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Recent Trends and Components of Change in Fertility in Egypt

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Abstract

Recent research indicates that fertility transition is underway in Egypt. However, after experiencing a rapid decline since the 1980s, the fertility decline in Egypt seems to be stalling since the second half of the 1990s. Of late, it has been realized that the total fertility rate as the conventional measure is a poor indicator of fertility for populations undergoing rapid fertility transition. In particular, if childbearing is postponed and, subsequently, the mean age at childbearing increases, the observed total fertility rate is lower than in the absence of such timing changes. Thus, the observed stalling in fertility in Egypt could be caused by a change in the timing of first and subsequent births. The present study investigates the levels and changes in total and parity-specific fertility by using the information on changes in the mean age of birth from the Demographic and Health Surveys from 1992, 1995, and 2000. Moreover, we decompose the decline in fertility into its proximate and socioeconomic components.

About the Author

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Recent Trends and Components of Change in Fertility in Egypt

Henriette Engelhardt

Introduction

There has been much discussion lately about the news that Egypt's fertility decline has been stalled over the last decade. Given the facts that minor differences in near term fertility levels have major impacts on the longer term population size of a country and that Egypt has an explicit government policy to bring fertility to replacement level by 2017, this has caused serious concern and publicity. Figure 1 presents various estimates of fertility trends in Egypt since 1960. It shows that during the 1980s, Egypt experienced a significant fertility decline from around six to around four children per woman. While studies based largely on interpolation show a continuation of this declining trend (although at a slower pace) during the 1990s, a study by El-Zanaty and Way (2004) finds that fertility may actually have increased during the late 1990s, based on recent DHS data.

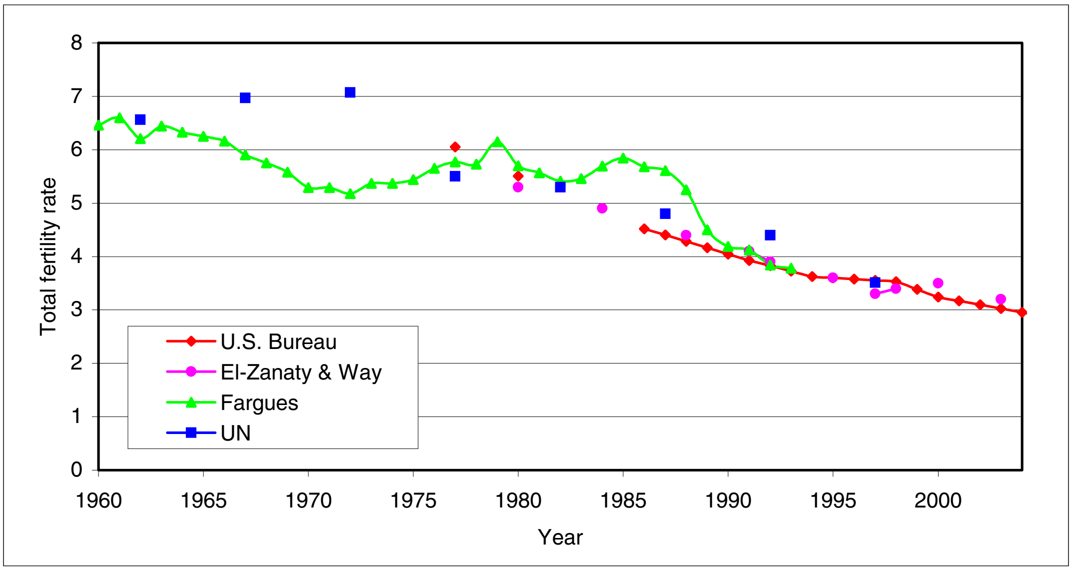

Figure 1. Total fertility rate per woman in Egypt. Sources: Fargues (1997); El-Zanaty and Way (2004); United Nations (2000); U.S. Bureau of the Census (2004).

A recent paper by the United Nations Population Division (2002) studying 74 countries at the intermediate level of fertility, singled out the recent stalling of fertility in Egypt as a cause for future concerns. Eltigani (2003) tried to analyze whether this recent fertility stalling was brought about by a particular population segment, most probably the lower socioeconomic class. Members of this class are expected to change their reproductive behavior only if there is structural change (i.e., improvement) in their socioeconomic conditions. Using data collected by the 1988, 1992, 1995, and the 2000 Egyptian Demographic and Health Surveys, his study indicates that the reproductive behavior of women from high and middle class households is largely responsible for the stalling in fertility during recent years, and that prospects for permanent lower fertility in the future are limited.

Recently, demographers have realized that the total fertility rate (TFR) as the conventional measure is a poor indicator of fertility for a population undergoing a rapid fertility transition (as is the case in Egypt). The TFR is defined as the average number of births a woman would have if she were to live through her reproductive years and bear children at each age at the rates observed in that particular year. It is a hypothetical measure because no real group of women has experienced or will necessarily experience these particular rates. When the timing of fertility changes over time, the TFR will differ from completed cohort fertility.

Following Bongaarts and Feeney (1998), the conventional TFR can be considered to consist of a tempo and a quantum component. The quantum component is defined as the TFR that would have been observed in the absence of changes in the timing of childbearing during the period in which the TFR is measured. The tempo component equals the distortion that occurs due to timing changes. In particular, if childbearing is postponed and, subsequently, the mean age at childbearing increases, the observed total fertility rate is lower than in the absence of such timing changes. Thus, the observed stalling in fertility in Egypt can also be caused by a change in the timing of first and subsequent births.

For these reasons, the present study investigates the levels and changes in fertility in Egypt, using the information on mean age of birth from the Demographic and Health Surveys of 1992, 1995, and 2000. Moreover, it takes care of misreporting of women's ages when estimating the age-specific fertility. Additionally, the study presents a decomposition of the fertility decline in its proximate and socioeconomic components.

Data and Methods

Data

Egypt has three sources for population data. Since the year 1882 Egypt has carried out population censuses on a regular basis with interruptions during war times. After World War II one full-scale census was carried out in 1960 and since 1966, there have been four decennial censuses on a sample basis. Moreover, since 1839 Egypt has maintained a vital registration system of live births and deaths, which was extended in 1912 to cover still births as well. Although compulsory, registration of birth events is estimated to be at about 90 percent, with lower levels in rural areas. Thus, the numbers provided by the Central Agency for Public Mobilization and Statistics (CAPMAS) have to be considered as less accurate. Fortunately, like many less developed countries, Egypt has implemented a World Fertility Survey (in 1980) and Demographic and Health Surveys (in 1988, 1992, 1995, and 2000) permitting the estimation of level and trends of reproductive behavior.

The present study is based on data collected by the 1992, 1995, and the 2000 Egyptian Demographic and Health Surveys (EDHS). The Demographic and Health Surveys (DHS) project is the third consecutive worldwide research project initiated by the U.S. Agency for International Development (USAID) to provide data and analysis on the population, health, and nutrition of women and children in developing countries. The DHS were designed to provide estimates for key indicators such as fertility, contraceptive use, infant and child mortality, immunization levels, coverage of antenatal, maternal and child healthcare and nutrition, as well as on the socioeconomic backgrounds of respondents and their households. The survey results are intended to assist policy makers and planners in assessing the current health and population programs and in designing new strategies for improving reproductive health and health services in Egypt.

The primary objective of the sample design for the three EDHS was to provide estimates of key population and health indicators including fertility and child mortality rates for the country as a whole and for six major administrative regions (the urban governorates, urban Lower Egypt, rural Lower Egypt, urban Upper Egypt, rural Upper Egypt, and the frontier governorates). To meet the survey objectives, the number of households selected in the EDHS samples from each governorate was not proportional to the size of the population in that governorate. As a result, the EDHS samples are not self-weighting at the national level, and weights have to be applied to the data to obtain the national-level estimates presented in this report.

The DHS surveys consisted of a household questionnaire and a women's questionnaire. A nationally representative sample of ever-married women aged 15-49 was interviewed. The 1992 EDHS covered 9,864 women from 10,760 households, while the 1995 and 2000 EDHS covered 14,779 women from 15,567 households and 15,573 women from 16,957 households, respectively. The three surveys adopted similar instruments; however, the 1995 EDHS added two modules to obtain information on female circumcision and on women's status, and the 2000 EHDS included two modules to collect data on female circumcision and on the education of children.

Quality of data on the ages of women and children

Accurate reporting of ages of women and children is essential for accurate estimation of fertility from survey data. In obtaining age data, respondents in the Egyptian DHS were asked to report both their birth dates (month and year) and their ages in completed years. If a respondent gave neither her birth date nor her age, the interviewer was instructed to probe and to try to estimate the respondent's age by referring to national events, other members of the household, the date of the respondent's first marriage or birth, or in any other way that was plausible. However, these latter procedures may entail a measurement error, particularly when the interviewer estimates the respondent's age on the basis of physical appearance, as such assessment is always influenced by both the respondent's as well as the interviewer's background.

Table 1 shows the extent to which the women interviewed in the three surveys gave complete information about their birth dates. A majority of respondents (61 percent) provided both the month and year of birth. Nearly 40 percent provided the year and age, whereas a negligible percentage (0.1 percent) knew only their age. For these groups, the month of birth was imputed and/or the year of birth was calculated (Croft 1991). The comparison of the three surveys indicate that the percentage reporting a complete date of birth in the 1992 EDHS is higher than in the 2000 EDHS.

Table 1. Percent distributions of ever-married women, 15-49, by completeness of reporting of age information. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

	1992	1995	2000
Month and year	60.7	52.1	59.9
Month and age, year imputed		0.0	0.1
Year and age, month imputed	39.2	1.4	10.2
Year and age, year ignored		44.0	7.8
Age, year, and month imputed	0.1	2.5	21.9
Total	100.0	100.0	100.0
Number of women	9,864	14,779	15,573

Age data is typically prone to errors of recall and other types of biases (Ewbank 1981). Age misreporting takes two basic forms: "heaping" or digit preference, and "shifting." In less literate populations like Egypt, the reporting of events, especially births, is usually clustered at certain preferred digits, as a result of ignorance, genuine reporting errors, or deliberate misreporting. Thus, it is common to find concentrations of people at ages ending in the digits 0 and 5.

