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RECENT TRENDS AND COMPONENTS OF CHANGE IN FERTILITY IN NEPAL

ROBERT D. RETHERFORD* AND SHYAM THAPA†

**East-West Center, Honolulu, Hawaii, USA and* †*Family Health International, Arlington, Virginia, USA*

Summary. The objectives of this article are, first, to provide improved estimates of recent fertility levels and trends in Nepal and, second, to analyse the components of fertility change. The analysis is based on data from Nepal's 1996 and 2001 Demographic and Health Surveys. Total fertility rates (TFR) are derived by the own-children method. They incorporate additional adjustments to compensate for displacement of births, and they are compared with estimates derived by the birth-history method. Fertility is estimated not only for the whole country but also by urban/rural residence and by woman's education. The own-children estimates for the whole country indicate that the TFR declined 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 before each survey.

Introduction

Recent research indicates that fertility transition is well underway in Nepal (Thapa *et al.*, 1998; Collumbien *et al.*, 2001). For various reasons to do with quality of data and accuracy of measurement, however, actual levels of and rates of change in fertility are less certain. More accurate estimates of fertility levels and trends are needed, especially for the purpose of evaluating the effectiveness of Nepal's family planning programme. Accordingly, one objective of this article is to provide improved estimates of recent fertility levels and trends. The principal measure of fertility in this part of the analysis is the total fertility rate (TFR).

A second objective is to analyse the components of fertility change. One question regarding components of change is how much of the decline in the TFR stems from declines in marital fertility and how much from declines in age-specific proportions currently married. This is of interest because the family planning programme aims primarily to reduce marital fertility, not age-specific proportions married. A second question is how much of the decline in marital fertility stems from changes in population composition by demographic and socioeconomic characteristics and how much from changes in contraceptive use. This is of interest because the family planning programme aims primarily to increase contraceptive use. Both parts of the analysis are based on data from Nepal's 1996 and 2001 Demographic and Health Surveys (DHSs) (Ministry of Health *et al.*, 1997, 2002).

The first part of the article presents the new estimates, explains how they are derived, and explains why they are probably more accurate than the estimates published previously in the basic DHS 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). The second and third parts of the article analyse components of fertility change.

Data

The two surveys

The data are from Nepal's 1996 and 2001 DHSs. 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 individual ever-married women aged 15–49 within the sampled households.

The 1996 DHS was a national survey based on a representative sample of households throughout the country (Ministry of Health *et al.*, 1997). The 1996 sample included completed interviews for 8082 households, and, within these households, 8429 ever-married women aged 15–49. The survey was conducted over a 6-month period, from mid-January to mid-June 1996. The year before the survey falls mainly in 1995 and is labelled as such in tables that identify time periods before the survey.

The 2001 DHS was a national survey based on a representative sample of households throughout the country (Ministry of Health *et al.*, 2002). The sample included completed interviews for 8602 households, and, within these households, 8726 ever-married women. (In the 2001 survey, six 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.) The survey was conducted over a 5-month period, from the last week of January to the end of June 2001. The year before the survey falls mainly in 2000 and is labelled as such in tables that identify time periods before the survey.

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	3060	2999	1·02
1986–1990	3582	3406	1·05
1991–1995	3698	3574	1·03
1981–1995	**10,340**	**9978**	**1·04**
2001 survey			
1986–1990	3152	2881	1·09
1991–1995	3568	3499	1·02
1996–2000	3450	3528	0·98
1986–2000	**10,170**	**9907**	**1·03**

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 retrospective survey data. The quality of data on age in the 1996 and 2001 DHSs in Nepal is good. Heaping on ages ending in 0 and 5 is not pronounced, and Myers' Index of digit preference (Shryock & Siegel, 1980) for females ages 10–69 was only 3·01 in the 1996 survey and 1·72 in the 2001 survey. (By way of comparison, Myers' Index was 10·0 in India's 1998–99 National Family Health Survey: Retherford & Mishra, 2001.) For further detail on the quality of age reporting in Nepal's 1996 and 2001 DHS surveys, see Retherford & Thapa (2003).

The trend in the sex ratio at birth is another useful indicator of data quality. Because there is considerable preference for sons in parts of Nepal, women who forget to mention children who have died or moved away are more likely to omit girls than boys. If 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 5 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 reports, which is based on fertility estimates for the 3 years before each survey, is too steeply downward, especially in the second survey. The new fertility estimates presented later in this article compensate for this bias.

Fertility estimates

Methodology for estimating fertility rates

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 first 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 Demographic and Health Surveys. The inclusion of the 2001 DHS in the analysis allows an update of estimates of TFR trends presented in earlier articles by the authors (Retherford & Thapa, 1998, 1999).

