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Reading Fertility Stalls in Census Data: the Case of Kenya

by

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Abstract

Fertility stalls are defined as a period of several years without fertility decline after a period of steady decrease in fertility rates. Several cases were documented in the 1990's and early 2000's in Africa using DHS data. When fertility rates stop declining, the size of birth cohorts tends to increase, leaving a trace in the age pyramid. Conversely, the size of birth cohorts in successive censuses allows one to reconstruct past trends in the General Fertility rate (GFR). This study illustrates this point using five censuses from Kenya, all available as samples in the IPUMS-International database. Results show that fertility was declining in Kenya since the mid-1960's, and that a fertility stall could be identified from 1994 to 2003; after this date, the fertility decline resumed until 2008, the last point available. Fertility levels and trends found in census data were consistent with those identified in DHS surveys. The level of the GFR estimated from census data was somewhat lower before 1985, possibly due to census undercount in the earlier censuses, but similar thereafter, whether before the fertility stall (GFR= 193 and 200 per 1000 respectively in 1985-1993), during the fertility stall (166 and 171 per 1000 respectively in 1994-2002), and after the stall (153 and 155 respectively in 2003-2008). In conclusion, census data could be used for investigating levels and trends in fertility, and for identifying the fertility stall in Kenya.

Key words: Fertility transition; Fertility stall; Census; DHS survey; IPUMS; Kenya; Sub-Saharan Africa.

Introduction

This study is part of a series of studies aiming at documenting fertility trends and fertility stalls using African census data available in the IPUMS database. This study focuses on Kenya, the first and best documented case of fertility stall. [Bongaarts, 2006 & 2008; Ezeh et al., 2009; Westoff & Cross, 2006]

In the 1960's Kenya was the country with the highest fertility rates recorded in the world. Since then, fertility has been declining steadily until the mid-1990's when it stalled. The peak fertility, the date of onset of the fertility transition, the speed of the fertility decline, the date of the fertility stall are still matters of debates, and sometimes controversies. [Machiyama, 2010; Machiyama et al., 2010; Schoumaker, 2009 and 2010; Shapiro and Gebreselassie, 2008; Shapiro et al., 2010; Sneeringer, 2009] In this study, we refer primarily to a prior analysis of DHS data. [Garenne and Joseph, 2002; Garenne, 2008; Garenne 2011] This analysis showed a peak of fertility in the early 1960's, with a very high Total Fertility Rate: TFR= 7.7 children per women in urban areas, and TFR= 8.4 in rural areas. Then followed a fertility decline until 1994, reaching average values: TFR= 3.3 in urban areas, and TFR= 5.8 in rural areas. The fertility stall lasted for about 10 years, until 2004, and fertility decline resumed until 2008, the last point available, with TFR= 2.8 in urban areas and TFR= 5.1 in rural areas. Since the fertility stall was similar in urban and rural areas, both areas were combined for this analysis.

This paper aims at documenting fertility trends in Kenya using census data available in the IPUMS-international database. The method followed for reconstructing fertility trends is straightforward: censuses provide the size of cohorts surviving at time of the census. These cohorts can be backward projected to estimate the size of birth cohorts. These births can be divided by the estimated population of women age 15-49 at the same year, providing an estimate of the General Fertility Rate (GFR). Trends in GFR can then be studied to investigate periods of fertility decline and fertility stalls, and can be compared with DHS data.

1. Data

1.1 IPUMS census data

Five Kenyan censuses are available in the IPUMS database, conducted in 1969, 1979, 1989, 1999, and 2009. These censuses were conducted regularly 10 years apart, usually in late August, with the exception for the 1989 census conducted in October. This regularity greatly facilitates the reconstruction of birth cohorts, although it tends to cumulate age errors due to digit preference, since persons aged 10 at the first census, will be 20 at the second, 30 at the third, 40 at the fourth and 50 at the fifth. During the 40-year period (1969 to 2009), urbanization increased rapidly, reaching 31% in 2009. Note that the 1969 IPUMS census file has no variable for urban residence. Note also that the extrapolated data, using the person weights are not totally identical to the official population, although they are very similar. Furthermore, sampling fractions vary from 5 to 10% depending on the census. Extrapolation weights are uniform for the last 3 censuses (1989, 1999 and 2009), but are complex by age and sex for the first 2 censuses (1969 and 1979). The sample data of censuses conducted in 1969 and 1979 were particularly disturbed, with an overall sex ratio of 117.1 in 1969 and 77.2 in 1979. Extrapolation weights corrected for some of the major errors, but induced serious distortions in the age and sex structure, especially for the young adults. (Table 1)

Table 1: IPUMS census data for Kenya

Census year (reference date)	Official population	IPUMS sample Extrapolated	Sampling fraction	Percent Urban	Percent women 15-49
24/08/1969	10,942,705	10,936,939	6.0		20.4%
24/08/1979	15,327,061	15,327,611	6.7	12.8%	21.9%
25/10/1989	21,448,047	21,481,960	5.0	16.5%	22.2%
25/08/1999	28,686,607	28,150,940	5.0	24.3%	24.6%
25/08/2009	38,610,097	38,419,350	10.0	31.3%	24.3%

The 1969 and 1979 censuses are based on private households (also called conventional households), but weights seem to extrapolate to the total population. The other three censuses include private households, institutions, homeless persons and refugees. In any case, the total extrapolated population by age and sex was considered for this analysis, without any attempt to correct for the minor biases included by the extrapolation method.

