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Evaluation of Birth Histories: A Case Study of Kenya

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Evaluation of Birth Histories: A Case Study of Kenya

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Preface

Kenya is fortunate in that it has been covered by a number of demographic enquiries in recent years and there have been available fairly reliable demographic data. So far Kenya has had four population censuses, that is, in 1948, 1962, 1969 and 1979. Further, four demographic surveys were undertaken between the last two censuses. In 1973, a Demographic Baseline Survey was carried out by the Central Bureau of Statistics on a subsection of the country. Following the creation of a national sample, two National Demographic Surveys were conducted: one in 1977 and another in 1978. Finally, as part of the World Fertility Survey Programme, the Kenya Fertility Survey was undertaken in 1977–8.

This report will focus on the birth history data collected by the Kenya Fertility Survey (KFS) of 1977–8. In addition, fertility estimates will be presented from the 1962 census, the 1969 census, and the 1977 National Demographic Survey (NDS). Although each of these sources differ in terms of questionnaire design and sample size, all yield national estimates.[1] The inclusion of the 1979 census data would add a great deal of information. The results were not available at the time of this analysis but some preliminary data are in accord with the findings of this report.

In chapter 1 we shall examine the levels and trends in fertility indicated by the results of the four sources of data over the time period 1962–78. This serves as an introduction to the main section, chapter 2, which deals with the evaluation of the birth histories obtained in the KFS. After a discussion of the trends and levels suggested by the national totals of the birth histories, we examine the possible reporting errors. Finally, in chapter 3, fertility estimates, calculated using the Brass P/F model and the Gompertz relational model, are presented in order to clarify the results noted in chapters 1 and 2.

Acknowledgements

The authors wish to acknowledge gratefully the major contribution made to chapter 3 by Professor William Brass.

[1] Central Bureau of Statistics 1977 and 1980; Ministry of Finance and Planning 1966; Population Studies and Research Institute 1979.

1 Comparison of Fertility Data: 1962–1978

1.1 CURRENT FERTILITY ESTIMATES

Table 1 presents the current age-specific fertility rates from the reported number of births in the 12-month period prior to each census or survey. These data indicate a rising trend in the level of fertility over the period considered. Even the adjusted total levels (6.8 in 1962, 7.6 in 1969 and 8.1 in 1977), although reducing the increase shown by the unadjusted total fertility rates, suggest nearly a 20 per cent rise in fertility over the 15-year period.

The relative rates (the proportion of total births occurring in each age group) given in table 2 indicate that the fertility distribution was becoming younger over the period under consideration. The rates for women under the age of 30 consistently increase over time while the rates of those women age 35 and over decrease. It should be noted at this juncture, however, that the fertility distributions reported in the 1962 and 1969 censuses were found to be distorted. And, although the reasons for the biases have never been fully examined, even the adjusted total fertility rates presented in table 1 are now thought to be under-estimates of the true fertility, with the consequence that the increase indicated by these current fertility rates could be completely spurious.

1.2 LIFETIME FERTILITY ESTIMATES

Lifetime fertility data show a pattern similar to the current data, that is, an apparent rise in fertility. The average number of live births are given in table 3 by age groups for the two censuses and the two surveys. These reported averages increase over time for every age group, with the exception of the teenagers. However, these results are confounded with the fact that the quality of the reporting of the number of children ever born has almost certainly increased over time. For example, compared with the vast number of quickly trained interviewers used for the two censuses, the NDS utilized permanent male staff in a complete enumeration of the national sample, created in 1974 at the Central Bureau of Statistics (see Central Bureau of Statistics 1976). The KFS female interviewers on the other hand, were more

Table 1 Reported current age-specific fertility rates, 1962–78

Age group	1962 census	1969 census	1977 NDS	1978 KFS
15–19	0.083	0.111	0.135	0.177
20–24	0.207	0.284	0.365	0.369
25–29	0.223	0.290	0.361	0.356
30–34	0.203	0.253	0.316	0.284
35–39	0.163	0.200	0.231	0.216
40–44	0.109	0.121	0.133	0.132
45–49	0.063	0.060	0.056	0.051
Total (X 5)				
Unadjusted	5.3	6.6	8.0	7.9
Adjusted	6.8	7.6	8.1	–

Table 2 Reported current age-specific fertility rates, 1962–78 (relative rates where TFR = 1.000)

Age group	1962 census	1969 census	1977 NDS	1978 KFS
15–19	0.079	0.084	0.084	0.112
20–24	0.197	0.215	0.229	0.233
25–29	0.213	0.219	0.226	0.225
30–34	0.193	0.192	0.198	0.179
35–39	0.155	0.152	0.145	0.136
40–44	0.103	0.092	0.083	0.083
45–49	0.060	0.046	0.035	0.032
Total	1.000	1.000	1.000	1.000

Table 3 Reported parities, 1962–78

Age group	1962 census	1969 census	1977 NDS	1978 KFS
15–19	0.36	0.36	0.33	0.35
20–24	1.65	1.88	1.83	1.84
25–29	3.01	3.65	3.72	3.76
30–34	4.20	5.11	5.55	5.55
35–39	5.07	6.00	6.67	6.82
40–44	5.61	6.44	7.25	7.59
45–49	5.90	6.69	7.46	7.88

closely supervised and trained to obtain not only numbers of children ever born but also a complete birth history in a carefully worded questionnaire designed to reduce the possibility of any omission of births.

In 1969 and perhaps 1962, the reporting of women who had no children was often identical to that of women for whom no information was collected, that is, the enumerators would enter dashes to signify both. Since the total percentage of women in the category created by these two sets of women decreases over age (from 10 per cent for ages 15–19 to 4 per cent for all five-year age groups between 35 and 49 in the 1969 census), the effect of this confounding is minimized as the age of the women increases. But for the younger age groups, this certainly means that the average number of live births (which is based only on the women reporting) is over-estimated. For the 1977 NDS there was no such confusion between how to code not stated cases and zero parity women. However, in the NDS there was a certain number of 'not stated' women, whereas, in the KFS all women had complete fertility information.

Because of this problem in the earlier censuses, we will now examine the percentage of women with no recorded births both including and excluding the 'not stated' categories. Table 4 shows the percentage of women who are childless by age and source. A comparison of these two sets of figures points again to the fact that the quality of birth reporting in recent years has improved. This can be seen from the narrowing differences between the two categories (*excluding* not stated and *including* not stated) in 1977, as compared with 1969 or 1962. But the lower panel in table 4, that includes 'not stated', suggests a possible decline in the incidence of childlessness over the period under consideration. The magnitude of the decline cannot, unfortunately, be ascertained for there is little doubt that part of the differences in the proportions childless is due to better reporting in recent years.

Mean births per mother is a measure of the cumulative fertility of women who had at least one live birth. In other words, childless women as well as women who have not stated their parity are excluded from the calculations. In this way it becomes possible to see whether rises in fertility have occurred because an increasing proportion of women are becoming mothers during their lifetime, or whether women are having more children than they used to have. Its presentation here is particularly useful in order to eliminate the effect of the misreporting of childless women. The mean births per mother, presented in table 5, indicate an increase in fertility only for the women aged 30 and over, a relatively constant fertility for women aged 25–29 and a decrease for women under the age of 25 during the period 1962–78.

Table 4 Percentage of childless women in each age group, 1962–78

Age group	1962 census	1969 census	1977 NDS	1978 KFS[a]
A Excluding 'not-stated'				
15–19	34.1	65.7	75;5	73.9
20–24	11.7	16.7	21.1	19.1
25–29	7.2	6.2	5.5	5.4
30–34	5.9	4.0	3.2	3.3
35–39	4.8	3.8	3.2	1.6
40–44	4.8	3.6	3.2	3.4
45–49	4.9	3.8	3.1	2.8
B Including 'not-stated'				
15–19	79.1	75.5	77.3	73.9
20–24	36.8	24.7	24.2	19.1
25–29	22.3	11.1	7.6	5.4
30–34	17.8	8.2	4.6	3.3
35–39	15.3	7.6	5.1	1.6
40–44	14.4	7.8	4.1	3.4
45–49	13.7	8.0	4.6	2.8

[a]There were no 'not-stated' women in the KFS.

Table 5 Mean parity per mother by age group, 1962–78

Age group	1962 census	1969 census	1977 NDS	1978 KFS
15–19	1.71	1.45	1.45	1.34
20–24	2.61	2.50	2.41	2.27
25–29	3.87	4.11	4.02	3.98
30–34	5.11	5.56	5.82	5.74
35–39	5.99	6.50	7.03	6.93
40–44	6.55	6.99	7.56	7.86
45–49	6.84	7.26	7.82	8.11

This change from increasing fertility for all women to decreasing fertility for mothers within the younger age groups can be attributed to the decline noted earlier in the percent childless.

1.3 LIFETIME FERTILITY ESTIMATES AND EDUCATION

If we assume that women with some education are more reliable respondents than those with none, and if we also assume that there was no real rise in fertility, we would expect that differences between the 1969 census and the 1977–8 KFS figures of lifetime fertility would be greatest for women with no education and would disappear as the number of years of education increases. The graphs in figure 1 show the average parities by age groups and educational attainment for the 1969 census and the KFS. For all three educational groups, there is almost no difference in average parity for women under the age of 35. However, older women with no education have higher average parities in the KFS while women with five to eight years of primary schooling show a much closer correspondence over all age groups. This evidence lends support to the view that older women with no education, and to a lesser extent older women with one to four years of schooling, omitted children in the 1969 census.

1.4 CONCLUDING COMMENTS

Comparison of fertility data from the 1962 and 1969 censuses, the 1977 NDS and the 1977–8 KFS show an apparent increase in fertility over the time period considered. However, improvements in the data collection process probably accounts for most, if not all, of this change.

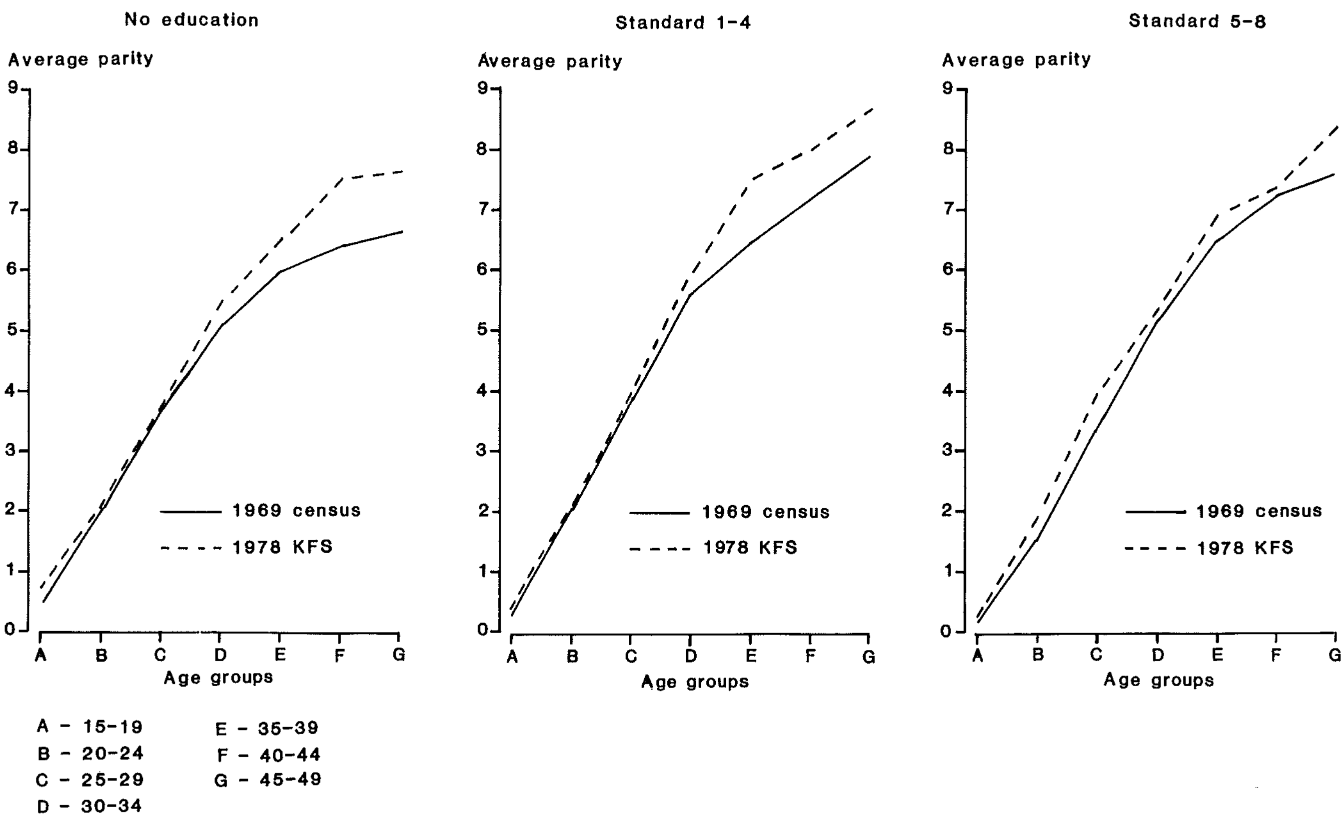

Figure 1 Average parity by age groups for three education levels in 1969 and 1978

