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# Fertility in Nepal 1981-2000: Levels, Trends, and Components of Change

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# FERTILITY IN NEPAL, 1981–2000:

# LEVELS, TRENDS, AND COMPONENTS OF CHANGE

Robert D. Retherford

and

Shyam Thapa

ABSTRACT

The objectives of this paper are, first, to provide improved estimates of recent fertility levels and trend in Nepal and, second, to analyze the components of fertility change. The analysis is based on data from Nepal's 1996 and 2001 Demographic and Health Surveys.

The first part of the analysis assesses the quality of the data from the 1996 and 2001 Nepal Demographic and Health Surveys (DHS) on which the fertility estimates are based. Fertility levels and trends are then estimated using the own-children method of fertility estimation. The own-children estimates incorporate additional adjustments to compensate for displacement of births, and they are compared with previously published estimates derived by the birth-history method. Fertility is estimated not only for the whole country but also by ecological region, development region, urban/rural residence, and woman's education.

The own-children estimates indicate that the total fertility rate (TFR) fell from 4.96 to 4.69 births per woman between the 3-year period preceding the 1996 survey and the 3-year period preceding the 2001 survey. About three-quarters of the decline stems from reductions in age-specific marital fertility rates and about one-quarter from changes in age-specific proportions currently married.

Further decomposition of the decline in marital fertility, as measured by births per currently married woman during the 5-year period before each survey, indicates that almost half of the decline in marital fertility is accounted for by changes in population composition by ecological region, development region, urban/rural residence, education, age at first cohabitation with husband, time elapsed since first cohabitation, number of living children at the start of the 5-year period, and media exposure. With these variables controlled, another one-third of the decline is accounted for by increase in the proportion sterilized at the start of the 5-year period. About one-fifth of the fertility decline is not accounted for by any of these variables, but this remaining unexplained component does not differ significantly from zero.

Emerging evidence suggests that fertility transition is well underway in Nepal (Thapa, Neidell, and Dahal 1998). Actual levels of and rates of change in fertility are, however, less certain. The objectives of this report are, first, to provide improved estimates of recent fertility levels and trend in Nepal and, second, to analyze the components of fertility change. The analysis is based on data from Nepal's 1996 and 2001 Demographic and Health Surveys (DHS) (Ministry of Health *et al*. 1997; 2002). The inclusion of the 2001 DHS in the analysis allows an update of fertility estimates presented in earlier papers by the authors (Retherford and Thapa, 1998; 1999).

The first part of the report presents the updated estimates, explains how they are derived, and explains why they are probably more accurate than estimates published previously in the 1996 and 2001 DHS survey reports. Fertility estimates are calculated not only for the whole country but also by urban/rural residence and by level of woman's education (no education, at least some primary education, and beyond primary). Also calculated are decompositions of the change in the TFR into components due to changes in nuptiality (age-specific proportions married) and marital fertility (age-specific marital fertility rates). Decompositions are calculated not only for the country as a whole but also for each of four development regions (Eastern, Central, Western, and Mid- and Far-western) and each of three ecological regions (Mountain, Hill, and Terai) (see map in Figure 1). They are also calculated for each education category (no education, at least some primary education, and beyond primary).

The second part of the report focuses on components of change in marital fertility, as measured by births per currently married woman during the five years before each survey. Multiple regression is used to estimate components of marital fertility change due to changes in various demographic, geographic, and socioeconomic variables.

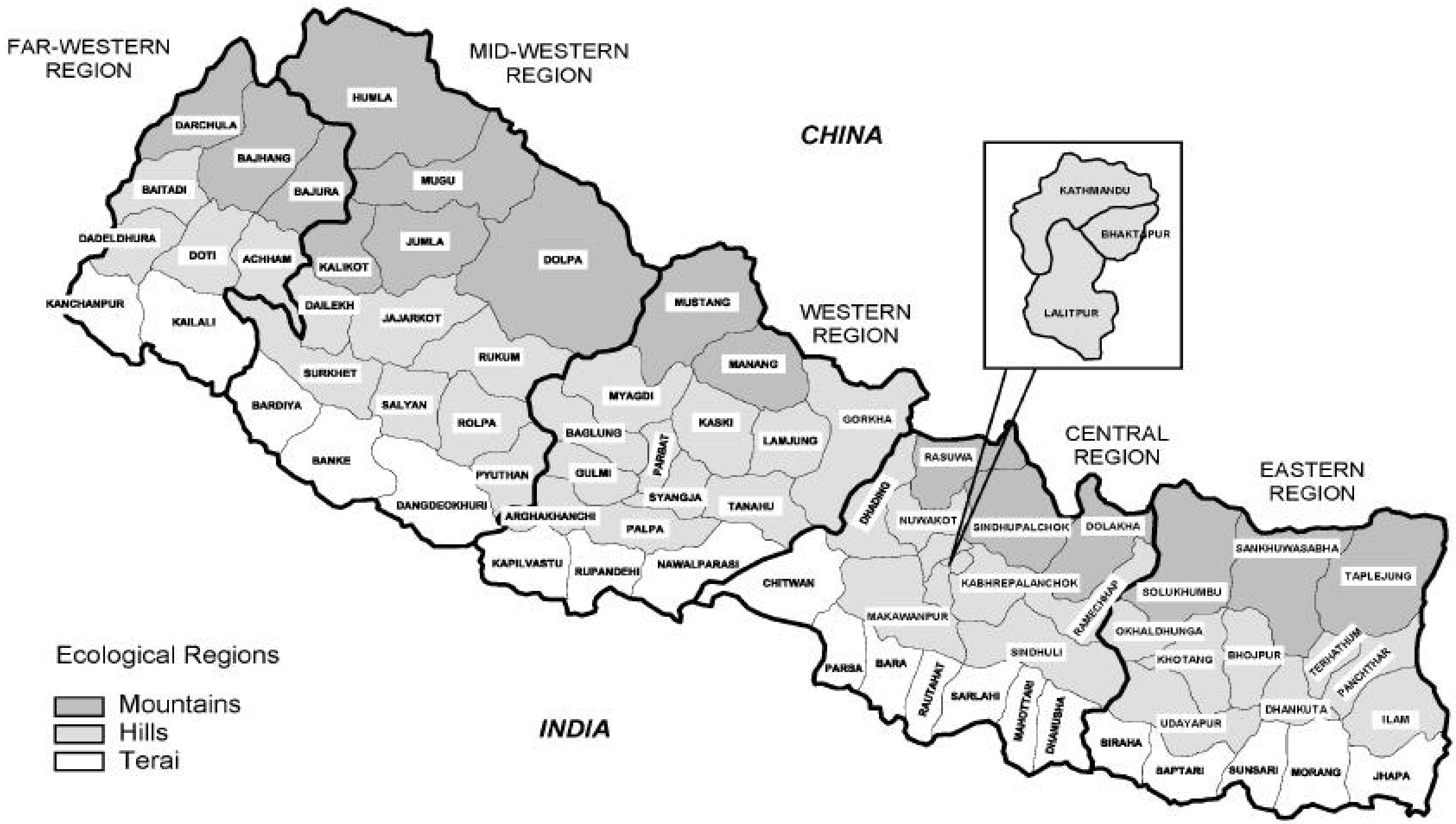
## DATA

### The two surveys

As already mentioned, the data are from Nepal's 1996 and 2001 Demographic and Health Surveys (DHS). Both survey samples were *de facto,* meaning that persons who slept in the household during the night before the interview, including visitors, were interviewed. Each survey included a household schedule, with the household head or any other knowledgeable adult in the household responding for the entire household, and an individual schedule administered to each individual ever-married woman between the ages of 15 and 49 within the sampled households.

The 1996 DHS was a national survey based on a representative sample of households throughout the country (Ministry of Health, 1997). The 1996 sample included completed interviews for 8,082 households, and, within these households, 8,429 ever-married women age 15–49. The survey was conducted over a six-month period, from mid-January to mid-June 1996. The year before the survey falls mainly in 1995 and is labeled as such in tables that identify time periods before the survey.

Figure 1: Ecological regions, development regions, and districts of Nepal



The 2001 DHS was a national survey based on a representative sample of households throughout the country (Ministry of Health, 2002). The sample included completed interviews for 8,602 households, and, within these households, 8,726 ever-married women.[1] The survey was conducted over a five-month period, from the last week of January through the end of June 2001. The year before the survey falls mainly in 2000 and is labeled as such in tables that identify time periods before the survey.

## Quality of data on ages of women and children

Accurate reporting of ages of women and children is essential for accurate estimation of fertility from survey data. The first step in assessing the quality of age reporting is to visually examine the distribution of the population by age. The age distributions for females in the two surveys are shown in Figures 2 and 3.

In each of the two surveys, the proportion of infants (children age 0, i.e., below one year of age) is considerably higher than the proportions of children age 1, 2, 3, or 4. This may occur not only because of population growth and the cumulative effects of infant and child mortality over successive ages, but also because of emphasis during the training of interviewers on the importance of complete and accurate identification of infants for purposes of computing infant mortality rates and other health indicators for infants. The distribution of children below age 5 by single years of age varies considerably between the two surveys.

Heaping on ages 8, 10, and 12 is commonly observed in south Asian countries (Retherford and Alam, 1985), but the 1996 and 2001 surveys do not conform to this pattern. The 2001 survey shows no heaping on age 10, which is unusual, and the 1996 survey actually shows a deficit at age 10, indicating that interviewers were well-trained to beware of the tendency to indicate age 10 when the ages of children close to age 10 are not known precisely by their mothers. At ages 20 and above, the typical pattern of heaping on ages ending in the digits 0 or 5 is also not very pronounced in the two surveys, indicating that interviewers were well-trained in collecting accurate age data. In the 1996 survey, the moderate heaping on ages 9 and 49 suggests a tendency on the part of interviewers to overcompensate by moving too many girls reported as age 10 to age 9 in order to avoid heaping on age 10, and too many women reported as age 50 to age 49 in order to avoid heaping on age 50.

In general, Figures 2 and 3 indicate that age reporting was quite good in both the 1996 and the 2001 surveys, not only at childhood ages but also at adult ages. This is also indicated by low values of Myers' Index of digit preference (Shryock and Siegel, 1980), which, for females ages 10–69, was 3.01 in the 1996 survey and 1.72 in the 2001 survey. When calculating this index, the ages of ever-married women age 15–49 were first copied over from the individual sample to the household sample, over-riding these women's ages in the household sample.

[1] In the 2001 survey, 6 of the 257 enumeration areas were left out because of security concerns. They were rural areas in the western hill/mountain regions of the country.

Figure 2: Female age distribution: 1996 survey

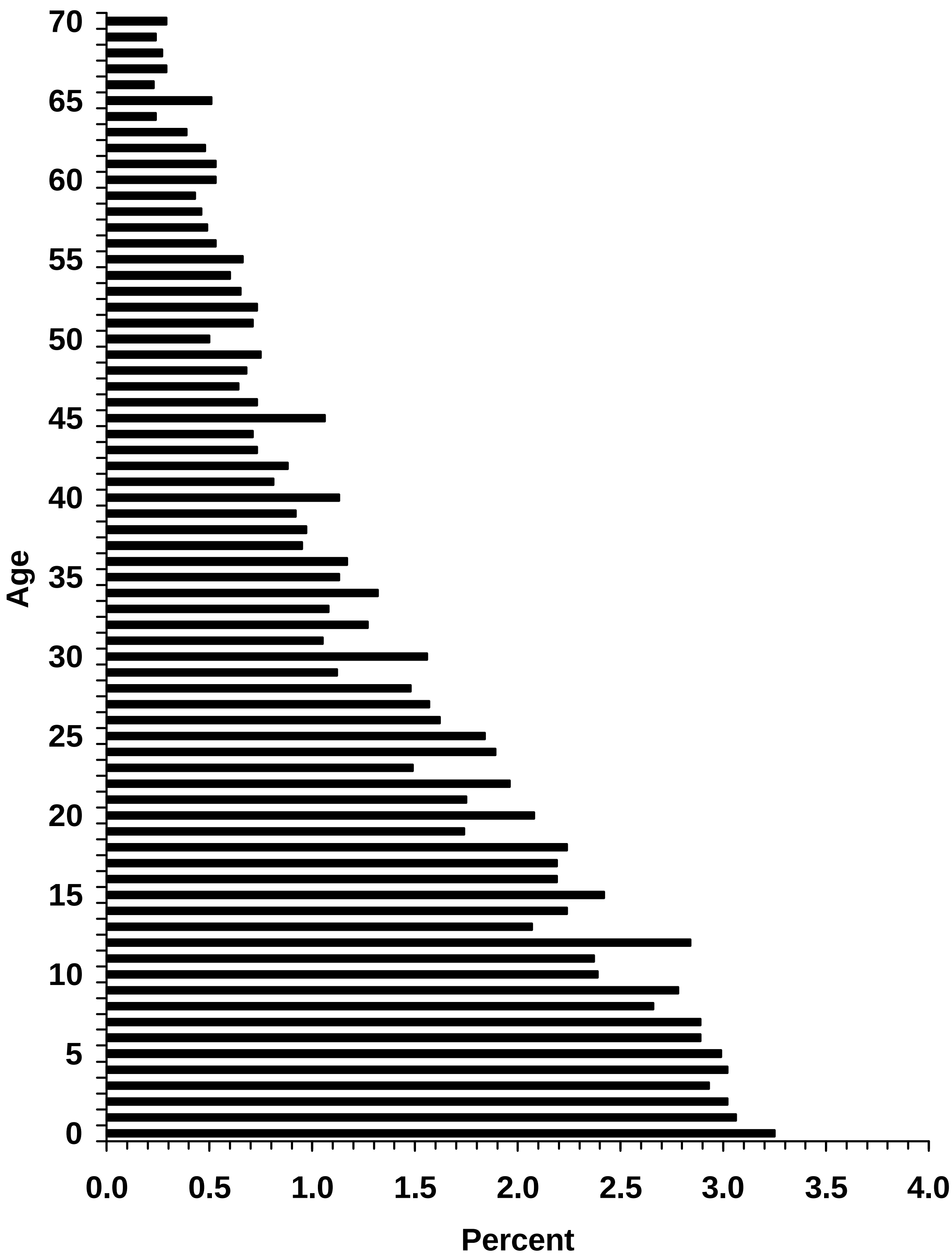
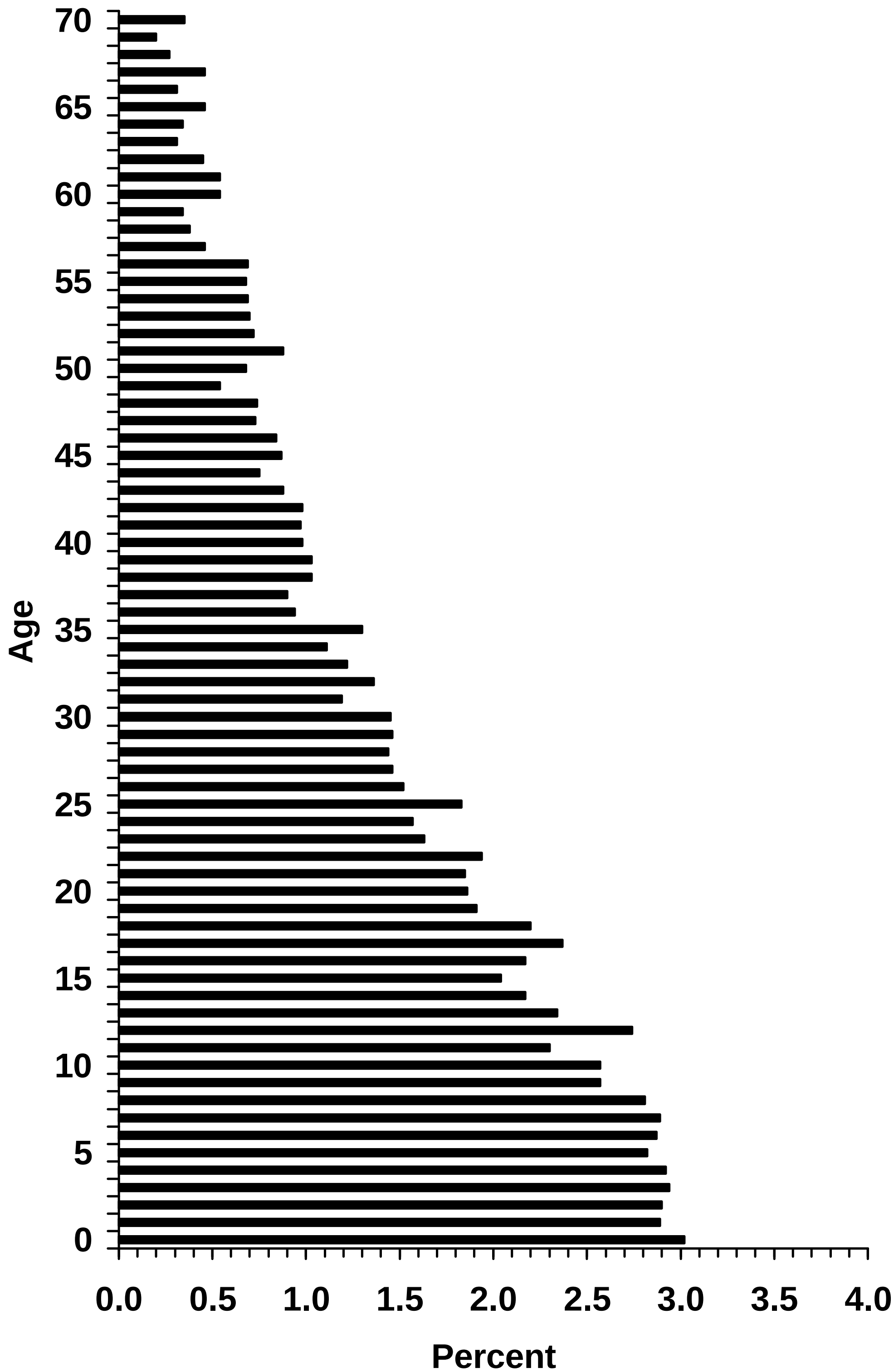


Figure 3: Female age distribution: 2001 survey



The trend in the sex ratio at birth is another useful indicator of data quality. Because there is considerable preference for sons in Nepal, women who forget to mention children who have died or moved away are more likely to omit girls than boys. If such omissions are a problem, then one expects the sex ratio at birth, as ascertained from the birth histories, to become progressively more male in earlier years when omissions are more likely to occur. The sex ratio at birth is largely biologically determined and is usually close to 1.05 male births for every female birth. If female births are selectively omitted, the ratio should be higher than 1.05.