Figure 2, which presents the distribution of respondents in the 1992, 1995, und 2000 EDHS by single year of age, confirms that there is some heaping on selected ages. Note that all data are weighted by the sample weight. The high preference for digits 0 and 5 is accompanied by a dislike for other digits, especially digits 1 and 9, as well as 4 and 6. Thus, over-reporting of persons at ages ending in zero appears to be from those at the preceding and succeeding digit.

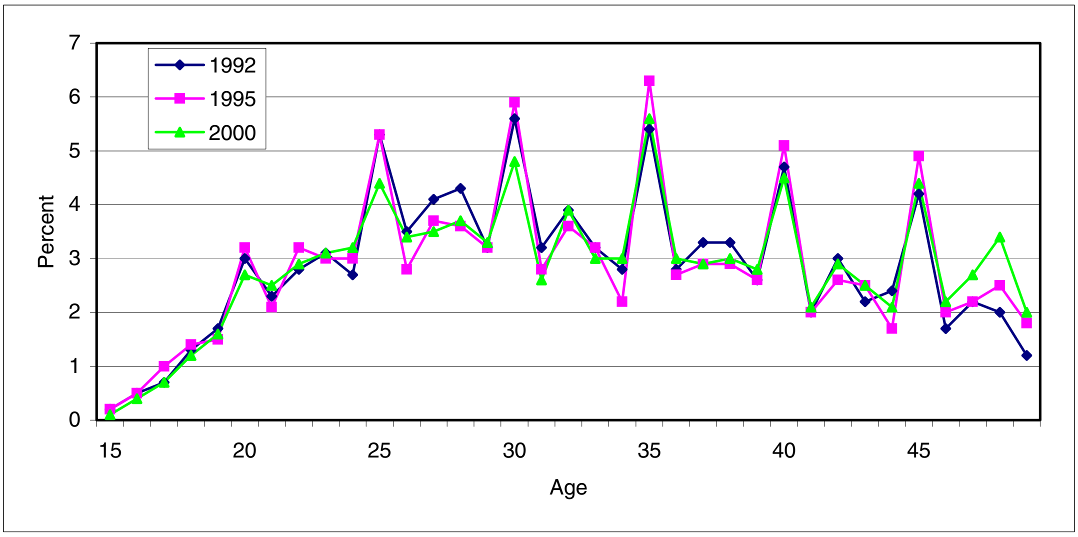

Figure 2. Distribution of ever-married women by single year of age. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

In order to quantitatively evaluate the quality of age-reporting, demographers proposed several indices (Swanson and Siegel 2004). The Whipple index, among those most widely used, is specially designed for measuring a digit preference of 0 and 5 and age heaping. While the Whipple index was originally computed for data between ages 23 and 62, we redefine it for our purposes as follows:

$$\text{Whipple index} = \frac{(\text{sum of numbers at ages } 20, 25, \ldots, 45) \times 100 \times 5}{\text{total number between ages 18 and 47}}$$

If there were neither digit preference nor age heaping, the Whipple index would be 100. If all persons in the population reported their ages as ending in 0 or 5, the Whipple index would be 500. The values of the Whipple index are thus in a range between 100 and 500. The United Nations (1955) notes that if Whipple index values are less than 105, then age distribution data are deemed to be "highly accurate"; if the values are between 105 and 109.9, they are "fairly accurate"; if between 110 and 124.9, "approximate"; if between 125 and 174.9, "rough"; and if 175 or more, "very rough" (United Nations 1955: 39-45).

Table 2 presents the Whipple indices calculated for the total age distributions as well as for the age distributions according to urban-rural residence, place of residence, and level of education. Generally, the age distributions in the three surveys seem to be rough. While urban residents and higher educated women report their ages more validly then rural residents and less educated women, it is only for higher educated women that we find accurate data quality according to the U.N. standards.

Table 2. Whipple index for age distributions of ever-married women aged 15-49, according to urban-rural residence, place of residence, and level of education. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

	1992	1995	2000
Urban-rural residence:			
Urban	127.67	138.67	122.26
Rural	164.11	184.19	156.34
Place of residence:			
Urban governorates	128.29	133.01	121.38
Lower Egypt – urban	110.78	140.54	119.41
Lower Egypt – rural	153.58	163.28	151.89
Upper Egypt – urban	145.73	148.00	126.80
Upper Egypt – rural	177.07	209.99	161.37
Frontier governorates	n.a.	165.35	153.85
Educational level:			
No education	179.46	200.57	171.53
Primary education	129.84	157.65	139.66
Secondary education	108.81	120.19	109.83
Higher education	93.75	106.75	110.65
Total	147.18	163.12	141.18

Note: n.a. = not available.

To obtain information on the timing of fertility events, respondents were asked to give the birth dates (i.e., month and year) and age for each surviving child and a birth date and age at death for each child who had died. Again the accuracy of the reporting of this information varies. Greater error is usually associated with the reporting of more distant events or of dates for children who have died.

Table 3 examines the completeness of reported dates of birth for all live births and for all births during the period five years preceding the survey. The completeness of reporting varies according to the survival status of the child. For nearly 90 percent of all living children, mothers reported both the month and year of birth, while for only around 60 percent of children who had died a complete birth date was given. The reporting of birth dates was better for recent births, i.e., those that occurred during the five-year period preceding the survey, than for other births, whatever the survival status. Further analysis (not shown here) shows that the completeness of birth date information varies significantly by residence, with reporting of date information being better for urban than for rural births. Birth date reporting increases with the educational level of the mother. Overall, the percentage of live births for which information on date of birth was complete is higher in the 2000 EDHS than 1992 EDHS, indicating that date reporting is improving in Egypt.

Table 3. Percent distributions of all births and more recent births according to survival status of the birth and completeness of reporting of age information. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

	1992			1995			2000		
	Alive	Dead	Total	Alive	Dead	Total	Alive	Dead	Total
Month and year given	88.8	59.3	84.3	77.7	38.8	72.1	89.1	55.7	85.3
Month and age, year imputed	0.0		0.0	0.1		0.0			
Year and age, month imputed	11.2		9.5	0.9		0.7	6.3		5.6
Year and age given, year ignored				21.4		18.3	4.5		4.0
Year given, age and month imputed		40.2	6.1		61.1	8.8	0.0	43.5	5.0
Age given, year and month imputed		0.4	0.1	0.0		0.0	0.0		0.0
Month given, age and year imputed		0.1	0.0		0.1	0.0			
Age, year, and month imputed					0.1	0.0		0.8	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of births	32410	5801	38211	46857	7863	54720	48385	6237	54622
All births 60 months before survey									
Month and year given	99.9	99.4	99.9	100.0	100.0	100.0	100.0	99.8	100.0
Month and age, year imputed	0.0		0.0						
Year and age, month imputed	0.0		0.0				0.0		0.0
Year and age given, year ignored				0.0		0.0			
Year given, age and month imputed		0.2	0.0					0.2	0.0
Month given, age and year imputed		0.5	0.0						
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of births	8248	618	8866	10867	779	11646	11025	508	11534

One area of specific concern in estimating fertility levels in all DHS surveys is the extent to which fertility rate estimation may be influenced by the displacement of children's birth dates, usually by interviewers seeking to avoid asking the extensive set of child health questions (Hussein and Shawky 1995). Since such displacement typically results in a deficit of births in the fifth calendar year before the survey (the boundary for the DHS health section), significant displacement may result in underestimation of the fertility rate for the five-year period before the survey and an overestimation of the rate for the preceding five-year period.

In assessing the extent of birth displacement on DHS surveys, Figure 3 shows the distribution of birth years for all children of the three surveys. Most interestingly, there is indeed a systematic underreporting of births for the years preceding the survey. Thus, our fertility analysis based on DHS data will underestimate the true fertility in Egypt.

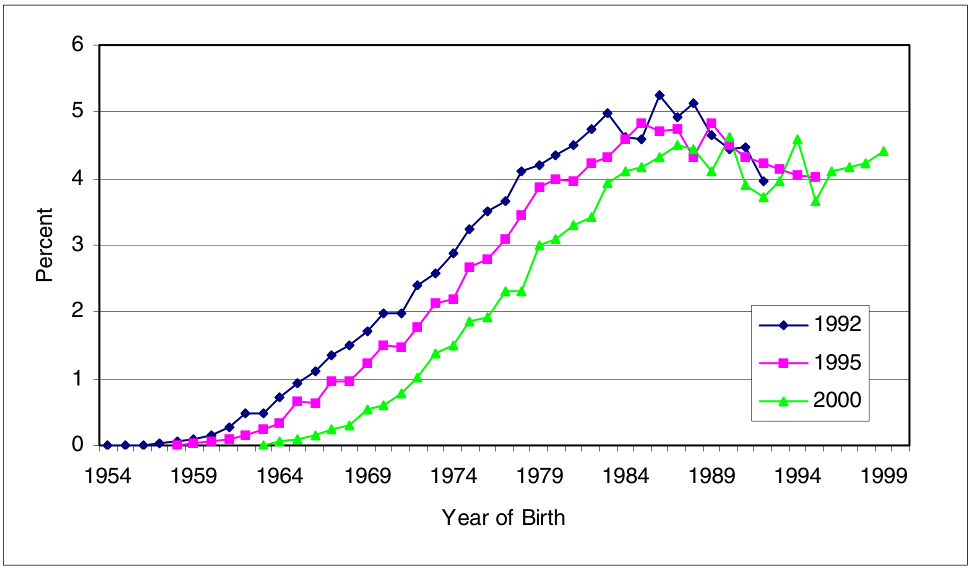

Figure 3. Distribution of birth years of all children. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

Another useful indicator of data quality is the sex ratio at birth (Retherford and Thapa 1999). Because there is considerable preference for sons in Egypt, women who forget to mention children who have died or moved away are more likely to omit girls than boys. 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 omitted the ratio should be higher than 1.05. Table 4 shows that in the five years preceding each survey, the sex ratio at birth is 1.11 in 1992, 1.07 in 1995, and 1.05 in 2000. Obviously, in respect to sex ratio the data quality of the EDHS improved over time. However, the deviations in the 1995 and 1992 surveys are only slightly above the expected value of 1.05, indicating that the selective omission of girls is not a problem.