This is evidenced by the fact that lifetime fertility estimates from 1969 and 1978 for older women are more similar as the education of the women increases and for younger women are similar over all three educational levels. In addition, when childless women were eliminated and average parity per mother was shown, there was no longer an increase in fertility for all women under the age of 30. It is fortunate that the KFS contains birth histories that can be used to look at trends in fertility over this period, as the earlier census data have been shown to be faulty and the NDS did not collect such information.

2 Birth Histories of the Kenya Fertility Survey

We shall start our analysis of the birth histories by looking at the data for the whole country. This will be followed by considering the possible types of recording errors.

2.1 MATERNITY HISTORIES FOR THE WHOLE COUNTRY

Table 6 gives the age-specific fertility rates for the whole country by five-year periods before the survey. The approximate calendar years corresponding to each five-year period are also shown.

Each horizontal row shows the age-specific fertility rate for successive five-year periods over the last 35 years. Each vertical column provides estimates of fertility over all age groups for a particular time period in the past. The diagonals from bottom left to top right give the experience of successive 'cohorts' when they were passing through the same age range for each period. Whenever these 'cohorts' are discussed one needs to remember that the label we have chosen to represent each 'cohort' corresponds to the age at the time of the survey. This, however, is not completely accurate. For example, half of the data for the 'cohort' labelled 30–34 *during the five years before* the survey comes from women aged 35–39 at the time of the survey. Because of this, the 'cohort' aged 45–49 has only half the amount of data that the remaining 'cohorts' have. We have taken the liberty of omitting the quotation marks around the word cohort from now on but this point should be remembered.

Looking at the data horizontally and comparing the more recent periods with the more distant, we have the impression that fertility at each age group rose to a high point at least ten years prior to the survey and has subsequently declined. For example, at ages 15–19, fertility rose from 0.593 for the period 30–34 years before the survey (1943–7) to 1.062 for the period approximately 15–19 years ago (1958–62) and then declined back to 0.887 for the most recent five-year period. At ages 25–29, however, the highest rate of fertility is no longer found during the period 15–19 years prior to the survey but more recently during the period 10–14 years before the survey (1968–72).

Looking at the data diagonally, we find that the older cohorts had a mean age of childbearing higher than that of the younger cohorts. The three five-year cohorts between the ages 20–34 showed maximum childbearing at ages 20–24 (0–4, 5–9 and 10–14 years before the survey, respectively), while women over the age of 39 had maximum fertility at age 30–34. It seems unlikely that these older cohorts would reach maximum childbearing at so late an age; a more probable explanation is that older women have mislocated births by transferring births which occurred at an earlier period to a later period or that the age of the older women has been over-estimated. It is, of course, possible that older women have omitted births which occurred in the more distant past; however, the high total rate of fertility found for these older women (8.2 children for women age 45–49) does not indicate at first glance that this is the most plausible explanation.

At this point, we feel it is of interest to refer to the results from a survey in the city of Lagos. Lesthaeghe, Page and Adegbola (1981) identified counteracting forces affecting the shape of the fertility curve and indicated resulting 'traditional' and 'transitional' patterns. Figure 2 shows their

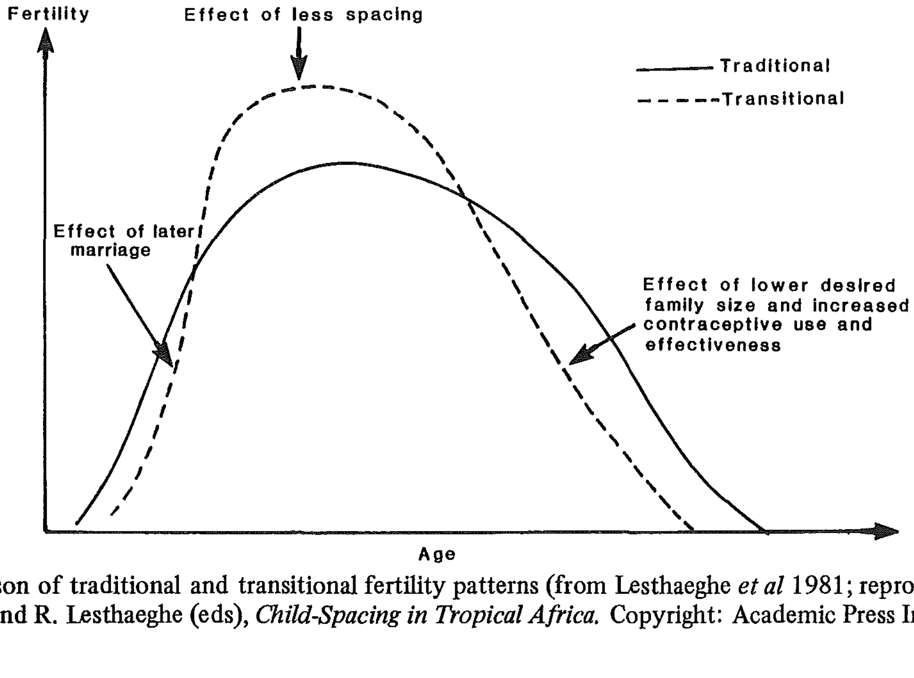

Figure 2 Comparison of traditional and transitional fertility patterns (from Lesthaeghe *et al* 1981; reproduced with permission from H.J. Page and R. Lesthaeghe (eds), *Child-Spacing in Tropical Africa.* Copyright: Academic Press Inc. (London) Ltd.)

summarized findings. In figure 3 we have plotted the fertility rates available for each cohort throughout the available periods (the diagonals in table 6) as a comparison to the patterns shown by Lesthaeghe *et al.* The general pattern shown by the Kenyan data for younger women does appear to indicate a change from the traditional to the transitional patterns in figure 2. Any effect of later age at marriage would be a relatively recent phenomena in Kenya, since the mass education of females has occurred primarily since independence in 1963. Therefore, a decline in teenage fertility from the high of 1.062 for women in the age group 30–34 (these women were ages 15–19 at independence) would be expected: the rates of the women under the age of 25 were not graphed so figure 3 does not show the extent of this decline completely. If the births for the older women were spread more evenly over the age span 15–34 to give more reasonable mean ages at childbearing, then there is correspondence between the traditional pattern

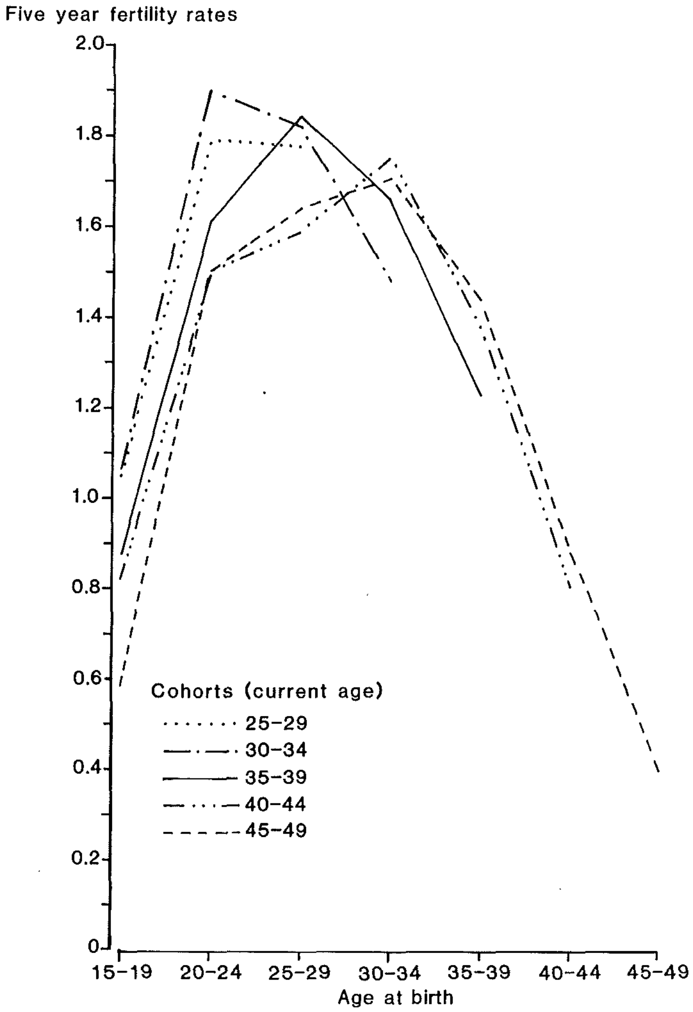

Figure 3 Five-year fertility rates for women currently aged 25–49 by age groups at birth

Table 6 Age-specific fertility rates for five-year periods prior to survey

Age group for period	Interval before survey (completed years)[a]						
	0–4 (1973–7)	5–9 (1968–72)	10–14 (1963–7)	15–19 (1958–62)	20–24 (1953–7)	25–29 (1948–52)	30–34 (1943–7)
15–19	0.887	0.992	1.051	1.062	0.879	0.824	0.593
20–24	1.719	1.786	1.904	1.614	1.501	1.503	
25–29	1.779	1.817	1.844	1.588	1.638		
30–34	1.484	1.656	1.750	1.705			
35–39	1.231	1.376	1.440				
40–44	0.806	0.884					
45–49	0.397						

[a]Approximate calendar years for each period prior to the survey are given in parentheses.

indicated in figure 2 and the curves drawn in figure 3 for all women over 35. The rates for cohorts under the age of 35 indicate that these younger women are having fewer babies during the last five years than older women did at the same age, which again corresponds to a shift from the traditional to the transitional fertility pattern as hypothesized by Lesthaeghe *et al.* As a society goes from the traditional to transitional pattern any cross-sectional analysis of age-specific fertility rates at various periods in time would falsely indicate a rise in fertility. The fact that Kenya may be at the very start of such a transition should therefore be kept in mind throughout this analysis.

In order to examine more closely the trends indicated in table 6, the fertility rates are cumulated vertically to produce synthetic cohort measures for five-year periods prior to the survey (table 7) and diagonally to estimate mean children born to each cohort up to specific ages (table 8). When the rates are cumulated up to exact ages as in table 8 we need to remember that the estimates for the top diagonal are not based on complete data, as the women have not all reached the exact age and also that the cohorts listed correspond to the current age at the survey only.

A striking feature of table 7 is the apparent increase in fertility which took place up to 1963–7, followed by a gradual fall in 1968–72 and 1973–7. In other words, the cumulated fertility for the 1963–7 period is higher than that of the adjacent time periods.