Table 1 shows that, in the 1996 survey, the sex ratio at birth does not become progressively more male in earlier years. Moreover, during the 15 years as a whole before the 1996 survey, the sex ratio at birth is 1.04, slightly less than the expected value of 1.05, indicating that selective omission of girls is not a problem. In the 2001 survey the sex ratio at birth rises from 0.98 in the first five years before the survey to 1.09 in the third five years before the survey. In the 15 years as a whole, however, the sex ratio at birth is only 1.03. These results from the 2001 survey suggest displacement of births but not omission of births. The nature of the displacement is that male births tend to be displaced backward in time to a greater extent than female births.

The evidence that displacement of births is more pronounced in the second survey than in the first suggests that the estimated trend in fertility published in the basic DHS survey reports, which is based on fertility estimates for the three years before each survey, is too steeply downward. The new fertility estimates presented later in this report compensate for this bias.

**Table 1:** Male births, female births, and the sex ratio at birth during the 15-year periods before the 1996 and 2001 surveys

| Survey and time period | Male births | Female births | Sex ratio at birth |
|---|---|---|---|
| 1996 survey | | | |
| 1981-1985 | 3,060 | 2,999 | 1.02 |
| 1986-1990 | 3,582 | 3,406 | 1.05 |
| 1991-1995 | 3,698 | 3,574 | 1.03 |
| **1981-1995** | **10,340** | **9,978** | **1.04** |
| 2001 survey | | | |
| 1986-1990 | 3,152 | 2,881 | 1.09 |
| 1991-1995 | 3,568 | 3,499 | 1.02 |
| 1996-2000 | 3,450 | 3,528 | 0.98 |
| **1986-2000** | **10,170** | **9,907** | **1.03** |

# METHODOLOGY FOR ESTIMATING FERTILITY RATES

In this report, improved estimates of fertility are derived by the own-children method of fertility estimation (Cho *et al*., 1986). For purposes of validation, fertility estimates derived by the own-children method are compared with estimates derived by the birth-history method, which is used to generate the fertility estimates in the basic reports for the 1996 and 2001 DHS surveys.

In the birth history method, as applied here, one simply counts births by age of mother as reported in the birth histories for each year up to the fifteenth year before the survey. Similarly, woman-years of exposure to the risk of birth are counted by woman's age for each year up to the fifteenth year before the survey. The births by age of mother in any given year are then divided by woman-years of exposure by woman's age in that same year to yield estimates of age-specific fertility rates (ASFRs) for that year. Total fertility rates (TFRs) are obtained by summing ASFRs in five-year age groups and multiplying the sum by five. ASFRs can similarly be calculated for longer time periods, such as five-year time periods.

Birth histories were collected only for ever-married women age 15–49. When calculating ASFRs for all women, regardless of marital status, it was assumed that never-married women, for whom limited information is available from the household questionnaire, have had no births. This assumption is reasonable for Nepal, where very few births occur outside marriage.

Because birth histories were collected from women only up to the age of 49, we cannot calculate a complete set of ASFRs for earlier years. For example, the oldest women in the sample, who were age 49 at the time of the survey, were only 44 five years earlier. Therefore, one cannot use the birth-history method to calculate an ASFR for women 45–49 for years earlier than five years before the survey. In this report, we are interested in estimating fertility during the 15-year period preceding the survey. Fifteen years before the survey, the oldest woman in the sample was 34 years old. Therefore, if we want comparable fertility measures for each of the 15 years before the survey, derived alternatively by the own-children method and the birth-history method, we cannot make use of fertility at ages 35 and older. A suitable summary measure of fertility that is comparable over the entire period is CFR(35), i.e., the cumulative fertility rate up to age 35. This measure is calculated by summing ASFRs in five-year age groups from 15–19 to 30–34 and multiplying the sum by five.

The own-children method is a reverse-survival method for estimating ASFRs for years prior to a census or household survey. In the present instance, the method is applied to the 1996 and 2001 DHS household samples (with ages of ever-married women age 15–49 first copied over from the individual sample to the household sample, replacing the ages that were collected in the household 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. A computer algorithm is used for matching. The matched (i.e., own) children, classified by their own age and their mother's age, are then reverse-survived to estimate the number of births by age of mother in each of the 15 years before the survey. Reverse-survival is similarly used to estimate the number of women by age in previous years. After adjustments are made 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 or groups of years before the survey. Estimates are not usually computed further back than 15 years because births must then be based on children age 15 or older at the time of enumeration, a substantial proportion of whom (especially girls who left the household upon marriage) do not reside in the same household as their mother and hence cannot be matched. All calculations are done initially by single years of age and time. Estimates for grouped ages or calendar years are obtained by appropriately aggregating single-year numerators (births) and denominators (women) 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 (Cho *et al*., 1986).

The own-children method may be thought of as fertility estimation from incomplete birth histories. The missing births are those corresponding to dead children and children not living with their mothers. Because of this similarity between the own-children method and the birth history method, fertility estimates derived by these methods suffer from similar biases from displacement of births and age misreporting, as will be discussed further below.

Reverse-survival requires life tables. The own-children fertility estimates derived from the 1996 DHS utilized life expectancies from official life tables by sex for 1981 and 1991 (CBS, 1995). Life expectancies from these life tables were linearly interpolated and extrapolated to other calendar years and then matched to Coale-Demeny Model West life tables (Coale and Demeny, 1967) to obtain complete life tables by sex for each calendar year. Previous work has shown that fertility estimates derived by the own-children method are affected very little by errors in the mortality estimates, if present (Cho *et al*., 1986).

The own-children method, which is based on data from the household sample, is not constrained by the problem of age truncation at age 50. It therefore allows estimation of ASFRs and TFRs for each of the 15 years prior to each survey. For this reason, it is our preferred method for estimating fertility trends from the 1996 and 2001 surveys.

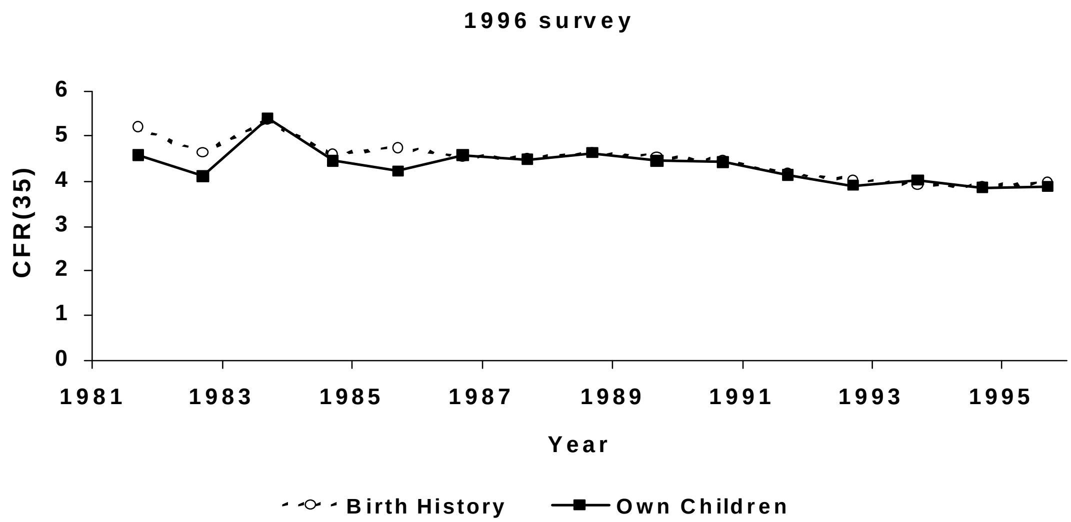
## FERTILITY ESTIMATES

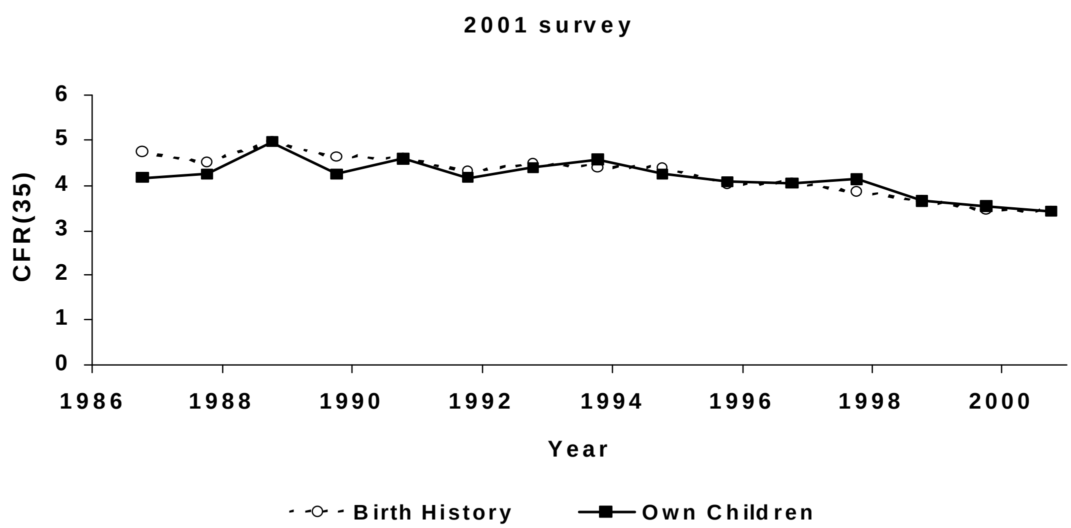
The analysis leading up to the improved fertility estimates is organized as follows: First we compare trends in CFR(35) during the 15-year period preceding each survey, estimated alternatively by the own-children method and the birth history method.  The purpose of this comparison is to validate the subsequent use of the own-children method.  Having validated the own-children method, we then move on to present results of applying the own-children method to the two surveys. This section includes an analysis of overlapping trends in TFRs and ASFRs estimated from the 1996 and 2001 surveys. Finally, we synthesize the various estimates into a single trend in the TFR over the period 1978–2000, in an attempt to minimize the biases contained in the trends estimated from each survey separately.

**Trends in CFR(35), estimated alternatively by the birth history method and the own-children method**

Figure 4 shows trends in the cumulative fertility rate up to age 35 [CFR(35)], estimated alternatively by the birth history method and the own-children method applied to each of the two surveys. In each survey, the birth history method and the own-children method yield substantially the same trend in CFR(35). The agreement is not quite as good 10–14 years before each survey as it is in years closer to the survey, indicating that results presented below for the period 10–14 years before the survey must be interpreted more cautiously than results for more recent years.

Figure 4: Trend in CFR (35), estimated alternatively by the birth history method and the own-children method from the 1996 and 2001 surveys



The year-to-year fluctuations in the fertility estimates 10–14 years before the survey, as trend in the TFR will be based TFRs calculated for the combined 15-year time period preceding each survey, so that annual fluctuations within each of these 15-year time periods are effectively averaged out.

The estimates derived by the birth history method and the own-children method, as shown in Figure 4, agree sufficiently well to justify the use of the own-children method in the remainder of this report.

### Trends in the TFR and ASFRs

Table 2 shows trends in the TFR and ASFRs for the whole country, derived from the 1996 and 2001 surveys. The table shows estimates for three 5-year time periods as well as the combined 15-year period immediately preceding each survey.

**Table 2:** Trends in age-specific birth rates and total fertility rates for the whole country, estimated from the 1996 and 2001 surveys

| | 1996 survey | | | | 2001 survey | | | |
|---|---|---|---|---|---|---|---|---|
| Fertility measure | 1981-1985 | 1986-1990 | 1991-1995 | **1981-1995** | 1986-1990 | 1991-1995 | 1996-2000 | **1986-2000** |
| ASFRs | | | | | | | | |
| 15-19 | 140 | 143 | 121 | **134** | 135 | 138 | 111 | **127** |
| 20-24 | 271 | 290 | 268 | **276** | 282 | 287 | 259 | **275** |
| 25-29 | 277 | 260 | 230 | **254** | 270 | 256 | 225 | **248** |
| 30-34 | 221 | 208 | 172 | **198** | 204 | 177 | 153 | **176** |
| 35-39 | 146 | 126 | 109 | **126** | 132 | 129 | 88 | **115** |
| 40-44 | 65 | 56 | 41 | **54** | 62 | 52 | 42 | **51** |
| 45-49 | 16 | 11 | 13 | **14** | 12 | 12 | 6 | **10** |
| TFR | 5.68 | 5.48 | 4.77 | **5.27** | 5.48 | 5.25 | 4.42 | **5.01** |

Note: The estimates of TFRs and ASFRs in this table and in all subsequent tables are derived by the own-children method. TFRs are per woman, and ASFRs are per thousand women. The trends over five-year periods, as estimated from each survey separately, are biased and should not be regarded as true trends. See text for explanation.

The table indicates a number of peculiarities and inconsistencies in the estimated trends. The trends in the TFR estimated from each survey separately (which we refer to as within-survey estimates of the trend) indicate relatively steep declines in the TFR during the 15 years preceding each survey. In contrast, the trend estimated from two values of the TFR computed for the combined 15-year period preceding each survey (which we refer to as the between-survey estimate of the trend) is much more gradual.

The two within-survey trends in the TFR are quite inconsistent with each other. The estimates from the first survey show a drop from 5.68 in 1981–85 to 4.77 in 1991–95. The estimates from the second survey then show an increase back to 5.25 in 1991–95 followed by a drop to 4.42 in 1996–2000. The comparison of estimates from the two surveys indicates that the sequence of three estimates derived from each survey separately start too high and end too low. As a consequence, each of the two within-survey trends indicates a considerably faster rate of decline in the TFR than does the between-survey trend. Based on estimates for the first and third 5-year periods before each survey, the within-survey rates of decline are 0.091 child per woman per year from the 1996 survey and 0.106 child per woman per year from the 2001 survey. In contrast, the between-survey rate of decline, based on estimates aggregated over the 15-year time period before each survey, is 0.052 child per woman per year.

Another oddity is that each survey separately shows a high and fairly constant value of ASFR(15–19) during the first two 5-year periods, followed by a sharp drop in the third (most recent) 5-year period. In contrast, the between-survey trend, based on aggregation over 15-year time periods, shows a very small drop in ASFR(15–19). In the case of ASFR(20–24), each survey separately shows a substantial declines over the three 5-year time periods, whereas the between-survey trend indicates a quite small decline at 25–29 and a somewhat larger decline at 30–34. A larger decline at 30–34 is expected, inasmuch as family limitation commences at the older reproductive ages.

Overall, it is evident from Table 2 that the within-survey estimates of trend are severely biased, whereas the between-survey estimates of trend look quite reasonable. The nature of the biases affecting the trend estimates are discussed in more detail in the next two sections.