Table 4. Male and female births (in percent), and the sex ratio at birth, for all births and for the births during the five-year period before the surveys. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

	All births			60 months before survey		
	1992	1995	2000	1992	1995	2000
Males	51.3	51.9	51.3	51.6	51.6	51.3
Females	48.7	48.1	48.7	47.5	47.5	48.7
Sex ratio at birth	1.05	1.08	1.05	1.07	1.07	1.05

Methodology of estimating fertility rates

Measures of current fertility presented in this paper include age-specific fertility rates and the total fertility rate. These rates are generally presented for the three-year period preceding the survey, a period covering portions of the calendar years 1997 through 2000. The three-year period is chosen for calculation (rather than a longer or shorter period) to provide the most current information in order to maximize their policy and program relevance (Rutstein and Rojas 2003).

Age-specific fertility rates (ASFR) are useful in understanding the age pattern of fertility. Numerators of age-specific fertility rates are calculated by identifying live births that occurred in the 1 to 36 months preceding the survey (determined from the date of interview and date of birth of the child), and classifying them by the mother's age (in five-year age groups) at the time of the child's birth. The denominators of these rates are the number of women-years lived in each of the specified five-year age groups during the 1 to 36 months preceding the survey. Although information on fertility was obtained only for ever-married women, the age-specific rates are presented for all women regardless of marital status. Data from the household questionnaires on the age structure of the population of never-married women were used to calculate the all-women rates. This assumption is very solid since births in Egypt occur within marriage, the number of births to single women is negligible.[1] The total fertility rate is calculated by summing the age-specific fertility rates. It is presented for women aged 15-49.

As mentioned earlier, changes in the TFR can arise as a result of changes in its quantum component or in its tempo or timing component or as a result of changes in both components. To overcome the problems inherent in the methods of Ryder (1964) and others, Bongaarts and Feeney (1998) developed a method to adjust the TFR for changes in tempo of childbearing. Application of this method gives the tempo-adjusted TFR.

The principle behind the method is simple, and the derivation of the formula is straightforward. If the mean age of mothers at childbearing of any TFR order *i* changes by an amount *r* per annum (r_i), then the observed TFR of order *i* (TFR_i) may be expressed as 1– r_i times the TFR, had there been no change in their timing (TFR'_i). In other words,

$$TFR'_i(t) = \frac{TFR_i(t)}{1 - r_i(t)}, \tag{1}$$

where $r_i(t)$ equals the annual rate of change in the mean age at childbearing for birth order *i* in year *t*. TFR'_i can be interpreted as the total fertility rate of order *i* that would have been observed had there been no change in the timing. Summing over *i*, we get the adjusted total fertility rate:

$$TFR'(t) = \sum_i TFR_i(t) \tag{2}$$

[1] Following Rutstein and Rojas (2003), when calculating age-specific fertility rates, the denominators (number of exposures 1-36 months preceding the interview) and numerators (number of births) are weighted differently. The numerators were weighted with the sample weight, while the denominators were weighted twice with an all-women factor and a sample weight.

Application of this method depends on the availability of age-order-specific fertility rates for at least two points in time, say *t* and *t* – *n*. Using the age-order-specific fertility rates, order-specific total fertility and order-specific mean ages at childbearing can be derived.

If childbearing is postponed and, subsequently, the mean age at first marriage increases, the observed total fertility rate is lower than in the absence of such timing changes. In the opposite case, if childbearing occurs at an earlier age, the mean age at childbearing decreases, and hence the observed total fertility rate is higher than without the change in timing.

Fertility Estimates

Levels and trends of fertility

Current estimates of fertility levels are presented in Table 5. The total fertility rate indicates that if fertility rates were to remain constant at the level prevailing during the three-year period before the survey (for the 2000 EDHS approximately March 1997 to February 2000), an Egyptian woman would bear 3.5 children during her lifetime. However, this rate has declined from a level of 3.9 births per woman at the time of the 1992 EDHS to 3.6 births per woman at the time of the 1995 EDHS, and leveled off at 3.5 children at the 2000 EDHS.

Table 5. Age-specific fertility per 1,000 women and total fertility rates of women in Egypt (aged 15-49). Sources: EDHS (1992, 1995, 2000); weighted data.

	1992 1988-1992	1995 1991-1995	2000 1996-2000
15-19	69	67	53
20-24	224	211	195
25-29	231	213	208
30-34	170	147	145
35-39	102	83	72
40-44	45	29	25
45-49	5	7	4
TFR	4.23	3.78	3.51
Percentage distribution			
15-19	8	9	8
20-24	26	28	28
25-29	27	28	30
30-34	20	19	21
35-39	12	11	10
40-44	5	4	4
45-49	1	1	1
Total	100	100	100

The results in Table 5 indicate that all age groups shared the decline in fertility rates, resulting in a lower TFR. For example, according to the 1992 and 2000 EDHS data, the fertility rates for the group aged 25-29 years were 222 and 208 births per 1,000 women, while they were 208 and 196 for age group 20-24, respectively. The decline has been more rapid among younger and older women. The smallest decline was observed for women in the age group 30-34. The shift in the younger age group may be due to the fact that Egyptian women marry later and postpone the birth of their first child. An increase in the level of women's education, participation in the labor market, and participation in family planning programs may have also contributed to this recent phenomenon. These factors will be discussed below.

The percentage distribution of ASFR, which is calculated by dividing the ASFR with the sum of fertility rates and multiplying the results by 100, is also provided in Table 5. Based on the 1992 EDHS data, 8 percent of fertility rates were attributed to the fertility rates of women in age group 15-19 years. These figures show that although the shape of the fertility rates curve has changed over time, the percentage distributions of fertility rates by age group have been relatively constant. Over time, women aged 20-24 account for about 26 to 28 percent of the total fertility rates, and women aged 25-29 years account for 28 percent in the year 1992 to 29 percent in the year 2000.

In more general terms, the shape of the age distributions of fertility rates may remain invariant. Thus, concerning the total fertility rate we do not observe a tempo effect, i.e., distortions due to changes in the mean age of childbearing. Once tempo effects are present, then the distribution may shift to higher or lower ages over time. The TFR that would have been observed in the absence of changes in the timing of childbearing is defined as a quantum (Bongaarts and Feeney 1998; Bongaarts 1999). However, it is quite possible that tempo effects exist for parity-specific fertility rates, which are dissembled in the aggregated total fertility rate (see below).

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

When plotting the age-specific fertility rates based on ungrouped data, we get a roller-coaster fertility distribution (Figure 4). This hilly pattern results mainly from misreporting of women's ages on preferred digits. In the case of Nepal, Retherford and Thapa (1999, 2004) note that misreporting of women's ages in the DHS tends to shift the age curve of fertility to the right, i.e., to the older ages. Thus, there is a net upward bias in reported ages of women who have a higher than average number of children relative to their true age. However, there also may be some downward bias in reported ages of women who have a lower than average number of children relative to their true age.

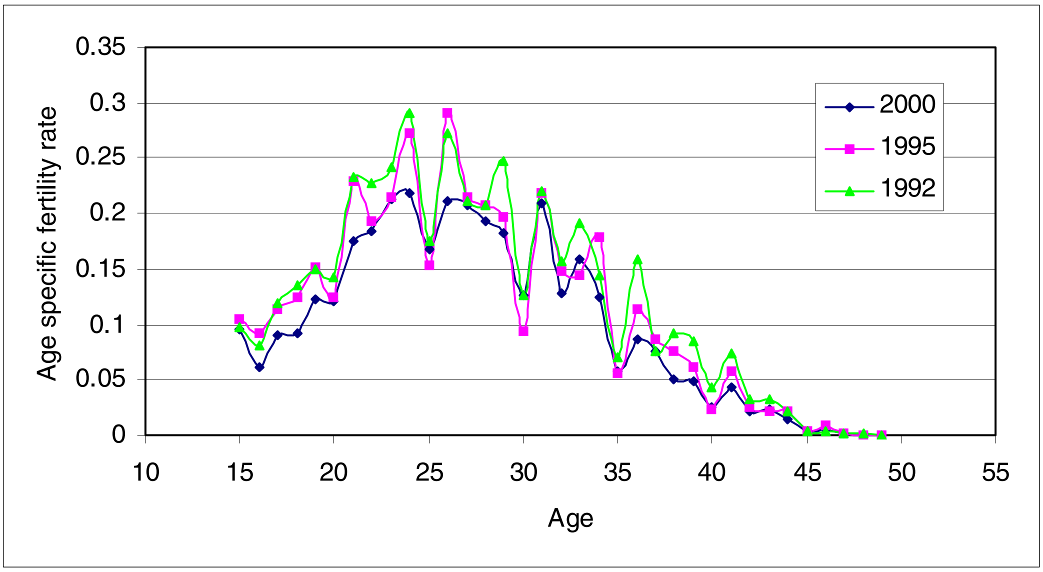

Figure 4. Age-specific fertility rates for the 60-month period preceding the surveys. Sources: EDHS (1992, 1995, 2000); weighted data.

Underreporting of births in Egypt tends to result in underestimates of fertility in the first five years before the survey. At the same time, incorrect reporting of birth dates could also appear in the first five years before the survey as well as before. Some of this is due to intentional displacement on the part of interviewers who wish to avoid asking the extensive set of questions on child health, and some occurs because of upward rounding of children's ages by survey respondents (for example, a child age 3 years and 10 months might be reported as age 4). In the case of Nepal, Retherford and Thapa (2004) note that dates of recently occurred births in the year before the survey 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. However, according to Retherford and Thapa (2004) it seems likely, 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 effectively displaces births further into the past.

Displacement of birth also results in an age pattern of bias (pertaining to the estimates of ASFR) 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 the estimates of fertility above the peak age of fertility bias (Retherford and Thapa 2004).

The net effect of these leftward and rightward shifts from misreporting of women's ages and displacement of births on the estimated age curves of fertility is not entirely clear and may vary from one survey to the next. 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 ASFR still adds up to approximately the same number of children per woman, i.e., to the same value of TFR (Retherford and Thapa 1999, 2004).

Birth displacement outside the period of observation, however, distorts the estimates of ASFR, and therefore has a distorting effect on the estimates of the TFR. Age heaping, however, should not have a disturbing effect on the estimation of the TFR since the effect of heaping is expected to cancel out when summing over the age-specific rates. The estimates of absolute declines in ASFR and TFR may be about right in the case of Egypt because the extent of age misreporting does not differ much between the three surveys.