At their face value the time period measures suggest such a remarkable level and trend of fertility as to raise immediate doubts. By extrapolation to the end of the reproductive period on the assumption that the fertility rates of the cohort aged 45–49 at the survey applied also to other cohorts, the following estimates of total fertility are obtained:

Period	Estimated total fertility
1958–62	8.32
1963–67	9.04
1968–72	8.83
1973–77	8.28

The estimates for the late sixties are much higher than indicated by the 1969 census data, even with substantial adjustment to the latter. The trend of sharp increase in 1963–7 and fast fall in 1973–7 is not obviously consistent with any social, economic or political events.

An examination of table 8 shows that the estimated mean number of children born is the highest for the cohort aged 30–34 at all exact ages up to age 35. Generally a rise or a decline in fertility, at least in developing countries, affects a cross-section of the female population rather than one cohort only. However, as noted earlier, this cohort may have been most affected by independence in 1963, when they were aged 15–19. Their higher fertility could be reasonable if the Lesthaeghe *et al* model is appropriate for Kenya and assuming the transitional pattern is very recent. Being in their middle childbearing years these women had no fertility-inhibiting effects of later marriage and may have had higher fertility in their twenties because of less spacing. If these women are now following the transitional pattern, they will have fewer births during the remainder of their

Table 7 Age-specific fertility rates cumulated up to exact ages for five-year periods prior to survey

To exact age	Interval before survey (completed years)						
	0–4 (1973–4)	5–9 (1968–72)	10–14 (1963–7)	15–19 (1958–62)	20–24 (1953–7)	25–29 (1948–52)	30–34 (1943–7)
20	0.887	0.992	1.051	1.062	0.879	0.824	0.593
25	2.606	2.778	2.955	2.676	2.380	2.327	
30	4.385	4.595	4.799	4.264	4.018		
35	5.869	6.251	6.549	5.969			
40	7.100	7.627	7.989				
45	7.906	8.511					
50	8.303						

Table 8 Age-specific fertility rates cumulated up to exact ages for cohorts

Cohort[a]	Exact age						
	20	25	30	35	40	45	50
15–19	0.887						
20–24	0.992	2.711					
25–29	1.051	2.837	4.616				
30–34	1.062	2.966	4.783	6.267			
35–39	0.879	2.493	4.337	5.993	7.224		
40–44	0.824	2.325	3.913	5.663	7.039	7.845	
45–49	0.593	2.096	3.734	5.439	6.879	7.763	8.160

[a]The age range is the ages that the calculated rates are centred around. See text for further explanation.

childbearing years resulting in a total fertility that is lower or equal to that of the older cohorts. We have already seen from table 6 that these women during the last five years have had much lower fertility than older cohorts did when they were of the same age, which could indicate the start of such a transition. This trend is further enforced by the fact that we believe that the older cohorts have probably overstated their ages at maternity, since their mean age at childbearing appears unrealistically high.

The argument that the pattern of fertility reported for the older cohorts is greatly distorted is powerfully supported by direct comparison of the mean parities from the 1962 and 1969 censuses with corresponding measures from the 1978 Fertility Survey, as shown below:

Mean births per mother aged 30–34 years			
1962 census:	5.11	1969 census:	5.56
45–49 years cohort, 1978:	4.68	40–44 years cohort, 1978:	5.17

Mean births per mother are used rather than mean births per woman to eliminate the errors in the reporting of childlessness, already examined. The cohorts aged 45–49 and 40–44 years in 1978 were 30–34 in 1963 and 1968, respectively; the assumption can be made with negligible error that if the data were accurate there should be agreement with the 1962 and 1969 census measures. In fact, the KFS mean parities are about 0.4 of a birth lower than the census values, even though it seems likely that the latter are too low. The massive additions of births by the time of the survey (3.4 and 2.65 per mother for the 45–49 and 40–44 cohorts, respectively) can only be due to time location errors, which have brought the events forward, or age errors. However, we should mention that a tendency on the part of the interviewer to allocate younger women with high parity to this age group could also inflate the fertility level of this cohort. The effect of age estimation of the women will be examined later.

The fertility rates have been cumulated in single-year intervals before the survey for five-year age groups and have been graphically plotted for the country as a whole in figure 4. The same pattern can be depicted for the single-year intervals as for the five-year intervals before the survey. There is general rise from the early to the middle periods, followed by a slight decline for the recent years. This pattern, however, has been noted in many fertility history analyses to be a consequence of interviewing women who do not know the exact birth dates of all their children (Potter 1977). There appears to be a tendency for women to displace births in the more remote past towards the survey date. Birth dates of younger children are not as affected presumably because the child is still at home and perhaps even present at the interview. This possibility of birth date misplacement will also be examined later.

The sawtooth-like shape of the curves for all ages is explained by dating-of-births preferences, which may also help account for the heaping of births in the middle periods. The graph shows that there was an exaggeration of the number of births in the twelve months prior to the survey. This is possibly due to a tendency among interviewers to count children who are breastfeeding as being under one year of age. In Kenya, where breastfeeding normally extends well beyond one year, this will inflate the number of births in the past year at the expense of births occurring in the period between one and two years before the survey. There was also a preference for dating births in the periods 3, 8, 10, 12 and 14 years before the survey.

2.2 EXAMINATION OF POSSIBLE REPORTING ERRORS

Errors in the birth histories are likely to arise in any or all of three ways: births could be omitted, especially births of children who have died or left home; the age of the mother could be misreported; and finally, the dates of births could be misallocated, most probably from a distant period to one closer to the time of the survey.

Omission of Births

We have seen from chapter 1 that the KFS data when compared to the 1969 census data did not indicate that omission of births was a problem in 1978 as it possibly was earlier. Indeed, the high levels of completed fertility found for older women in the KFS offer further evidence that few women could have forgotten or omitted some of their children from their birth histories. Figure 5 adds more support to this supposition. Here we have plotted the cumulated

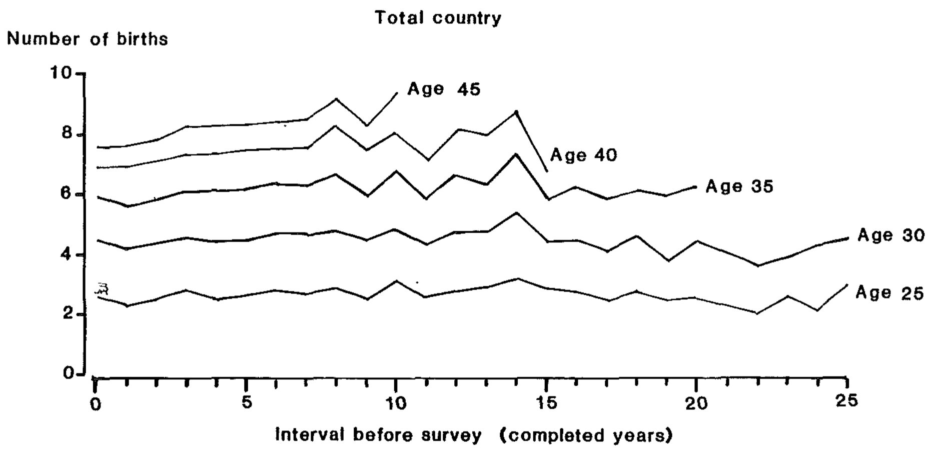

Figure 4 Age-specific fertility rates cumulated to exact specified ages, for single-year periods prior to survey

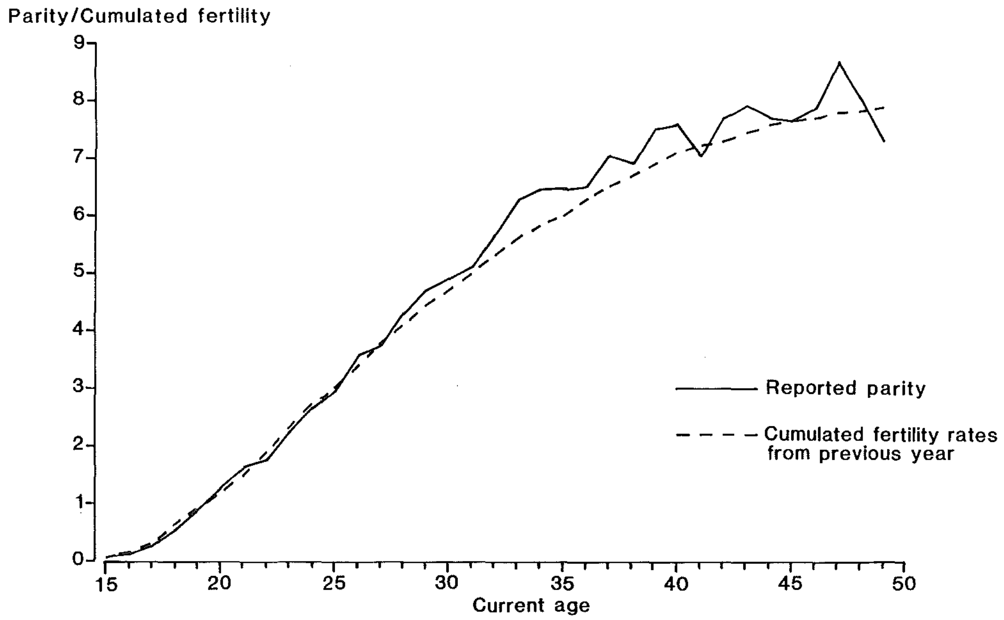

Figure 5 Average parity and cumulated fertility rates from the previous year by single years of age

age-specific fertility rates found in the year previous to the survey against the reported average total children ever born by single years of age. If fertility has been constant in the years preceding the survey and if the births have been reported accurately in the past year, one would expect these curves to coincide. Since births are more likely to be omitted in the more distant past, the reported children ever born would tend to be less than the cumulated rates if the omission of births is a problem. One would also expect this discrepancy to increase as the age of the woman does. For the KFS data, the opposite is true. There is very close correspondence between the two curves until the age 27; then the reported children ever born is consistently higher. Only at age 41 and 49 does the average fall below the cumulated rates. This trend is in spite of the apparent over-statement of fertility in the past year shown in figure 4 which indicated that the previous year rates could be inflated.

The cumulated rates presented in table 7 indicate an apparent decline in fertility over the past 10–14 years. However, there is nothing to support this view in terms of desired family size, which is relatively high, or in terms of contraceptive usage, which is low. In addition, as stated before, this phenomenon of highest fertility during the period 10–14 years prior to the survey is a common feature of maternity histories and shown to be the possible result of birth date misplacement (Chidambaram *et al* 1980). But the disparity between the two curves in figure 5 still indicated declining fertility at the older ages. If in fact Kenya was at the start of the transition as outlined by Lesthaeghe *et al*, one would expect the cumulated rates to be lower or about the same as the average children ever born at the young ages, higher at the middle ages and then lower again at the older ages. This also is not the case in figure 5.

One possible explanation for the high values of children ever born among older women is that these women are reporting the children of their unmarried daughters or the children of previous wives as their own. For example, in one Western tribe it is customary for a new wife to accept all her husband's children, legitimate and illegitimate, as her own. This misunderstanding between *bearing* children and *raising* them should be minimized in a detailed interview and it seems unlikely that it was sufficiently widespread for such an effect as seen in figure 5 to be realized. Unfortunately, this possibility of reporting the children of others as their own cannot be examined with the data available. We can conclude, however, that the omission of births does not appear to be of any consequence in the KFS birth histories data.

Knowledge of Age

Age misreporting can affect the distribution of reported children ever born. If the estimation of age is related to parity, women with high parity might tend to have their age inflated. If this were the case the women at commonly heaped ages would have higher reported average parities than those at adjacent ages which are not heaped.

Conversely at older ages, where total fertility does not change quickly over a year or two, one might expect the average lifetime fertility at heaped ages to be lower because of the likelihood that women who were unable to report their age are also prone to omit births.

In table 9, containing a comparison of the average children ever born for the commonly heaped ages in the KFS with the average of two adjacent ages, neither of these patterns is consistently indicated. The differences between the two columns were minimal until age 38, where the unheaped adjacent ages to ages 38 and 45 had higher reported average parities and those neighbouring ages 40 and 42 had lower parities.