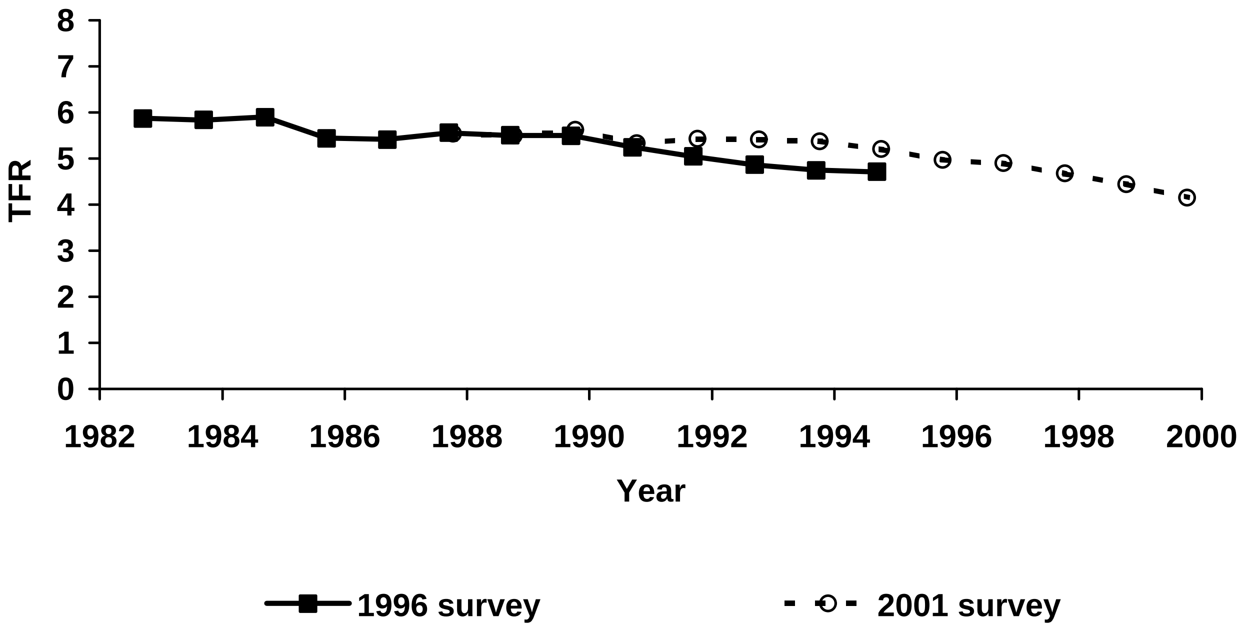
**Bias from displacement of births and misreporting of women's ages**

The inconsistencies in Table 2 result mainly from displacement of births and misreporting of women's ages. The TFR trends estimated from each survey separately clearly indicate some displacement of births from the first five years before the survey to the second five years before the survey, and from the second five years to the third five years before the survey. At the same time, there does not appear to be much displacement from the third five years to the fourth five years before the survey, inasmuch as there is little or no heaping on age 15 in either of the two surveys, as seen earlier in Figures 2–3. (It should be borne in mind, however, that displacement can occur even in the absence of heaping.) Thus, displacement tends to result in underestimates of fertility in the first five years before the survey and overestimates in the second and third five years before the survey.

Some of this displacement of births (which, in the case of living children, is equivalent to exaggerating children's ages at the time of the survey) is due to intentional displacement on the part of interviewers who wish to avoid asking the block of questions asked of young children, as discussed earlier, and some occurs because of upward rounding of children's ages by survey respondents. (For example, a child age 2 years and 10 months might be reported as age 3.) Because births during the year before the survey (corresponding to children age 0 at the time of the survey) occurred recently, their dates of birth are probably remembered relatively accurately, so that relatively few of these births get displaced into the previous year as a consequence of upward rounding of infants' ages to age 1. It seems likely, however, that a larger proportion of children age 1 are erroneously reported as age 2, especially by adults who do not remember the exact birth dates and ages of their children. This kind of upward rounding of ages of children effectively displaces their births further into the past.

A more detailed picture is provided by overlapping TFR trends over single calendar years, derived from the two surveys. The overlapping trends are graphed in Figure 5. The substantial inconsistencies in the two trends for calendar years 1992–95 are additional evidence that the fertility estimates derived from the 1996 survey for those years are underestimates and the fertility estimates from the 2001 survey for those years are overestimates, as a result of displacement of births away from the survey date in both surveys.

Figure 5: Overlapping trends in the TFR, estimated from the 1996 and 2001 surveys




Displacement of births results also in an age pattern of bias (pertaining to the estimates of ASFRs) that is superimposed on the overall bias just described. Displacement of births to earlier years tends to shift the age curve of fertility to the left—i.e., to younger ages. This occurs because shifting birth dates to earlier years is equivalent to shifting irths to younger ages of mothers. Shifting the age curve of fertility to the left results in an upward bias in estimates of fertility below the peak age of fertility (mainly at 15–19) and a downward bias in the estimates of fertility above the peak age of fertility (mainly 25–29 and higher age groups).

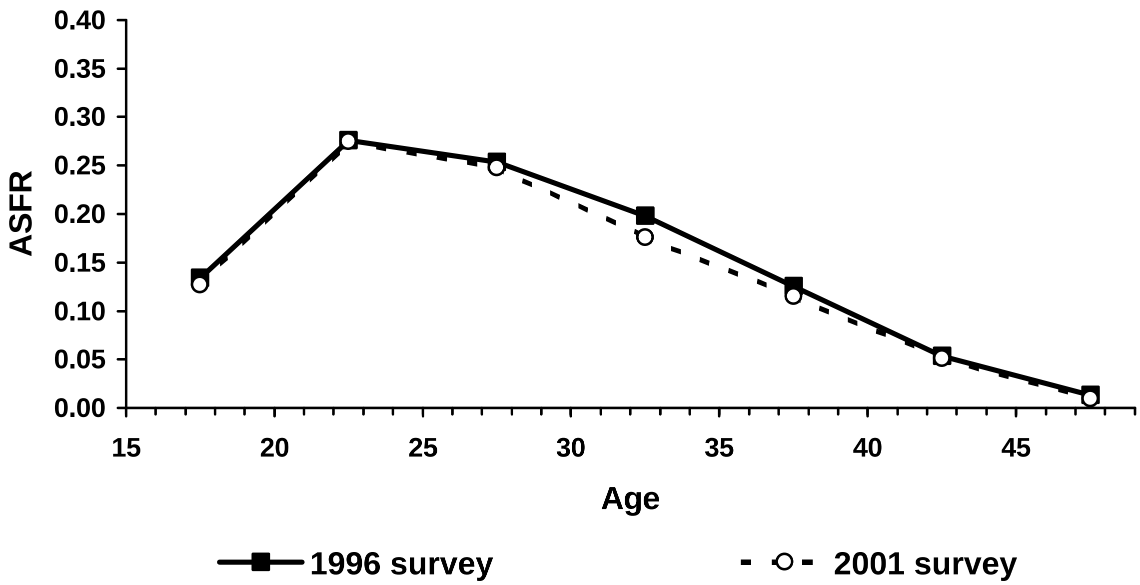
Displacement is not the only source of bias affecting the age pattern of fertility. Misreporting of women's ages tends to shift the age curve of fertility to the right — i.e., to older ages. In this type of age misreporting, there is a net upward bias in reported ages of women who are young but married, and of married women who have a higher than average number of children relative to their true age. There may also be some downward bias in reported ages of older single women and married women who have a lower than average number of children relative to their true age.

These leftward and rightward shifts of the estimated age curve of fertility have been discussed in more detail by Narasimhan *et al*.,(1997a; 1997b) in the case of India and by Retherford and Thapa (1998; 1999) in the case of Nepal. The net effect of the leftward and rightward shifts is not entirely clear and may vary from one survey to the next. As explained by Retherford and Thapa (1999), however, displacement of births and misreporting of women's ages, combined with some real fertility decline, could result in the kind of inconsistencies observed in Table 2—namely (1) within-survey estimates of TFR decline that are too steep; (2) between-survey estimates of TFR decline, based on 15-year time aggregations, that are fairly accurate; (3) within-survey estimates of substantial declines in ASFRs at 15–19 and 20–24 that are probably spurious, inasmuch as these ASFRs probably changed little over the time period spanned by the two surveys; and (4) between-survey estimates of declines in ASFRs that may be about right in the case of Nepal because the extent of age misreporting does not differ much between the 1996 and 2001 surveys, as seen earlier in Figures 2 and 3. (Note, however, that the age curve of fertility derived for the 15-year time period before each survey separately may still be somewhat distorted because of net shifting of the curve to the left or right.)

Between-survey estimates of the age-pattern of fertility (based on own-children estimates of ASFRs for the 15-year period preceding each survey) are shown in Figure 6. Fertility declined virtually not at all at ages 15–19 and 20–24. The fertility decline that did occur was concentrated at ages 25–29, 30–34, and 35–39, consistent with increasing use of contraception for purposes of family limitation. Despite the 15-year aggregation, the two ASFR curves may still be shifted somewhat to the left or right, for reasons already explained. The net shift should be similar in the two curves, because the pattern of age misreporting is similar in the two surveys. Therefore, biases in the estimates of ASFRs resulting from the shift should mostly cancel out when computing changes in ASFRs, so that the estimated changes in ASFRs as shown in Figure 6 should be fairly accurate.

Although displacement distorts to some extent the 15-year-aggregated estimates of ASFRs, it should have practically no distorting effect on the 15-year-aggregated estimates of the TFR, for three reasons: First, births displaced over the time boundary 15 years before the survey are a very small proportion of the much larger number of births that occurred during the entire 15-year period. Second, displacements of births within the 15-year time period tend to cancel out in the aggregate. In terms of ASFRs, this means that any displacement-induced distortion in one ASFR tends to be offset by compensating distortions in the other direction in other ASFRs. Third, because fertility is low at the extremes of the reproductive age span, shifting the age curve of fertility to the left or right means that the shifted ASFRs still add up to approximately the same number of children per woman—i.e., to the same value of the TFR.

Figure 6: Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys




Note: In this figure and all subsequent figures, ASFRs and derived TFRs are estimated by the own-children method.

**Fertility estimates by urban/rural residence and geographic region**

Own-children fertility estimates can also be generated by geographic region and by socioeconomic characteristics, as long as regional membership and socioeconomic characteristics do not change for women after they reach age 15. Because only a very small proportion of individuals in a region migrate out of the region each year, regional membership does not change after age 15 for the vast majority of individuals. This lack of change also typifies some, but by no means all, socioeconomic characteristics. For example, in almost all cases in Nepal a woman's education is complete by age 15 and does not change after age 15. In contrast, woman's activity status (in the labor force or not in the labor force) may change when she gets married or has a child or when her children become older. This means that one cannot produce own-children fertility estimates by activity status for years before the survey, because a woman's activity status is known only at the time of the survey and may have been different earlier.

If the assumption of constancy of characteristics is violated for only a very small proportion of women, the violation will not appreciably bias the own-children fertility estimates by characteristics for earlier years. Thus, in the case of fertility estimates by region, the bias is probably quite small. In the case of fertility estimates by urban/rural residence, however, the bias is larger, at least in Nepal, because urbanization is proceeding rapidly from a very small urban base, so that a sizeable proportion of urban residents were rural only a few years before. This means that the own-children fertility estimates for urban areas in prior years are in fact a mix of urban and rural, so that the urban fertility estimates are increasingly biased upward the further back one goes in time, because rural fertility is higher than urban fertility.

This kind of bias is not a serious problem in the case of own-children fertility estimates for rural areas. This is so partly because the movement of persons is out of rather than into rural areas, so that a woman who was rural at the time of the survey was also rural in earlier years. Of course, there may still be some bias if urban migrants had atypical fertility while they were still rural, but this bias is probably quite small, especially since migrants in Nepal are a much smaller proportion of the relatively large rural population than they are of the relatively small urban population. We therefore expect that the own-children fertility estimates will be more consistent and accurate for rural areas than for urban areas. The question is, how big is the bias in the case of the own-children fertility estimates for urban areas?

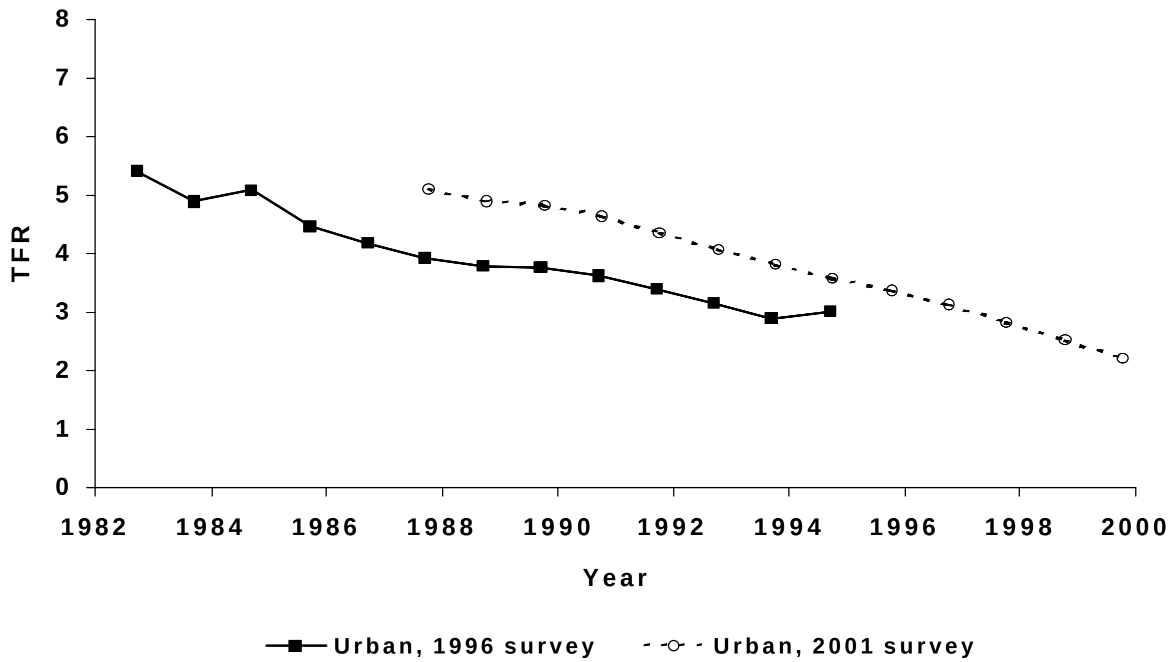
Table 3 and Figure 7 shed some light on this question. In the upper graph in Figure 7 (which is based on 3-year moving averages of TFRs in order smooth out annual fluctuations), the overlapping TFR trends for urban are sharply divergent. Consider the year 1994, for example. In 1994 the urban TFR estimated from the 2001 survey is considerably higher than the urban TFR estimated from the 1996 survey. The reason for this discrepancy is that 1994 is seven years before the 2001 survey but only two years before the 1996 survey, implying a higher proportion of urban women from the 2001 survey than from the 1996 survey who were actually rural in 1994. Because rural fertility is higher than urban fertility, the urban TFR in 1994 estimated from the 2001 survey is more upwardly biased than the urban TFR in 1994 estimated from the 1996 survey. The discrepancies for the other calendar years between 1987 and 1993 are in the same direction and are similarly explained. Not only are the levels of the urban TFR estimates too high, but also the urban TFR trend estimated from each survey is too steeply downward. This is so because the proportion of urban women who were actually rural increases as one goes back in time.

In contrast to the urban TFR trends in Figure 7, the two rural TFR trends in the lower graph agree quite well, although they still show evidence of displacement of births to earlier years, as expected.

The bias in the urban TFR estimates is not entirely solved by aggregating over the entire 15-year period before each survey, because it is still the case that some of the fertility during the 15-year period that is classified as urban was in fact rural. On the other hand, the trend indicated by the two 15-year urban TFR estimates should be fairly accurate, even though the levels are too high.

The 15-year-aggregated TFR estimates for urban and rural are shown in Table 3. Whereas the two within-survey estimates of the TFR trend in Figure 7 each indicate (erroneously) that urban fertility fell more rapidly than rural fertility, Table 3, based on 15-year-aggregated estimates, shows that fertility fell by about a quarter of a child in both urban and rural areas. Although the 15-year aggregated estimates of the urban TFR are upwardly biased, the 15-year-aggregated estimates of the rural TFR in Table 3 do not appear to be biased upward or downward.