For smoothing fertility distributions, several methods have been suggested in the literature including cubic splines, the Hadwiger function, the Gamma and Beta function, the Brass polynomial, and the Gompertz function, as well as the Coale-Trussel function (Hoem et al. 1981). Hoem et al. concluded that the cubic spline provided the best fit for Danish fertility data. The Coale-Trissell procedure, Gamma density, and Hadwiger function offered second-best fits, while Beta density, the Brass polynomial, and the Gompertz function were less accurate. Chandola et al. (1999) find the simple Hadwiger and mixture Hadwiger models useful in describing and comparing distorted fertility patterns across Europe. As suggested by this research, Figure 5 presents observed and estimated fertility rates based on the Gamma model, the Hadwiger model, the Hadwiger mixture model, and the Coale Trussel model for the EDHS 2000. Moreover, we present the estimated distribution based on a robust non-linear smoother.

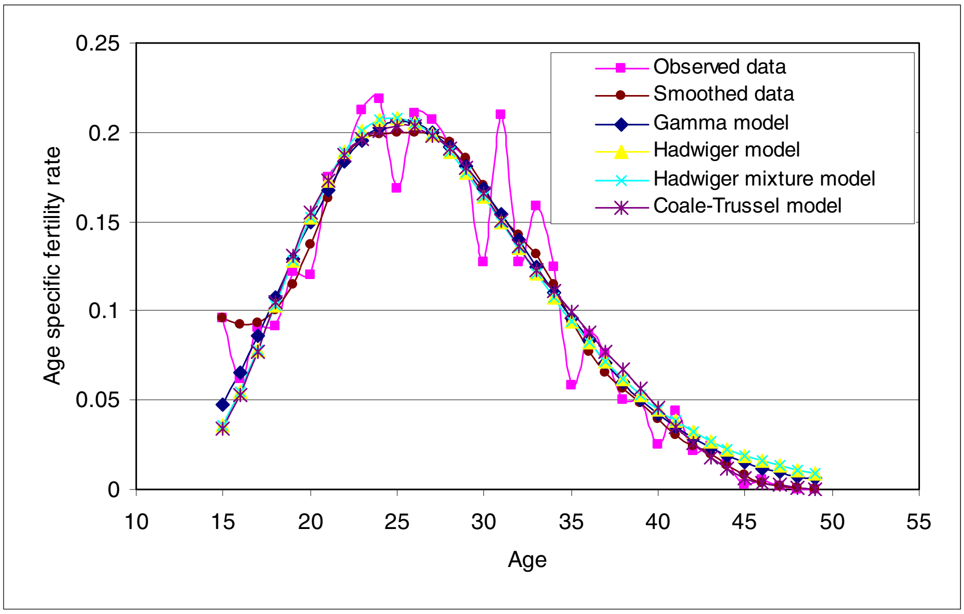

Figure 5. Observed and predicted age-specific fertility rates for Egypt, 2000. Source: EDHS (2000); weighted data.

Table 6 shows observed, smoothed, and model-based estimated fertility rates based on single-year age data. While the TFR based on single-year age data in 1992 and 1995 was above the TFR based on grouped data, the value for the year 2000 is lower. Considering the model-based estimates, the Gamma model, Hadwiger model, and the Hadwiger mixture model yield higher TFR than the calculation based on observed single-year age data. The estimations based on smoothed data are in all years between the fertility rates based on grouped and single-year age data.

Table 6. Estimates of TFR based on observed and estimated single-year age data. Sources: EDHS (1992, 1995, 2000); weighted data.

	1992	1995	2000
Observed data (five-year age groups)	4.23	3.78	3.51
Observed data	4.36	4.02	3.54
Smoothed data	4.36	3.96	3.51
Gamma model	4.40	4.06	3.54
Hadwiger model	4.41	4.07	3.54
Coale-Trussel model	4.36	4.00	3.51

Birth-order components of fertility

The birth-order components of total fertility are defined here as the parts of this measure that are attributable to births of a given order (cf. Bongaarts 1999). To illustrate, examine the components of the total fertility for a cohort of women who have reached the end of their reproductive years. The cohort total fertility rate (CTFR) equals the average number of births these women had during their lifetimes. The first-order component of cohort fertility ($CTFR_1$) is simply the average number of first births born per woman, which equals the proportion of the cohort that had a first birth during their lives; the second-order component ($CTFR_2$) is the average number of first births born per woman, which equals the proportion of the cohort that had a first birth during their lives, and so forth. The sum of these components equals $CTFR$ ($= \Sigma\ CTFR_o$).

Figure 6 presents the CTFR components for cohorts of women age 45-49 in Egypt with the three DHS surveys from 1992, 1995, and 2000. The cohort total fertility ranges from 6.06 in 1992, 6.02 in 1995, to 5.51 in 2000. Note that the CTFR is proportional to the area under the curves plotted in Figure 6. As expected, the components decline as order rises, because no woman can have a birth of a given order without also having had a birth of the preceding order. For both the 1992 and 1995 EDHS, the figure looks similar; there was not much change in completed fertility from the 1992 EDHS to the 1995 EDHS. Reasonable differences, however, can be observed compared to the 2000 survey. The differences over time in the birth-order components are largest for the higher order births and relatively modest for birth order one. This implies that reductions in the CTFR over time are primarily achieved by limiting higher-order births.

This component analysis of the fertility of cohorts can be repeated for period total fertility. The conventional TFR estimates fertility in a given period in terms of average number of births per woman and includes births of all orders. It is computationally straightforward to calculate the total fertility for any specific birth order. Instead of including births of all orders in the numerators of the age-specific fertility rates on which the TFR is based, only births of a single order are included and the same denominators are used. The results of such a calculation for each birth order *o* is a set of birth-order components TFR_o which when summed equal the TFR

($TFR = \Sigma TFR_o$). The TFR_o is supposed to estimate the proportion of women who will have at lest *o* births during her reproductive years, given the propensity to reproduce at the time of the survey.

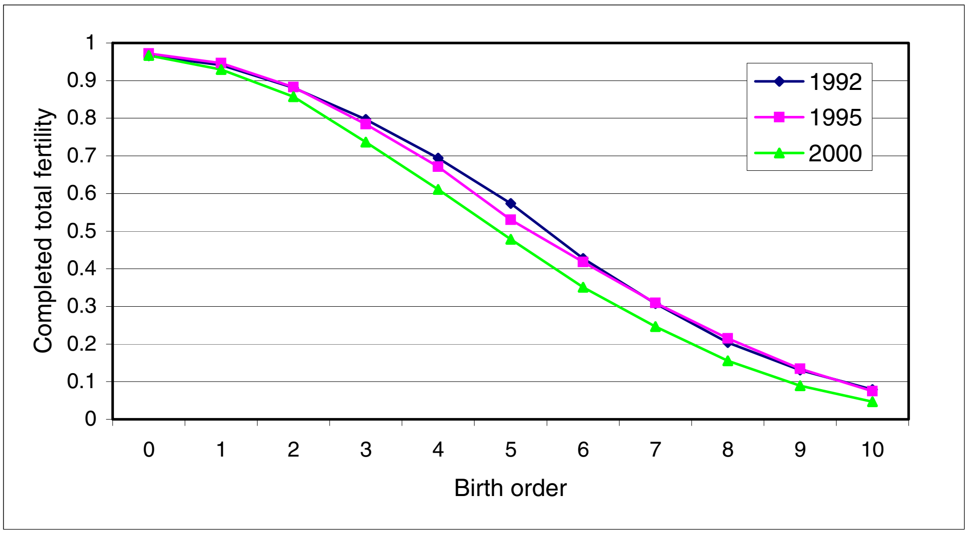

Figure 6. Birth-order components of the period total fertility. Sources: EDHS (1992, 1995, 2000); data weighted by sample weight.

Estimates of the TFR components for the three-year period before the DHS surveys are provided in Figure 7. The values for 1992, 1995, and 2000 are calculated from the single year age-specific birth rates from the corresponding EDHS data. An examination of the trend in the birth-order components reveals that the recent decline in fertility is due to the decrease in lowest birth orders. The TFR1 is estimated at 0.81 first births per woman in 1992 and 0.78 in 2000. Thus, the percentage of women who remained childless increased from 19 percent in 1992 to 22 percent in 2000. Between the 1992 and 2000 surveys, TFR2 declined from 0.77 to 0.69, and TFR3 from 0.63 to 0.60.

The existence of tempo effects during Egypt's rapid fertility transition can be inferred from a trend in the mean ages at births of different orders. Figure 8 plots these means as estimated from each of the three surveys. (Average ages are derived from age-order-specific birth rates for the three-year period preceding each survey.) Figure 8 confirms that tempo distortions are present during the 1990s. The means that orders 1 to 8, plotted in this figure, show a steady rise over time, implying a downward distortion of the TFR and its components. For example, the mean age at first birth declined from 23.96 years in 1992 to 22.35 years in 2000, a decrease of 1.61 years over the period or 0.2 years per year. As a consequence, the first-order component of TFR is, on average 20 percent per year higher than it would have been without the timing distortions during the 1990s. It is important to keep in mind, however, that all estimates plotted in Figure 8 are subject to a variety of errors (sampling, age and birth misreporting) and that errors of a few tenths are likely to be common. This is unfortunate, because a highly accurate measurement of means is necessary to obtain reliable estimates of tempo effects.

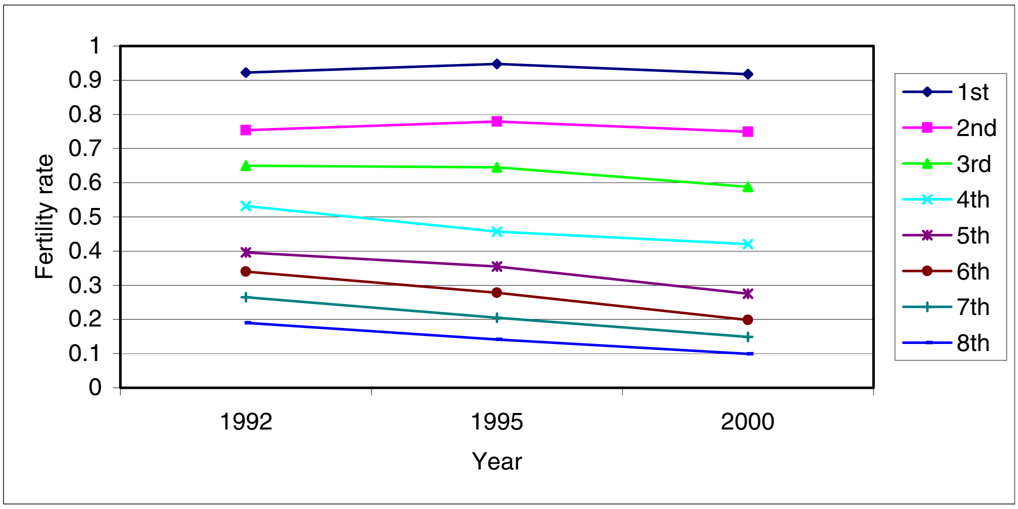

Figure 7. Total fertility and its birth-order components. Sources: EDHS (1992, 1995, 2000); weighted data.