Age misreporting can also affect the pattern of period and cohort fertility rates. If the older women reported their more distant births as closer to the present it could lead to a cohort-time pattern with the odd features found. The apparent rise and fall of total fertility would then be entirely or largely spurious. On the other hand, the configuration of

Table 9 Mean parity for heaped ages in the KFS with the mean parities of the neighbouring ages

Age	Mean parity	Mean parity of neighbouring ages
16	0.12	0.15
18	0.56	0.55
20	1.24	1.22
23	2.22	2.21
25	2.95	3.12
28	4.33	4.21
30	4.93	4.91
32	5.66	5.69
35	6.47	6.50
38	6.87	7.28
40	7.59	7.32
42	7.73	7.52
45	7.68	7.80

specific rates could be the result of particular kinds of age errors. If, say, the women recorded at ages 35–39 were in reality somewhat younger the births would appear to be located too close to the present; conversely, if the women recorded as 25–29 years old were on average older the opposite effect would occur. In this case, the time location and hence the period total fertilities could be correct even with the distortion in interval pattern. The slight amount of good evidence available on age reporting in Africa indicates that such a pattern of errors is not unlikely. Gibril (1975) compared the ages of persons in a small area of Gambia as shown at the census with the much more reliable values in the records of a long-term medical follow-up study. The findings for women of reproductive age are given below:

Census age	Mean recorded age
15–19	18.38
20–24	24.04
25–29	28.35
30–34	32.75
35–39	35.50
40–44	42.12
45–49	47.16

The KFS data allow us to look at the maternity histories separately for women who stated their age and those whose age was estimated by the interviewer. It seems likely that women who knew their age would also report more accurately ages of their children than women who were ignorant of their own age. Hence, if some of the trends noted for the country as a whole were spurious, and caused only by errors in reporting age, we would expect the maternity histories of the women who stated their ages to give a more plausible picture.

If we compare the average parity at the time of the survey for these two groups, according to whether age was estimated or not, we see close agreement for the younger women (see figure 6). For women over age 35, the two curves separate, with women who knew their age having higher parity. There is evidence of some heaping for ages 40–44 for those women whose age was estimated. This discrepancy could be linked to the fact that a majority of the women who did not know their age have never been to school. That is, 57 per cent of these uneducated women did not know their age while only 9 per cent of the women with 5–8 years of schooling did not. Evidence from Kenya and other African countries show that women with only a few years of education (roughly primary education) have higher fertility than women with no education.[2] Only for women with five or more years of education does fertility tend to decline. However, there are so few older women with this level of education that overall one would expect older women who knew their age to have higher average parities.

If older women who did not know their age tended to omit births, it seems logical that they would most often omit the births of children who died as infants. As a cursory look at this possibility, we have plotted in figure 7 the percentage of all children born who died at age one or less for all age groups by whether the woman knew her age or not. Women who knew their age, because they have more education, are expected to have lower percentages of infant deaths unless women whose ages had to be estimated tended to omit from their birth histories infants who died. Although the exact patterns shown by the figure cannot be easily explained, they do not indicate that the older women who did not know their age omitted births of infants who died.

Figure 8 shows the age-specific rates cumulated up to specified five-year ages for single years prior to the survey (ie synthetic cohort measures) and table 10 shows the mean parity for each cohort up to exact ages, according to whether the respondents knew their age or not.

Contrary to what may have been expected, the pattern already noted for the whole country is maintained for the group of women who knew their age. Fertility seems to have been rising, at all ages, from the period over 20 years before the survey, to reach a peak 10–14 years before and then to decline subsequently. When we look at cohorts, the cohort aged 30–34 still had the highest cumulated fertility at all ages. The older cohorts also have extremely high fertility in recent years.

For the cohort of women whose age was estimated, the pattern is similar though less clear: the cohort aged 25–29 years has high fertility and there is a less marked decline in the ten years prior to the survey. The values in figure 8 for these women are quite irregular and show considerable heaping of births for the twelve months preceding the survey, and then a preference for reporting children at current ages 6, 8, 10 and 14 years.

Overall, in the KFS we did not find any consistent trend that a woman's ability to recall her age or date of birth was linked with her parity. And, although the average parity of older women who knew their age was greater than that of older women who did not, this could be expected due to the fact that most uneducated women did not know their age. In addition, when the percentages of children ever born who died as infants were compared by age groups for these

[2] For example, according to the 1973 National Demographic Survey of Tanzania, women aged 35–44 with no years of education had an average of 4.7 live births compared with 5.3 live births for women with 1–4 years of education, 4.7 live births for women with 5–8 years of education, and 3.9 live births for women with 9–13 years of education. For more information see Henin 1976.

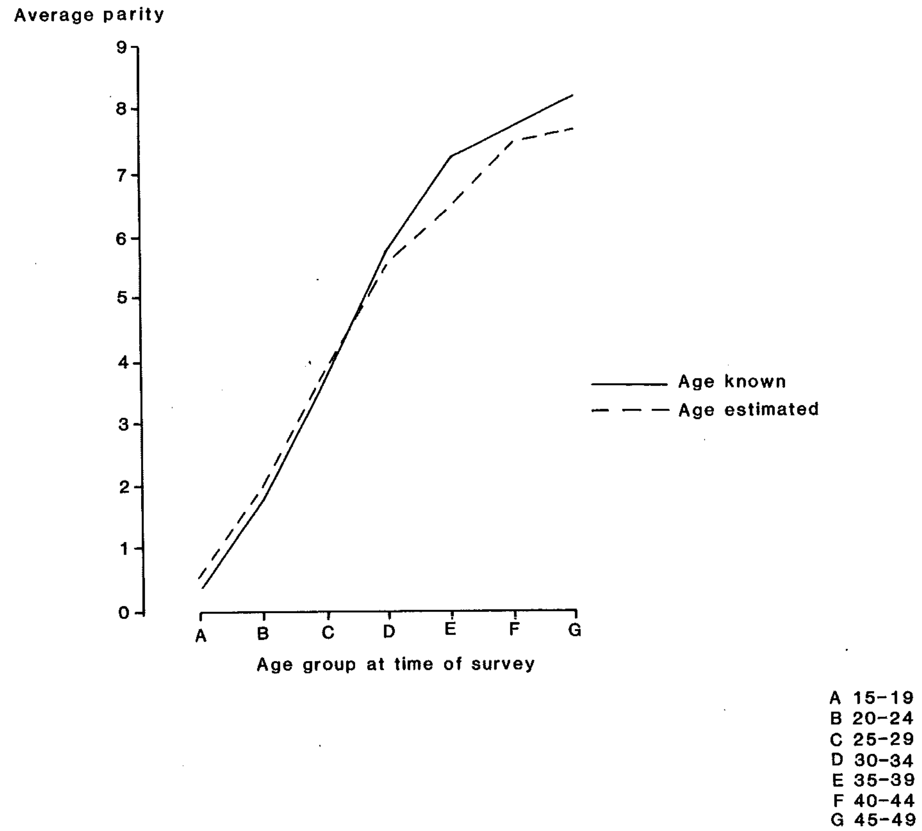

Figure 6 Average parity at the time of survey by whether age of mother known or estimated

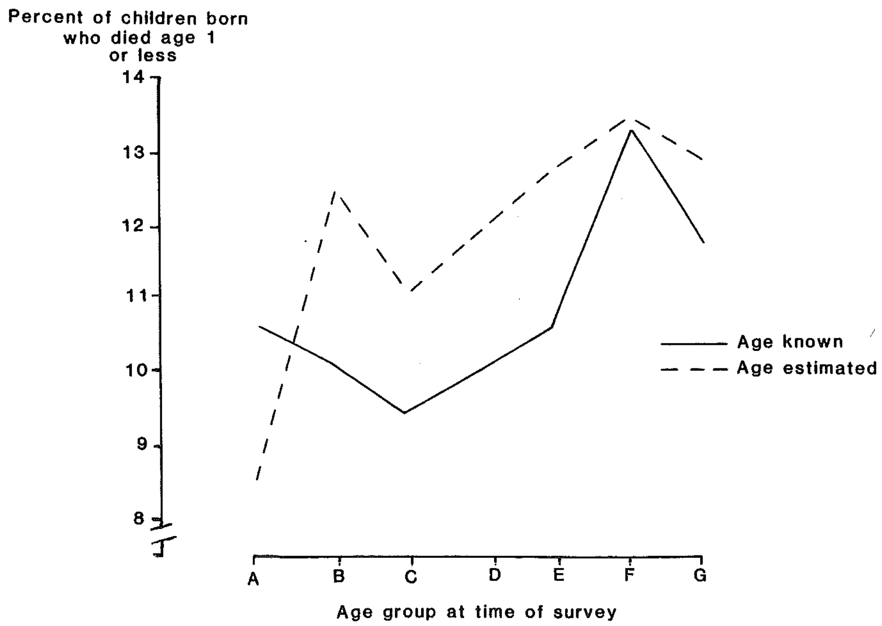

Figure 7 Percentage of children ever born who died age one or less, by age group at survey, and whether age of mother known or estimated

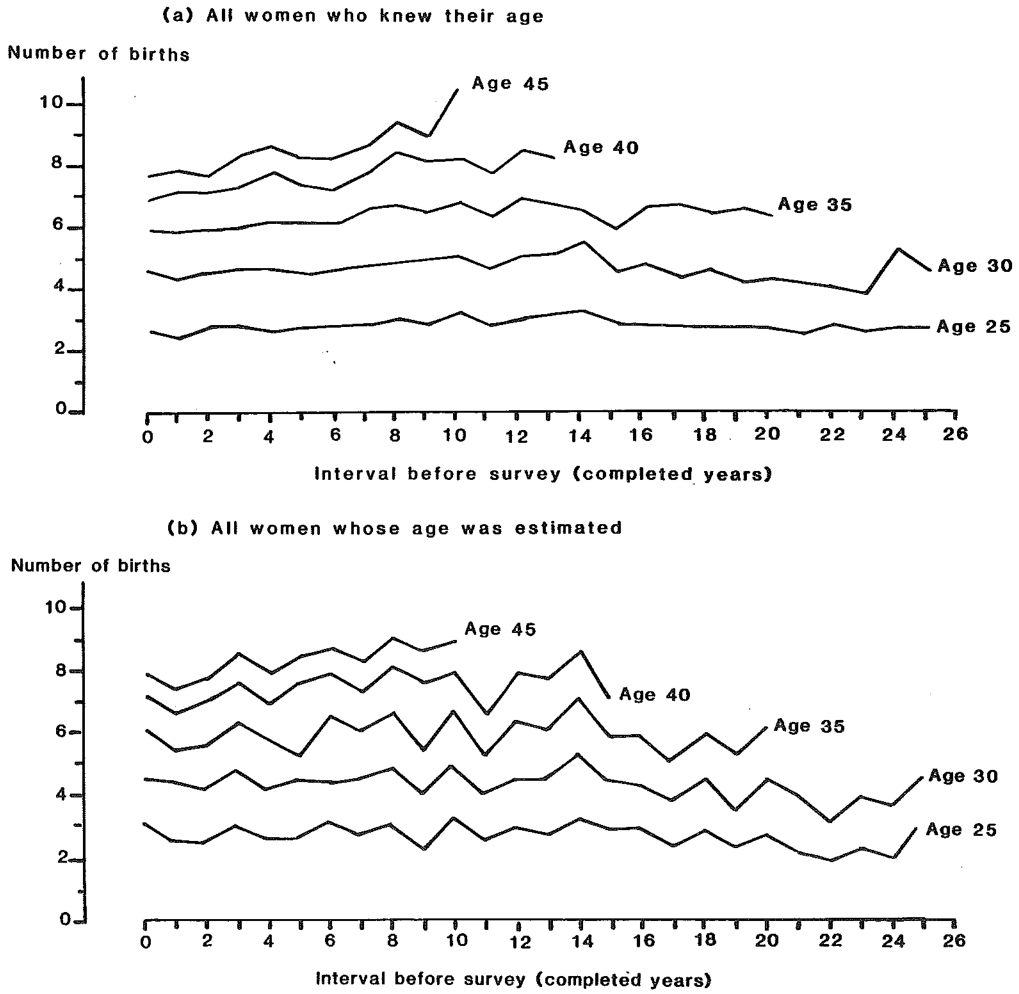

Figure 8 Age-specific fertility rates cumulated to exact specified ages, for single-year periods prior to survey

Table 10 Age-specific fertility rates cumulated up to exact ages, for cohorts with age known and age estimated

Cohort	Exact age						
	20	25	30	35	40	45	50
A Age known							
	0.842						
	0.965	2.718					
	0.999	2.814	4.663				
	1.047	3.047	4.898	6.390			
	0.965	2.696	4.650	6.336	7.608		
	0.771	2.384	4.091	5.910	7.309	8.090	
	0.481	2.177	3.841	5.757	7.233	8.117	8.416
B Age estimated							
	1.087						
	1.069	2.702					
	1.136	2.877	4.534				
	1.091	2.877	4.665	6.144			
	0.798	2.302	4.042	5.670	6.861		
	0.872	2.288	3.778	5.474	6.839	7.661	
	0.663	2.052	3.680	5.255	6.670	7.552	8.011

two types of women, there was no obvious omission of such births indicated for women who did not know their age. The birth histories of both groups of women still indicate a rise and decline in fertility over the 35 years prior to the survey. It was found, however, that women who did not know their age had a greater tendency to heap their children's ages.