Figure 7: Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by urban-rural residence, from the 1996 and 2001 surveys



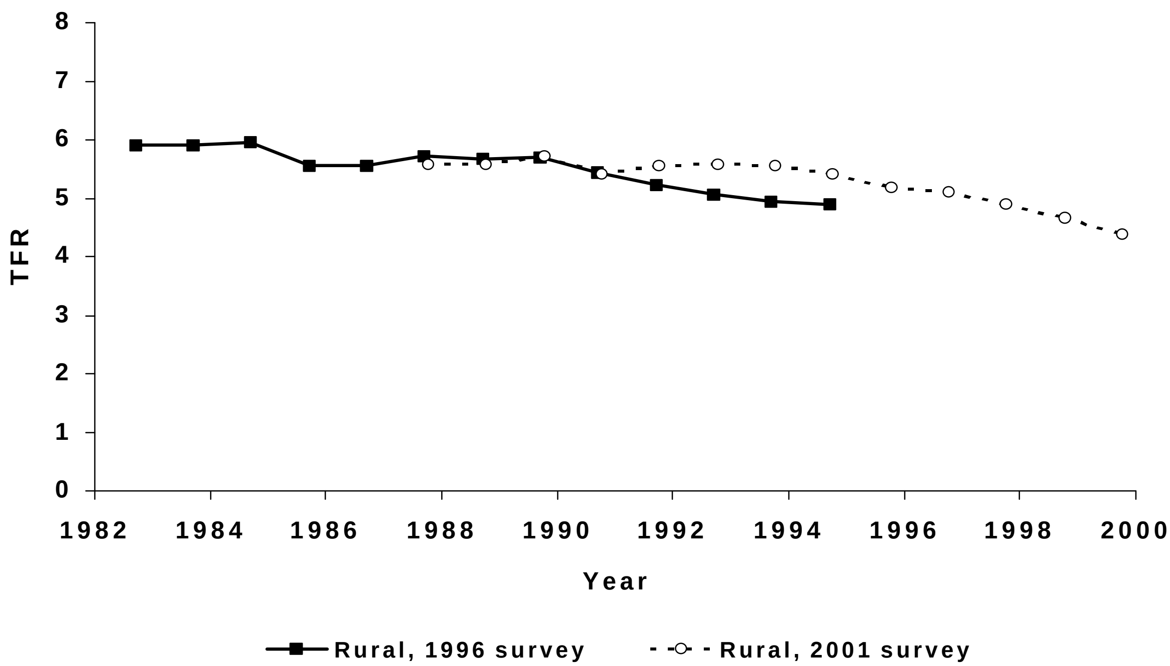



**Table 3**: Fertility by residence, estimated for the 15-year periods preceding the 1996 and 2001 surveys

| Fertility measure | Urban 1981-1995 | Urban 1986-2000 | Rural 1981-1995 | Rural 1986-2000 |
|---|---|---|---|---|
| ASFRs | | | | |
| 15-19 | 132 | 116 | 135 | 128 |
| 20-24 | 243 | 233 | 280 | 280 |
| 25-29 | 181 | 177 | 262 | 256 |
| 30-34 | 110 | 116 | 207 | 183 |
| 35-39 | 78 | 62 | 130 | 122 |
| 40-44 | 31 | 19 | 56 | 55 |
| 45-49 | 2 | 4 | 14 | 10 |
| TFR | 3.88 | 3.64 | 5.42 | 5.17 |

Note: The estimates for 1981-95 are derived from the 1996 survey, and the estimates for 1986-2000 are derived from the 2001survey. TFRs are per woman, and ASFRs are per thousand women. As explained in the text, the urban TFR estimates are upwardly biased, but the estimated extent of decline in the urban TFR is probably not biased.

Estimates of how ASFRs changed between the two surveys in urban areas and rural areas are shown in Figure 8, based on estimates for the 15-year period immediately preceding each survey. In urban areas, fertility declined at both young and old reproductive ages, suggesting some increase in age at marriage and/or increased use of spacing methods of contraception at the younger reproductive ages as well as increasing use of contraception for family limitation at the older ages. In rural areas, on the other hand, fertility decline occurred only at the older reproductive ages. Again, in both urban areas and rural areas, the two ASFR curves considered individually may be somewhat biased because of shifting of the curves to the left or right, but because the biases tend to cancel out when computing change, the estimated changes in ASFRs should be fairly accurate.

Table 4 and Figure 9 show own-children fertility estimates for each of the four development regions. Fifteen-year-aggregated TFR estimates are shown in Table 4, and overlapping trends of 3-year moving averages of TFRs are shown in Figure 9. In Figure 9, the overlaps are reasonably good, although there is evidence of displacement in all the development regions except possibly the Mid- and Far-western region. The 15-year-aggregated estimates of the TFR in Table 4 indicate TFR declines of about one-half child in the Mid- and Far-Western region, about one-third child in the Western and Eastern regions, and no decline at all in the Central region. In the more recent 15-year period 1986–2000, the TFR was highest in the Mid- and Far-western region, at 5.53, and lowest in the Eastern region, at 4.63.

Figure 8: Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys

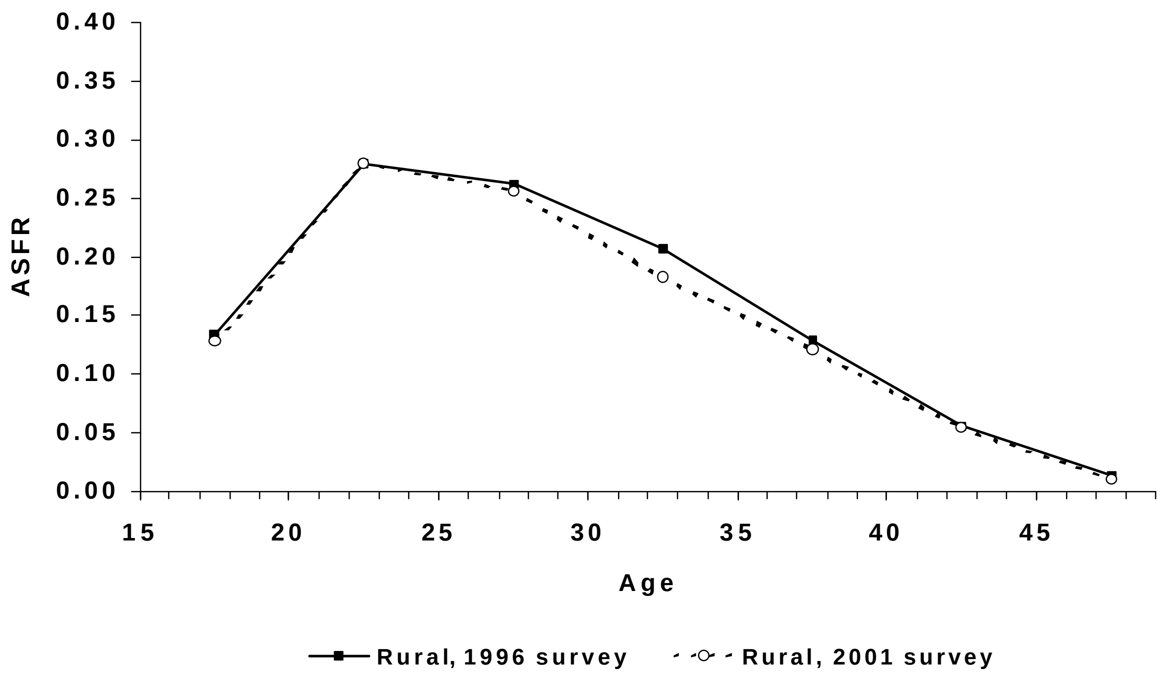
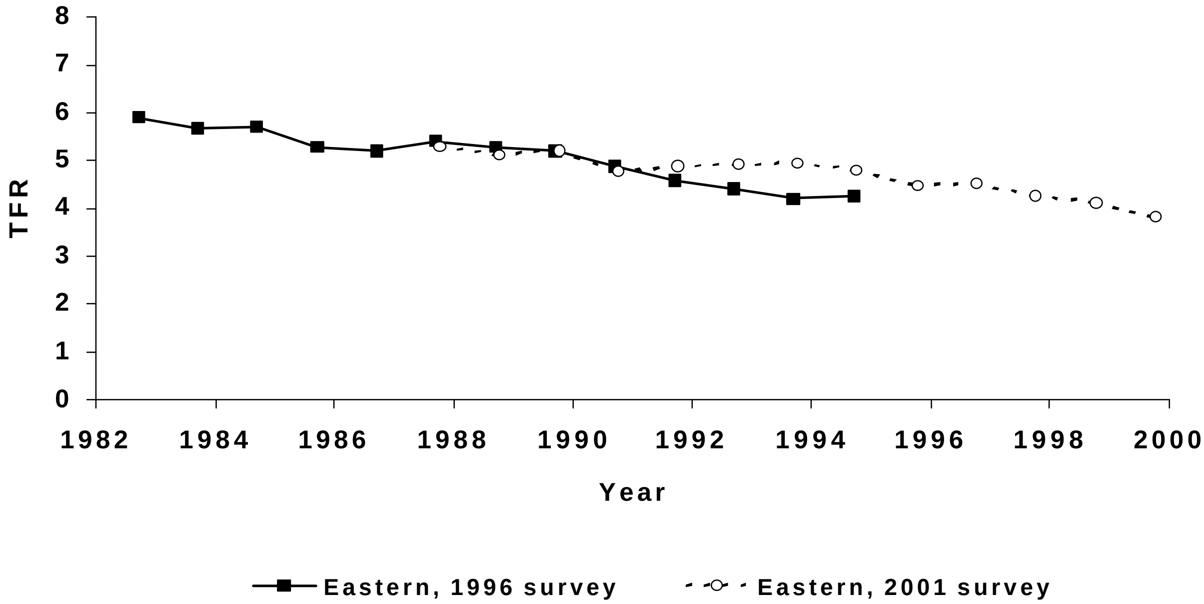



Figure 9: Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by development region, estimated from the 1996 and 2001 surveys



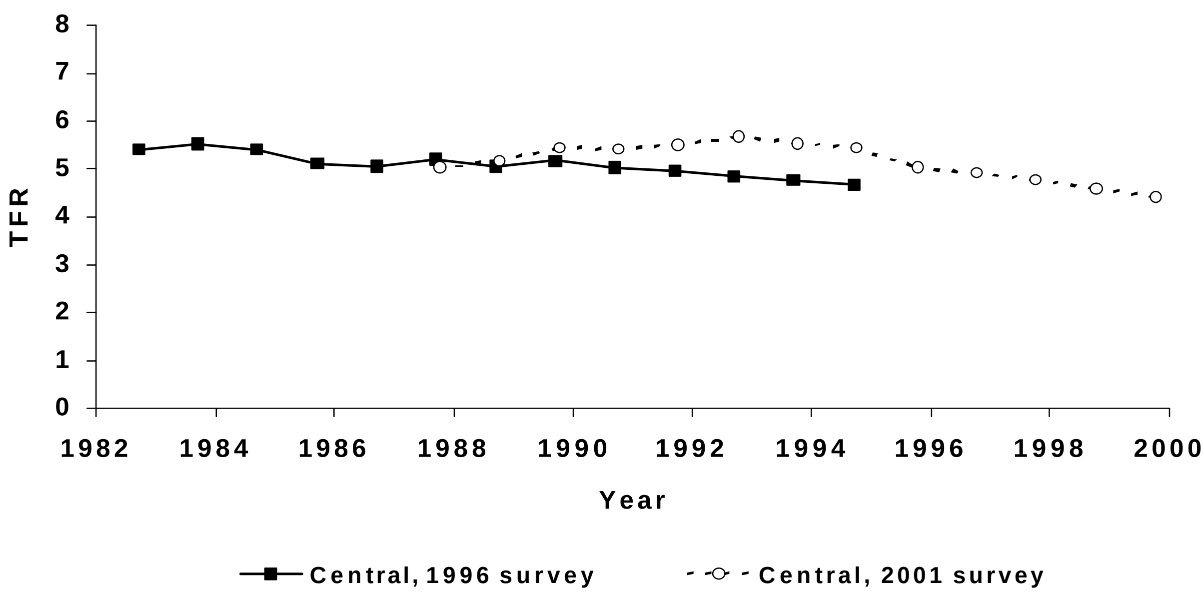
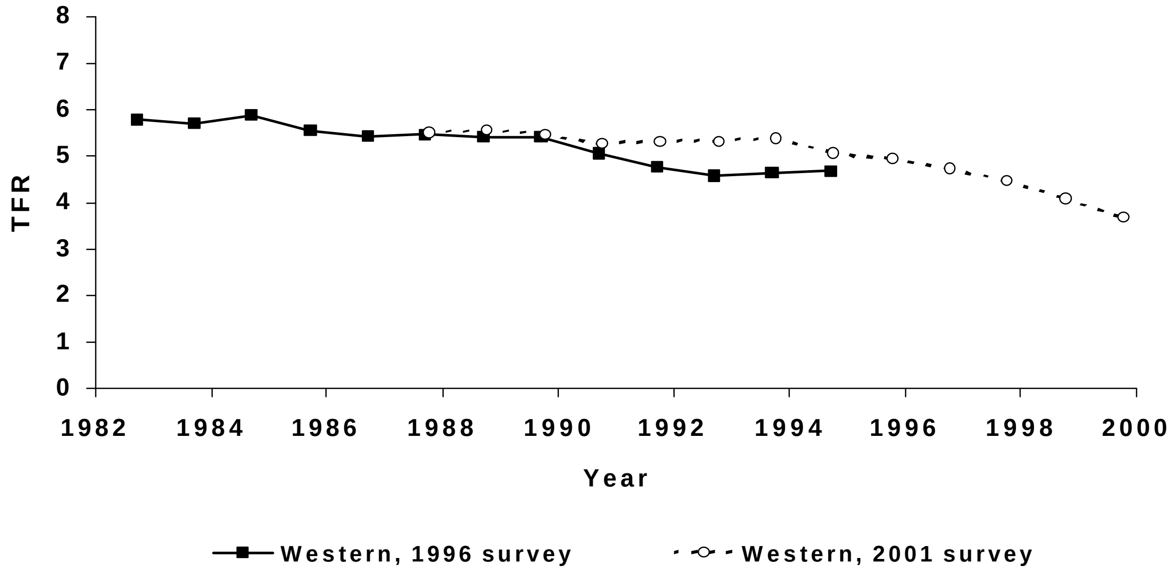



Figure 9 (cont.): Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by development region, estimated from the 1996 and 2001 surveys



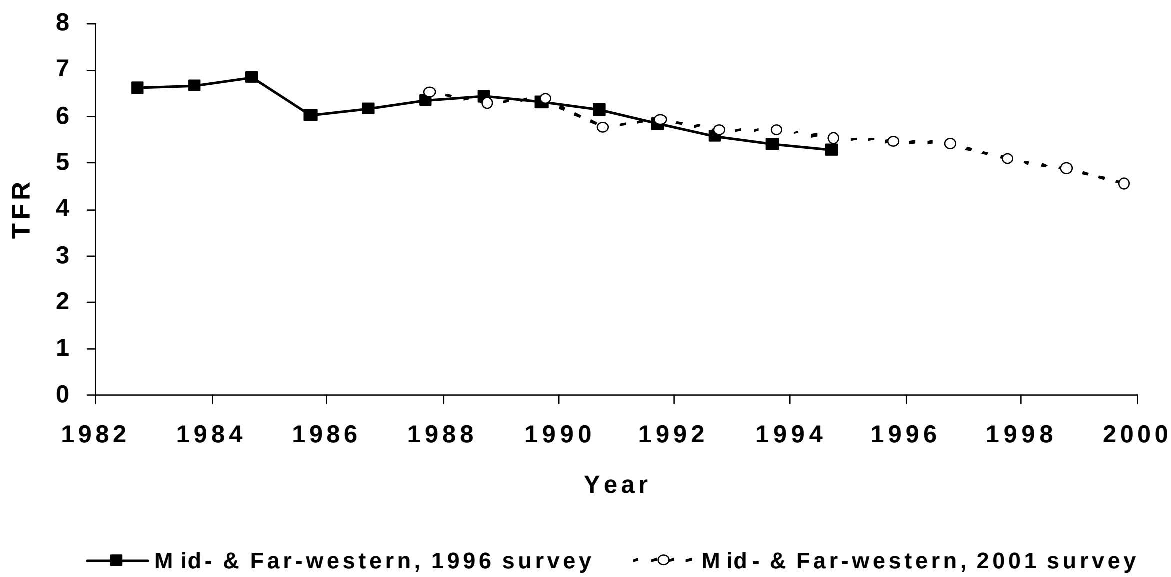



**Table 4**: Fertility by development region, estimated for the 15-year periods preceding the 1996 and 2001 surveys

| | Eastern | | Central | | Western | | Mid- & Far-western | |
|---|---|---|---|---|---|---|---|---|
| Fertility measure | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 |
| ASFRs | | | | | | | | |
| 15-19 | 118 | 100 | 145 | 139 | 130 | 126 | 143 | 140 |
| 20-24 | 268 | 257 | 265 | 284 | 286 | 263 | 297 | 292 |
| 25-29 | 242 | 239 | 242 | 246 | 253 | 246 | 280 | 263 |
| 30-34 | 182 | 171 | 185 | 169 | 196 | 167 | 231 | 201 |
| 35-39 | 120 | 104 | 108 | 112 | 126 | 115 | 156 | 133 |
| 40-44 | 55 | 49 | 50 | 49 | 39 | 46 | 75 | 63 |
| 45-49 | 16 | 6 | 11 | 9 | 10 | 9 | 20 | 15 |
| TFR | 5.00 | 4.63 | 5.03 | 5.04 | 5.20 | 4.85 | 6.01 | 5.53 |

Note: The estimates for 1981-95 are derived from the 1996 survey, and the estimates for 1986-2000 are derived from the 2001survey. TFRs are per woman, and ASFRs are per thousand women.

