculation of a correction factor. We expect, however, that fewer births were omitted in NFHS-1 than in NFHS-2 because of the generally higher quality of data in the earlier survey. When the 15-year TFR from NFHS-2 is adjusted upward by a factor of 1.0472 and the 15-year TFR from NFHS-1 is left unadjusted, the trend line derived by using the 2-point formula is:

$$\text{TFR} = 9.8665 - .0471\, t \qquad (2)$$

Predicted values for 1991.5 and 1997.5 are 5.55 and 5.27, as also shown in Table 5. Because equation (2) assumes an omission rate of zero for NFHS-1, the rate of decline indicated by this equation (as specified by the coefficient –.0471) is, however, too gradual.

Our 'best estimate' of the trend line for the TFR in Uttar Pradesh begins with the annual TFRs published by the SRS and adjusts these TFRs for underregistration of births using corrected results from NFHS-2. We assume that the NFHS-2 estimate of the 15-year TFR for 1984–98, adjusted upward by a factor of 1.0472 based on the the post-enumeration check, is correct. This upwardly adjusted TFR is calculated as 5.3001 x 1.0472 = 5.5503. The next step is to calculate a correction factor for TFRs from the SRS as the ratio of 5.5503 to the unweighted average of annual TFRs published by the SRS for the same 15-year time period. (When taking this average, the SRS 1997 value of the TFR is used also for 1998 since the 1998 value was not available at the time of writing.) This ratio is calculated as 1.0639.

In a similar fashion, we also calculated the ratio of the 15-year TFR for the period 1978–92 from NFHS-1 to the unweighted average of annual TFRs for the same 15-year period from the SRS. The ratio between these two 15-year TFRs is 1.0507. The estimated correction factor of 1.0639, based on data from NFHS-2 and the SRS, compares well with the estimated correction factor of 1.0507, based on data from NFHS-1 and the SRS. The small difference is due presumably to an omission rate of approximately 1 percent of births in NFHS-1.

Assuming that the degree of completeness of birth registration in the SRS has been constant over time, the correction factor of 1.0639 can be used to correct each annual SRS estimate of the TFR between 1978 and 1998. We multiply each unadjusted annual SRS estimate of the TFR by 1.0639 to yield a set of adjusted annual estimates. In order to be consistent with the procedure used to obtain equations (1) and (2), the two-point formula is again used to fit a line. To obtain the two points, two average values of the adjusted annual TFR estimates are calculated, one for the period 1978–92 and the other for the period 1984–98, with the two values dated at the midpoints 1985.5 and 1991.5.

The equation of the line obtained from the two-point formula is:

$$\text{TFR} = 11.0639 - .0603\,t \qquad (3)$$

In effect, this equation adjusts TFRs from the SRS to agree with the 15-year TFR from NFHS-2, upwardly adjusted by a factor of 1.0472, while retaining the slope (i.e., the rate of TFR decline) implied by the upwardly adjusted TFRs from the SRS for each calendar year. We obtain estimates of the TFR for the 3-year period preceding each survey by substituting t = 91.5 and t = 97.5 into the right side of equation (3), yielding TFRs of 5.55 in 1990–92 and 5.19 in 1996–98, as shown in Table 5. These are our best estimates of the TFR for the two 3-year time periods.

From equation (3) we can also estimate more precisely the rate of omission of births in NFHS-1. The mean date of interview in NFHS-1 was 1992.96, and the midpoint of the 15-year period preceding NFHS-1 was 7.5 years earlier than this, or 1985.46. Substituting t = 85.46 into equation (3), we obtain a predicted TFR of 5.9107. The ratio of this value to the 15-year TFR, which was obtained earlier by applying the own-children method to NFHS-1 data, is 1.0124. This correction factor for omitted births in NFHS-1 is considerably smaller than the correction factor of 1.0472 for omitted births in NFHS-2, consistent with other indications that data quality is higher in NFHS-1 than in NFHS-2.

The correction factors for TFRs, based on 15-year aggregated data, are not affected much by displacement of births or misreporting of women's ages. As already mentioned, the net number of births displaced to earlier years from the 15-year period before each survey is very small compared with the total number of births in the 15-year period. Similarly, misreporting of women's ages moves very few births out of the 15–49 age range because fertility for the youngest and oldest age groups is very low. Thus age misreporting has little effect on estimates of the TFR from NFHS-1 and NFHS-2 data. For the same reason, age misreporting in the SRS also has little effect on TFR estimates derived from that source.

Age-specific fertility rates (ASFRs)

Fertility rates calculated for 5-year age groups of women are more susceptible to bias due to age misreporting and displacement of births than are total fertility rates. Figure 5 shows age-specific fertility rates (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 more recent time period, SRS estimates are for the 2-year period 1996–97 instead of the 3-year period 1996–98 because SRS fertility estimates for 1998 were not available at the time of writing.

Figure 5a suggests that the comparatively small fertility decline between 1990–92 and 1996–97 estimated from the SRS stemmed primarily from fertility reduction at ages 15–19, 20–24, and 35–39, with the biggest drop occurring at 15–19. Inasmuch as the proportion currently using contraception increased only marginally, from 3 to 5 percent at 15–19 and from 7 to 12 percent at 20–24, most of the fertility decline at these ages, if real, would have to have occurred because of increases in age at marriage. In fact, this apparent decline in the ASFR among young women results from changes in the pattern of age misreporting caused by the phasing in of a new SRS sample over the period 1993–95, as we shall explain shortly. The fertility estimates for 1990–92 from NFHS-1 and for 1996–98 from NFHS-2, as shown in Figure 5b, indicate no fertility decline at age 15–19 but substantial declines at older ages.