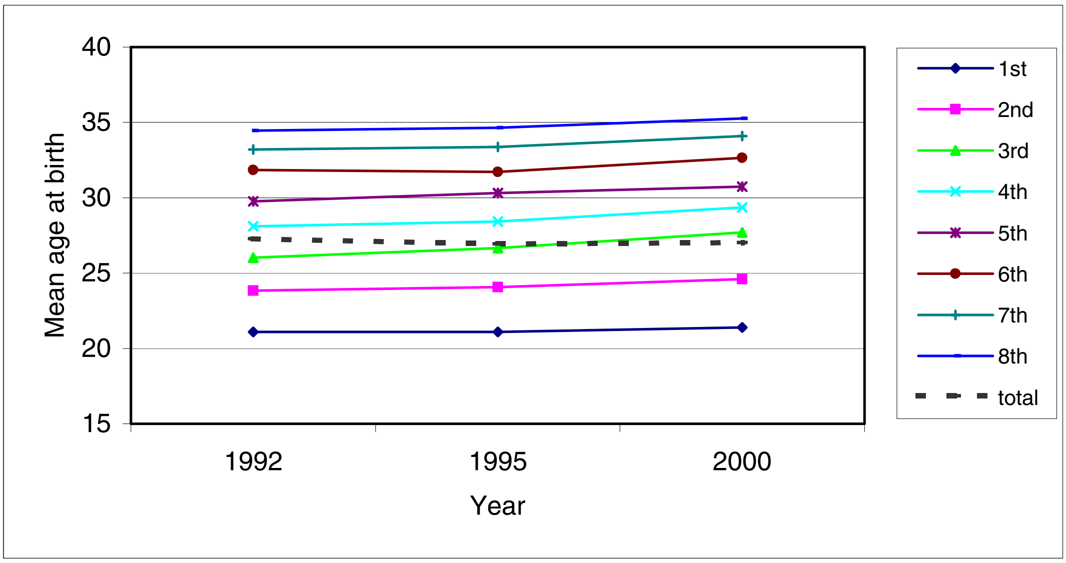

Figure 8. Mean age at birth by birth order. Sources: EDHS (1992, 1995, 2000); weighted data.

As Bongaarts (1999) notes, another problem with information from fertility surveys is that it is difficult to estimate the change in the mean age during the intervals in which fertility is measured. For example, to determine the tempo distortion in a particular fertility component based on births occurring during the three-year interval preceding a survey, one ideally would like to known the mean age of births at each order at the time of the survey as well as exactly five years before the survey. Subtracting these two estimates would give the change in mean age over the three-year period and hence would provide the information necessary to calculate the tempo distortions obtained from survey data. Unfortunately, such precise estimates are not available and it is therefore not possible to say with certainty whether Egypt experienced tempo distortions of the TFR components measured in any particular survey. However, it seems very likely that tempo distortions existed during most of the 1990s because the means at different orders rose fairly steadily (see Figure 8).

Tempo distortions in the components of the fertility rate

A crude estimate of the tempo distortion of these components can be obtained by linear interpolation of the age-specific TFR components and, subsequently, the mean ages at order-specific births. Application of Eq. (2) for all birth orders yield time series of adjusted tempo-free TFR components. The results of these exercises are plotted in Figure 9.

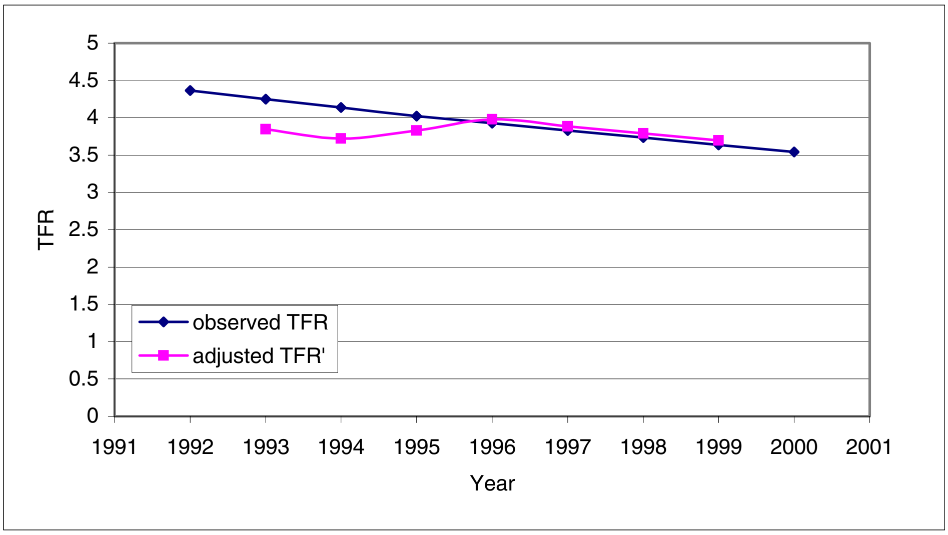

Figure 9. Observed and tempo-adjusted total fertility. Sources: EDHS (1992, 1995, 2000); weighted data.

Given the observed changes in the timing of births, the Bongaarts-Feeney adjusted fertility rates suggest that there was actually no fertility decline from 1993 to 1996, but a resumed fall from 1997 to 1999. The ordinary fertility rates seem to be overestimated until the mid-1990s, given the change in the age structure in the first and subsequent births (cf. Figure 8). While the mean age at birth has risen for the lower birth orders, the overall age at birth declined from 27.3 in 1992 to 26.9 in 1995 and has remained almost constant since.

As can be seen from the additional calculations for the parities one to four depicted in Figures 10 to 13, the actual fertility rate seems to be underestimated for these lower parities except for parity one until the mid-1990s. Taking into account the slight increase in the mean age at first, second, third, and fourth births, the fertility was actually higher than suggested by the unadjusted fertility rate. For parities five to eight (not shown here), the pattern looks the same as for parities two to four, however, the difference between the observed and tempo-adjusted fertility rate decreases by parity.

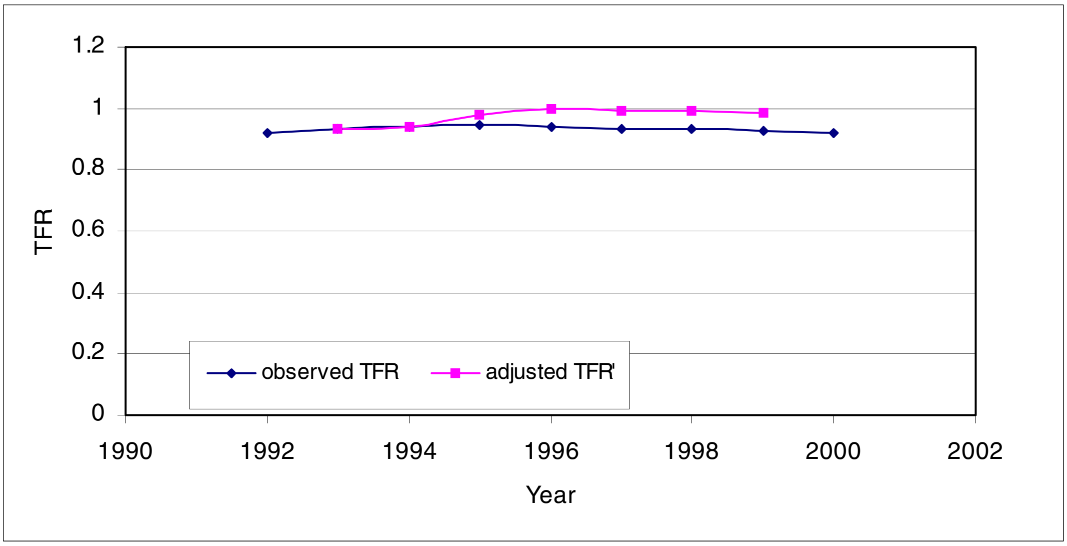

Figure 10. Observed and tempo-adjusted total fertility at parity one. Sources: EDHS (1992, 1995, 2000); weighted data.

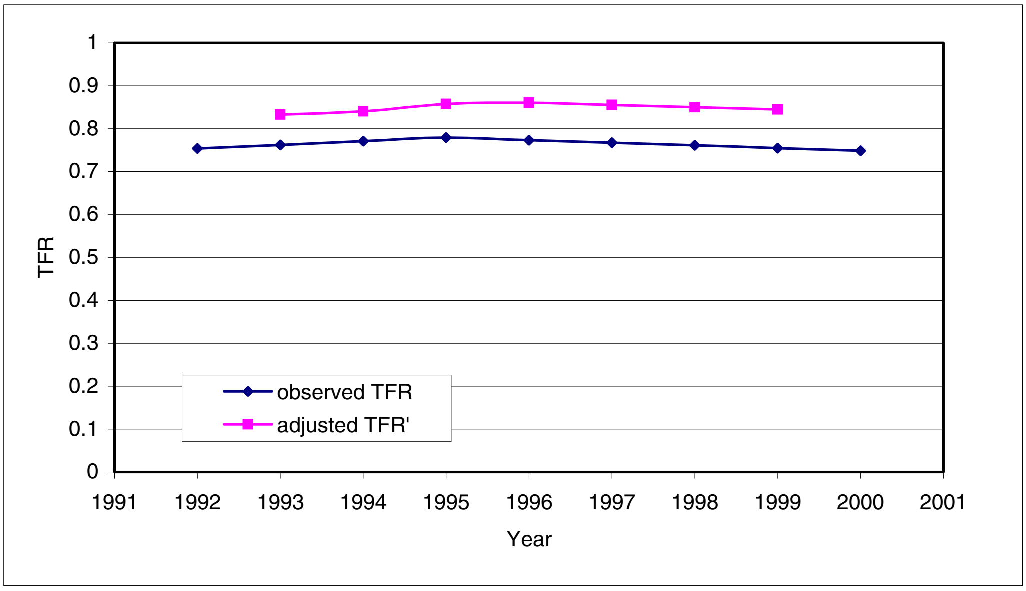

Figure 11. Observed and tempo-adjusted total fertility at parity two. Sources: EDHS (1992, 1995, 2000); weighted data.