Estimates of how ASFRs changed between the two surveys in each of the four development regions are shown in Figure 10, based on estimates for the 15-year period immediately preceding each survey. Fertility at 15–19 did not change, except in the Eastern region, where it declined slightly. Fertility declined only at older ages in the Western region and in the Mid- and Far-western region. In the Central region, a slight increase in fertility at age 20–24 was counterbalanced by a slight decline at age 30–34. Again, these estimates of changes should be fairly accurate, despite some likely shifting of the ASFR curves to the left or right.

Table 5 and Figure 11 show own-children fertility estimates for each of the three ecological regions. Again, 15-year-aggregated TFR estimates are shown in the table, and overlapping trends of 3-year moving averages of TFRs are shown in the figure. In Figure 10, for reasons that are not clear, the overlaps are not as good in the Hill region as in the Mountain and Terai regions. The 15-year-aggregated estimates of the TFR in Table 5 indicate TFR declines of about one-fifth of a child in the Hill region, one-fourth of a child in the Mountain region, and slightly more than one-fourth of a child in the Terai region. In the more recent 15-year period 1986–2000, the TFR was highest in the Mountain region, at 5.43, and lowest in the Terai region, at 4.90.

Estimates of how ASFRs changed between the two surveys in each of the three ecological regions are shown in Figure 12, based on estimates for the 15-year period immediately preceding each survey. Fertility at 15–19 declined slightly in the Terai, but remained unchanged in the Hill and Mountain regions. Fertility at older reproductive ages fell in the Terai and Mountain regions, especially the latter. In the Hill region, ASFRs hardly changed, except at age 30–34, where fertility declined slightly. Again, these estimates of changes should be fairly accurate, despite some likely shifting of the ASFR curves to the left or right.

Figure 10: Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys, by development region


Figure 10 (cont.): Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys, by development region

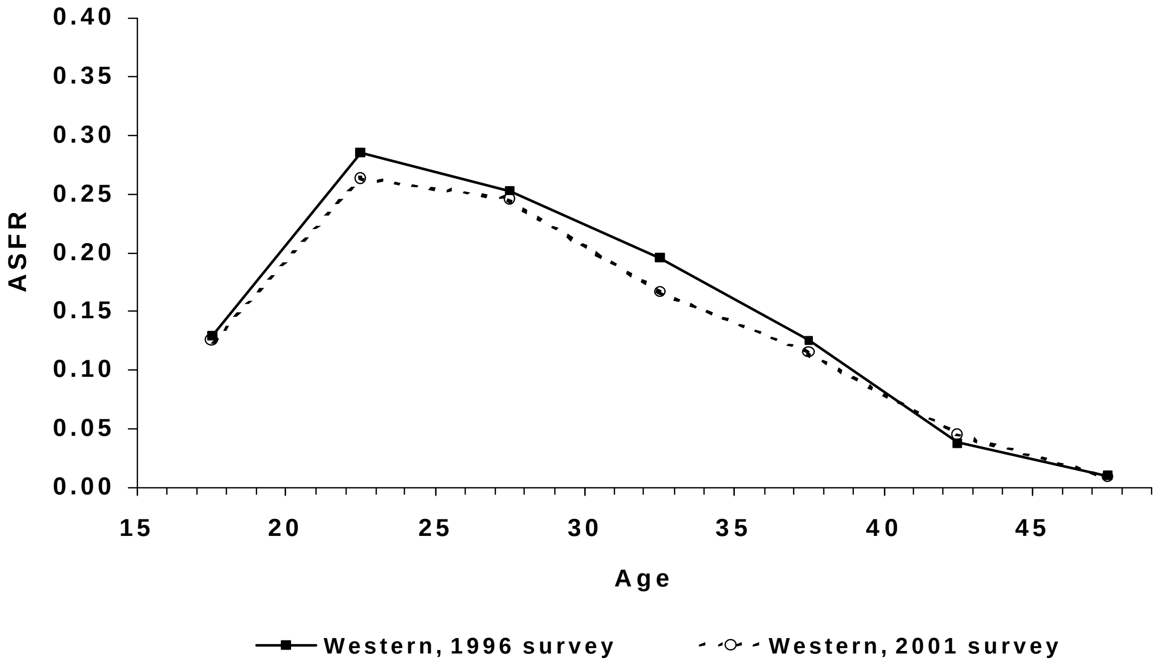
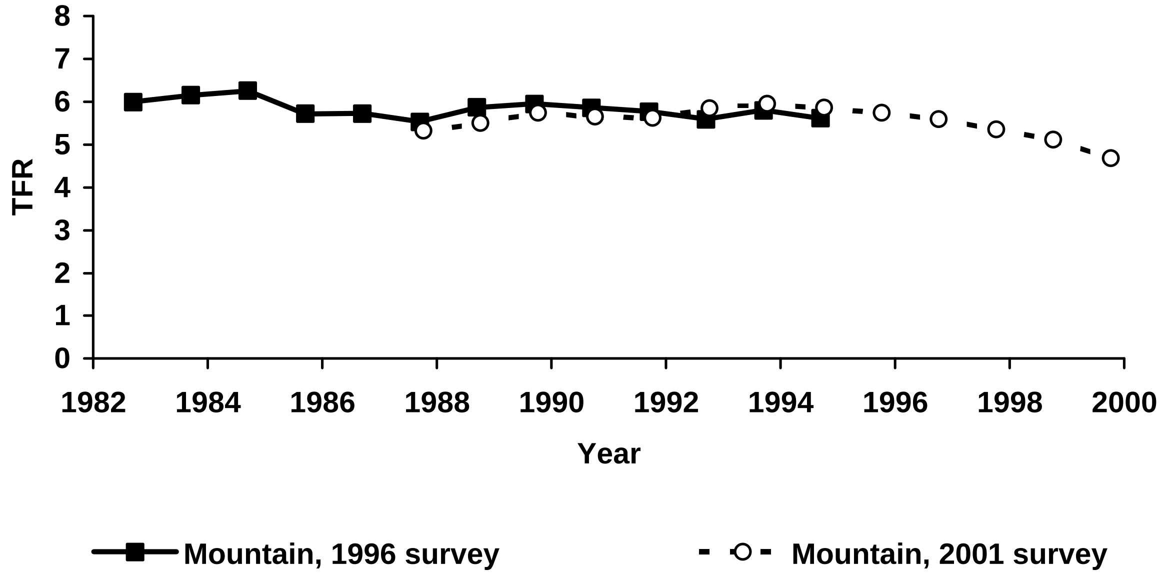



Figure 11: Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by ecological region, estimated from the 1996 and 2001 surveys



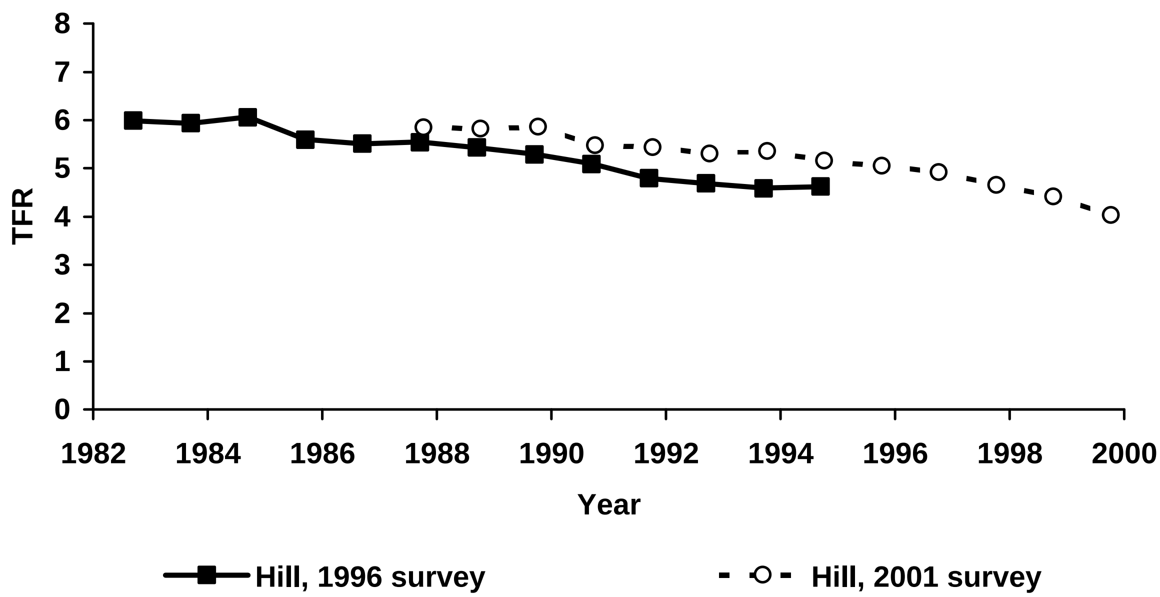



Figure 11 (cont.): Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by ecological region, estimated from the 1996 and 2001 surveys

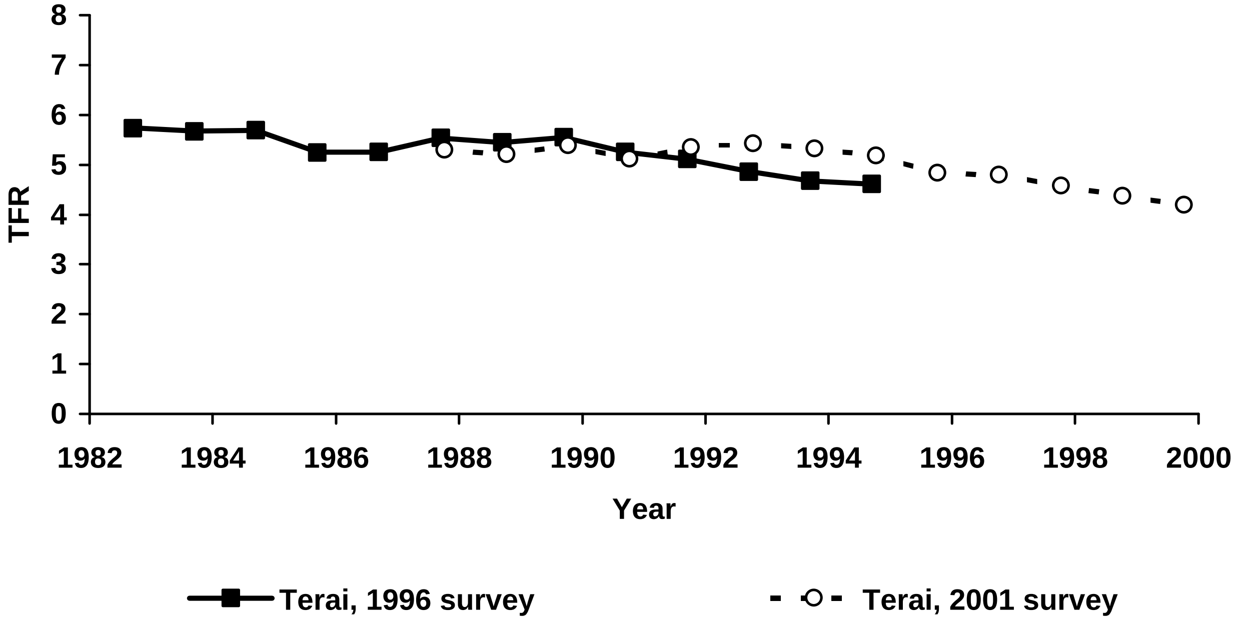
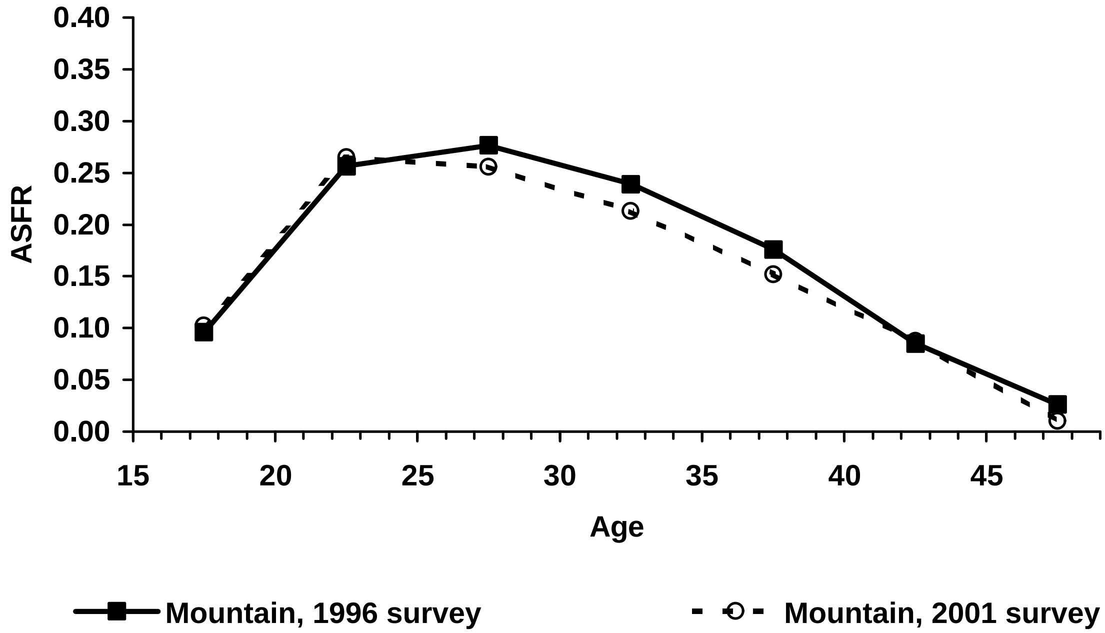


Figure 12: Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys, by ecological region



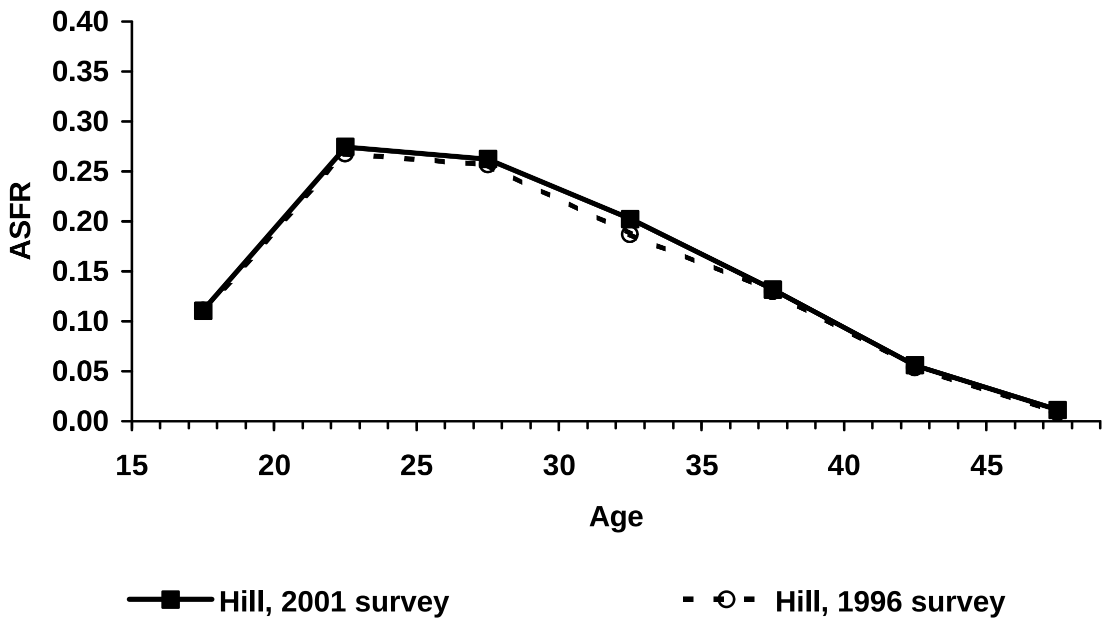



Figure 12 (cont.): Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys, by ecological region