The age pattern of fertility decline shown in Figure 5b, based on NFHS-1 and NFHS-2, is partly spurious, stemming from the sharp decline in the quality of age reporting between the two surveys. As already mentioned, in demographic surveys of this kind, there tends to be displacement of births from years close to the survey to earlier years because of a tendency of respondents to round up children's ages (e.g., from age 2 years 10 months to age 3). In addition, some interviewers who wish to reduce their workload may move up the age of a child to avoid having to ask the large block of questions pertaining to children born after a cutoff date, which corresponds approximately to age 5 in NFHS-1 and age 4 in NFHS-2.

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 fertility among younger women and lowering fertility among older women. This shift occurs because a birth that is displaced into the past is erroneously reported to have occurred when the mother was younger. Thus ASFRs below the peak age of fertility are overestimated, and ASFRs above the peak age of fertility are underestimated. Because displacement of births is more severe in NFHS- 2 than in NFHS-1, the leftward shift of the age-specific fertility curve is more marked in fertility estimates derived from NFHS-2 than in estimates derived from NFHS-1. This creates a spurious increase in fertility at age 15–19 and a spurious decline in fertility at older ages. At the same time, the net

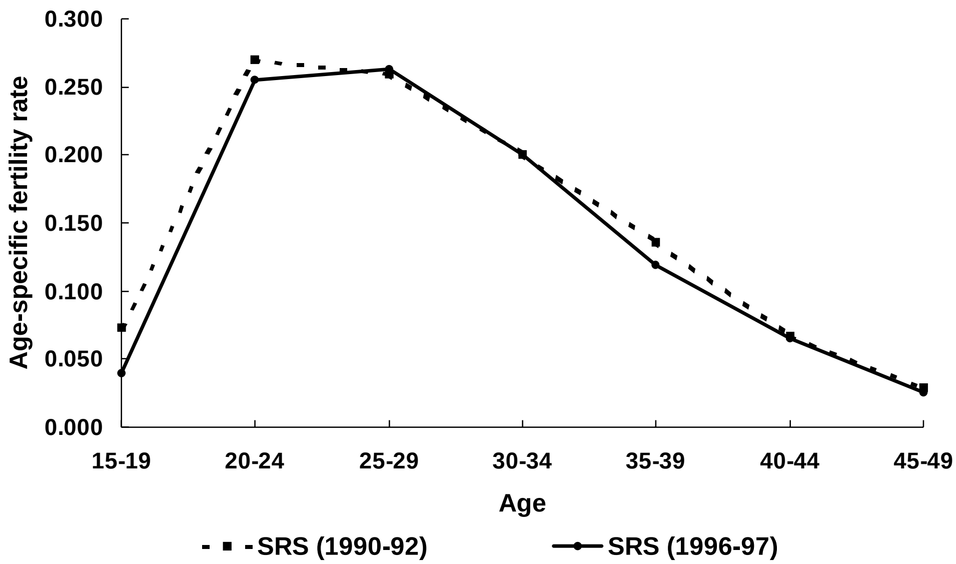

Figure 5a Age-specific fertility rates from the SRS for 1990–92 and 1996–97: Uttar Pradesh

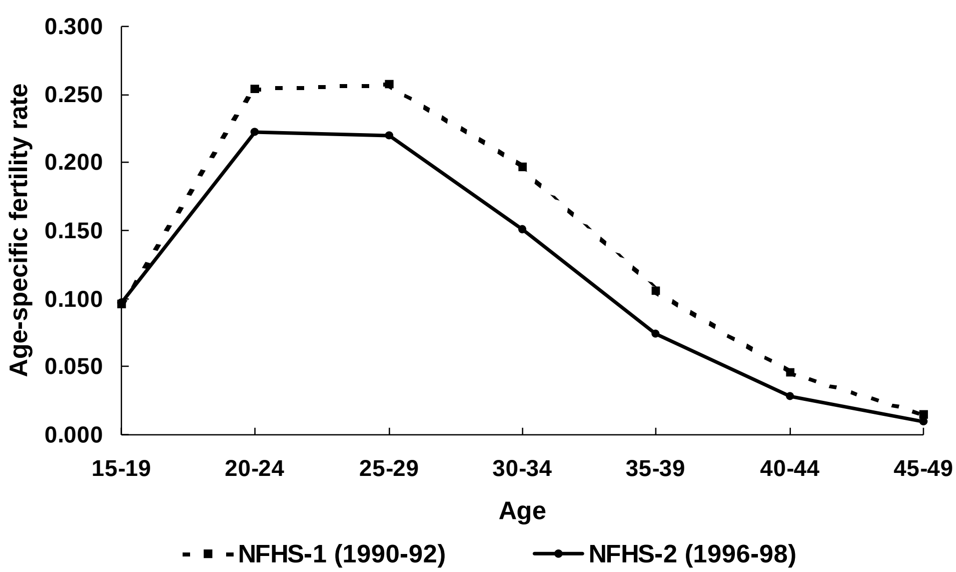

Figure 5b Age-specific fertility rates from NFHS-1 (1990–92) and NFHS-2 (1996–98): Uttar Pradesh

displacement of births out of the 3-year period before the survey to earlier years tends to lower fertility at all ages. In Figure 5b, the net effect of these biases is that estimates of the ASFR at 15–19 from the two surveys are virtually the same, while estimated fertility declines at older ages are spuriously large.

Displacement of births is not the only problem. Misreporting of women's ages also tends to distort age-specific fertility estimates. In India as elsewhere in South Asia (except Sri Lanka), most women do not know their age precisely, and there is a tendency for women's ages to be rounded up. This is especially true for 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). Conversely, there is a tendency for never-married women and married women with fewer than the typical number of children for their age to be reported as younger than they really are. The net effect is to shift the age curve of fertility to the right, increasing fertility among older women and decreasing fertility among younger women. Figure 5b suggests, however, that in Uttar Pradesh the leftward shift associated with displacement of births in NFHS-1 and NFHS-2 predominates over the rightward shift associated with misreporting of women's ages.