We should state at this time two deficiencies in this analysis. The first is that we cannot be certain of the accuracy with which women stated their age or date of birth. There still could be a large amount of estimation and misstatement that cannot be measured. In addition, we have not tried to elicit from the data the existence and extent of over-estimation of age.

Time Misallocation of Births

We have already discussed the possibility of the high fertility noted 10–20 years before the survey as being an example of the effect of time misplacements of births. Potter (1977) has shown that, when comparing 'true' fertility with the 'observed' fertility over a woman's reproductive lifetime, the observed rates are often lower during the younger ages and higher at the older ages because of misreporting. In figure 9, we have plotted the age-specific rates of women aged 49 over their reproductive life against the current rates

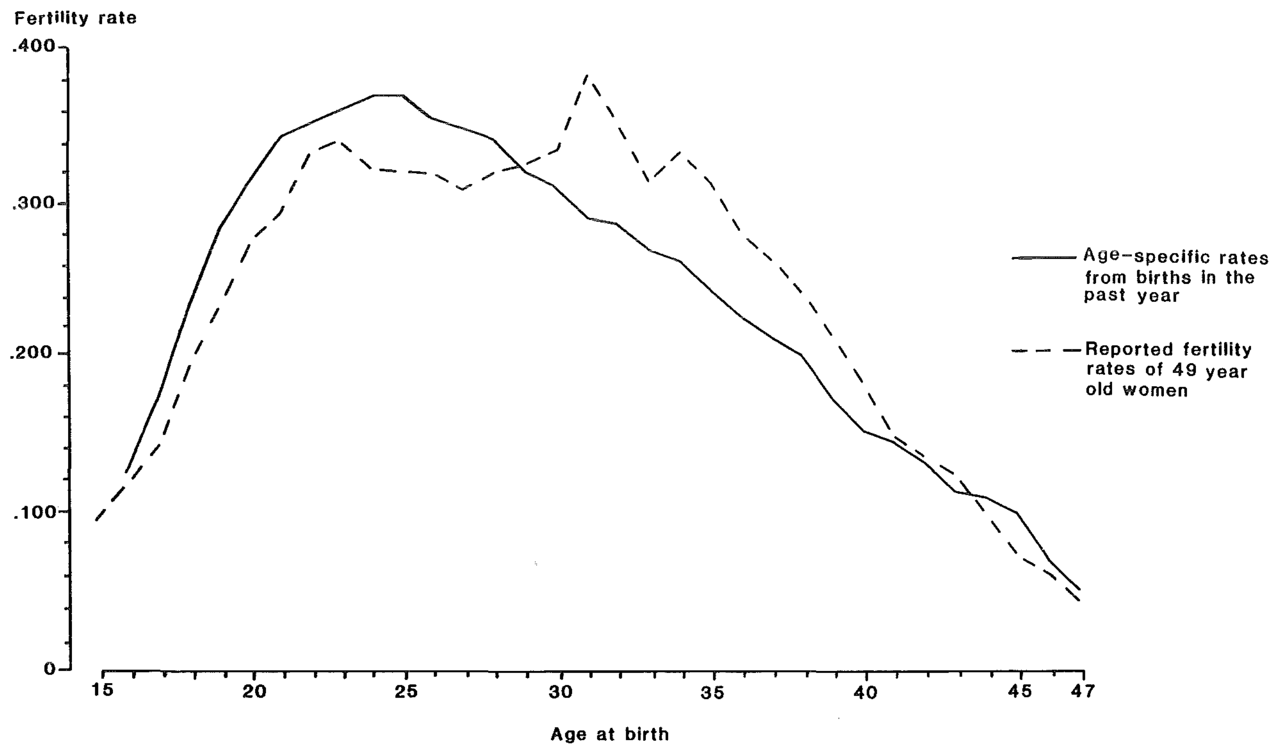

Figure 9 Comparison of age-specific fertility rates from past year and age-specific rates of 49 year old women. (The rates were calculated as five-year averages to smooth the curves.)

found over the twelve months prior to the survey by single years of age. Five-year running averages were used to smooth both curves for comparison. In general terms these curves follow the pattern expected if birth misplacement took place, that is to say, the age pattern of fertility of the 49 year old cohort is much older than the correct rates. However, if these 49 year old women are in fact younger and they have over-stated their age, the same pattern would be expected.

Given that this misallocation of births results in lower fertility rates at the young ages for older women, one would expect the rates of childlessness to be inflated most in the distant past. And since childlessness is only affected by the misplacement of the first birth then the women over age 24 should not be as affected. Any decline in these older age groups should reflect the true decline in lifetime childlessness, assuming that women who report 'no births' are not more likely to omit their births than women reporting children. During the period considered there has been a great deal of improvement in health care and facilities, so in fact some decline in childlessness is to be expected. For teenagers the trend over the recent years should be toward increasing childlessness as education of women in Kenya has resulted in a delay in childbearing.

At ages 15–19, there is an initial decline in childlessness which is followed by an almost systematic rise during the 10–15 years before the survey; from about 60 per cent 18 years before the survey to over 70 per cent just before the survey. As stated earlier, it is reasonable that the recent rise is because of the higher level of schooling for younger women and thus later age of starting childbearing.

This effect is also found, but to a smaller extent, for women aged 20–24. For these women the rate of childlessness drops from over 30 per cent to about 15 per cent 15 years before the survey, and then rises to approach 20 per cent at the time of the survey. Beyond age 25, the decline in childlessness continues up to the most recent years before the survey.

The percentage childless at ages 20–24, 25–29 and 30–34 by single-year intervals before the survey are plotted in figure 10 separately for women who knew their age and women who did not. Women who knew their age showed a sharp decline in childlessness from the earliest period until about 10–14 years ago, followed by an increase for younger women. This no doubt reflects the increasing age at first marriage for these better educated women and a delay in childbearing which can explain to some extent the observed recent overall decline in fertility for these women.

For women whose age was estimated, there was an overall decline in rates of childlessness throughout the entire period under consideration, which again corresponds to the earlier finding that this group of women did not show an overall decline in fertility over the past 15 years.

The large differences between the rates of childlessness for women aged 20–24 and those aged 25–29, especially in the distant past, indicate that the data are deficient. Even now, it is highly unlikely that women in Kenya who have not given birth by their mid-twenties would do so later in life. And although education is delaying childbearing, universal primary education is only now becoming a reality for Kenyan women. Therefore, this effect is not expected to influence rates beyond the teenage years.

Either misplacement of births or a large amount of overestimation of age for the mothers does appear to have

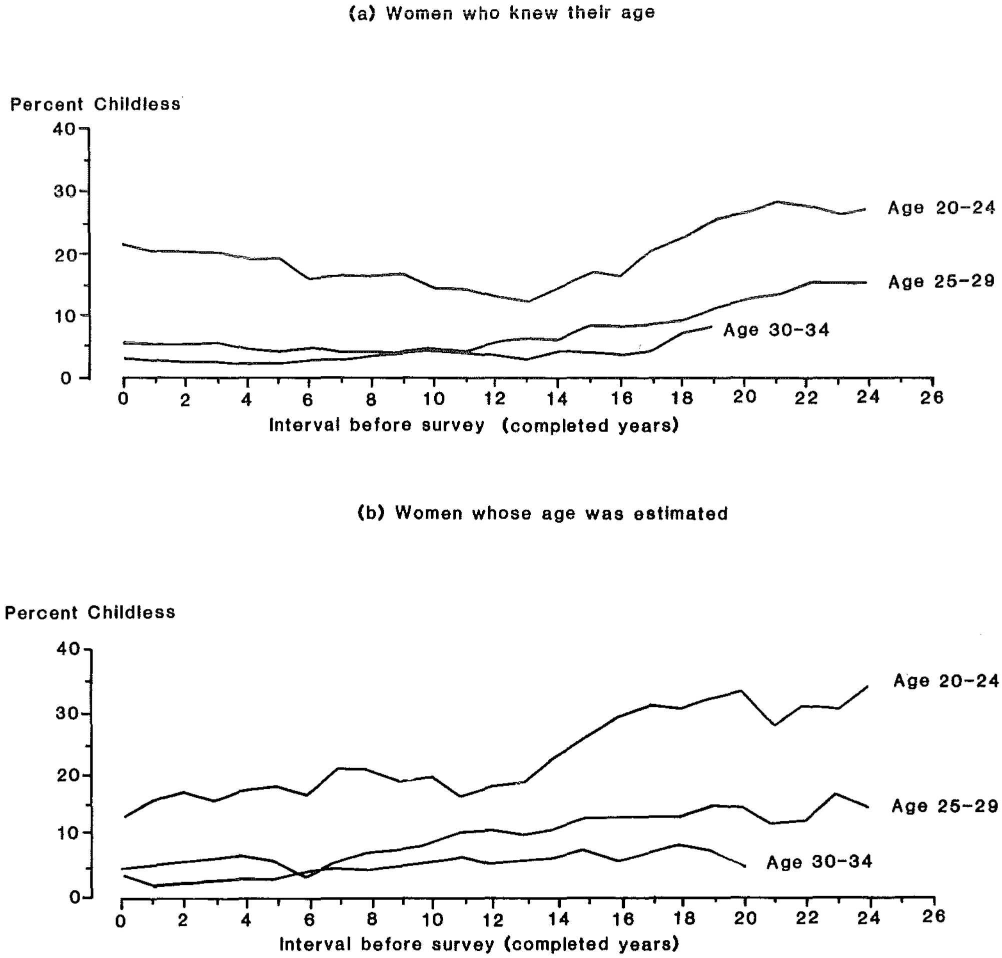

Figure 10 Percentage childless by interval before survey

occurred when women in the KFS reported their birth histories. This is shown by the inflated declines in the percentage childless, especially in the distant past for women in their late twenties, compared to women in their early twenties. The further decline for women aged 30–34 is also unrealistic. In addition, the pattern of lifetime fertility for 49 year olds and the single-year current fertility rates are similar to what Potter expected when he investigated the misallocation of births in birth histories.