In the birth-history method, as applied here, births by age of mother as reported in the birth histories are simply counted 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 5-year age groups and multiplying the sum by five. ASFRs can similarly be calculated for longer time periods, such as 5-year time periods.

Birth histories were collected only for ever-married women aged 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, the birth-history method cannot be used to 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, the birth-history method cannot be used to calculate an ASFR for women 45–49 years old for years earlier than five years before the survey. This article is 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 comparable fertility measures are required for each of the 15 years before the survey, derived alternatively by the own-children method and the birth-history method, fertility at ages 35 and older cannot be made use of. 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 5-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 aged 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 aged 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 grouped 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, 1987, 1995). Life expectancies from these life tables (48·1 years for females and 50·9 years for males in 1981 and 53·5 years for females and 55·0 years for males in 1991) were linearly interpolated and extrapolated to other calendar years and then matched to Coale-Demeny Model West life tables (Coale & 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 the authors' preferred method for estimating fertility trends from the 1996 and 2001 surveys.

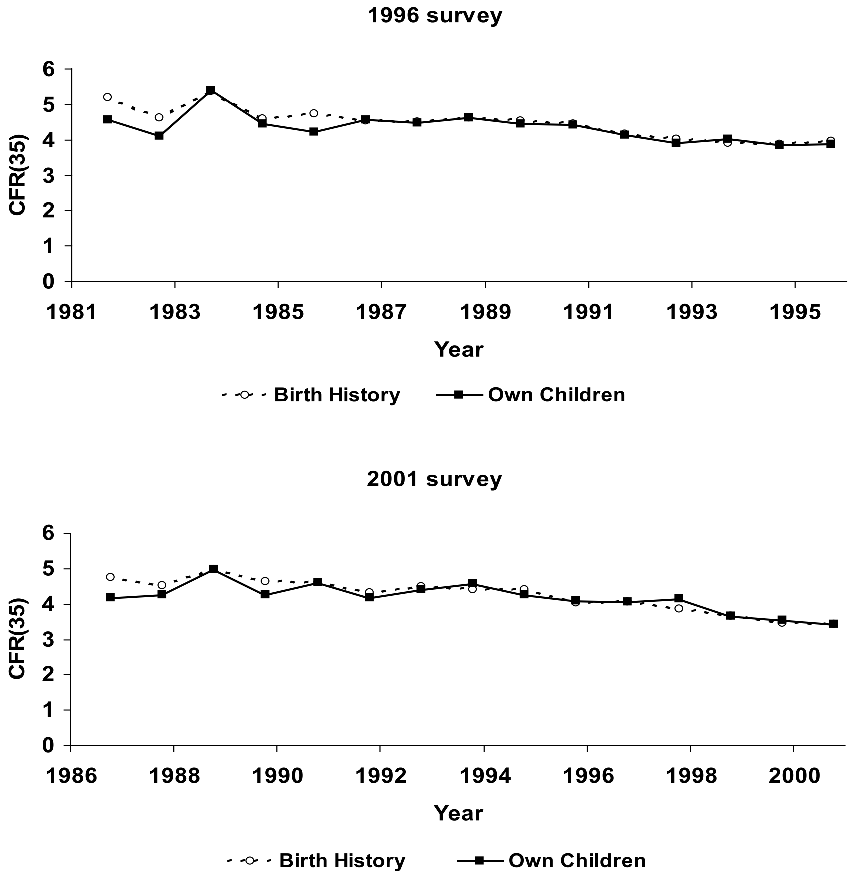

Fig. 1. Trend in CFR(35), estimated alternatively by the birth-history method and the own-children method: 1996 and 2001 surveys.

The analysis leading up to the improved fertility estimates is organized as follows. First, trends in CFR(35) are compared 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. Second, results of applying the own-children method to the two surveys are presented. This section includes an analysis of overlapping trends in TFRs estimated from the 1996 and 2001 surveys. Finally, the various estimates are synthesized 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 1 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

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Table 2. Trends in age-specific birth rates (ASFRs) and total fertility rates (TFRs) 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 5-year periods, as estimated from each survey separately, are biased and should not be regarded as true trends. See text for explanation.

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.

The year-to-year fluctuations in the fertility estimates 10–14 years before the survey, as shown in Fig. 1, will ultimately not matter in this analysis, because the final estimate of the trend in the TFR will be based on 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 Fig. 1, agree sufficiently well to justify the use of the own-children method in the remainder of this article.

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.