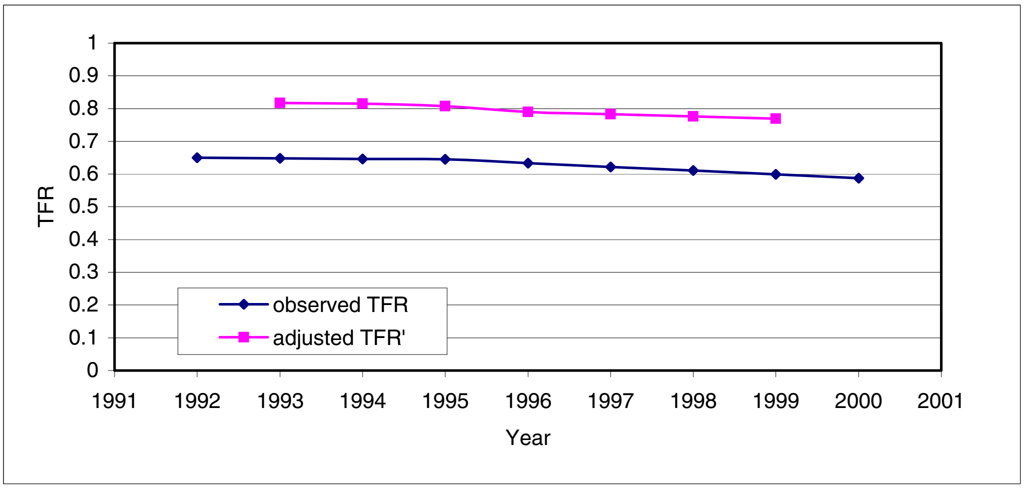

Figure 12. Observed and tempo-adjusted total fertility at parity three. Sources: EDHS (1992, 1995, 2000); weighted data.

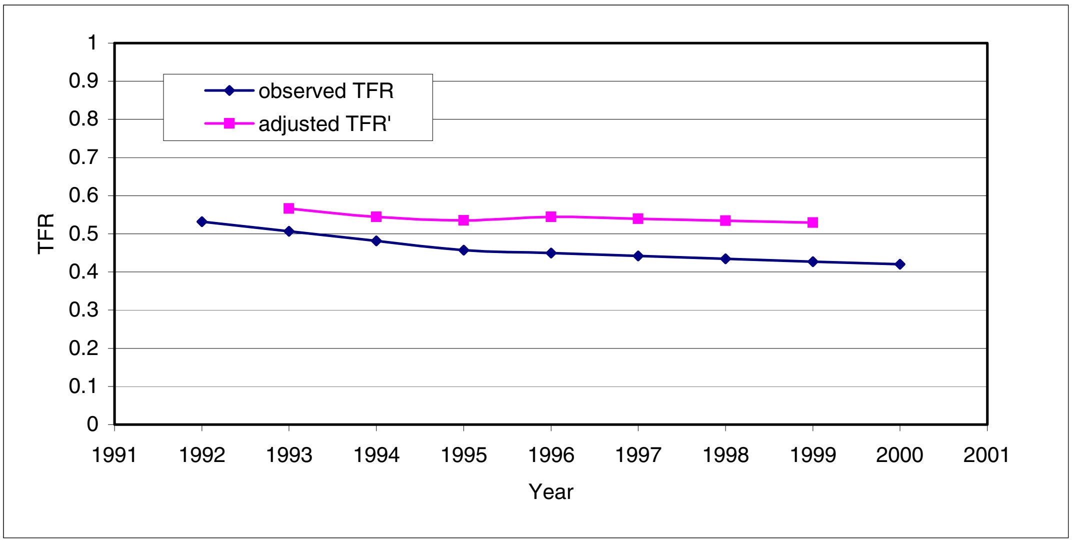

Figure 13. Observed and tempo-adjusted total fertility at parity four. Sources: EDHS (1992, 1995, 2000); weighted data.

Components of Fertility Change

Proximate components

To estimate the share of the proximate determinants of fertility, the Bongaarts method is usually employed, which uses aggregate-level decompositions. Bongaarts (1978, 1982) showed that in any population, the actual level of fertility achieved by a woman is influenced by seven intermediate variables or proximate determinants: marriage, contraception, induced abortion, lactational infecundability, fecundability, spontaneous intrauterine mortality, and sterility. These variables constitute a complete set of proximate determinants through which socioeconomic and cultural factors affect fertility (Bongaarts and Potter 1983). Bongaarts and Potter further demonstrate that most of the variations in fertility are mainly due to the differential impact of the first four of these variables. The survey data enable us to apply the Bongaarts model of proximate determinants of fertility. The model formulates the TFR that is determined by total fecundity (TF),[2] a hypothetical potential of fecundity that a woman would have in her lifetime, being inhibited by the indices of non-marriage (C_m), contraception (C_c), induced abortion (C_a), and lactational infecundability (C_i). The model can be quantified through the following equation:

$$TFR = C_m \times C_c \times C_a \times C_i \times TF \quad (3)$$

Based on studies of historical populations with the highest recorded fertility, Bongaarts recommends using 15.3 as the maximum number of births, the total fecundity rate. The index of marriage, C_m, measures the effects on fertility of the proportion of women in a sexual union. It is calculated as the weighted average of age-specific proportions married and age-specific marital fertility rates. The index of marriage equals one when all women of reproductive age are in a union and zero when no women are in a union. Implicit in the use of the index is the assumption that only women in unions are exposed to the risk of childbirth. This assumption holds in Egypt. The index of contraception, C_c, equals one if no form of contraception is used and zero if all fecund women use modern and effective methods. Owing to the unavailability of information on the sensitive issue of induced abortion, we have assumed that the overall total induced abortion rate is zero. Finally, the index of postpartum infecundability, C_i, equals one in the absence of breastfeeding and zero when infecundability is permanent. It is calculated as the average birth interval in the absence of breastfeeding, divided by the average length of the interval when breastfeeding takes place.

Theoretically, the value of each index ranges from 0 to 1. The complement of each index represents the proportionate reduction in fertility attributed to each determinant of fertility; the smaller the index value, the greater the fertility-reducing effect of the variable. Multiplying all of the indices together by the total fecundity rate of 15.3 produces the predicted TFR for the population. The predicted TFR will typically differ from the observed TFR because of the underreporting of births, underreporting of any of the behaviors measured by the indices, or the omission of proximate determinants that are influential in determining fertility levels, such as induced abortion.

The summary measures that are needed for the application of the model are presented in the first panel of Table 7. The second panel presents the estimated values of the indices of the three principal proximate determinants of fertility. In 2000, the marriage pattern reduces the actual fertility level by almost 29 percent (C_m=0.712). Contraception has the strongest effect on fertility, accounting for a reduction of about 50 percent (C_c=0.502) in the total fecundity rate. Postpartum infecundability has the lowest fertility-reducing impact, reducing the total fecundity rate by almost 22 percent (C_i=0.784).

[2] If in a population all women married early and if breastfeeding and post-partum abstinence, contraception and induced abortion were not practiced, then the total fecundity rate is the expected number of children a woman will bear during her reproductive lifespan.

Table 7. Estimates of selected reproductive measures and derived indices of proximate determinants.

	1992	1995	2000	Percent change 1992-1995	Percent change 1995-2000	Percent change 1992-2000
Reproductive measures:						
Proportion married	65.3	65.1	62.8	-0.31	-3.53	-3.83
Median age at first marriage	19.2	19.3	19.5	-4.52	1.04	1.56
Crude birth rate (per 1000 women)	29.7	28.0	27.8	-5.72	-0.71	-6.40
Prop. using modern contraception	41.5	42.2	49.8	1.69	18.01	20.00
Mean dur. postpartum amenorrhea	8.2	8.4	7.0	2.44	-16.67	-14.63
Model indices:						
Index of marriage (C_m)	0.727	0.726	0.712	-0.14	-1.93	-2.06
Index of contraception (C_c)	0.585	0.578	0.502	-1.20	-13.15	-14.19
Index of postpartum infecund. (C_i)	0.749	0.743	0.784	-0.80	5.52	4.67
$C_m \times C_c \times C_i \times C_a$	0.319	0.312	0.280	-2.12	-10.12	-12.03
TFR (predicted)	4.87	4.77	4.29	-2.12	-10.12	-12.03
TFR (observed)	4.36	4.02	3.54	-7.80	-11.94	-18.81

Notes: C_m = sum of age-specific proportion currently married times age-specific marital fertility, divided by age-specific marital fertility. C_c = 1 - proportion using modern contraceptive techniques. C_i = 20/(18.5 + average duration of postpartum amenhorrhea). C_a = 1.

To document the changes among the indices over the period 1992-2000, estimates for three time points are compared in Table 7. The results indicate that during the 9-year period, an appreciable amount of change has occurred only for contraceptive use. During the period 1992-2000, the index of marriage declined by just over 2 percent and the index of contraception declined by more than 14 percent, but the index of lactational infecundability increased by almost 5 percent. Thus, the decline in TFR based on observed single-year age data (from 4.36 to 3.54) between 1992 and 1995 was caused primarily by the fertility-reducing effect of contraception. The fertility-reducing effect of marriage pattern was offset by a reduction in duration of lactational infecundability. The combined fertility-limiting effect of the three proximate determinants (C_m, C_c, C_i) was 0.319 in 1992, 0.312 in 1995, and 0.280 in 2000, indicating a decline of almost 13 percent in fertility during the period 1992-2000.