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 upward bias at older ages is offset, however, by underregistration of births.

The rightward shift of the age curve of fertility in the SRS is reduced to some extent by an offsetting effect that stems from the way that the SRS records ages. The SRS tabulates age-specific fertility rates (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 actuality age groups 15.5–20.4, 20.5–25.4, …, 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).

The spurious age pattern of fertility decline indicated by NFHS results, as shown in Figure 5b, gives the false impression that the contraceptive prevalence rate increased substantially at ages 20–24 and above between the two surveys. Contraceptive use did increase but not enough to produce this degree of fertility decline. Between NFHS-1 and NFHS-2, the contraceptive prevalence rate among currently married women of reproductive age increased from 20 to 28 percent. The composition of the 8-percentage-point increase, however, is 3 percentage points from increased use of modern methods and 5 percentage points from increased use of traditional methods (mainly rhythm and withdrawal) (IIPS and ORC Macro 2000). This increase in contraceptive prevalence is perhaps large enough to explain the small decline in the ASFR at age 35–39 shown in Figure 5a but not much more than that.

Figure 6 depicts the same data as Figure 5 but arranged somewhat differently. Figure 6a compares the age curves of fertility for 1990–92 derived from the SRS and from NFHS-1, and Figure 6b compares the age curves of fertility for 1996–98 derived from the SRS and from NFHS-2. (The SRS curve in Figure 6b is actually for 1996–97, as discussed earlier.) In Figure 6a, for the period 1990–92, NFHS-1 shows higher fertility than the SRS at age 15–19 and lower fertility than the SRS at most older ages. The discrepancies reflect errors in the SRS (the rightward shift of the SRS-derived curve) as well as errors in NFHS-1 (the leftward shift in the NFHS-1-derived curve). The much larger discrepancies in Figure 6b occur because of the much greater displacement of births in NFHS-2 than in NFHS-1, resulting in a much larger leftward shift in the age curve of fertility, and because of the changeover of the SRS sample during the period 1993–95, resulting in a larger rightward shift in the SRS-derived age curve of fertility after the changeover than before, as will be explained shortly.

There is an especially large discrepancy between the SRS and NFHS-2 in estimates of the ASFR at age 15–19, as shown in Figure 6b. The NFHS-2 estimate is more than twice as large as the SRS estimate. This large discrepancy reflects both overestimation of the ASFR for this age group in NFHS-2 and underestimation in the SRS. Shifts of the ASFR curve affect estimates of the ASFR more at age 15–19 than at older ages because the slope of the ASFR curve is steeper between 15–19 and 20–24 than between older age groups.

To minimize the effects of displacement of births, Figure 7 shows the age curves of fertility for the full 15-year period before NFHS-1 and NFHS-2 and compares them with the corresponding curves from the SRS. Figure 7a compares the age curve of fertility for the 15-year period 1978–92 from NFHS-1 and the SRS, and Figure 7b compares the age curve of fertility for the 15-year period 1984–98 from NFHS-2 with the curve for 1984–97 from the SRS. The NFHS curves are higher, relative to the SRS curves, in Figure 7 than in Figure 6, reflecting the smaller proportion of births displaced out of the longer 15-year estimation period used in Figure 7. This is especially true for the NFHS-2 curve relative to the corresponding SRS curve. Age exaggeration occurs in both Figures 6 and 7, however, so that the leftward and rightward shifts occurring in Figure 6 also occur in Figure 7.

Figure 8 shows overlapping trends in ASFRs from NFHS-1, NFHS-2, and the SRS, based on estimates for single years. As with single-year trends in the TFR (Fig-

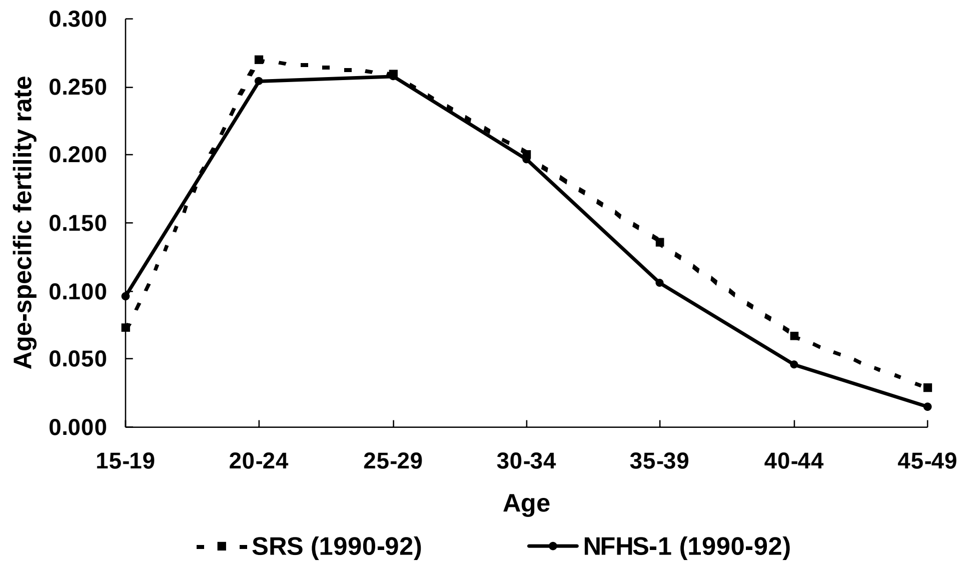

Figure 6a Age-specific fertility rates from the SRS (1990–92) and NFHS-1 (1990–92): Uttar Pradesh