The table indicates a number of peculiarities and inconsistencies in the estimated trends. The trends in the TFR estimated from each survey separately (which are referred 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 the two values of the TFR computed for the combined 15-year period preceding

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each survey (which is referred to as the between-survey estimate of the trend) is much more gradual.

The two within-survey trends in the TFR are 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 decline over the three 5-year time periods, whereas the between-survey trend indicates virtually no change. In the case of ASFRs for age groups 25–29 and older, the within-survey trends are again much steeper than the between-survey trends. The between-survey estimates indicate a very small ASFR 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. The between-survey estimates of declines at ASFR(40–44) and ASFR(45–49) are modest.

Overall, it is evident from Table 2 that the within-survey estimates of fertility trend are severely biased, whereas the between-survey estimates of trend look quite reasonable. The nature of the biases affecting the trend estimates is 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. (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

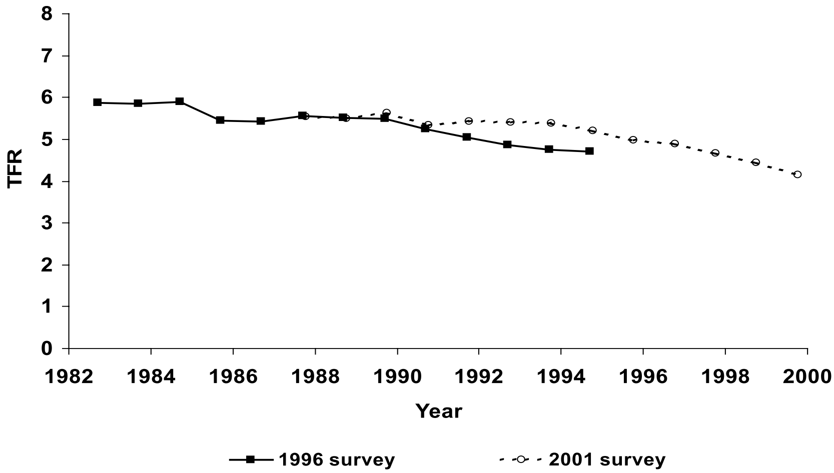

Fig. 2. Overlapping trends in the TFR, estimated from the 1996 and 2001 surveys. TFRs are shown as 3-year moving averages of estimates for single years in order to smooth out annual fluctuations.

intentional displacement on the part of interviewers who wish to avoid asking the large block of questions asked of young children, 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 shown in Fig. 2. 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.

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 births 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, b) in the case of India and by Retherford & 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 & 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 in reality 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. (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.)

Regarding point (3) above, relating to estimated within-survey trends in ASFRs, it should be noted that between the two surveys the proportion of currently married who were currently using contraception was only 7% in the first survey and 12% in the second survey at age 15–19, and only 16% in the first survey and 23% in the second survey at age 20–24. Moreover, as will be seen later, there was also almost no change in proportions married at these ages. These low rates of contraceptive use and lack of change in proportions married are consistent with very small changes in ASFRs at 15–19 and 20–24, which are indicated by the between-survey estimates of trend but not the within-survey estimates of trend.

Between-survey estimates of changes in the age pattern of fertility, based on own-children estimates of ASFRs for the 15-year period preceding each survey, are shown in Fig. 3, which shows virtually no decline at all in ASFRs 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. 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 Fig. 3 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

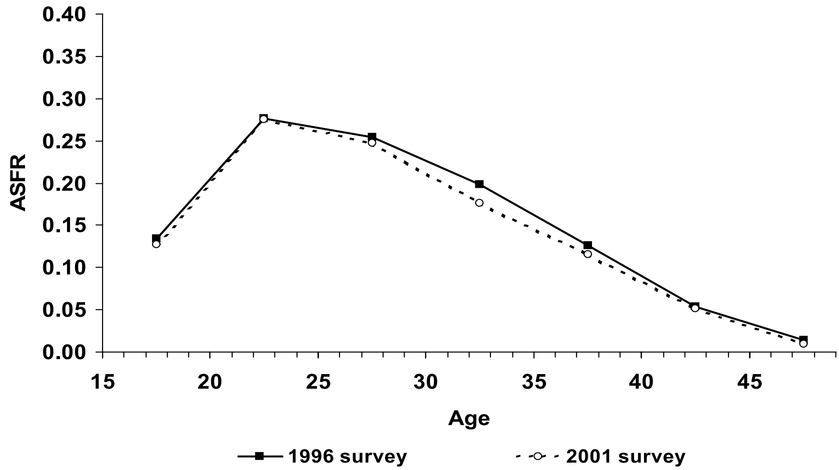

Fig. 3. Age-specific fertility rates for the 15-year period preceding the 1996 and 2001 surveys. In this and subsequent figures ASFRs and TFRs are estimated by the own-children method.