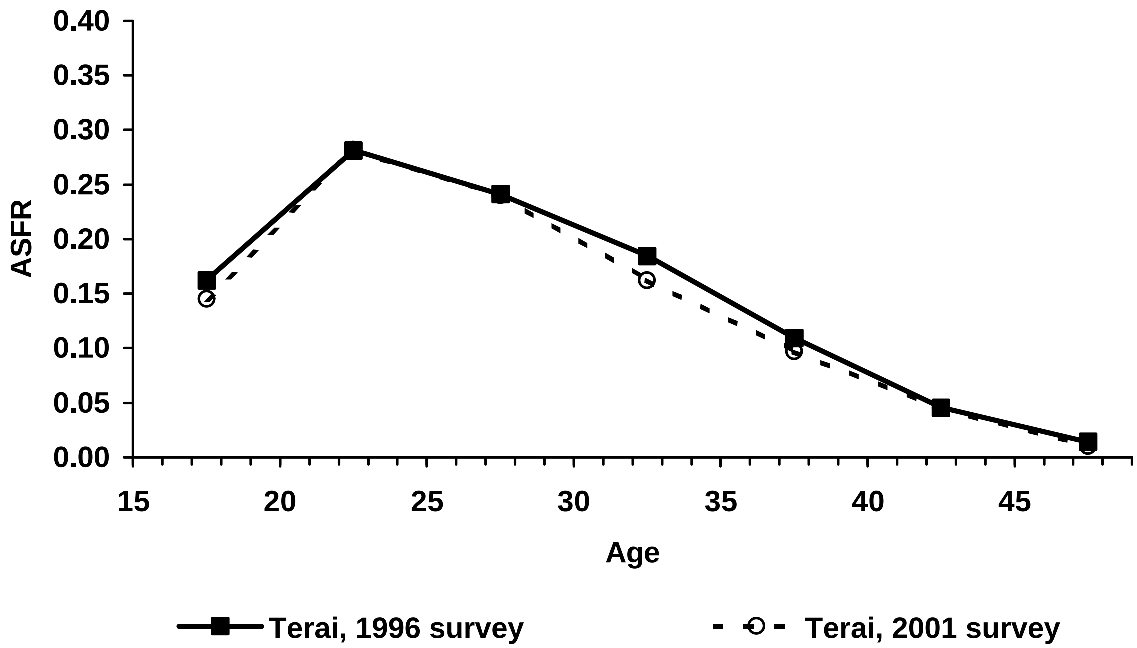


**Table 5**: Fertility by ecological region, estimated for the 15-year periods preceding the 1996 and 2001 surveys

| | Mountain | | Hill | | Terai | |
|---|---|---|---|---|---|---|
| Fertility measure | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 |
| ASFRs | | | | | | |
| 15-19 | 96 | 102 | 111 | 110 | 162 | 145 |
| 20-24 | 256 | 265 | 275 | 267 | 281 | 282 |
| 25-29 | 276 | 256 | 262 | 256 | 241 | 240 |
| 30-34 | 239 | 213 | 202 | 187 | 185 | 162 |
| 35-39 | 176 | 152 | 132 | 130 | 109 | 97 |
| 40-44 | 85 | 88 | 56 | 54 | 46 | 45 |
| 45-49 | 26 | 10 | 11 | 9 | 14 | 10 |
| TFR | 5.78 | 5.43 | 5.24 | 5.06 | 5.19 | 4.90 |

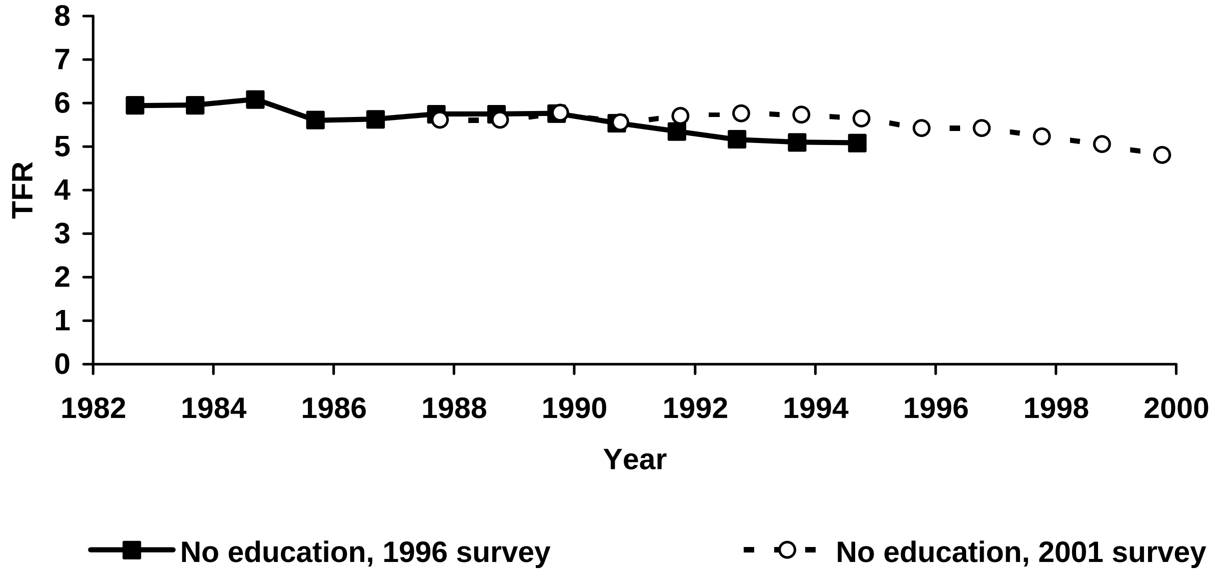
Note: The estimates for 1981-95 are derived from the 1996 survey, and the estimates for 1986-2000 are derived from the 2001 survey. TFRs are per woman, and ASFRs are per thousand women.

## Fertility estimates by education

Table 6 and Figure 13 show own-children fertility estimates by woman’s education. Education is categorized into “no education”, “at least some primary education”, and “beyond primary". (“Primary complete” means completion of grade 5, so “beyond primary” corresponds to beyond grade 5.) In Figure 13, for reasons that are not clear, the overlaps are better for “primary” than for "no education" or "beyond primary". The 15-year-aggregated estimates of the TFR in Table 6 indicate TFR declines of about one-tenth of a child among women with no education, two-thirds of a child among women with at least some primary education, and one-quarter of a child among women with more than a primary education. In the more recent 15-year period 1986–2000, the TFR was highest among women with no education, at 5.41, much lower among women with at least some primary education, at 3.99, and much lower yet among women with more than a primary education, at 2.79.

Estimates of how ASFRs changed between the two surveys in each of the three education categories are shown in Figure 14, based on estimates for the 15-year period immediately preceding each survey. Fertility at 15–19 did not change in any of the education categories. It declined only at older ages. Among women with no education, it declined mainly at ages 30–34 and 35–39. Among women with at least some primary education, it declined in all of the older reproductive age groups, starting at 20–24. Among women with more than a primary education, it declined mainly at age 35–39. Again, these estimates of changes should be fairly accurate, despite some likely shifting of the ASFR curves to the left or right.

Figure 13: Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by education, estimated from the 1996 and 2001 surveys



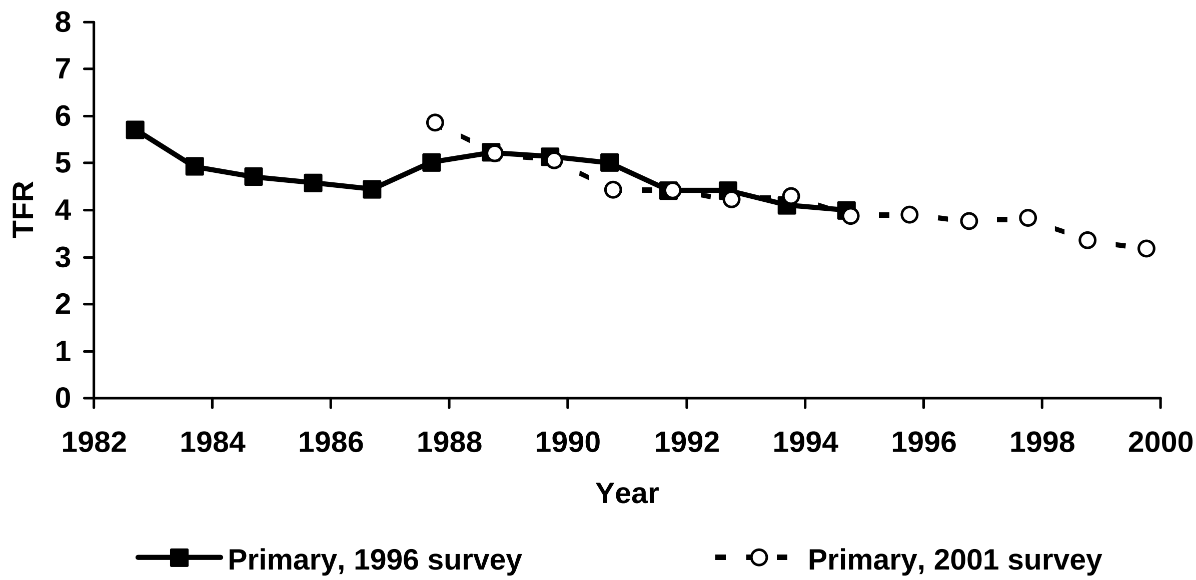



Figure 13 (cont.): Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by education, estimated from the 1996 and 2001 surveys

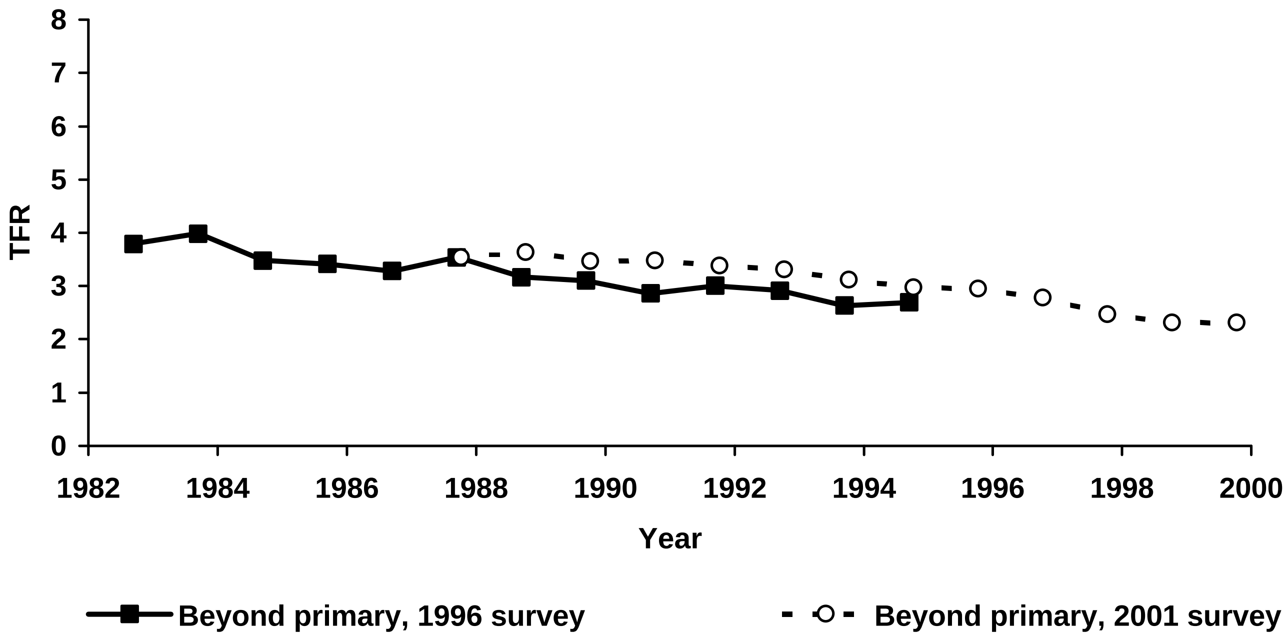
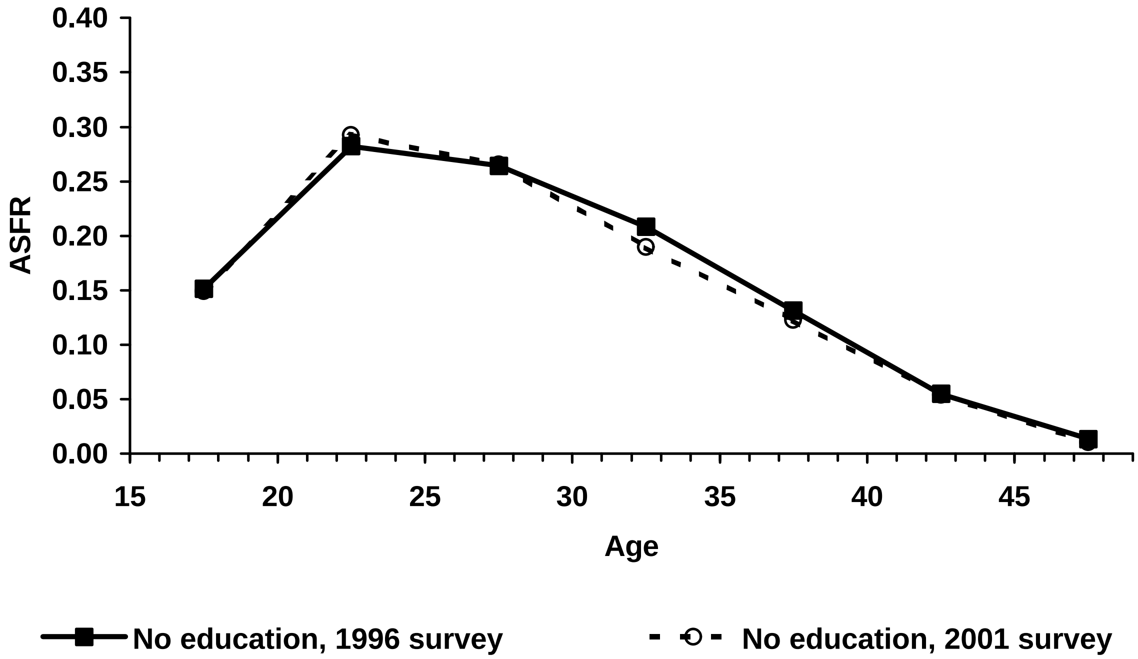


Figure 14: Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys, by education



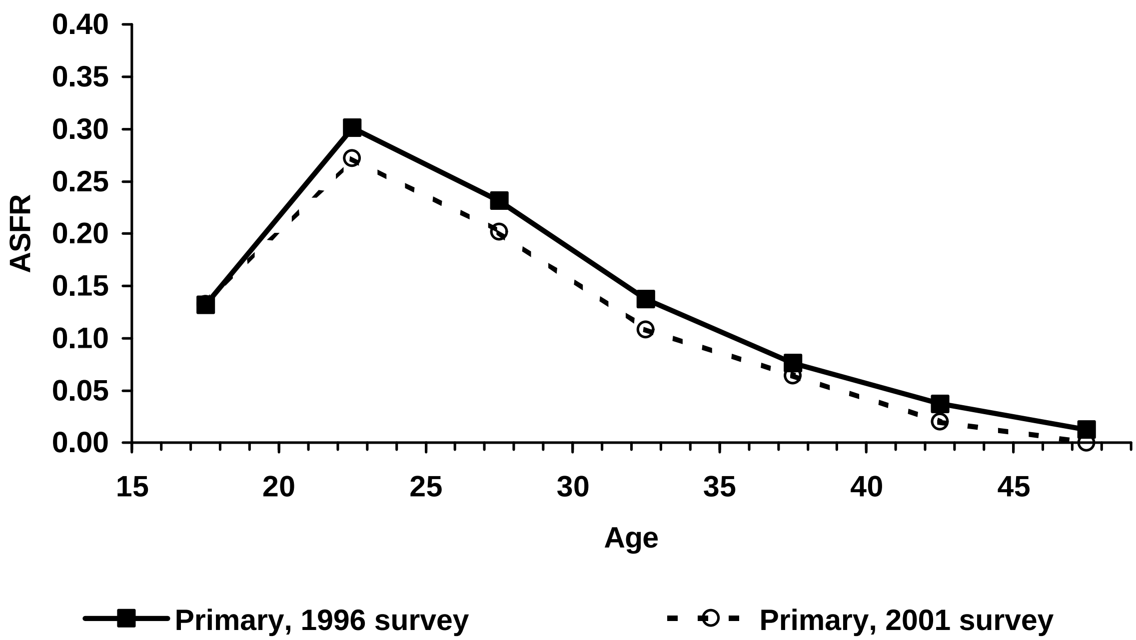



Figure 14 (cont.): Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys, by education