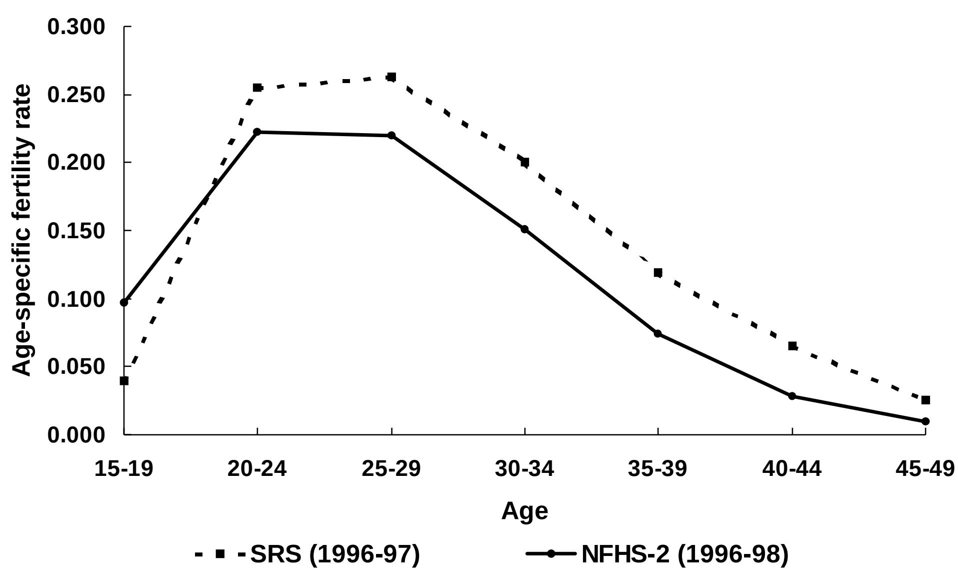

Figure 6b Age-specific fertility rates from the SRS (1996–97) and NFHS-2 (1996–98): Uttar Pradesh

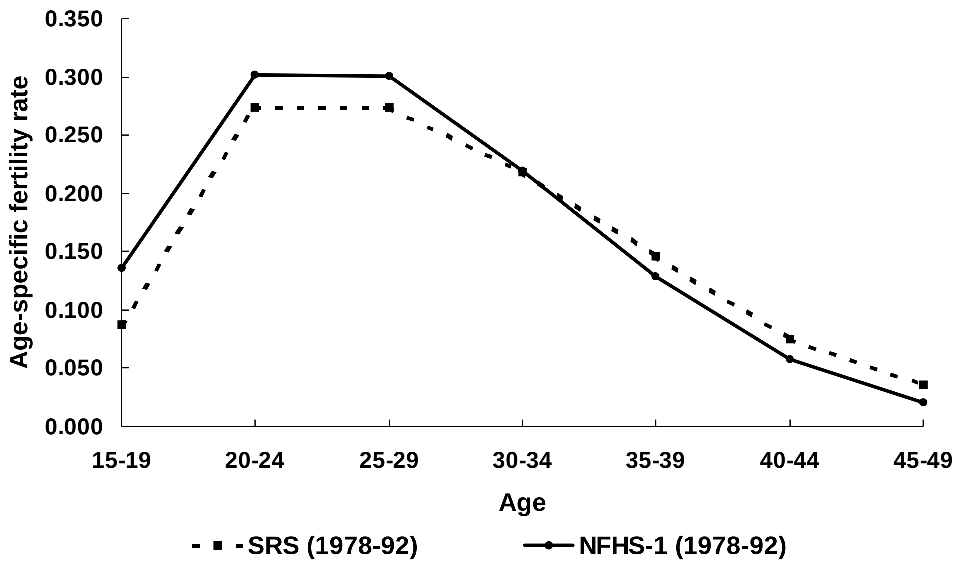

Figure 7a Age-specific fertility rates from the SRS (1978–92) and NFHS-1 (1978–92): Uttar Pradesh

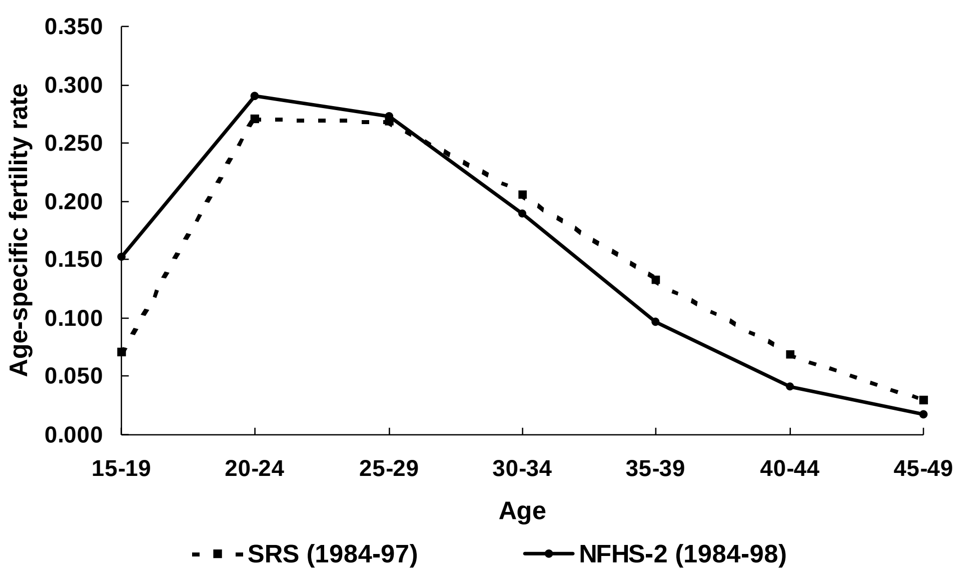

Figure 7b Age-specific fertility rates from the SRS (1984–97) and NFHS-2 (1984–98): Uttar Pradesh