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 almost all fertility remains within the 15–49 age span, so 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.

Fertility estimates by urban/rural residence and by education

One can also calculate own-children fertility estimates by socioeconomic and other characteristics, as long as the characteristic does not change for women after they reach age 15. For example, in almost all cases in Nepal, a woman's education is complete by age 15 and does not change after that. (This is illustrated by the fact that, in the 2001 survey, only 1% of ever-married women age 15–49 had more than a 10th grade education.) In contrast, a woman's activity status (in the labour force or not in the labour 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. (In addition, a woman's activity status is correlated with her fertility, which introduces even greater potential for estimation error.)

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

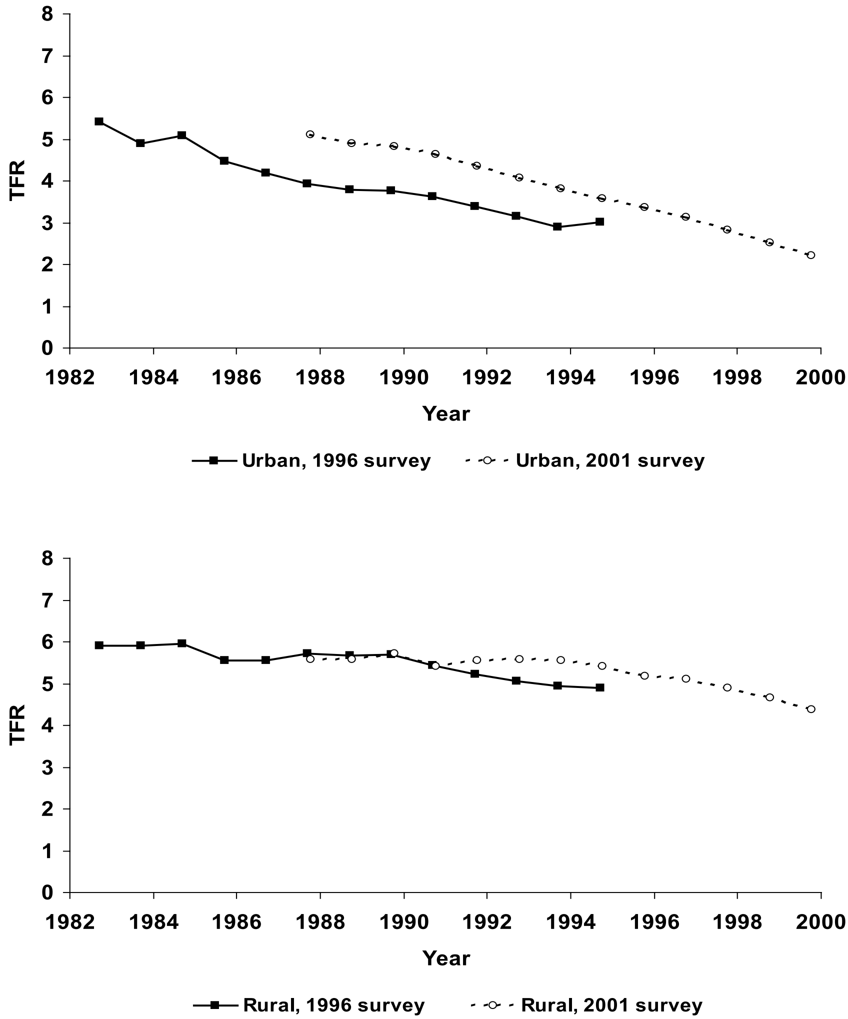

Fig. 4. Overlapping trends in the TFR by urban–rural residence, estimated from the 1996 and 2001 surveys. TFRs are 3-year moving averages.

estimates by characteristics for earlier years. This is true for fertility estimates by education, but it is not true for fertility estimates by urban/rural residence. In the latter case the bias is substantial 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.

Figure 4 sheds some light on this question. In the upper graph in Fig. 4 (which is again based on 3-year moving averages of TFRs in order to smooth out annual fluctuations), the overlapping TFR trends for urban are sharply divergent. 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, as expected since the proportion

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of ‘urban’ residents who were actually rural increases as one goes back in time. The bias in the urban TFR estimates is not eliminated 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.