2.3 EFFECT OF HIGH EDUCATION

One would expect the quality of reporting to be determined to some extent by the amount of education to which the respondent has been exposed. We have already seen that the reporting for women whose age was estimated was more irregular than of others. Now we will examine the fertility histories of the women with the most education, assuming

Table 11 Age-specific fertility rates cumulated up to exact ages for five-year periods before the survey, confined to women with 5–8 years of education

Exact age	Interval before survey (completed years)					
	0–4 (1973–7)	5–9 (1968–72)	10–14 (1963–7)	15–19 (1958–62)	20–24 (1953–7)	25–29 (1948–52)
20	0.874	0.974	0.881	0.762	0.817	0.481
25	2.738	3.008	2.983	2.633	2.418	
30	4.694	4.835	4.871	4.447		
35	5.999	6.513	6.658			
40	6.902	8.034				
45	7.676					

that these women will be the most accurate. Since the group of women with secondary education includes extremely small numbers of older women, we will examine the histories of women with 5–8 years of primary schooling. Even for this educational group, there were only 25 women aged 45–49. This age group was omitted in table 11 and combined with women aged 40–44 in figure 11.

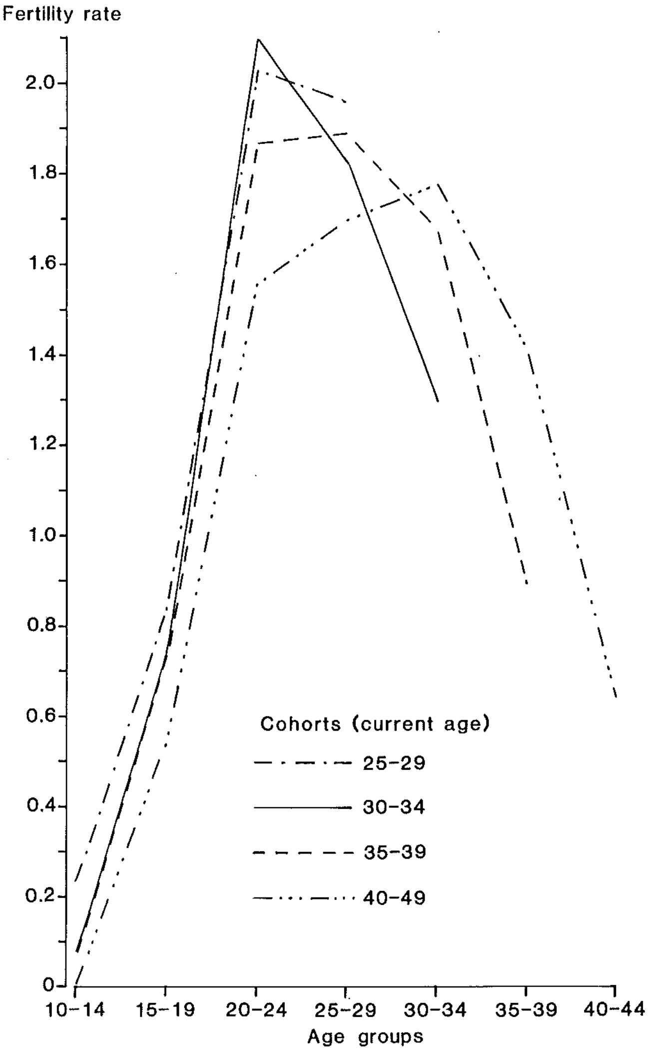

Figure 11 Five-year fertility rates for women currently aged 25–49, confined to those with 5–8 years of education

Table 11 gives the age-specific fertility rates cumulated up to exact ages for five-year periods before the survey. The rates up to age 20 for the last 24 years show no definite trend, indicating that these women were more accurate in the placement of their first birth. However, there does appear to be a large drop for the teenagers during the period 25–29 years before the survey. This could also be due to small numbers since this rate is based on the experience of only about 50 women. But the rising and falling of fertility as seen for the whole country reappears for cumulated fertility to older ages. The decline in fertility occurs only in the last ten years.

In order to investigate the appropriateness of the Lesthaeghe *et al* model for these relatively well-educated women, we have plotted in figure 11 the age-specific fertility rates for the various cohorts. The 40–44 year olds and the 45–49 year olds were combined because of the small numbers of women in these categories. This group does show possible age misallocation of children since the fertility of these women when they were teenagers is suspiciously low. In other respects the pattern of fertility for this ten-year cohort is similar to the traditional pattern in figure 2, while the two five-year cohorts in their thirties follow the transitional pattern. Although not all graphed, the values for women under 30 can be found from table 11 to show increases in the rates of teenage fertility. In fact this could be explained by the fact that, as more and more women are educated to this level, the 'éliteness' which would have inhibited fertility of the group declines. For example, only 4.5 per cent of the women aged 40–44 went to school beyond four years while 62 per cent of the teenagers had had this amount of schooling.

Overall, it appears that the relatively well-educated oldest women interviewed in the KFS still showed some signs of misplacement of births. However, the educated women between 30 and 39 show a definite shift from the traditional to the transitional patterns of fertility behaviour described in figure 2. The rates for the youngest age groups indicate that fertility among these women while teenagers could be increasing.

2.4 CONCLUDING COMMENTS

The birth histories for the entire sample of 8100 Kenyan women showed two trends. The data first indicated that there had been a rise in fertility from the distant past to the period 10–14 years before the survey (1963–7) and then a decline. Although one cannot base any justification for rejecting this trend on the past census data, which also showed an apparent increase over the last 15 years, there was still little evidence in lifestyle to indicate either the rise or fall as being realistic in Kenya. When the birth histories were examined by synthetic cohorts, another trend of rising and falling fertility was found. The data indicated that the cohort aged 30–34 had higher cumulative fertility than any other cohort and there were gradual declines from this cohort both to the youngest and to the oldest cohorts.

An examination of the possible types of recording errors commonly found in birth histories helped to clarify the observed figures. The apparent rise in fertility from the distant past to 10–14 years before the survey and the rise from the oldest age group to the 30–34 year old cohorts were not too difficult to explain. Given the high total fertility found for women over 34 and the fact that the average reported children ever born was not less than the cumulated single-year fertility rates, it appeared that omission of births by older women was not the cause of the discovered rise. And, although women who did not know their age did tend to heap the ages of their children much more than women who knew their age, this distinction did not shed much further light on the high fertility during this specific period. The major cause, we believe, of this 'bunching' is the misallocation of dates of live births by the older women. These older women had their highest fertility at older ages than expected. As stated earlier, however, this effect could also be achieved by a general tendency for women to overstate their own ages. The percentages of childlessness, especially for the older women, also tended to decrease more than expected between the ages 20–24 and 25–29. A further unrealistic decline in childlessness was noted for women aged 30–34 in the past. In addition, a comparison of the current single-year rates found for all women with the historical single-year rates found for 49 year old women showed patterns similar to those expected by the work done by Potter when he examined the effects of misallocation of dates of birth by older women.

The apparent decline in recent years has been more difficult to explain. By comparing the five-year rates for each cohort with the transitional and traditional patterns hypothesized by Lesthaeghe *et al*, we did see an indication that Kenya could be at the start of such a transition. For younger women less than age 25, there could be a justification for believing that the fertility rates have declined because of the increase in education for women since independence 15 years before the survey. In fact, if the transitional model applies to Kenya, the cohort aged 30–34 might be expected to show a genuine increase in fertility, because they had no large fertility-inhibiting effect during their teenage years of postponement of maternity under the impact of more education, and have had higher fertility (because of less spacing) during their twenties. This would be due to the breakdown of traditional or cultural inhibiting factors without the substitution of contraception during a period of high fecundity. The desired average family size for younger women was lower than the achieved size of the oldest women in the KFS: for women aged 25–29 it was 6.6 children; for ages 30–34 it was 7.2. So the non-use of contraception in the future will dictate whether these women will have a lifetime fertility that is the same or lower than that achieved by the older cohorts.

Our analysis of the birth histories leads us to the conclusion that fertility in Kenya has been at a fairly consistent high level throughout the period available for study. We do feel, however, that Kenya is at the start of a transitional period, which has affected the fertility rates of the last five years. Whether this transition will result in a final lower fertility for the women under age 35 at the time of the survey depends upon their future use of contraception and their desire to have fewer children.

3 Fertility Model Estimates

3.1 INTRODUCTION

In this chapter the assessment of the previous pages is extended further by the use of a model of cohort fertility by age of women over time. The comparison of the observed measure with the model highlights the anomalies already noted. On hypotheses about the possible nature of the errors the parameters of the model can be estimated and hence adjustments made to the levels and trends of fertility. Before the model is described the unlikely features of the observations which must be taken into account will be recapitulated.

The large decreases over time in fertility rates at later ages, but increases at younger ages (apart from the most recent period), have been discussed in detail, as has the phenomenon of a peak in fertility in the period 10–14 years prior to survey. There is no evidence that omission of births is a significant cause for distortions nor does it seem probable that age misreporting can account for the anomalies. Further, it is not possible to make sense of these patterns in terms of changes in marriage or health (particularly diseases causing sterility), factors often invoked as possible influences on fertility trends. Data from the KFS and censuses show negligible movements in the proportions of women ever marrying and only a small and recent increase in the age at first marriage. Proportions currently married are also changing little and, if anything, because of reduction in widowhood, in a direction tending to raise fertility at later ages rather than lower it. Reductions in sterility because of, for example, the cure of gonorrhoea would not increase fertility greatly at younger ages of a cohort without similar effects over the remainder of the reproductive period. The evidence on the impact of antibiotics in the treatment of venereal diseases, mainly from the Pacific Islands, shows that fertility is increased for cohorts over the whole of their reproductive range. Also in Kenya, as has been noted above, the percentage of women reported as childless was only 3 per cent for all cohorts over 30 years.

A more attractive explanation of the shape of the fertility trend is that it might be due to the combined effects of two opposing forces, increases in fertility due to reductions in post-partum amenorrhoea and abstention, offset by the use of contraception to limit families, first at higher parities and later ages but progressively by younger women. But such a hypothesis is not easily reconciled with the evidence from the survey. The level of contraceptive use is not consistent with the substantial effect needed for the suggestion to have credibility. There remains the possibility of shortening birth intervals. Since information on amenorrhoea and abstention comes only from the last pregnancy interval trends cannot be determined. On the other hand such movements would be likely to show up in differentials by cohorts and there is little sign of effects with the required magnitude.

3.2 THE GOMPERTZ RELATIONAL MODEL

The attempt to construct more sensible fertility levels and trends will be made by the application of the Gompertz relational model. This describes fertility rates by age in terms of three parameters, a more rigid framework than the Coale-Trussell four-parameter model and other functions which give reasonable fits to observations. Apart from the rigidity its greatest strength is that the fertility measures are linearized; errors and corrections can thus be assessed by convenient graphical procedures. The basic equation of the Gompertz relational model is

$$Y(x) = \alpha + \beta Y_s(x),$$

where α, β are constants for the particular fertility distribution, and

$$Y(x) = -\ln[-\ln\{F(x)/F\}],$$

a transformation of $F(x)/F$. $F(x)$ is fertility up to age x, and F or F(U) the total fertility, that is up to age U, the upper limit of reproduction. The s in $Y_s(x)$ denotes the transformation for a standard age specific fertility schedule. Different standards may be constructed for particular purposes but a general 'average' standard for high fertility populations has been developed by Heather Booth (1979). The model also holds if F(x) is replaced by P_i, where P_i is the mean parity (children ever born) for an age group of women. β is an inverse measure of the width or spread of the age-specific fertility distribution (equal to 1 for the standard) and α an index of central location. An important development has come from the work of Basia Zaba (1981). She has shown that the series of partial fertility ratios $(F(x)/F(x+5))$ [or P_i/P_{i+1}] can also be represented linearly in the form of

$$Z(x) - e(x) = \alpha^* + \beta g(x),$$

where β is the same constant as before and α^* approximates closely to $\alpha + 0.48(\beta - 1)^2$. Z(x) is

$$-\ln[-\ln\{F(x)/F(x+5)\}]$$

and e(x) and g(x) are standard values calculated from $F_s(x)$. The advantage is that $F(x)/F(x + 5)$ does not depend on the total fertility F but only on the shape of the age-specific fertility distribution. The model can then be conveniently used with measures for cohorts whose fertility is not completed or to check local consistency, for example of mean parities for younger women, without the necessity of first estimating F. Tables of standard values for the application of the Gompertz relational model are shown in the appendix A.