ure 4), the single-year trends in ASFRs from NFHS-1 and NFHS-2 show sharp peaks in the 9th, 11th, and 13th years before the surveys, reflecting heaping of children's ages on 8, 10, and 12 years that is worse in NFHS-2 than in NFHS-1. Trends based on the SRS are much smoother because births are recorded in the year in which they occur so that heaping of children's ages is not a source of bias. The curves derived from NFHS-1 and NFHS-2 also provide clear evidence that births were displaced backward out of the most recent three or four years before the surveys. The ASFR trends from NFHS-1 and NFHS-2, as shown in Figure 8, tend to be higher than the corresponding trends from the SRS at the younger reproductive ages and lower than the corresponding SRS trends at the older reproductive ages. This net leftward shift in the age curves of fertility, due to displacement of births to earlier ages, is also clearly evident in Figures 5–7.

It might seem reasonable to expect that biases in the SRS estimates of ASFRs are approximately constant from one year to the next, so that trends in ASFRs estimated by the SRS are accurate even if the absolute levels of the ASFRs are not. This is not the case, however, particularly at the younger reproductive ages, because of the bias caused by the phasing in of new sample of registration areas during 1993–95.

To see how phasing in a new sample creates bias, consider women age 15–19 in the SRS sample in 1993, just before the new sample started to be phased in. Some of these women were recent brides from elsewhere whose ages had to be estimated by the local part-time enumerator when they moved into the registration area. Among these women, many who did not know their ages were undoubtedly shifted upward

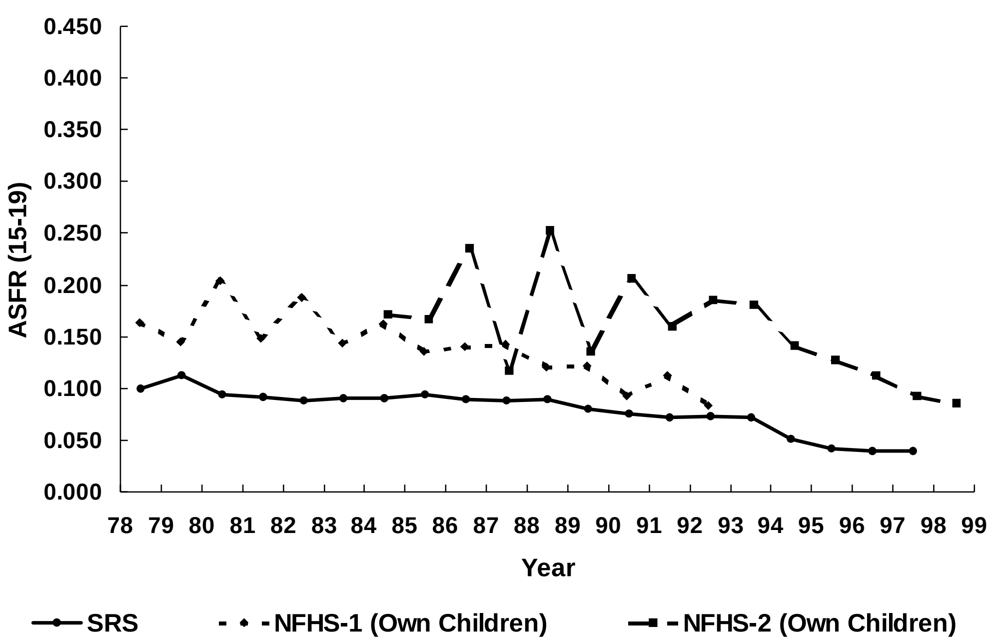

Figure 8a Overlapping trends in the ASFR (15–19), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

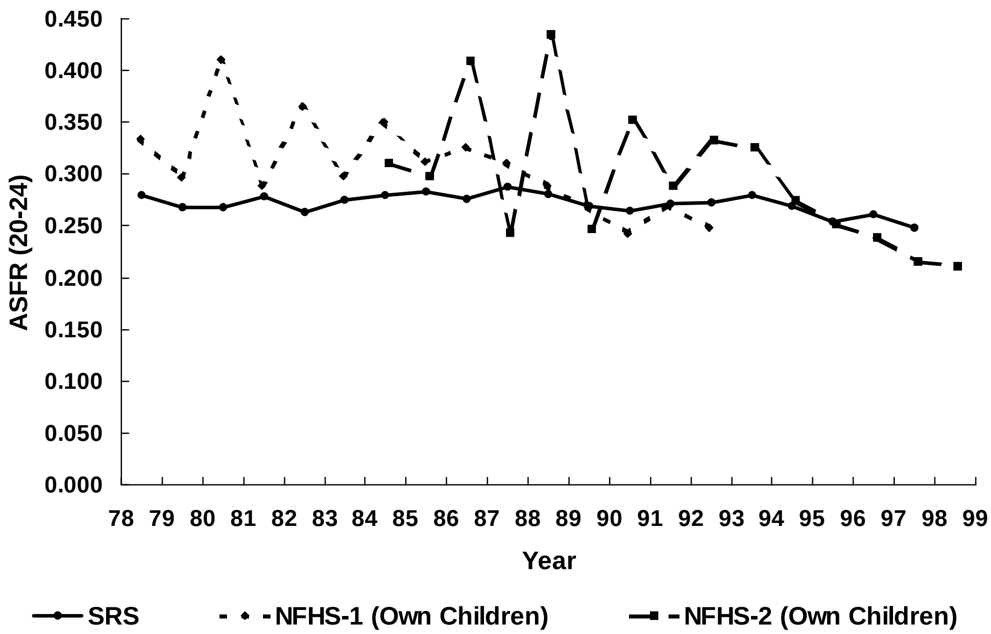

Figure 8b Overlapping trends in the ASFR (20–24), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