Table 8 exhibits the magnitude of the total fertility-inhibiting effect being accounted for by each proximate fertility determinant at three points of time, 1992, 1995, and 2000. The difference between the total fecundity (TF), taken as 15.3, and the estimated TFR is attributed to the result of the inhibitory effect of each determinant. The total fertility-inhibiting effect is pro-rated by the proportion of the logarithm of each index to the sum of the logarithm of all indices (Wang et al. 1987). For example, the fertility-inhibiting effect of the marriage variable is obtained as:

$$\frac{(TF - TFR) \times \log C_m}{\left(\log C_m + \log C_c + \log C_a + \log C_i\right)} \qquad (4)$$

The fertility-inhibiting effects of other factors are obtained similarly. The results presented in Table 8 indicate that, of a total of about 10 births being inhibited in 1992, 3.1 births (29.2 percent) are due to the effect of the marriage variable, 5.1 birth (49.2 percent) is due to contraception, and 2.8 births (26.5 percent) are due to lactational infecundability. Similarly, in 2000, the three proximate variables (marriage, contraception, and lactational infecundability) which inhibited 11 births, are distributed as 3.1 births (28.5 percent), 6.4 births (57.9 percent), and 2.3 births (20.4 percent), respectively.

Table 8. Magnitude of the total inhibiting effect accounted for by each proximate fertility determinant.

	Births per woman			Percent		
	1992	1995	2000	1992	1995	2000
Marriage	3.05	3.10	3.14	29.24	29.43	28.51
Contraception	5.13	5.31	6.37	49.18	50.39	57.85
Lactational infecundability	2.76	2.88	2.25	26.51	27.31	20.43
Total: 15.3-TFR (estimated)	10.43	10.53	11.01	100.00	100.00	100.00

From the foregoing analysis, it may be noted that contraception has the highest fertility-reducing effect; this may be considered as the single most important determinant of fertility-reduction in Egypt. The proportion of women non-married was the second most important fertility-reducing factor in all three surveys. Although the impact of the non-marriage component has increased, the rate of change is very slow. However, the fertility-reducing effect of lactational infecundability is gradually decreasing from 1992 to 2000. It should be noted that the effect of marriage did not change much during the 8-year period, 1992-2000. The prevailing cultural and social norm in Egypt is unlikely to permit a change in the proportion non-married beyond a certain limit and the prospect for an immediate rise in age at marriage for females beyond 20 years does not seem to be very bright. This leads to the conclusion that future reductions in fertility in Egypt will depend largely on increased use of effective contraception and decreased lactational infecundability.

To quantify the contribution made by each of the proximate determinants of fertility to an observed change in fertility between two points in times (in this analysis, 1992 and 2000), Bongaarts and Potter (1983) turned the Bongaarts (1978) model into a decomposition equation. The equation states simply that a given proportional change in the TFR between two points of time equals the sum of the proportional fertility changes due to the different proximate determinants plus an interaction term.

The decomposition results are presented in Table 9. It indicates that TFR declined during the whole period of observation by almost 19 percent (or in absolute terms by 0.82 births per woman), from 4.36 births in 1992 to 3.54 in 2000. This total decrease in TFR is found to come from a decline of just over 2 percent (or 0.09 births per woman) owing to the marriage pattern, a decline of more than 14 percent (or 0.6 births per woman) owing to an increase in contraceptive use, and a 4.7 percent (or 0.2 birth per woman) increase due to the shortening of the duration of lactational infecundability. The change in TRF, caused by changes in other proximate determinants, is in no way negligible. In the second column of Table 9 the decomposition results are standardized to add up to 100 percent. It is evident that contraception played the largest role in the reduction of fertility during the period 1992-2000.

Separate decompositions of the changes in TFR between 1992 and 1995 as well as between 1995 and 2000 are displayed in the second and third panels of Table 9. The results indicate strong differences in the components of fertility decline for these two periods. While the total decline in TFR was much stronger in the second period than in the first (0.34 births and 0.48 births), the main driving forces seem to be other proximate determinants in the first period (including natural fecundability, spontaneous intrauterine mortality, and permanent sterility), while contraceptive practice is the overwhelming determinant of fertility decline between 1995 and 2000.

Table 9. Decomposition of the change in total fertility between 1992 and 2000.

	Percentage change in TFR	Distribution of percentage	Absolute change in TFR
1992-2000:			
Proportion of married women	-2.06	10.97	-0.09
Contraceptive practice	-14.19	75.44	-0.62
Duration of lactational infecundability	4.67	-24.85	0.20
Other proximate determinants	-7.70	40.96	-0.34
Interaction	0.47	-2.52	0.02
Total	-18.81	100.00	-0.82
1992-1995:			
Proportion of married women	-0.14	1.76	-0.01
Contraceptive practice	-1.20	15.34	-0.05
Duration of lactational infecundability	-0.80	10.27	-0.03
Other proximate determinants	-5.80	74.36	-0.25
Interaction	0.14	-1.74	0.01
Total	-7.80	100.00	-0.34
1995-2000:			
Proportion of married women	-1.93	16.15	-0.08
Contraceptive practice	-13.15	110.12	-0.53
Duration of lactational infecundability	5.52	-46.21	0.22
Other proximate determinants	-2.02	16.93	-0.08
Interaction	-0.36	3.01	-0.01
Total	-11.94	100.00	-0.48

Individual components

Additional insight into the decline of fertility can be obtained by analyzing the individual components of the change, including direct (or proximate) and indirect (or socioeconomic) determinants. Many analyses have consisted of individual-level linear regressions with children ever born as the dependent variable, in the tradition of Easterlin and Crimmins (1985). The form of the data suggests that event-history analysis would have advantages over the other two methodologies. However, due to unreliable reporting of the exact times of events, we refrain from this method. Instead, we follow the suggestion by Retherford and Thapa (2004) and concentrate on the number of births per woman in the five years preceding the survey. This variable has the advantage of being closer to the TFR with regard to content.

In the applied method, however, we differ from Retherford and Thapa (2004). When analyzing the determinants of the number of births in a multivariate model, one has to take care of the nature of the dependent variable, which is typical count data. In principle, we could analyze these data using the standard multiple linear regression. But the predominance of zeros and the small values indicate that the dependent variable is clearly of a discrete nature. The Poisson regression model accounts for these characteristics and has been widely used to study such data. A problem with the standard Poisson model is often that the equidispersion assumption (E(Y|X)=V(Y|X)) is violated, i.e., the conditional mean does not equal the conditional variance. To solve this problem, different approaches have been proposed, including the generalized event count model and the generalized Poisson model to account for overdispersion (E(Y|X)<V(Y|X)) and underdispersion (E(Y|X)>V(Y|X)) (Winkelmann 2003). Descriptive statistics for the EDHS data indicate strong evidence of underdispersion, i.e., the conditional mean exceeds the conditional variance in the full sample. Therefore, we estimated a zero-inflated Poisson model which accounts for underdispersion and for the prevalence of zero counts in the data (Winkelmann 2003).

In the zero-inflated Poisson model, zero outcomes can arise from one of two regimes. In one regime, the outcome is always zero (e.g., the infertile). In the other, the usual Poisson process is at work, which can produce a zero outcome or some other. Let c denote a binary indicator for regime 1 ($c_i = 1$) or regime 2 ($c_i = 0$), and let y_i^* denote the outcome of the Poisson process in regime 2. Then the observed count y_i is given by:

$$y_i = \begin{cases} 0 & \text{if } c_i = 1 \\ y_i^* & \text{if } c_i = 0 \end{cases}. \tag{5}$$

If the probability that $c_i = 1$ is denoted by ω_i, the probability function of y_i can be written as

$$P(Y_i = y_i \mid x_i) = \begin{cases} \omega_i + (1-\omega_i)e^{-\lambda_i}, & \text{if} \quad y_i = 0 \\ (1-\omega_i)\dfrac{\lambda_i^{y_i} e^{-\lambda_i}}{y_i!} & \text{if} \quad y_i = 1, 2, \ldots \end{cases}. \tag{6}$$

Thus, the probability of zero outcomes equals the probability of belonging to regime 1 (ω_i) plus the probability of belonging to regime 2 ($1-\omega_i$) times the probability of a zero outcome when following the Poisson process ($\exp\{-\lambda_i\}$). The probability of outcomes greater than zero is the probability of belonging to regime 2 times the probability from the Poisson process. Hence, the standard Poisson model is nested in the zero-inflated Poisson model for $\omega = 0$.

Systematic variation can be introduced in the parameter λ_i, as in a log-linear model:

$$\lambda_i = \exp(x_i \beta). \tag{7}$$

The coefficients in this model cannot be interpreted directly; only the sign of a coefficient indicates the direction of an effect. However, the expected number of events is given by:

$$\frac{\partial E(y_i \mid x_i)}{\partial x_i} = \frac{\lambda_i}{(1+\lambda_i)^2} \beta. \tag{8}$$

In our analysis, we calculated this marginal effect at the means of the independent variables. The effect can be interpreted as the percent increase in the number of events accompanying a one-unit increase of the independent variable.

Table 10 shows the means of the direct and indirect determinants of the number of births five years preceding the survey. Most interestingly, the mean number of births during the five years before the survey declined from 0.89 in 1992 to 0.73 in 2000. At the same time, the age at marriage decreased. The number of women who never used any contraceptive method declined from 35.4 percent in 1992 to 24.9 percent in 2000. The percentage of women using only folkloric or traditional methods remained stable while the share of modern-method users increased considerably from 62.9 percent to 73.4 percent. Wives' and husbands' average education decreased during our observation time. Finally, the number of living children at the start of the five-year period declined slightly.

Table 10. Means of variables used in the regressions.