Census data shed further light on the nature and magnitude of the bias in the estimates of the urban TFR in Fig. 4. (Census data are used because Nepal’s censuses provide a more accurate indication than the two surveys of how fast the percentage urban has been increasing. The two surveys give a less accurate indication because they both used the 1991 census as the sampling frame.) Between the 1981 and 1991 censuses, Nepal’s population grew from 14·9 to 18·5 million, and the percentage urban grew from 6·1% to 9·2% (Bastola, 1995), implying that approximately 72% of urban residents in 1991 migrated from rural to urban areas between 1981 and 1991. (The calculation is as follows: Multiply the 1991 population total by the 1981 percentage urban to obtain an estimate of what the number of urban residents would have been in 1991 in the absence of migration. The difference between this estimate and the actual number of urban residents in 1991 is a rough estimate of the number of urban residents in 1991 who migrated from rural areas during the previous 10 years. Dividing this number by the number urban in the 1991 census yields 72%.) Similarly, between 1991 and 2001, the population grew from 18·5 to 23·2 million, and the percentage urban grew from 9·2% to 14·2%, implying that approximately 75% of urban residents in 2001 migrated from rural areas between 1991 and 2001.

As a further rough approximation, suppose that the 75% who migrated between 1991 and 2001 spread their migration evenly over the 10 years, so that 37·5% migrated between 1996 and 2001. Consider the urban TFR estimates for 1995 as an example, and consider the following question: How do we expect this level of migration to affect the discrepancy between the urban TFR for 1995 estimated from the 1996 survey and the urban TFR for 1995 estimated from the 2001 survey? The first TFR estimate is based on a group of urban women (i.e. urban at the time of the 1996 survey), 3·8% of whom were rural at the midpoint of the first year before the 1996 survey (i.e. in 1995). The second TFR estimate is based on a group of urban women (i.e. urban at the time of the 2001 survey), 41·3% of whom were rural at the midpoint of the sixth year before the 2001 survey (i.e. in 1995). If urban–rural fertility differentials are large, as is indeed the case in Nepal, the large difference of 37·5 percentage points (41·3 − 3·8) in the proportion of urban women (i.e. urban at the time of the survey) who were actually rural in 1995 can be expected to produce large discrepancies in overlapping estimates of the urban TFR for 1995.

The extent of the discrepancy can be estimated roughly as follows. Suppose that the true urban TFR is 3·0 and the true rural TFR is 5·0: values that correspond roughly to those shown for urban and rural in Table 3. What would the ‘urban’ TFR be if ‘urban’ were actually a mix of 62·5% urban and 37·5% rural? In this case, the ‘urban’ TFR would be calculated as (3·0)(0·625)+(5·0)(0·375)=3·75. The estimate for urban is increased by 0·75 child, from 3·0 to 3·75. This rough estimate of the expected discrepancy agrees rather well with the discrepancies shown for overlapping estimates of the urban TFR in Fig. 4.

Further evidence that the proportion of rural migrants among urban residents is large is that, among urban women in the 2001 DHS survey, 64% grew up in the