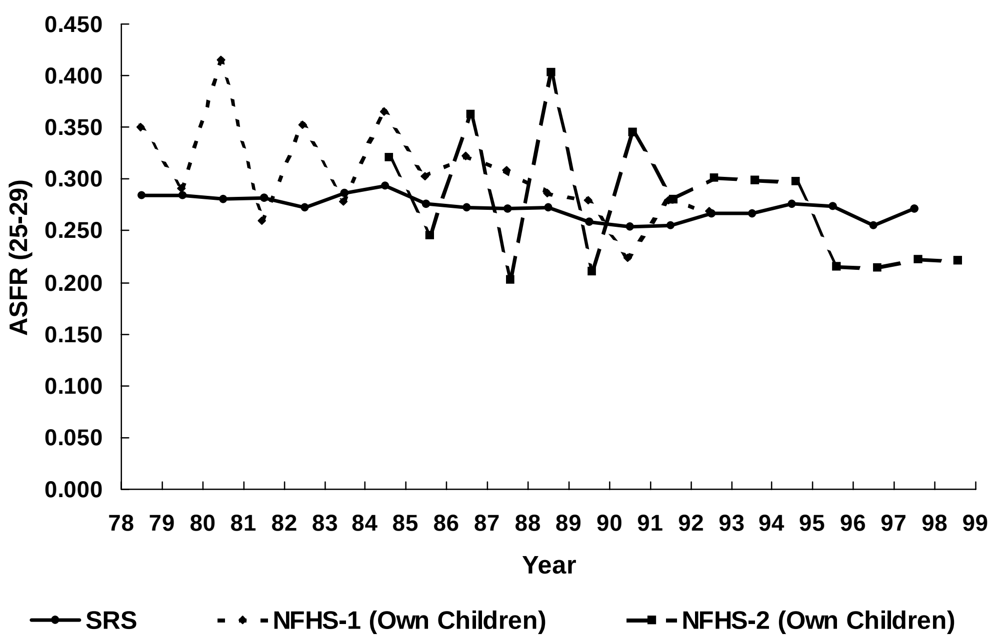

Figure 8c Overlapping trends in the ASFR (25–29), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

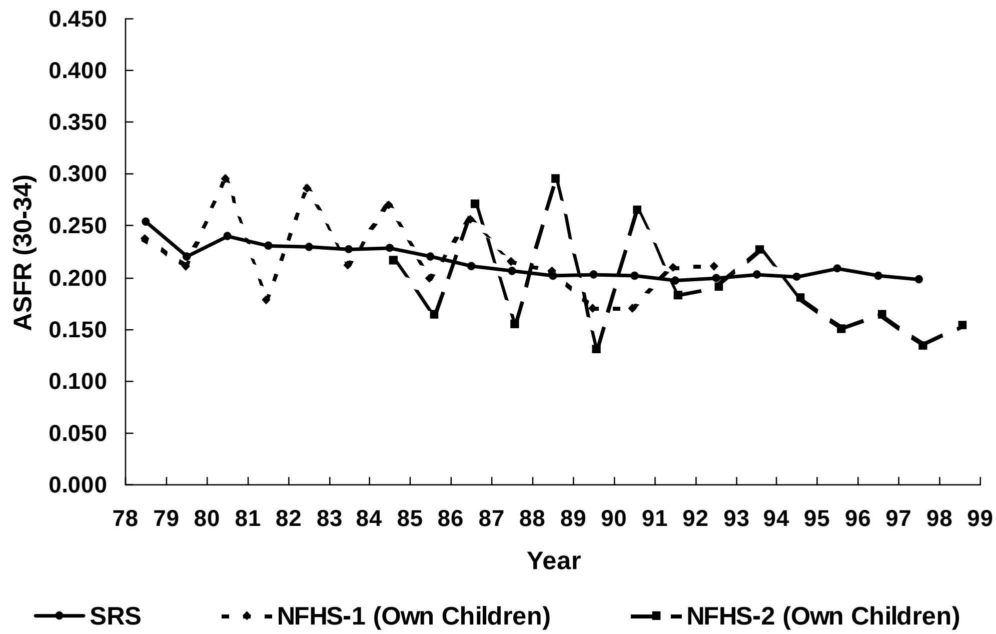

Figure 8d Overlapping trends in the ASFR (30–34), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