The mean parities for women by five-year age groups at the time of the survey demonstrate no obvious signs of birth omission. This is confirmed by fitting a Gompertz model to the partial fertility ratios. The results are taken from an unpublished report by K. Moser, in which the measures at

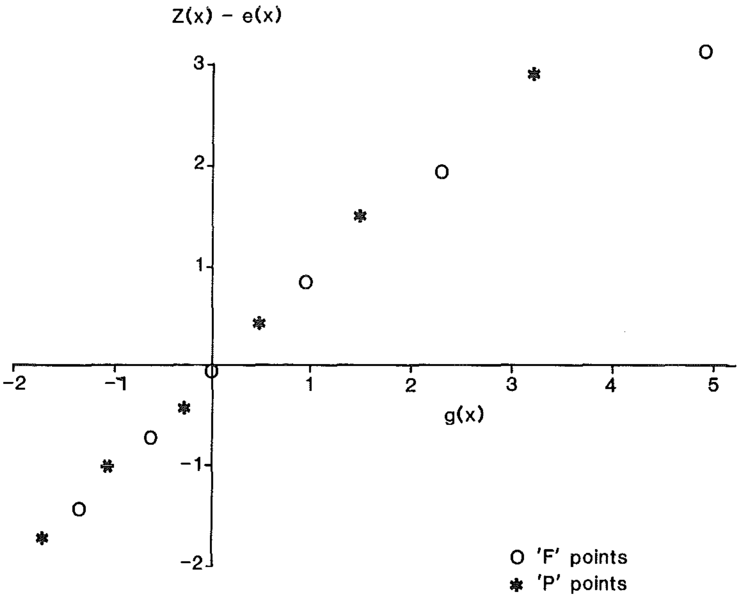

Figure 12 Mean parity and current fertility rates plotted on the Gompertz relational model scales

ages under 40 years are fitted by least squares. Figure 12 indicates that the points are so linear that the method of fitting is unimportant. For comparison, the Gompertz model fit to the age-specific fertility rates, calculated from births reported in the year preceding the survey, is also shown. Observed and fitted measures are given in table 12.

The shape parameters α and β are almost the same for the parity and current model fits. β is near to 1 and α to 0, showing that the observations follow the standard pattern quite closely. The agreement between model and observations is excellent for the cohort parities but there are discrepancies in the fit to current rates. The age-specific fertilities at 40–44 years and 45–49 years are too high to be well represented by the model pattern. Such discrepancies have been common with survey data, particularly in Africa.

There are two plausible explanations. Infants of mothers who have died may have been fostered by grandmothers or older sisters of the mother and wrongly allocated as births to them. Blacker has suggested this possibility. Alternatively there are large age errors for the age groups over 40 where the transfer in of younger women is likely to raise fertility rates to an extent which is not compensated by the transfer of older women, because of the non-linearity of the changes in rates towards the end of reproduction. If the first suggestion is correct the total fertility F is best estimated, after α and β have been found from the rates at under 40 years, to give agreement between the model and observed cumulated fertilities at age 40. With the second error the observed total fertility should be accepted, with consequent discrepancies in the fit at both lower and upper ages since the model is now correcting for the effects of age errors. Both approaches are used here, with estimated total fertilities of 7.66 and 8.07 respectively. Strong support for the second type of error comes from the proportions of women by age reported as pregnant at the time of the survey, which are consistent with the high observed current rates towards the end of reproduction. In these reports the first type of

Table 12 Mean parities and current age-specific fertility rates fitted by Gompertz relational model

Age group of women	Mean parities		Specific fertility rates from births in past year		
	Observed	Fitted	Observed	Fitted A	Fitted B
15–19	0.35	0.31	0.178	0.176	0.185
20–24	1.83	1.83	0.362	0.360	0.379
25–29	3.75	3.80	0.366	0.362	0.382
30–34	5.54	5.53	0.293	0.301	0.317
35–39	6.81	6.82	0.221	0.218	0.230
40–44	7.58	7.57	0.138	0.101	0.106
45–49	7.85	7.78	0.057	0.013	0.014
Total fertility	(7.87)	7.80	8.07	7.66	8.07
α	–	–0.042	–	–0.071	–0.071
β	–	1.051	–	1.003	1.003

Table 13 Comparison of P and F values with different procedures for determining F

Age group	P	F	P/F	P/F (Gompertz) A	P/F (Gompertz) B
20–24	1.83	1.76	1.04	1.05	1.00
25–29	3.75	3.61	1.04	1.05	0.99
30–34	5.54	5.31	1.04	1.05	0.99
35–39	6.81	6.62	1.03	1.03	0.98
40–44	7.58	7.61	1.00	1.02	0.97
45–49	7.85	8.03	0.98	1.03	0.97

error cannot be operating but the effects of the second would be the same as for births.

The good agreement between the parity and current fitted models in both pattern and level strongly suggests that fertility has shown little change in the 20–25 years preceding the survey. Direct comparison of the measures calculated from the observations using the P/F ratio technique gives the values in table 13. The slightly higher P's at under forty years with the falling P/F thereafter might be interpreted as a small under-reporting of current births and some omissions of children by the older women. But a combination of increases in the age at marriage and age errors might also lead to the P/F deviations from 1. It has been suggested that the P/F ratio method would be improved if the F values were estimated from a fitted Gompertz model rather than directly from the rates. If this modification is applied with the fitted values of the table even better agreement between current and lifetime fertility is achieved. The P/F ratios with the A fitting for the younger women are not much different from the original levels, but since the fitted total fertility is 7.66, adjusting by the factor 1.05 gives 8.04. With the B fitting the ratios for young women are close to 1.

3.3 ESTIMATED RATES BY COHORT AND TIME

The relational Gompertz model can be used to explore further the birth rates by cohort and time. The simple fitting of the model to the distributions for separate cohorts is not particularly useful because time location errors would be reproduced in the fit. Instead a number of alternative specifications of *patterns*, that is the α and β, were made and the total fertilities for cohorts estimated to give the observed mean parities at the time of the survey; that is on the assumption that the numbers of births reported but not necessarily the time location were reliable. Two of these specifications have been chosen for discussion. The model fertilities by cohorts and time periods are shown in table 14.

The decision on the best choices of values for α and β must be guided by a balancing of the plausibility of errors against the plausibility of pattern changes. If the data are very unreliable the best that can be done is to determine a fixed pattern, that is α and β, common to all cohorts. It can be shown that if the α and β are about right for the 'middle cohort' aged 30–34 years, regular trends in patterns do not seriously distort the estimates of period total fertility. Better results can be obtained, however, if a reasonable estimate of a trend in α can be made. Alterations in β are then relatively unimportant in the specification of the more recent fertility, say over the past 15 years; failure to account for them can cause errors in the estimation of the more distant rates but this is not of much practical significance.

On the Gompertz model

$$|Z(x+5) - e(x+5)| - |Z(x) - e(x)| = \beta\{g(x+5) - g(x)\},$$

where

$$Z(x) = -\ln|-\ln\{F(x)/F(x+5)\}|.$$

An estimate of β is obtained, therefore, from every successive pair of ratios $F(x)/F(x+5)$, for a cohort with x at five-year intervals and at least three cumulation points. The

Table 14 Births per 1000 women to cohorts in calendar years: Gompertz relational model specifications

Cohort (age in 1973–7)	Births in calendar year 1973–7	1968–72	1963–7	1958–62	1953–7	1948–52	1943–7	Cohort total
Specification A								
15–19	889							889
20–24	1712	998						2710
25–29	1769	1800	1038					4607
30–34	1543	1827	1849	1052				6271
35–39	1131	1502	1775	1787	1003			7198
40–44	569	1152	1529	1801	1802	999		7852
45–49	84	570	1154	1529	1793	1784	977	7894
Specification B[a]								
35–39	1288	1655	1844	1670	741			7198
40–44	648	1289	1656	1846	1671	742		7852
45–49	95	643	1280	1646	1833	1660	737	7894

[a]Measures for cohorts under 35 are the same as in Specification A.

Table 15 Births per 1000 women, mean parities and total fertilities: observed and Gompertz relational model specifications

Age group of women	Births per 1000 women cumulated from rates in past five years: Observed	Specification A	Specification B	Cohorts: Mean parities per 1000 women at survey — Observed and model	Total fertility: Specification A	Specification B
15–19	889	889	889	889	6508	6508
20–24	2616	2601	2601	2710	7429	7429
25–29	4386	4370	4370	4607	7843	7843
30–34	5873	5913	5913	6271	8084	8084
35–39	7111	7044	7201	7198	7838	7940
40–44	7931	7613	7849	7852	7935	7947
45–49	8279	7697	7944	7894	7894	7894

values of β thus found from the Kenya measures are close to but slightly below 1 for the 25–29 and 30–34 cohorts; they fall to 0.91 on average for the 35–39 cohort and fall steeply at later ages. A specification of β as 0.96 gives a fair fit for all but the last two cohorts for which reliability in the time location of births is hardly to be expected. With this estimate of β, α can be determined for each F(x) to make the model exact for that measure, conditional on the cumulated fertility of the cohort up to the time of the survey. The average values of these α (excluding the tails of the distribution for the older cohorts where the estimates are very unreliable) are as follows:

Cohort	20–24	25–29	30–34	35–39	40–44	45–49
$\hat{\alpha}$	–.033	–.043	–.048	–.200	–.366	–.433

The sharp change between the 30–34 and 35–39 cohorts is evident. Probably the soundest procedure is to ignore the information at over 35 as too biased and to specify $\hat{\alpha}$ as a constant –.048 or to fit the slight downward trend shown by the younger cohorts. The results from these two alternatives differ little. More speculatively, the jump in $\hat{\alpha}$ might be interpreted as a changeover from the recording of women as too old to making them too young. This might be captured by changing the $\hat{\alpha}$ to –.200 for the cohorts aged 35 years and over. The two specifications presented are then for β equal to 0.96 and:

Cohort		15–19	20–24	25–29	30–34	35–39	40–44	45–49
α	A	–.025	–.033	–.041	–.049	–.057	–.065	–.073
α	B	–.025	–.033	–.041	–.049	–.200	–.200	–.200

In the examination of the model representation it must be noted that small changes in α can make large differences in the estimated total fertilities for the younger cohorts of women where only a small part of the childbearing period has been experienced. Thus the lower total fertilities for the cohorts of women aged 15–19 and 20–24 can be raised to around 8.0 by assuming a change in direction of the α trend because of the increases in age at marriage. This would have a negligible effect on the estimated *period* total fertilities.

The specifications are weighted towards the acceptance of the conclusion that the similar fertility patterns revealed by recent births and the mean parities imply that cohort patterns have shown little change, but in B, allowance is made for possible age error effects. Both of them make a substantial re-allocation of births over time for the older cohorts, A rather more than B. Both estimate that birth rates in the past five years have been exaggerated at the older ages. In the light of the earlier discussion it is likely that some of this was due to age errors but it is also a logical corollary of the shifts backwards in time of births reported at 5–15 years previously, necessary to make sense of the configurations. The important difference between A and B is that the former implies a constant level of time-period total fertility of around 8 with a slight fall to 7.7 in the most recent five years while the latter retains part of the rise and fall of the reported rates. Tables 15 and 16 extract certain measures for particular attention.

The agreement between the model specification and the reported measures is excellent up to the age cohort 30–34 years. Thereafter, the judgement is between a larger or smaller correction for time-location error. The difficulty about the hypothesis that the differential age error accounts for the jump in $\hat{\alpha}$ between the 30–34 and 35–39 cohorts is that the effect is big enough to bias the increase in mean parities around the point by some 25 per cent. But the Gompertz model fit in table 12 gives no indication of such a bias. More plausibly, the jump is partly due to time-location error and the age error effects should be allowed for by $\hat{\alpha}$ which are less discontinuous at 35–39, but diverge further for the older cohorts. The estimates of period and total fertilities with such specifications do not differ greatly from those under B above.