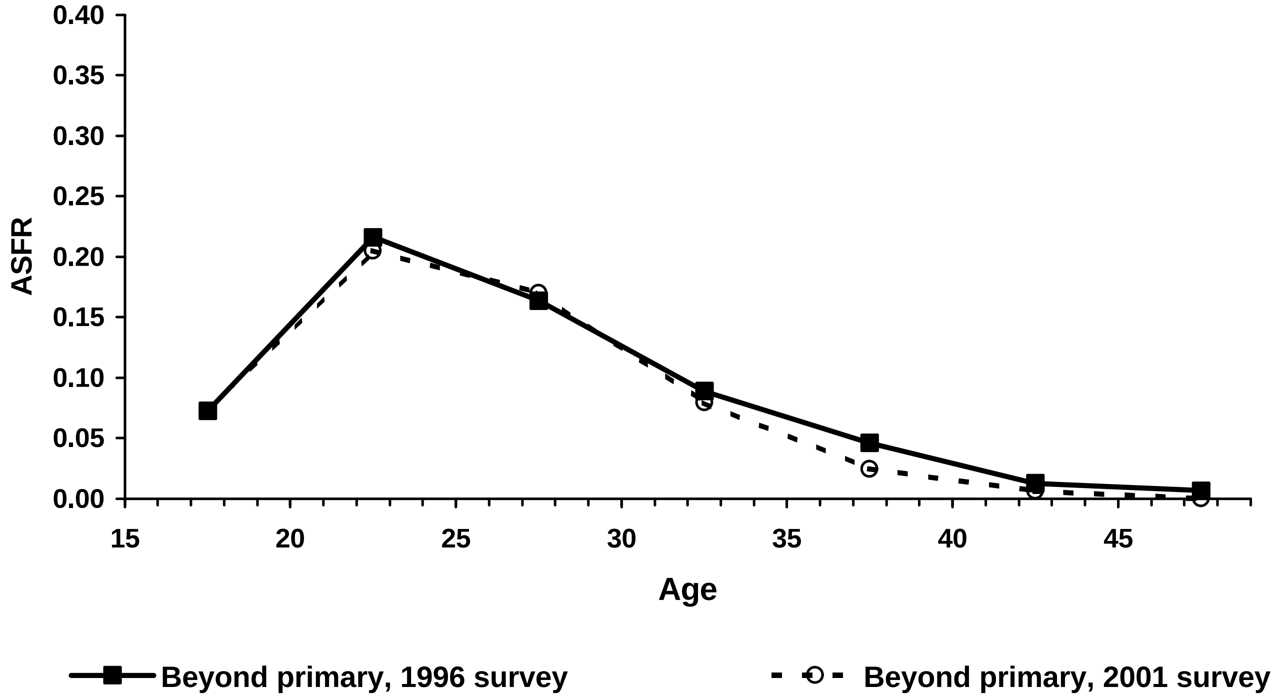


**Table 6**: Fertility by education, estimated for the 15-year periods preceding the 1996 and 2001 surveys

| Fertility measure | No education | | Primary | | Beyond primary | |
|---|---|---|---|---|---|---|
| | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 | 1981-1995 | 1986-2000 |
| ASFRs | | | | | | |
| 15-19 | 151 | 149 | 132 | 133 | 73 | 72 |
| 20-24 | 282 | 292 | 301 | 272 | 216 | 205 |
| 25-29 | 264 | 265 | 231 | 202 | 164 | 170 |
| 30-34 | 208 | 190 | 137 | 108 | 89 | 79 |
| 35-39 | 131 | 123 | 76 | 64 | 46 | 25 |
| 40-44 | 55 | 54 | 37 | 20 | 13 | 6 |
| 45-49 | 14 | 10 | 13 | 0 | 7 | 0 |
| TFR | 5.53 | 5.41 | 4.64 | 3.99 | 3.03 | 2.79 |

Note: The estimates for 1981-95 are derived from the 1996 survey, and the estimates for 1986-2000 are derived from the 2001survey. TFRs are per woman, and ASFRs are per thousand women.

## Linear-trend estimates of the TFR for the 3-year period before each survey

For reasons explained earlier, our preferred fertility estimates are highly aggregated over 15-year time periods. One set of estimates is for the 15-year time period preceding the 1996 survey, and the second set of estimates is for the 15-year time period preceding the 2001 survey. Each set of estimates is centered at a time point that is 7.5 years preceding either the 1996 survey or the 2001 survey.

It is desirable, of course, to have estimates that pertain to years closer to the survey in order to maximize their policy and program relevance. Indeed, that is why, in the basic 1996 and 2001 survey reports, birth-history estimates of TFRs and ASFRs are computed for the 3-year period preceding each survey. Fortunately, it is possible to use the 15-year-aggregated estimates of fertility to generate estimates that are comparable to the 3-year-aggregated birth-history estimates. We do this only for the TFR, because, as explained earlier, the own-children estimates of ASFRs are likely to be considerably more biased than the TFR estimates, which we have argued are fairly accurate.

The methodology for producing comparable estimates is as follows: First, date the 15-year-aggregated estimates of the TFR at time points that are 7.5 years before each survey. Measure time $t$ in years since 1900. The mean date of interview in the 1996 survey was 1996.20 ($t$ = 96.20), and the mean date of interview in the 2001 survey was 2001.27 ($t$ = 101.27). Thus the two points 7.5 years before the two surveys are $t$ = 88.70 and $t$ = 93.77.

Second, assume that the TFR has been changing in a linear fashion and fit a line through the two points. The line has the form

$$\text{TFR} = a + b\,t \tag{1}$$

Once the line is fitted so that the values of $a$ and $b$ are known, use the line to estimate values of TFR for values of $t$ that are at the midpoints of the 3-year periods before the two surveys, i.e., at $t = 94.70$ and $t = 99.77$. The values of the TFR estimated in this way are comparable to the birth-history estimates of the TFR for 3-year periods before the survey that have been published in the basic DHS reports for the 1996 and 2001 surveys.

We fitted equation (1) for the whole country, urban and rural areas, development regions, ecological regions, and three categories of education. Parameter values for the fitted equations are given in Appendix Table 1. We then used the equations in the manner just described to estimate linear-trend estimates of the TFR that are comparable to published birth-history estimates of the TFR for 3-year time periods, as given in the basic reports from the 1996 and 2001 surveys. The results of this comparison are shown in Table 7. In the table, the linear-trend estimates are labeled as own-children estimates, since the fitted lines are derived from the 15-year-aggregated own-children estimates of the TFR from the two surveys.

For the country as a whole, the previously published birth-history estimates indicate that the TFR fell from 4.64 to 4.11 births per woman between the 3-year period preceding the 1996 survey and the 3-year period preceding the 2001 survey. The comparable own-children estimates indicate that the TFR was somewhat higher and declined somewhat less—from 4.96 to 4.69 children per woman. Because the own-children estimates minimize bias from displacement of births and misreporting of women's ages, we view the own-children estimates as more accurate than the birth-history estimates. If, however, the pace of fertility decline has been accelerating (violating our linear-trend assumption), the own-children estimate of 4.69 for the more recent period 1998–2000 may be somewhat too high. A similar caveat pertains to the other own-children estimates of the TFR for 1998–2000 that are shown in the table.

The last two columns of Table 7 indicate that the birth-history method underestimates the TFR to a greater extent in the earlier period, 1993–95, than in the later period, 1998–2000. This may be an artifact of the possibly incorrect assumption of a linear trend in the case of the own-children estimates. But the lower BH/OC ratio in 1998–2000 is also consistent with evidence discussed earlier (see the discussion relating to sex ratios at birth in Table 1) that indicates more displacement of births in the 2001 survey than in the 1996 survey. In any case, the evidence indicates that the birth-history estimates of the TFR for the country as a whole are somewhat too low in both surveys.

The own-children estimates for urban areas are too high, as explained earlier. We consider, however, that the estimates for rural areas, development regions, ecological regions, and education categories are reasonably accurate, though subject to the caveats mentioned earlier. The BH/OC ratios in the last two columns of Table 7 (excluding the ratios for urban) range from 0.92

to 1.04 for 1993–95 (based on the 1996 survey) and from 0.78 to 0.98 for 1998–2000 (based on the 2001 survey). One might have expected a pattern of decreasing BH/OC ratios with more education, because one expects the more-educated respondents to have more accurate knowledge of their own ages and the ages and birth dates of their children, so that displacement is less of a problem. For reasons that are not clear, this expected pattern is not found.

**Table 7**: Birth-history estimates and own-children linear-trend estimates of the TFR for the whole country by residence and education for the three-year periods preceding the 1996 and 2001 surveys

| | Birth History (BH) | | Own Children (OC) | | BH / OC | |
|---|---|---|---|---|---|---|
| | 1993-1995 | 1998-2000 | 1993-1995 | 1998-2000 | 1993-1995 | 1998-2000 |
| Total | 4.64 | 4.11 | 4.96 | 4.69 | 0.94 | 0.88 |
| Residence | | | | | | |
| Urban | 2.85 | 2.08 | 3.59 [a] | 3.34 [a] | 0.79 | 0.62 |
| Rural | 4.83 | 4.36 | 5.13 | 4.88 | 0.94 | 0.89 |
| Development region | | | | | | |
| Eastern | 4.11 | 3.79 | 4.56 | 4.18 | 0.90 | 0.91 |
| Central | 4.56 | 4.34 | 5.04 | 5.05 | 0.91 | 0.86 |
| Western | 4.66 | 3.47 | 4.79 | 4.44 | 0.97 | 0.78 |
| Mid- & Far-western | 5.34 | 4.68 | 5.45 | 4.97 | 0.98 | 0.94 |
| Ecological region | | | | | | |
| Mountain | 5.60 | 4.80 | 5.36 | 5.01 | 1.04 | 0.96 |
| Hill | 4.50 | 3.99 | 5.03 | 4.85 | 0.89 | 0.82 |
| Terai | 4.64 | 4.13 | 4.85 | 4.56 | 0.96 | 0.90 |
| Education | | | | | | |
| No education | 5.08 | 4.82 | 5.39 | 5.28 | 0.94 | 0.91 |
| Primary | 3.78 | 3.17 | 3.88 | 3.23 | 0.97 | 0.98 |
| Beyond primary | 2.51 | 2.23 | 2.74 | 2.49 | 0.92 | 0.90 |

Note: The own-children estimates are linear-trend estimates calculated from equations given in Appendix Table 1. See text for further explanation.

[a] The own-children estimates on the TFR for urban areas are too high, for reasons explained in the text.

## DECOMPOSITION OF THE CHANGE IN THE TFR INTO COMPONENTS

The change in the TFR can be decomposed into two components, one due to changes in nuptiality (age-specific proportions currently married) and one due to changes in marital fertility (age-specific marital fertility rates). Each of these two components can be broken down further into components due to changes in each 5-year age group between 15–19 and 45–49. The decomposition method used here has been used previously by Retherford and Ogawa (1978) and Retherford and Rele (1989), who adapted it from Kitagawa (1955).

The TFR is calculated as $5\sum F_x$ , where $F_X$ denotes the ASFR for the age group $x$ to $x$+5 and the summation ranges from the age group 15–19 to the age group 45–49. We also have that $F_x = P_x F_{mx}$, where $P_x$ denotes the proportion currently married in the age group $x$ to $x$+5, $F_{mx}$ denotes the age-specific marital birth rate (ASMFR) for the age group, and where it is assumed that all fertility occurs within marriage (a reasonable assumption for Nepal). It follows that

$$\Delta TFR = 5\sum \overline{F}_{mx}\Delta P_x + 5\sum \overline{P}_x \Delta F_{mx} \qquad (2)$$

where $\overline{F}_{mx}$ and $\overline{P}_x$ are averages, each obtained by summing beginning and end values and dividing the sum by 2 (the use of averages instead of starting values avoids the presence of residual terms in the decomposition), and where $\Delta$ denotes change between 1993–95 and 1998–2000. The first of the two main components on the right side of (2) is the portion of the change in the TFR due to nuptiality change, and the second of the two components is the portion due to marital fertility change. It is evident from the equation that each of these two main components is a sum of age-specific components.

The decompositions are based on own-children linear-trend estimates of the TFR and ASFRs for the 3-year periods before the two surveys.[2] Age-specific proportions currently married (ASPMs) for these 3-year periods are derived by linearly interpolating or extrapolating age-specific proportions currently married at the time of the two surveys. Table 8 shows the base data—including ASPMs, ASFRs, and ASMFRs—needed to compute the decomposition of the change in the TFR for Nepal as a whole.

Table 9 shows the decomposition of  the change in the TFR for the whole country. The TFR declined by 0.27 child, from 4.96 to 4.69. About three-quarters of the decline in the TFR is accounted for by declines in ASMFRs, and about one-quarter by changes in ASPMs. The marital fertility component is concentrated at ages 30 and above. About three-quarters of the decline in the TFR is accounted for by changes in ASFRs at these older reproductive ages.

Table 10 shows the decomposition of the change in the TFR in each of the four development regions. In this case, for reasons of space, the input data for calculating the decompositions are not shown. The TFR declined in all regions except the Central region, where there was virtually no change. In the other three development regions, the decline in the TFR ranged from 0.35 child in the Western region to 0.48 child in the Mid- and Far-Western region. In the Eastern and Western regions, declines in ASMFRs account for almost all of the decline in the TFR. In the Mid- and Far-western region, however, the nuptiality component accounts for one-third and the marital fertility component accounts for two-thirds of the decline in the TFR.

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[2] Appendix Table 1 shows the underlying linear equations for the TFR. The equations for each ASFR are numerous and are not shown.

In the Mid- and Far-western region, the marital fertility component is concentrated at ages above 30. But in the Eastern and Western regions, about one-third of the marital fertility component stems from declines in ASMFRs below age 30.

**Table 8**: Age-specific proportions married (ASPMs), age-specific fertility rates (ASFRs), and age-specific marital fertility rates (ASMFRs) for the 3-year periods before the 1996 and 2001 surveys

| | ASPMs | | ASFRs | | ASMFRs | |
|---|---|---|---|---|---|---|
| Age group | 1993-1995 | 1998-2000 | 1993-1995 | 1998-2000 | 1993-1995 | 1998-2000 |
| 15-19 | 0.439 | 0.405 | 0.125 | 0.118 | 0.286 | 0.292 |
| 20-24 | 0.843 | 0.824 | 0.274 | 0.273 | 0.326 | 0.331 |
| 25-29 | 0.934 | 0.932 | 0.247 | 0.241 | 0.265 | 0.259 |
| 30-34 | 0.929 | 0.939 | 0.172 | 0.150 | 0.185 | 0.160 |
| 35-39 | 0.915 | 0.921 | 0.113 | 0.102 | 0.124 | 0.111 |
| 40-44 | 0.884 | 0.897 | 0.051 | 0.048 | 0.058 | 0.054 |
| 45-49 | 0.826 | 0.857 | 0.009 | 0.005 | 0.011 | 0.006 |

Note: The 3-year periods indicated in the table correspond to the 3-year period before each survey. The midpoints of these 3-year periods are 1994.7 and 1999.77. ASPM denotes age-specific proportion currently married, ASFR denotes age-specific fertility rate, and ASMFR denotes age-specific marital fertility rate. ASPMs were first calculated for each survey at the survey date. ASPMs at the midpoints of the 3-year time periods indicated in the table were then obtained by linear interpolation. ASFRs for the 3-year periods are own-children linear-trend estimates, described earlier. ASMFRs were obtained by dividing each ASFR by the ASPM for that same age group.

**Table 9**: Decomposition of the change in the total fertility rate between the two 3-year time periods before the 1996 and 2001 surveys

| | Nuptiality and marital fertility components | | |
|---|---|---|---|
| Age-specific components | Nuptiality | Marital fertility | Total |
| 15-29 | -0.08 | 0.01 | -0.07 |
| 30-49 | 0.02 | -0.21 | -0.19 |
| Total | -0.07 | -0.20 | -0.27 |
| TFR declined by 0.27, from 4.96 to 4.69 | | | |

Note: Components in the body of the table add to the overall decline of 0.27. The table is calculated from input data shown earlier in Table 8.

**Table 10**: Decomposition of the change in the total fertility rate by development region between the two 3-year time periods before the 1996 and 2001 surveys

| | Nuptiality and marital fertility components | | |
|---|---|---|---|
| Age-specific components | Nuptiality | Marital fertility | Total |
| **Eastern** | | | |
| 15-29 | -0.06 | -0.10 | -0.16 |
| 30-49 | 0.01 | -0.22 | -0.21 |
| Total | -0.06 | -0.32 | -0.37 |
| TFR declined by 0.37, from 4.56 to 4.18 | | | |
| **Central** | | | |
| 15-29 | -0.05 | 0.13 | 0.08 |
| 30-49 | 0.04 | -0.12 | -0.08 |
| Total | -0.01 | 0.01 | 0.01 |
| TFR increased by 0.01, from 5.04 to 5.05 | | | |
| **Western** | | | |
| 15-29 | -0.03 | -0.14 | -0.17 |
| 30-49 | 0.02 | -0.20 | -0.18 |
| Total | -0.01 | -0.34 | -0.35 |
| TFR declined by 0.35, from 4.79 to 4.44 | | | |
| **Mid- & Far-western** | | | |
| 15-29 | -0.16 | 0.04 | -0.12 |
| 30-49 | 0.00 | -0.35 | -0.35 |
| Total | -0.16 | -0.31 | -0.48 |
| TFR declined by 0.48, from 5.45 to 4.97 | | | |

Table 11 shows the decomposition of the change in the TFR in each of the three ecological regions. The decline in the TFR ranged from 0.18 child in the Hill region to 0.35 child in the Mountain region. In the Mountain and Hill regions, the marital fertility component accounts for all of the decline in the TFR. In the Hill region, the nuptiality component—reflect-ing increasing ASPMs at ages both below 30 and above 30—actually acted to increase the TFR. In the Terai region, the picture is quite different. Nuptiality accounts for two-thirds and marital fertility only one-third of the decline in the TFR. The nuptiality component is concentrated at ages below 30, reflecting declining ASPMs at those ages.