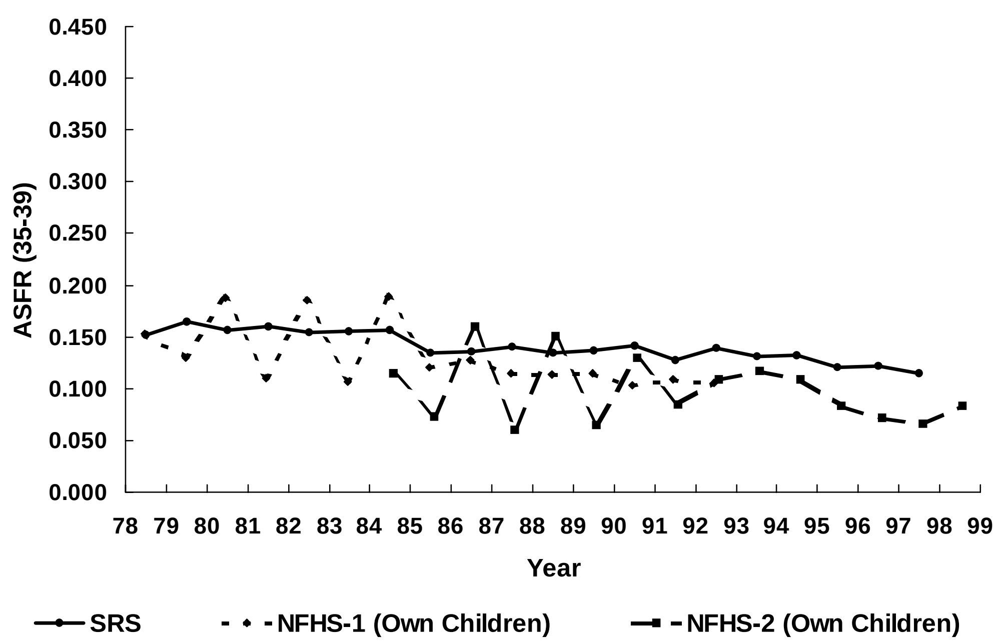

Figure 8e Overlapping trends in the ASFR (35–39), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

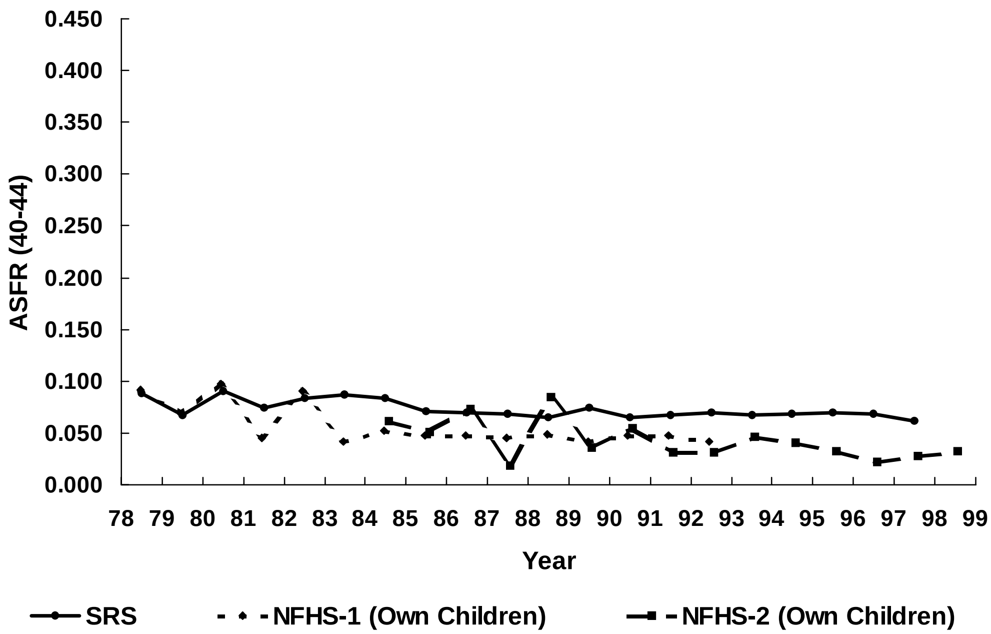

Figure 8f Overlapping trends in the ASFR (40–44), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

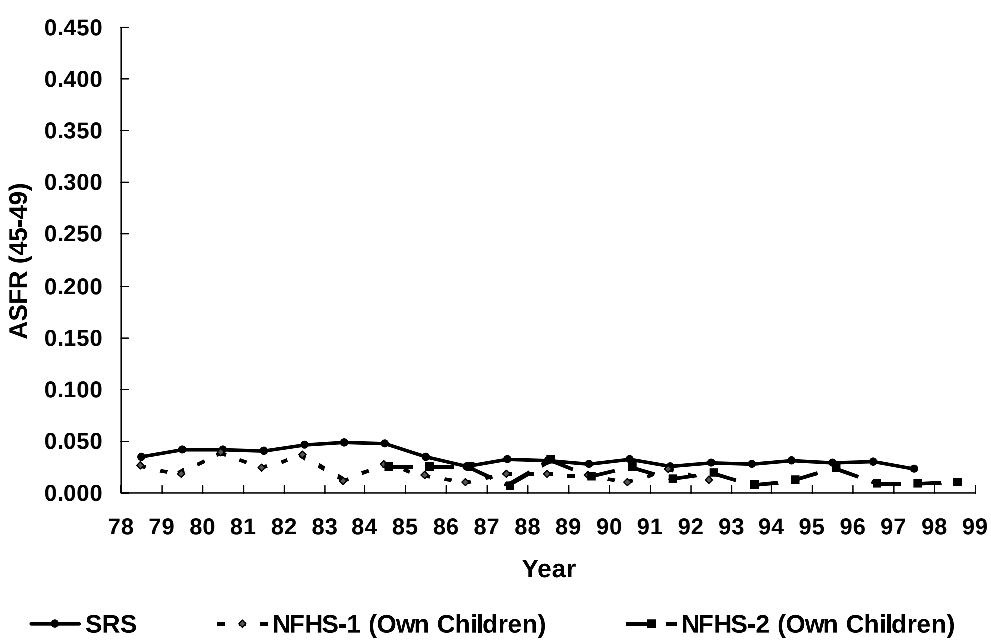

Figure 8g Overlapping trends in the ASFR (45–49), estimated from NFHS-1, NFHS-2, and the SRS: Uttar Pradesh

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 1983–85 SRS baseline survey. At the time of this baseline survey, no one in the group was shifted upward in age by virtue of being married because no one was married. 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 girls constituted a large group of young women age 15–19 whose ages had already been noted and could not be shifted. Similarly, single women age 20–24 could not be shifted downward to age 15–19 by virtue of being single.