Table 16 Estimated period total fertility

		1973–7	1968–72	1963–7	1958–62
Extrapolation		8.28	8.83	9.04	8.32
Model Specification	A	7.70	7.93	8.00	7.98
Model Specification	B	7.94	8.31	8.40	8.23

Table 17 Mean parities by age group, reported and standardized by age at marriage and proportions never married

Region	Age group at survey					
	25–34		35–44		45+	
	Rep.	Std.	Rep.	Std.	Rep.	Std.
Central	4.6	4.7	7.2	7.5	8.1	8.2
Eastern	4.4	4.6	6.7	6.8	7.9	7.9
Nyanza	4.6	4.3	7.5	7.3	8.3	8.6
Western	4.7	4.5	7.7	7.5	8.2	7.9
Rift. V.	4.6	4.6	7.2	7.1	7.6	7.6
Nairobi	3.9	4.4	7.1	6.8	*	*
Coast	4.1	3.8	5.9	5.8	6.0	5.0

*Too few women to calculate.

3.4 PROVINCIAL ESTIMATES

Table 17 shows selected fertility measures for the provinces of Kenya and the main city, Nairobi (shown separately from the rest of Central Province). These are taken from the Kenya Fertility Survey First Report. The variations in the level of fertility are small with the exception of Coast Province. The mean parity of 6.0 for women over 45 in the area is well below the average 8. The discrepancy when allowance is made for exposure to marriage is even greater since the Coast has the lowest age at marriage (median of 16.3 years compared with a national estimate of 18.1 for women aged 20–24 years at the survey). At earlier ages the divergence is not so marked, suggesting that the Coast fertility experience might be different from that of the other provinces. More detailed examination confirms these impressions and, consequently, separate attention is paid to the Coast Province. Although the number of women from this province included in the survey was small (only 648) and the sample errors for the cohort and time period measures high, the effects which will be examined are well outside the limit of chance variation.

Table 18 shows the births added per 1000 women by cohorts and time periods for the Coast Province. First those reported are presented and then the estimated numbers found using the framework of the Gompertz relational model. There are some extra difficulties because of the high sampling errors in the rates and the obvious impossibility of regarding the mean parities as consistent with a series for a cohort. The two youngest cohorts for which estimates of β can be made from the Zaba ratio procedure give values close to 1. There is a good case for taking β to be 0.96 as for the whole country. The values of α estimated for the cohorts are extremely erratic but not inconsistent with the simple hypothesis of a constant shift relative to the whole population of women. Since conclusions will be drawn by comparing the model fits for the Coast and Kenya, it is important to ensure that the relations with the observations are very much the same. The model specification for the Coast was therefore chosen to be the same as Specification A for Kenya as a whole except that 0.120 was added to the α for each age group cohort. This is approximately the average shift over all the cohorts and also for the two key cohorts aged 25–29 and 30–34 years. The fitted and observed values for cohorts and periods are shown in table 19 for both Kenya as a whole and Coast Province.

It is at once obvious that the similar procedure for correcting the time location errors and estimating total fertilities for cohorts and time periods has given quite different results in the Coast Province from those in Kenya. The

Table 18 Births per 1000 women to cohorts in calendar years, Coast Province: reported and Gompertz relational model specification

Cohort (age in 1973–7)	Births in calendar year							Cohort total
	1973–7	1968–72	1963–7	1958–62	1953–7	1948–52	1945–7	
A Reported								
15–19	1144							1144
20–24	1483	1267						2750
25–29	1452	1720	1175					4347
30–34	1271	1527	1746	1155				5699
35–39	982	1328	1369	1299	954			5932
40–44	492	739	1133	936	1182	985		5467
45–49	–	502	940	1003	815	1317	815	5392
B Model specification								
15–19	1144							1144
20–24	1616	1134						2750
25–29	1518	1671	1158					4347
30–34	1262	1560	1707	1170				5699
35–39	834	1138	1401	1526	1033			5932
40–44	353	725	986	1212	1313	878		5467
45–49	51	347	713	969	1186	1281	845	5392

Table 19 Observed and fitted births per 1000 women for age and synthetic time period cohorts

Age group	Kenya				Coast Province			
	1973–7		Cohort total fertility, A		1973–7		Cohort total fertility, A	
	Observed	Fitted A			Observed	Fitted A		
15–19	889	889	6508		1144	1144	6686	
20–24	2616	2601	7429		2627	2760	6725	
25–29	4386	4370	7843		4079	4278	6969	
30–34	5873	5913	8084		5350	5540	7139	
35–39	7111	7044	7838		6332	6374	6397	
40–44	7931	7613	7935		6824	6727	5518	
45–49	8279	7697	7894		6824	6778	5392	
	Calendar years				Calendar years			
	1973–7	1968–72	1963–7	1958–62	1973–7	1968–72	1963–7	1958–62
Total fertility								
Observed[a]	8.28	8.83	9.04	8.32	6.82	7.12	6.71	5.42
Fitted	7.70	8.00	8.07	8.05	6.78	6.63	6.37	6.12

[a]Extrapolated on assumption that measures for the 45–49 age group applied for older cohorts.

constant fertility with a very recent decline of the latter has been replaced by a substantial increase, apparently levelling off for the women aged less than 35 years at the time of the survey. Thus the change has largely taken place for the cohorts entering the childbearing period in the years before 1960. Since the older women continued to make a considerable contribution to the current fertility up to the survey the time trend is a steady rise. It would seem that the total fertility around 1977 in the Coast Province was still below the country average but by a modest amount.

It may be argued that all this is spurious and arises because of the omission of many births by the older women (about 1.5 per woman or 20 per cent of the total). Since the reporting of numbers of births in the other regions was clearly good and the bulk of the Coast population is neither isolated nor unsophisticated the argument is not *a priori* particularly strong. Even more pertinent is the lack of other indications that reporting in the Coast was different. Although the values by age group are erratic because of small numbers about 6 per cent of the women over age 25 were reported as childless compared with 3 per cent for the whole country. The slightly higher proportion for the Coast is in line with the lower fertility but obviously does not account for it, whether the difference is real or due to error. Table 20 shows by region the percentage of births occurring below age 30 years for the cohort of women aged 45–49 in the five years before the survey, and also for the time-period (synthetic cohort) values based on the rates in the past five years. The discrepancies between the two columns are a simple measure of the pushing back of births in time by the older women which is taken to be the major error in the data. The effect for the Coast is less than for the whole country and as low as in any of the regions. In fact there is a stronger case on the Coast than the other areas for the suggestion that part of the shift might be real. It is hard to believe that, if some 20 per cent of the births had been omitted by the 45–49 cohort on the Coast, it would have failed to show up in these comparisons. The expectation is that the omissions would tend to be of the earlier births leading to a considerable widening of the discrepancy.

3.5 CONCLUSIONS

A sound but cautious conclusion is that total fertility in Kenya was around 8 in the period from 1960. There is some evidence that fertility at early ages has fallen a little, probably because of an increase in the age at marriage. More speculatively there are signs that fertility may have risen since the late fifties but reliable estimation is made extremely difficult because severe errors in time-location of births to the older women mimic, in a greatly exaggerated form, what may be a small real effect.

Despite the lack of convincing evidence, from the Kenya birth histories, that there has been any increase in fertility over the past twenty years or so, counter-arguments can be put forward. The belief that in some

Table 20 Percentage of births to women under 30 years of age by region

Region	Calendar years 1973–7	Cohort 45–49
Central	49.9	42.7
Eastern	51.5	45.8
Nyanza	54.4	48.7
Western	58.5	50.1
Rift Valley	53.6	46.4
Nairobi	65.4	60.0
Coast	59.4	54.7
Kenya	53.0	46.4

parts of the country fertility was at a modest level in the 1950s is widespread. There are small-scale surveys which indicate this, eg the unpublished data from the East African Medical Survey study in Msambweni in the Coast Province in 1954. The mean parities of women near the end of the reproductive period were reported at about 3.5. There are also the 1962 and 1969 census results. The difficulty, of course, is the demonstration from comparisons with the 1977 and 1978 surveys that previously there had been substantial under-reporting of children by older women. However, since the East African Medical Survey recorded a mean parity of 7.5 for women aged 40–49 years in Kisii, Nyanza Province in 1953, the dismissal of the Msambweni estimate is not easy. In fact checks of the results using P/F ratios and models indicate that the recording in the East African Medical Surveys was reliable.

Even if the suspected increase in fertility came in the 1950s, a reasonable assumption is that if it was largely due to the widespread introduction of penicillin for the treatment of venereal and certain tropical diseases, there should be some trace of it in the 1978 survey measures. Over the country as a whole a fairly small effect might be hidden by errors in the data, particularly in the time-location of births. Therefore an analysis by regions revealed significant trends in parts of the country.

We believe that the indicated increase in fertility on the Coast is real and that an appreciable part of it took place in the 1950s or even earlier. It is interesting to note that in the 1954 Msambweni Survey 10 per cent of the women aged 30–49 years were reported as childless (1 per cent in Kisii, 1953) suggesting that the reported very low fertility was not due to complete sterility. Since the Coast women formed only 8 per cent of the total sample the impact on the Kenya analysis is small. There are signs that there may also have been a rise in fertility in the Rift Valley Province but from a high to an even higher level. Since the tribal composition of this province is diverse this may reflect changes for a subgroup only. For the country as a whole these findings do not imply an increase in the time-period total fertility of more than 0.2 of a child or so in the 20 years up to 1978. Opposite pressures such as later age at marriage and a small amount of family planning may have led to a slight rise and then fall of period fertility in the 20 years preceding the survey.

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Appendix A — Measures of the Standard Fertility Schedule

Table A1 The standard fertility schedule (F is taken as 1)

Age x	$Y_s(x) = -\ln[-\ln F_s(x)]$	Cumul. fert. $F_s(x)$	Age-spec. fertility rates $f_s(x)$
10	–	0.00000	0.00000
11	−3.17091	0.00000	0.00000
12	−2.74255	0.00000	0.00002
13	−2.36854	0.00002	0.00043
14	−2.04079	0.00045	0.00268
15	−1.75210	0.00313	0.00855
16	−1.49286	0.01168	0.01875
17	−1.25061	0.03043	0.02783
18	−1.04479	0.05826	0.03602
19	−0.85927	0.09428	0.04156
20	−0.69130	0.13584	0.04603
21	−0.53325	0.18187	0.04806
22	−0.38524	0.22993	0.04904
23	−0.24423	0.27897	0.04932
24	−0.10783	0.32829	0.04902
25	0.02564	0.37731	0.04866
26	0.15853	0.42597	0.04774
27	0.29147	0.47371	0.04642
28	0.42515	0.52013	0.04504
29	0.56101	0.56517	0.04344
30	0.70000	0.60861	0.04155
31	0.84272	0.65016	0.03952
32	0.99014	0.68968	0.03754
33	1.14407	0.72722	0.03553
34	1.30627	0.76275	0.03343
35	1.47872	0.79618	0.03133
36	1.66426	0.82751	0.02912
37	1.86597	0.85663	0.02691
38	2.08894	0.88354	0.02462
39	2.33992	0.90816	0.02203
40	2.62602	0.93019	0.01906
41	2.95500	0.94925	0.01555
42	3.32873	0.96480	0.01218
43	3.75984	0.97698	0.00893
44	4.26499	0.98591	0.00597
45	4.80970	0.99188	0.00367
46	5.41311	0.99555	0.00227
47	6.12864	0.99782	0.00133
48	7.07022	0.99915	0.00067
49	8.64839	0.99982	0.00018
50	+ ∞	1.0	

Table A2 Derived ratio measures

Age	e(x)	g(x)
15	0.9866	−2.3138
20	1.3539	−1.3753
25	1.4127	−0.6748
30	1.2750	0.0393
35	0.9157	0.9450
40	0.3966	2.3489
45	–	4.8097