**Table 11**: Decomposition of the change in the total fertility rate by ecological region between the two 3-year time periods before the 1996 and 2001 surveys

| | Nuptiality and marital fertility components | | |
|---|---|---|---|
| Age-specific components | Nuptiality | Marital fertility | Total |
| Mountain | | | |
| 15-29 | -0.03 | -0.01 | -0.03 |
| 30-49 | 0.03 | -0.35 | -0.32 |
| Total | 0.00 | -0.35 | -0.35 |
| TFR declined by 0.35, from 5.36 to 5.01 | | | |
| Hill | | | |
| 15-29 | 0.05 | -0.12 | -0.07 |
| 30-49 | 0.05 | -0.16 | -0.11 |
| Total | 0.10 | -0.28 | -0.18 |
| TFR declined by 0.18, from 5.03 to 4.85 | | | |
| Terai | | | |
| 15-29 | -0.20 | 0.11 | -0.09 |
| 30-49 | -0.01 | -0.19 | -0.20 |
| Total | -0.21 | -0.08 | -0.29 |
| TFR declined by 0.29, from 4.85 to 4.56 | | | |

Table 12 shows the decomposition of the change in the TFR in each of the three education categories. The TFR declined by 0.11 child among those with no education, by 0.65 child among those with at least some primary education, and by 0.25 child among those with more than a primary education.

Among those with no education, declines in ASMFRs at ages above 30 account for virtually all of the decline in the TFR but are offset slightly by small changes in nuptiality that tended to increase the TFR. Among those with at least some primary education, declines in ASMFRs again account for virtually all of the decline in the TFR. Among those with more than a primary education, declines in ASMFRs more than account for all of the decline in the TFR but are offset to a considerable extent by changes in nuptiality that tended to increase the TFR. Indeed, in the beyond-primary group, the positive nuptiality component of 0.18 child is more than one-third as large as the negative marital fertility component of –0.43 child. The positive nuptiality component probably stems from the rapid expansion of the beyond-primary group between the two surveys, resulting in an increase in the proportion of the beyond-primary group who come from social backgrounds where early marriage is common.

**Table 12**: Decomposition of the change in the total fertility rate by education between the two 3-year time periods before the 1996 and 2001 surveys

| | Nuptiality and marital fertility components | | |
|---|---|---|---|
| Age-specific components | Nuptiality | Marital fertility | Total |
| No education | | | |
| 15-29 | 0.01 | 0.04 | 0.05 |
| 30-49 | 0.02 | -0.18 | -0.16 |
| Total | 0.03 | -0.14 | -0.11 |
| TFR declined by 0.11, from 5.39 to 5.28 | | | |
| Primary | | | |
| 15-29 | -0.04 | -0.25 | -0.29 |
| 30-49 | 0.01 | -0.37 | -0.35 |
| Total | -0.03 | -0.61 | -0.65 |
| TFR declined by 0.65, from 3.88 to 3.23 | | | |
| Beyond primary | | | |
| 15-29 | 0.16 | -0.19 | -0.03 |
| 30-49 | 0.01 | -0.23 | -0.22 |
| Total | 0.18 | -0.43 | -0.25 |
| TFR declined by 0.25, from 2.74 to 2.49 | | | |

## DECOMPOSITION OF THE CHANGE IN MARITAL FERTILITY INTO COMPONENTS

This section uses multiple regression to further decompose change in marital fertility into components due to changes between the two surveys in selected demographic and socioeconomic variables. In this analysis, the measure of marital fertility is the number of births per currently married woman in the five years preceding the survey. Methodology is as follows:

The first step is to pool currently married women in the two surveys into a single sample, with an additional variable $Z$ that indicates whether the woman was interviewed in the 1996 survey or the 2001 survey. The variable $Z$ is defined as a dummy variable that is equal to 1 if the women was interviewed in the 2001 survey and 0 if she was interviewed in the 1996 survey. Fertility, denoted by $F$, is defined as the number of births that a currently married woman had in the 5-year period immediately preceding the survey (1996 survey or 2001 survey, as appropriate). The variables $X_1, X_2, \ldots, X_k$, denote selected demographic and socioeconomic variables. In order to simplify the analysis, women who experienced a child death during the five years before the survey and women who have been married more than once are excluded from the pooled sample.

The next step is to calculation the regression

$$F = a + bZ \tag{3}$$

When $Z = 0$, $F = a$, indicating that the average value of $F$ in the 1996 survey is $a$. Similarly, the average value of $F$ in the 2001 survey is $a+b$. Thus the fitted value of $b$ indicates the change in $F$ between the two surveys.

Now consider the equation

$$F = c + d_1 X_1 + d_2 X_2 + \ldots + d_k X_k + eZ \tag{4}$$

The coefficient $e$ denotes the change in $F$ that would occur between the two surveys if all the demographic and socioeconomic predictor variables were held constant.

Now consider the decomposition

$$b = (b - e) + e \tag{5}$$

The first term on the right $(b - e)$ is the component of $b$ (i.e., the component of the overall change in $F$) that is explained by changes in the demographic and socioeconomic variables. The second term is the unexplained component of the change in $F$.

We would also like to enter the variables $X_i$ one at a time (instead of all at once), cumulatively, to see how much each demographic and socioeconomic variable additionally contributes to the change. (In some cases a variable is represented by a block of dummy variables. In that case the block of variables is entered together rather than one at a time.) This amounts to calculating the increment to $b–e$ each time a variable is added to the regression. The incremental change is interpreted as the component of the change in $F$ that is due to between-survey change in population composition by that variable.

The unexplained component of change in F is presumably due to changes in unmeasured demographic or socioeconomic variables not included in the regressions, to the family planning program, or to diffusion effects unconnected with the program that cut across demographic and socioeconomic categories. (For example, latent receptivity to birth control may build for a while before birth control is adopted by opinion leaders, at which time others quickly follow suit, regardless of their socioeconomic status, as discussed in Retherford and Palmore (1983) and Retherford (1985); see also Casterline (2001).)

The demographic and socioeconomic variables, $X_1$, $X_2$, …, $X_k$, (listed in the order that they are added to the regression) are the following:

- Ecological region (mountain, hill, terai)
- Development region (four regions)
- Residence (urban, rural)

- Education (none, primary, more than primary)
- Age at first cohabitation (<17, 17–18, 19–20, 21+)
- Time elapsed since first cohabitation (0–4, 5–9, 10–14, 15+ years)
- Number of living children at start of 5-year period
- Media exposure (high, low)[3]
- Whether sterilized at start of 5-year period (yes, no)

These variables are chosen because they have strong effects on fertility in cross-sectional analyses. Because age at first cohabitation plus time elapsed since first cohabitation equals age at the time of the survey, there is no need to include age at the time of the survey as an additional variable. Note also that it is also not feasible to include "whether sterilized at the time of the survey" (i.e., at the end of the 5-year period) as an explanatory variable, because of reverse-causation. (The problem is that the positive effect of fertility on sterilization (which occurs because having a birth during the 5-year period makes sterilization by the end of the period more likely) is larger than the negative effect of sterilization on fertility, so that the coefficient of this variable turns out to be positive rather than negative.

For these predictor variables and for marital fertility (births per currently married woman in the five years before the survey), Table 13 shows mean values (in the case of continuous variables) and percent distributions (in the case of categorical variables) for each of the two surveys. There was very little change between the two surveys in the mean or distribution for ecological region, development region, urban/rural residence, time elapsed since first cohabitation, and number of living children at start of 5-year period. There were larger changes in the distributions by education, age at first cohabitation with husband, media exposure, and sterilization at the start of the 5-year period.

For the women under consideration, the mean number of children born in the five years before the survey declined from 0.801 children per woman in the 1996 survey to 0.755 children per woman in the 2001 survey—a decline in *F* of .047 child, amounting to a 6 percent decline in five years. Table 14 shows the result of decomposing this change into components by means of the method just described. Changes in population composition by ecological region, development region, urban/rural residence, education, age at first cohabitation with husband, and number of living children at the start of the 5-year period contribute very little to the overall decline in *F*. Changes in population composition by duration since first cohabitation, on the other hand, account for somewhat more than one-quarter of the decline in *F* after controlling for prior variables, and changes in population composition by extent of exposure to mass media account for another one-eighth of the decline in *F*.[4]

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[3] "High" means that the respondent reads a newspaper once a week, watches television at least once a week, or listens to the radio every day. "Low" means that the respondent has none of these three types of exposure.

[4] The component due to changes in the distribution by education is negligible, and the component due to changes in the distribution by time since first cohabitation is substantial, contrary to what one might expect from the changes in these distributions shown in Table 13. The reversals occur as a consequence of controlling for prior variables.

**Table 13**: Means and distributions of variables used in the regression-based decomposition of the change in marital fertility between the 1996 and 2001 surveys

| Variable | 1996 survey | 2001 survey |
|---|---|---|
| Births per currently married woman during 5 years before survey | 0.801 | 0.755 |
| Ecological region | | |
| Mountain | 6 | 6 |
| Hill | 42 | 41 |
| Terai | 52 | 52 |
| Development region | | |
| Eastern | 24 | 24 |
| Western | 20 | 21 |
| Central | 35 | 32 |
| Mid- & Far-western | 21 | 22 |
| Urban/rural residence | | |
| Urban | 9 | 10 |
| Rural | 91 | 90 |
| Education | | |
| No education | 77 | 69 |
| Primary | 12 | 16 |
| Beyond primary | 11 | 15 |
| Age at first cohabitation with husband | | |
| Less than 17 | 62 | 56 |
| 17-18 | 21 | 24 |
| 19-20 | 10 | 12 |
| 21 and over | 8 | 8 |
| Time elapsed since first cohabitation | | |
| 0-4 | 23 | 22 |
| 5-9 | 19 | 19 |
| 10-14 | 17 | 17 |
| 15+ | 41 | 41 |
| Number of living children at start of 5-year period | 1.96 | 2.02 |
| Media exposure | | |
| High | 44 | 51 |
| Low | 56 | 49 |
| Whether sterilized at start of 5-year period | | |
| Yes | 7 | 10 |
| No | 93 | 90 |

Note: Distributions are given in percentages. "Births per currently married woman" and "number of living children at start of 5-year period" are continuous variables, for which mean values are shown in the table.

**Table 14**: Regression-based decomposition of the change in marital fertility between the 1996 and 2001 surveys

| Component due to change between the two surveys in population composition by: | Size of component | Coefficient of *Z* |
|---|---|---|
| Ecological region | .000 | -.0470* |
| Development region | -.001 | -.0463* |
| Urban/rural residence | -.003 | -.0435* |
| Education | .000 | -.0438* |
| Age at first cohabitation with husband | .003 | -.0465* |
| Time elapsed since first cohabitation | -.013 | -.0340* |
| Number of living children at start of 5-year period | -.003 | -.0313* |
| Media exposure | -.006 | -.0252* |
| Whether sterilized at start of 5- year period | -.016 | -.0094 |
| Unexplained component | -.009 | -.0094 |
| | | |
| Total change in fertility between the two surveys | -.047 | -.0470* |

Note: In the regression analysis, the 1996 and 2001 surveys are pooled into a single sample. Units of analysis are currently married women still in their first marriage who did not experience any child deaths during the five years before the survey (1996 or 2001). Fertility is measured by the number of births that a woman had during the five years immediately preceding the survey. Each line corresponds to an underlying multiple regression. In the first line, *F* is regressed on *Z* and ecological region. In the second line, *F* is regressed on *Z*, ecological region, and development region. And so on. In the last line, corresponding to the total change in fertility, *F* is regressed on *Z* only. In the last column, an asterisk indicates that the coefficient of *Z* in the underlying regression is statistically significant at the 5 percent level.

The largest component, accounting for about one-third of the decline in *F*, stems from changes in "whether sterilized at start of the 5-year period." This component understates the independent effect of the family planning program, because sterilization accounts for only about 60 percent of contraceptive prevalence. Other contraceptive methods account for the other 40 percent. With all the predictor variables, including sterilization at the start of the 5-year period, in the regression, only one-fifth of the change in *F* remains unexplained, but this remaining unexplained component no longer differs significantly from zero.

## SUMMARY AND CONCLUSION

Own-children estimates rather than birth-history estimates of fertility have been used, because the own-children estimates are based on the DHS household samples with no upper age limit, enabling estimation of TFRs for each of the 15 years before the 1996 and 2001 DHS surveys. Fifteen-year-aggregated estimates of the TFR are used in order to minimize bias from displacement of births to earlier years before each survey. Each of the two 15-year-aggregated estimates of the TFR is taken as a point estimate located at the midpoint of the 15-year time period. A line is then fitted between the two points, and this line is used to estimate the TFR at the midpoint of the 3-year period before each survey in order to compare the TFRs so estimated with corresponding estimates derived by the birth-history method, as published in the 1996 and 2001 DHS reports.

The analysis indicates that Nepal's total fertility rate fell from 4.96 to 4.69 births per woman between the 3-year period preceding the 1996 survey and the 3-year period preceding the 2001 survey. These estimates are somewhat higher and decline somewhat more slowly than the published birth-history estimates, which indicate a decline from 4.64 to 4.11 births per woman. Were the rate of TFR decline as indicated by the own-children estimates to continue, the TFR would reach 4.42 five years later (at the midpoint of the 3-year period before the 2006 DHS survey, which is currently being planned).

The own-children estimates of the TFR for urban areas are too high and decline too steeply over time, because, as one goes backward in time 15 years, an increasing percentage of women who were urban at the time of the survey were rural in the recent past, as a consequence of substantial rural-to-urban migration. The own-children estimates for rural do not suffer from this bias however. The analysis indicates that the rural TFR fell from 5.13 to 4.88 children per women between the 3-year period before the 1996 survey and the 3-year period before the 2001 survey. The own-children estimates of the trend in the TFR by education between these same 3-year time periods indicate that the TFR fell from 5.39 to 5.28 for women with no education, from 3.44 to 3.23 to with at least some primary education, and from 2.74 to 2.49 for women with more than a primary education.

In Nepal as a whole, about three-quarters of the TFR decline from 4.96 to 4.69 stems from reductions in age-specific marital fertility rates and about one-quarter from changes in age-specific proportions currently married. The contribution of nuptiality change to TFR change is considerably higher for women with more than a primary education than for women with no education or women with at least some primary education.

Further analysis of the decline in marital fertility, as measured by births to currently married women during the five years before each survey, indicates that, in Nepal as a whole, almost half of the decline in marital fertility between the two surveys stems from changes in population composition by eight geographic, demographic, and socioeconomic variables. With these eight variables controlled, increases in sterilization account for another one-third of the fertility decline. About one-fifth of the fertility decline is not accounted for by any of these variables but may be accounted for partly by increased use of contraceptive methods other than sterilization. In terms of its statistical significance, this remaining unexplained component does not differ significantly from zero.

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**Appendix table 1**: Equations for calculating linear trend estimates of TFRs

| Characteristic | Equation for TFR | | |
|---|---|---|---|
| Total | 9.94403 | - | 0.05264 *t* |
| | | | |
| Residence | | | |
| Urban | 8.22493 | - | 0.04893 *t* |
| Rural | 9.73618 | - | 0.04868 *t* |
| | | | |
| Region | | | |
| Eastern | 11.54086 | - | 0.07373 *t* |
| Central | 4.90599 | + | 0.00140 *t* |
| Western | 11.30008 | - | 0.06876 *t* |
| Mid- & Far-western | 14.34705 | - | 0.09400 *t* |
| | | | |
| Ecological region | | | |
| Mountain | 11.92362 | - | 0.06929 *t* |
| Hill | 8.32993 | - | 0.03483 *t* |
| terai | 10.21773 | - | 0.05667 *t* |
| | | | |
| Education | | | |
| No education | 7.52869 | - | 0.02254 *t* |
| Primary | 15.94181 | - | 0.12742 *t* |
| Beyond primary | 7.36458 | - | 0.04884 *t* |

Note: Linear trend estimates of TFRs for particular calendar years are calculated by substituting a calendar year for *t* in the equations. Year *t* is measured in years since 1900 (e.g., instead of 1981, use 81.5).

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