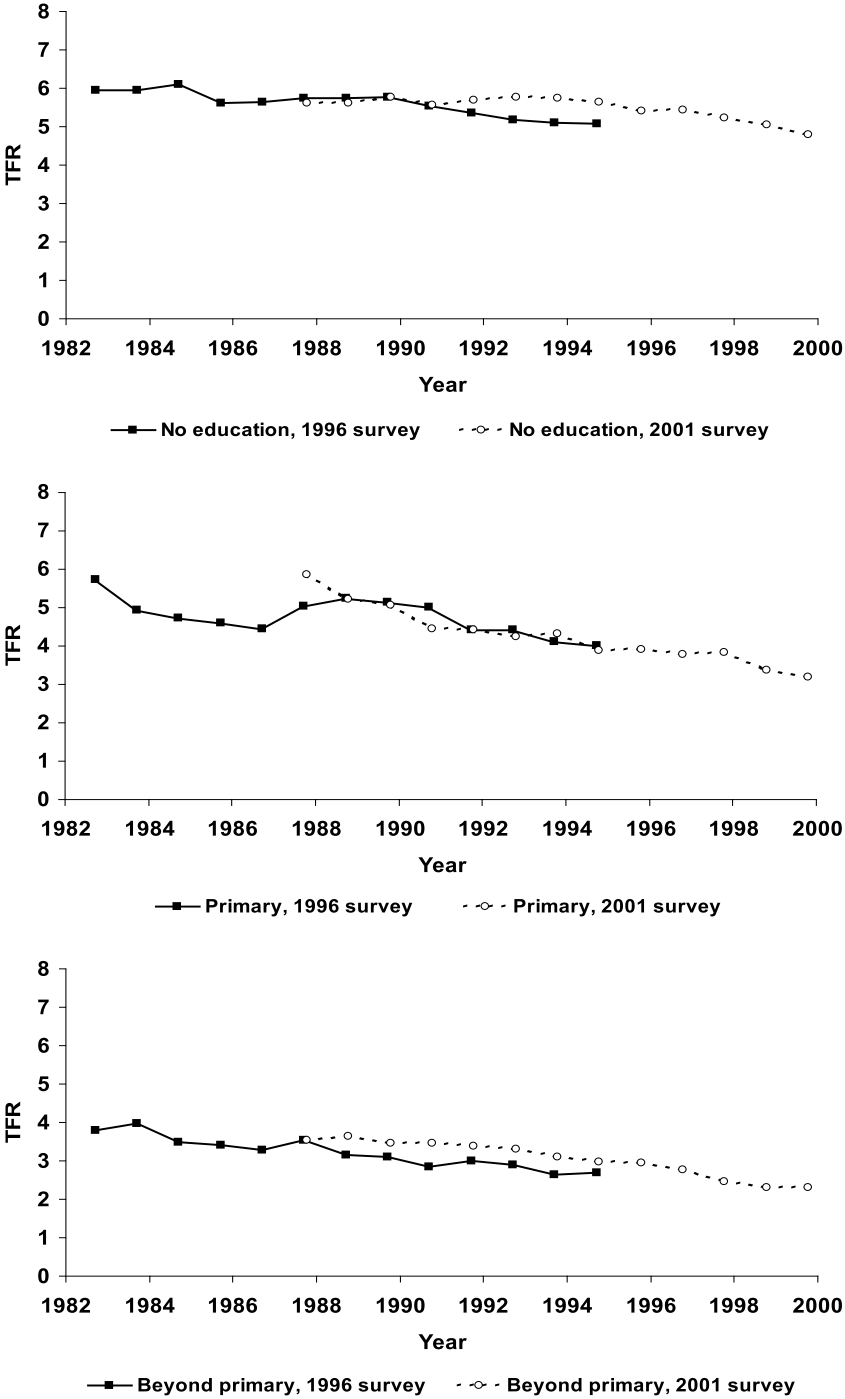

Fig. 5. Overlapping trends in the TFR, 3-year moving average of estimates for single calendar years, by education, estimated from the 1996 and 2001 surveys.

Table 3. Birth-history estimates and own-children linear-trend estimates of the TFR for the whole country by residence and education for the 3-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
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. See text for further explanation.
[a]The own-children estimates of the TFR for urban areas are too high, for reasons explained in the text.

countryside (based on the question on childhood residence). This is a lower figure than one would expect from the above rough calculations based on census data. But it is still very high, and it supports our explanation of the reasons for the discrepancies in the urban TFR estimates shown in Fig. 4.

Although this kind of bias is serious in the case of fertility estimates for urban areas, it is not serious in the case of fertility estimates for rural areas. This is so partly because the net movement of persons is out of rather than into rural areas, so that typically 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. It is therefore expected that the own-children fertility estimates will be more consistent and accurate for rural areas than for urban areas. In contrast to the urban TFR trends in Fig. 4, the two rural TFR trends in the lower graph agree rather well, although they still show evidence of displacement of births to earlier years, again as expected.

Figure 5 shows trends in own-children fertility estimates of the TFR 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.) Not surprisingly, the overlapping trends for women with no education resemble the overlapping trends for the whole country, since four-fifths of women in the 1996 survey and almost three-quarters of women in the 2001 survey had no education. What is surprising, however, is the finding that the estimated TFR trends overlap better for 'primary' than for 'no education' or 'beyond primary'. It is surprising because one expects the better-educated women to have more accurate knowledge of their own age and the ages of their children. The reasons for this unexpected pattern are not clear.

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 centred 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 programme 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 derived by the own-children method to generate estimates that are comparable to the 3-year-aggregated birth-history estimates. This is done 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, it has been 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 ($t=96{\cdot}20$), and the mean date of interview in the 2001 survey was 2001·27 ($t=101{\cdot}27$). Thus the two points 7·5 years before the two surveys are $t=88{\cdot}70$ and $t=93{\cdot}77$.

Second, assume that the TFR has been changing in a linear fashion and fit a line through the two points. (Fig. 1, shown earlier, indicates that the assumption of a linear trend is reasonable.) The line has the form:

$$\mathrm{TFR}=a+b\,t \qquad (1)$$

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 $t=94{\cdot}70$ and $t=99{\cdot}77$. 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.