During 1993–95, the situation changed with the phasing in of a new sample. By 1996, all women age 15–19 and 20–24 were new in the sample. Their ages had just been determined by the new baseline survey, and all (rather than just some) of those who did not know their age were at risk of having their age shifted. Because women in rural Uttar Pradesh generally leave their home villages when they marry, most of the additional shifting associated with the phasing in of the new sample is probably downward shifting of single women rather than upward shifting of married women.

Several findings indicate that age shifting increased between 1993 and 1996. The age-specific proportion currently married, or ASPM(15–19), fell from 34 percent in 1993 to 25 percent in 1996, ASFR(15–19) fell from 72 to 40 births per 1,000 women per year, and the age-specific marital fertility rate, or ASMFR(15–19), fell from 214 to 161 births per 1,000 currently married women per year. These declines in ASPM(15–19), ASFR(15–19), and ASMFR(15–19) between 1993 and 1996 appear to be mostly spurious, especially the decline in ASMFR(15–19), which is virtually entirely spurious given that the proportion using any kind of contraception at age 15–19 in Uttar Pradesh increased only from 3 to 5 percent between NFHS-1 and NFHS-2.

If this reasoning is correct, one should also see sharp declines in SRS estimates of ASMFR(15–19) in other high-fertility states of India where there is little use of contraception at age 15–19. Here we consider Madhya Pradesh, Bihar, and Rajasthan. Between NFHS-1 and NFHS-2, the proportion of currently married women age 15–19 who were currently using contraception changed from 7 to 5 percent in Madhya Pradesh, from 3 to 2 percent in Bihar, and from 2 to 4 percent in Rajasthan. Despite these very low (and often slightly falling) levels of contraceptive use, the SRS indicates that, between 1993 and 1996, ASMFR(15–19) fell from 256 to 228 births per 1,000 currently married women per year in Madhya Pradesh, from 196 to 139 in Bihar, and from 212 to 136 in Rajasthan. These large but highly implausible declines in ASMFR(15–19) in all three states provide additional supporting evidence for the argument that the fertility decline at age 15–19 in Uttar Pradesh, as estimated by the SRS, is an artifact of age misreporting caused by the changeover of the SRS sample during 1993–95 and does not indicate real change.

In sum, greater displacement of births and age misreporting in NFHS-2 than in NFHS-1 and changes in the pattern of age misreporting caused by the phasing in of a new SRS sample severely distort estimates of trends in ASFRs. Because of these distortions, we have not been able to formulate a methodology that yields accurate estimates of trends in ASFRs based on these data sources. In contrast, our 'best estimate' of the TFR trend is not greatly affected by either displacement of births or misreporting of women's ages.

TOTAL FERTILITY ESTIMATED FROM CONTRACEPTIVE PREVALENCE

Another approach for estimating fertility trends 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 uses 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:

$$TFR = 7.2931 - 0.0700\ CPR \qquad (4)$$

Despite the fact that other variables known to affect fertility are omitted from the right side of this equation, the equation fits the data remarkably well. $R^2 = 0.88$, indicating that the regression line explains 88 percent of the variation in TFR.[1]

Results from NFHS-1 and NFHS-2 indicate that the CPR in Uttar Pradesh increased from 19.8 to 28.1 percent between the two surveys. Age misreporting does not affect these estimates, which we consider to be reasonably accurate. Substitution of these values into equation (4) yields predicted TFRs of 5.91 for 1990–92 and 5.33 for 1996–98. These estimates are somewhat higher than our 'best estimates' of 5.55 and 5.19 derived from equation (3). We do not have much confidence in the TFR estimates derived from the international regression line because the line is based on the experience of other countries and because the fit of these countries to the line is not perfect. Yet the estimates derived from the international regression line do indicate that our new TFR estimates of 5.55 for 1990–92 and 5.19 for 1996–98 are plasuible.

CONCLUSION

Because there were greater displacement and omission of births in Uttar Pradesh in NFHS-2 than in NFHS-1, the unadjusted trend in the TFR based on estimates for the two three-year periods preceding the surveys is too steeply downward. The trend

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

estimated from the SRS, on the other hand, suffers from underregistration of births. Corrections for displacement and omission of births in NFHS-1 and NFHS-2 and underregistration of births in the SRS yield a 'best estimate' of the trend in the TFR described by the line, TFR = 11.0639 – .0603 t, where t is time in years since 1900. This line implies that the TFR in Uttar Pradesh fell from 5.55 in 1991 to 5.19 in 1997.

Estimates of changes in age-specific fertility rates (ASFRs) between NFHS-1 and NFHS-2 are severely distorted by differences between the two surveys in the extent of omission of births and misreporting of both mothers' and children's ages. Estimates of changes in ASFRs derived from the SRS are severely distorted by changes in the pattern of age misreporting caused by the introduction of a new SRS sample during 1993–95. Because of these distortions, neither data source estimates trends in age-specific fertility rates accurately. We have more confidence in our TFR estimates, which are not much affected by displacement of births or misreporting of women's ages. Even our new TFR estimates must be viewed as only roughly accurate, however, for two reasons: (1) our correction for missed births in NFHS-2 is based on a very small sample of births in the post-NFHS-2 evaluation check conducted in Uttar Pradesh; and (2) our assumption that the completeness of birth registration in the state did not change between 1984 and 1998 is undoubtedly not entirely correct.

Finally, although inaccurate age reporting is a problem in both NFHS-1 and NFHS-2, most of the data collected (e.g., on contraceptive use and a vast amount of information on maternal and child health) do not depend on age reporting and are reasonably accurate and trustworthy in both surveys. It is even possible, as this report shows, to correct to some extent for age-reporting errors and displacement of births and to derive reasonably accurate estimates of the trend in the total fertility rate.

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