	1992	1995	2000
Births during the five years before the survey	0.89	0.78	0.73
Direct determinants:			
Age at marriage:			
<15	13.2	13.9	11.5
15-19	50.1	48.4	48.9
20-24	27.0	27.8	30.1
25-29	8.0	8.3	7.8
>29	1.6	1.6	1.6
Wife's age:			
15-19	4.3	4.6	4.0
20-24	13.8	14.5	14.4
25-29	20.4	18.6	18.3
30-34	18.6	17.6	17.3
35-39	17.3	17.4	17.2
40-44	14.3	13.9	14.0
45-49	11.2	13.4	14.8
Duration of marriage:			
0-4	17.8	19.0	20.5
5-9	19.3	18.8	17.3
10-14	18.6	16.5	16.2
15-19	17.3	17.0	15.4
20-24	12.3	13.4	13.7
25+	14.6	15.3	16.9
Contraceptive use:			
Never	35.4	31.6	24.9
Only folkloric/traditional methods	1.7	1.8	1.8
Modern methods	62.9	66.7	73.4
Indirect determinants:			
Urban-rural residence:			
Urban	46.6	46.1	44.1
Rural	53.4	53.9	55.9
Wife's education:			
No education	48.4	43.7	43.2
Primary education	25.8	24.8	18.3
Secondary education	21.1	25.1	30.3
Higher education	4.8	6.4	8.2
Husband's education:			
No education	34.1	30.5	30.1
Primary education	28.2	27.4	21.8
Secondary education	25.2	27.6	31.6
Higher education	12.2	14.5	16.5
Wife worked before marriage:			
Yes	25.1	21.1	15.8
No	74.9	78.9	84.2
Number of living children at start of 5-year period	2.45	2.43	2.40

Note: Cases are weighted by sample weight.

Table 11. Effects of direct determinants on the number of births five years preceding the survey, zero-inflated Poisson regression (marginal effects).

	1992	1995	2000
Model 1:			
Age at marriage: 15-19	-0.005	-0.008	0.121***
Age at marriage: 20-24	-0.070*	-0.038	0.182***
Age at marriage: 25-29	-0.163***	-0.157***	0.097*
Age at marriage: >29	-0.209**	-0.171*	-0.097
N	9864	14779	15573
BIC	5.002	-1.835	-25.662
Model 2:			
Duration of marriage: 5-9	0.522***	0.411***	0.283***
Duration of marriage: 10-14	0.140***	0.076***	-0.020
Duration of marriage: 15-19	-0.099***	-0.169***	-0.237***
Duration of marriage: 20-24	-0.352***	-0.353***	-0.407***
Duration of marriage: 25+	-0.689***	-0.697***	-0.708***
N	9864	14779	15573
BIC	-2022.371	-3671.119	-4497.142
Model 3:			
Wife's age: 20-24	0.625***	0.542***	0.485***
Wife's age: 25-29	0.703***	0.619***	0.545***
Wife's age: 30-34	0.414***	0.333***	0.311***
Wife's age: 35-39	0.067	0.017	0.006
Wife's age: 40-44	-0.308***	-0.313***	-0.336***
Wife's age: 45-49	-0.706***	-0.649***	-0.634***
N	9864	14779	15573
BIC	-2413.260	-4110.909	-4983.737
Model 4:			
Contraceptive use: Only folkloric/traditional methods	0.509***	0.435***	0.824***
Contraceptive use: Modern methods	0.085***	0.096***	0.233***
N	9864	14779	15573
BIC	-27.173	-47.247	-260.053
Model 5:			
Age at marriage: 15-19	-0.065**	-0.053**	0.017
Age at marriage: 20-24	-0.148***	-0.108***	0.003
Age at marriage: 25-29	-0.121***	-0.062*	0.083***
Age at marriage: >29	0.099	0.146+	0.353***
Wife's age: 20-24	0.613***	0.500***	0.370***
Wife's age: 25-29	0.668***	0.546***	0.359***
Wife's age: 30-34	0.361***	0.258***	0.140***
Wife's age: 35-39	0.027	-0.042	-0.116***
Wife's age: 40-44	-0.333***	-0.347***	-0.398***
Wife's age: 45-49	-0.712***	-0.662***	-0.658***
Contraceptive use: Only folkloric/traditional methods	0.415***	0.349***	0.584***
Contraceptive use: Modern methods	0.121***	0.124***	0.210***
N	9864	14779	15573
BIC	-2476.914	-4238.927	-5354.572

Notes: + p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001.
Reference categories: Age at marriage < 15; duration of marriage 0-4; wife's age 15-19; contraceptive use never. Cases are weighted by sample weight.

The marginal effects of direct determinants on the number of births five years preceding the survey from the zero-inflated Poisson model are listed in Table 11. The overall goodness-of-fit can be evaluated using the Bayesian Information Criterion (BIC). The more negative the BIC, the better the model fit. Generally, the model fits increased from survey to survey. For all tested indirect determinants, the best model fit is obtained with the wife's age (model 3). Thus, the wife's age at the time of the survey seems to be the best predictor of the number of births during the last five years compared to the other direct determinants. Compared over the three years of investigation, the effect of the wife's age on the number of births five years preceding the survey decreased for the age group 20 to 39. Moreover, in each of the three surveys the effect of the wife's age decreased over the life course. Compared to women aged 15-19, the number of births for the age group 20-24 is about 48.5 percent higher in 2000, compared to 62.5 percent in 1992 and 54.2 percent in 1995. The number of births decreased for all age groups, except for women aged 45-49. Interestingly, the model fit for age at marriage is much worse (model 1). Concerning contraceptive use, at first glance our results are counterintuitive (model 4): women who have ever used modern contraceptive methods have a 23.3 percent increase in the number of births during the last five years compared to women who never used any contraceptive method. This effect, however, is most likely a result of the way of questioning: "ever use" of contraceptive methods seems to be a rather bad indicator for our purposes.

The marginal effects of the indirect determinants on the number of births during the previous five years are listed in Table 12. Compared to the direct determinants, the overall model fit is worse (model 6 in Table 12 and model 5 in Table 11). The best indirect determinant is clearly the number of living children at the start of the five-year period (model 4). With each additional child the number of births during the five years preceding the survey declined by 11.2 percent in 1992, 12.9 percent in 1995, and 14.6 percent in 2000. Concerning place of residence (model 1), urban residency clearly lowers the number of births compared to rural residency, though to a decreasing extent (from –32.8 percent in 1992 to –17.1 percent in 2000). The effects of female education (model 2) are as expected in 1992 and 1995, however not so in 2000. In the first two surveys, we observe negative effects of primary, secondary and higher education compared to no education at all. In 2000, women with secondary and higher education have an 18.1 percent and 5.4 percent increase in the number of births compared to women with no education at all. Additional calculations (not shown here) yield that this effect is due to the increase in education for younger cohorts, which also have an increased number of births in the five years preceding the survey.

Table 12. Effects of indirect determinants on the number of births five years preceding the survey, zero-inflated Poisson regression (marginal effects).

	1992	1995	2000
Model 1:			
Urban-rural residence: Urban	-0.328***	-0.248***	-0.171***
N	9864	14779	15573
BIC	-279.734	-271.643	-140.036
Model 2:			
Wife's education: Primary education	-0.143****	-0.155***	-0.067**
Wife's education: Secondary education	-0.071**	0.027	0.181***
Wife's education: Higher education	-0.127**	-0.172***	0.054+
N	9864	14779	15573
BIC	-14.775	-91.419	-146.230
Model 3:			
Husband's education: Primary education	0.053*	0.071**	0.111***
Husband's education: Secondary education	-0.008	0.086***	0.266***
Husband's education: Higher education	-0.063+	-0.003	0.152***
N	9839	14745	15553
BIC	14.164	1.643	-170.802
Model 4:			
Number of living children at start of 5-year period	-0.112***	-0.129***	-0.146***
N	9864	14779	15573
BIC	-623.539	-1439.637	-2059.577
Model 5:			
Wife worked before marriage	0.040+	-0.002	-0.028
N	9863	14779	15573
BIC	5.971	9.593	7.455
Model 6:			
Urban-rural residence: Urban	-0.305***	-0.212***	-0.172***
Wife's education: Primary education	-0.067**	-0.106***	-0.090***
Wife's education: Secondary education	-0.089**	-0.078***	-0.040*
Wife's education: Higher education	-0.097+	-0.179***	-0.077**
Husband's education: Primary education	0.095***	0.058**	0.080***
Husband's education: Secondary education	0.000	0.001	0.085***
Husband's education: Higher education	0.017	0.005	0.064*
Number of living children at start of 5-year period	-0.117***	-0.133***	-0.144***
Wife worked before marriage	0.014	-0.006	-0.051**
N	9838	14745	15553
BIC	-932.424	-1800.946	-2263.773

Notes: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Rural residence; wife's education: no education; husband education: no education; wife did not work before marriage. Cases are weighted by sample weight.

Conclusions

The objectives of this paper are, first, to provide improved estimates of recent fertility levels and trends in Egypt that account for chances in the timing of first and subsequent births, and second, to analyze the components of fertility change. The analysis is based on data from the Egyptian Demographic and Health Surveys 1992, 1995 and 2000. Total fertility rates are derived by the birth-history method.

The analysis in this study shows that fertility trends estimated from the three waves of the EDHS suffer from various distortions due to errors in the data. These distortions have much to do with the quality of age reporting, both for women and for children. In all three surveys, we find a misreporting of women's ages at the time of the survey and, thus, a misreporting of the age at first and subsequent births. Moreover, there is a systematic underreporting of children under age 5. As a consequence, estimates of the decline in the total fertility rate are most likely downward biased.

As a consequence of the evident age heaping and birth displacement, we must be very cautious in interpreting the tempo-adjusted estimations of the total fertility rate. However, bearing this caution in mind, and given the observed changes in the timing of births, the Bongaarts-Feeney adjusted fertility rates suggest that there was little fertility decline from 1992 to 1996, but a resumed fall from 1997 to1999.We agree with Bongaarts (1999: 288): "Countries where substantial tempo effects are present today are the most vulnerable to stalls in their fertility transition." The proof of tempo effects, however, is nontrivial in the case of developing countries where data quality often suffer from poor age reporting as in Egypt.

To estimate the share of the proximate determinates of fertility decline, we employed Bongaart's aggregate level decompositions. Our results indicate that the main driving force in the change in fertility was the increase in contraceptive use. However, contraceptive use began to decrease fertility mainly around 1995.

On the individual level, we decompose the decline in fertility in its direct and indirect determinants by applying a zero-inflated Poisson model to the number of births per woman in the five years preceding the survey. Our results show that the number of children is decreasingly determined by the wife's age over time. Moreover, with each additional child the number of births during the five years preceding the survey declined from survey to survey. This result is a hint that fertility decrease is underway in Egypt.

A final assessment of the actual level of fertility in Egypt and its determinants using individual-level data remains difficult because of misreporting of women's ages and births of children. However, given that the extent and the way of misreporting remained constant over the period of investigation, our results shed some light on the trends and causes of fertility decline in Egypt.

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