Equation (1) was fitted for the whole country, urban and rural areas, development regions, ecological regions and three categories of education. The equations were then used 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 3. In the table, the linear-trend estimates are labelled 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, the own-children estimates are viewed as more accurate than the birth-history estimates. If, however, the pace of fertility decline has been accelerating (violating the 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. Figure 2 suggests, however, that the linearity assumption is not far off the mark.

The last two columns of Table 3 indicate that the birth-history method underestimates the TFR to a greater extent in the later period, 1998–2000, than in the earlier period, 1993–95. The lower BH/OC ratio in 1998–2000 is consistent with evidence discussed earlier (see the discussion relating to sex ratios at birth in Table 1), which indicates more displacement of births in the 2001 survey than in the 1996 survey. Overall, 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 of the TFR for urban areas are too high, as explained earlier. The authors consider, however, that the own-children estimates for rural areas and for education categories are reasonably accurate, although subject to the caveats mentioned earlier. The BH/OC ratios in the last two columns of Table 3 (excluding the ratios for urban) range from 0·92 to 0·97 for 1993–95 (based on the 1996 survey) and from 0·88 to 0·98 for 1998–2000 (based on the 2001 survey). It is noteworthy that in the case of both surveys, the BH/OC ratio is higher for 'primary' than for either 'no education' or 'beyond primary', again indicating that the results are more accurate for 'primary' than for the other two education categories.

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 & Ogawa (1978) and Retherford & Rele (1989), who adapted it from Kitagawa (1955).

The TFR is calculated as $5\Sigma F_x$, 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. Also $F_x = P_x F_{mx}$, 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:

$$\Delta \mathrm{TFR} = 5\Sigma\, \bar{F}_{mx}\, \Delta P_x + 5\Sigma\, \bar{P}_x\, \Delta F_{mx}, \qquad (2)$$

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Table 4. 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. 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 or extrapolation. 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.

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 Δ denotes change between 1993–95 and 1998–2000. The first of the two main components on the right side of equation (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. 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 4 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 5 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 6 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,

Table 5. 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 in Table 4.

Table 6. 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			

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

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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 category between the two surveys, resulting in an increase in the proportion of women in this category who come from social backgrounds where early marriage is common.

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 5 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 dummy variable Z that indicates whether the woman was interviewed in the 1996 survey or the 2001 survey. The variable Z is defined as 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, ..., X_k denote selected demographic and socioeconomic variables. In order to simplify the analysis, women who experienced a child death during the 5 years before the survey (9% of women in the combined sample) and women who were married more than once (8% of women in the combined sample) are excluded from the pooled sample. The omission of 17% of the women introduces an unknown degree of bias in the decomposition results.

The next step is to calculation the regression:

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

when $Z=0$, $F=a$, indicating the average value of F in the 1996 survey. Similarly, the average value of F in the 2001 survey, when $Z=1$, 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*.

It would also be good 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 explained component of change in *F*. (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 programme, or to diffusion effects unconnected with the programme 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 & 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 (yes, no)
- Whether sterilized at start of 5-year period (yes, no)

Regarding media exposure, a ‘yes’ response means that the respondent reads a newspaper at least once a week, watches television at least once a week, or listens to the radio every day. A ‘no’ response means that the respondent has had none of these three types of exposure.

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 5 years before the survey), Table 7 shows mean values (in the case of

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Table 7. 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+	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.

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Table 8. 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	0·000	− 0·0470*
Development region	− 0·001	− 0·0463*
Urban/rural residence	− 0·003	− 0·0435*
Education	0·000	− 0·0438*
Age at first cohabitation with husband	0·003	− 0·0465*
Time elapsed since first cohabitation	− 0·013	− 0·0340*
Number of living children at start of 5-year period	− 0·003	− 0·0313*
Media exposure	− 0·006	− 0·0252*
Whether sterilized at start of 5-year period	− 0·016	− 0·0094
Unexplained component	− 0·009	− 0·0094
Total change in fertility between the two surveys	− 0·047	− 0·0470*

Note: Fertility is measured by the number of births that a woman had during the 5 years immediately preceding the survey. The variable *Z* is defined as 1 if the woman was interviewed in the 2001 survey and 0 if she was interviewed in the 1996 survey. In the last column, an asterisk indicates that the coefficient of *Z* in the underlying regression is statistically significant at the 5% level. See text for further explanation.

continuous variables) and percentage 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 0·047 child, amounting to a 6% decline in five years. Table 8 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*. (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

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substantial, contrary to what one might expect from the changes in these distributions shown in Table 7. The reversals occur as a consequence of controlling for prior variables.)

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 programme, because sterilization accounts for only about 60% of contraceptive prevalence. Other contraceptive methods account for the other 40%. 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 unexplained component no longer differs significantly from zero.

Conclusion

This analysis of fertility trends, which is based on the own-children method of fertility estimation, 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 should be viewed as approximate, inasmuch as they involve adjustments for displacement that are rather rough. The own-children estimates of the TFR 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). This projected value will of course be too high if fertility decline accelerates, which may well happen.

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 fertility estimates for rural Nepal, however, do not suffer from this bias. 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 estimated 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 greater in absolute magnitude for women with more than a primary education than for women with no education or women with at least some primary education. Among women with more than a primary education, nuptiality change tends to increase the TFR rather than decrease it.

Further analysis of the decline in marital fertility, as measured by births to currently married women during the 5 years before each survey, indicates that, in

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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 partly accounted for by increased use of contraceptive methods other than sterilization.

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References

Bastola, T. S. (1995) Urbanization. In National Planning Commission Secretariat (ed) *Population Monograph of Nepal*, Chapter 8. Central Bureau of Statistics, Kathmandu.

Casterline, J. B. (ed.) (2001) *Diffusion Processes and Fertility Transition.* National Academy Press, Washington, DC.

CBS (Central Bureau of Statistics) (1987) *Population Monograph of Nepal*. Central Bureau of Statistics, Kathmandu.

CBS (Central Bureau of Statistics) (1995) *Population Monograph of Nepal 1995*. Central Bureau of Statistics, Kathmandu.

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

Coale, A. & Demeny, P. (1967) *Methods of Estimating Basic Demographic Measures from Incomplete Data*. Manual IV. Population Studies No. 42. United Nations, New York.

Collumbien, M., Timaeus, I. M. & Acharya, L. (2001) Fertility decline in Nepal. In Sathar, Z. A. & Phillips, J. F. (eds) *Fertility Transition in South Asia*. Oxford University Press, Oxford.

Kitagawa, E. M. (1955) Components of a difference between two rates. *Journal of the American Statistical Association* **50**, 1168–1194.

Ministry of Health [Nepal], New ERA & ORC Macro (1997) *Nepal Family Health Survey 1996*. Family Health Division, Ministry of Health; New ERA; and ORC Macro; Calverton MD.

Ministry of Health [Nepal], New ERA & ORC Macro (2002) *Nepal Demographic and Health Survey 2001*. Family Health Division, Ministry of Health; New ERA; and ORC Macro; Calverton MD.

Narasimhan, R. L., Retherford, R. D., Mishra, V. K., Arnold, F. & Roy, T. K. (1997a) *Measuring the Speed of India's Fertility Decline*. National Family Health Survey Bulletin, No. 6. International Institute for Population Sciences, Mumbai; East-West Center, Honolulu.

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

Retherford, R. D. (1985) A theory of marital fertility transition. *Population Studies* **39**, 249–268.

Retherford, R. D. & Mishra, V. K. (2001) *An Evaluation of Recent Estimates of Fertility Trends in India.* National Family Health Survey Subject Reports, No. 19. International Institute for Population Sciences, Mumbai; East-West Center, Honolulu.

Retherford, R. D. & Ogawa, N. (1978) Decomposition of the change in the total fertility rate in the Republic of Korea, 1966–70. *Social Biology* **25**, 115–127.

Retherford, R. D. & Palmore, J. A. (1983) Diffusion processes affecting fertility regulation. In Bulatao, R. A. & Lee, R. D. (eds) *Determinants of Fertility in Developing Countries*, Vol. 2. Academic Press, New York, pp. 295–339.

Retherford, R. D. & Rele, J. R. (1989) A decomposition of recent fertility changes in South Asia. *Population and Development Review* **15**, 739–747.

Retherford, R. D. & Thapa, S. (1998) Fertility trends in Nepal, 1977–95. In *Contributions to Nepalese Studies* (Journal of the Centre for Nepal and Asian Studies, Tribhuvan University, Kathmandu), Vol. 25 (special issue, July 1998), pp. 9–58.

Retherford, R. D. & Thapa, S. (1999) The trend of fertility in Nepal, 1961–95. *Genus* **55**, 61–98.

Retherford, R. D. & Thapa, S. (2003) *Fertility in Nepal, 1981–2000: Levels, Trends, and Components of Change*. East-West Center Working Papers: Population Series No. 111. East-West Center, Honolulu.

Shryock, H. S. & Siegel, J. S. (1980) *The Methods and Materials of Demography*, Vol. 1 (fourth edition, revised). US Bureau of the Census, Washington, DC.

Thapa, S., Neidell, S. G. & Dahal, D. R. (eds) (1998) Fertility transition in Nepal. *Contributions to Nepalese Studies* **25** (special issue).