1.2 UNPD population data used for comparison

The United Nations Population Division (UNPD) publishes regularly country estimates of total population, proportion urban, age structure, births and deaths, and fertility estimates (CBR and TFR). The population, age and sex structure and births could be used to calculate the GFR. The 2012 revision of the UNPD estimates was used for this study. Data were taken from the UNPD web site. As will be seen below, the UNPD estimates could not always be used because of various inconsistencies with census data. [United Nations, 2013]

1.3 DHS fertility data

The Demographic and Health Survey (DHS) data on fertility and the reconstruction of fertility trends were described in details elsewhere. [Garenne, 2008 and 2011] In brief, maternity histories were used to compute age specific fertility rates in the 10 years before each survey. The cumulated fertility by age 40, noted here TFR(40), was calculated by summing them. The cumulated fertility by age 50, the regular Total Fertility Rate, noted here: TFR(50) was derived from TFR(40) by assuming that 90% of the fertility occurs before age 40. This value is common in Africa and was validated on Kenyan DHS data.

For this study, the TFR was converted into GFR using a linear regression line. The equation was:

$$GFR = A + B \times TFR$$

With A= 24.497, and B= 28.544, TFR in births per women, and GFR in births per 1000 women aged 15-49. This regression line was obtained from empirical values in DHS data from Kenya. It predicts a value of GFR= 253 per 1000 for a TFR= 8.0, and GFR= 139 per 1000 for a TFR= 4.0.

2. Methods

The method to estimate the GFR and fertility trends from census data was straightforward:

1) Reconstructing the total population of Kenya by single year period, from 1950 to 2009: this was done by log-linear interpolation between census data.

2) Calculating the proportion of females aged 15-49 by single year period. Since the IPUMS census estimates were consistent with the UNPD data, the UNPD estimates were used to reproduce the changes in the age structure, year by year from 1950 to 2009. This allowed computing the size of the female population aged 15-49 by single year period, the denominator of the GFR.

3) Tabulating census data by single year of age, and keep only reliable age groups from birth to age 18. Since censuses were 10-years apart, yearly cohorts are defined by their age at census, and go from September to August (and not from January to December).

4) Backward projecting survivors age (x) at census to obtain births that occurred in year (t-x), the numerator of the GFR. This was done by computing a relationship between survival at age x and level of mortality defined by the under-five death rate, labelled q(5), in General pattern of the UN model life tables for developing countries. This assumes that the level of mortality of the cohort born in year (t) is determined by the level of under-five mortality that same year. This relationship was then applied to trends in q(5) estimated from DHS surveys, and published elsewhere. [Garenne 2006; 2012]

5) Merging estimates of birth cohorts from the five censuses, by eliminating erratic data. A further refinement was used by smoothing fluctuations due to age misreporting with a moving average.

6) Computing the annual GFR, by dividing the number of births by the female population aged 15-49.

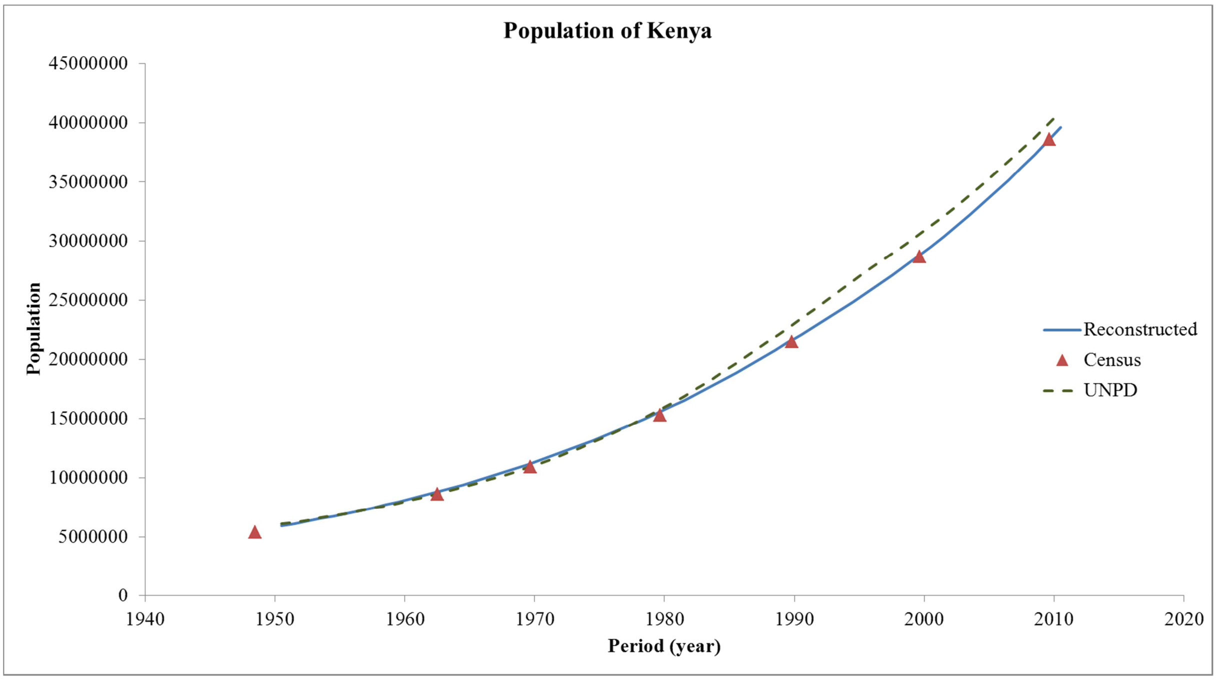
7) Comparing the census GFR with that derived from DHS surveys and with UNPD estimates.

3. Results

3.1) Population estimates 1950-2009

Figure 1 displays the reconstructed population trends from 1950 to 2010. The reconstruction fits accurately the official population at census and in the IPUMS database. It differs somewhat from the UNPD estimates, which tend to be higher after 1979, and could not be readily used for our purpose. Population trends are rather smooth in Kenya from 1948 to 2009, and do not show any major inconsistency.

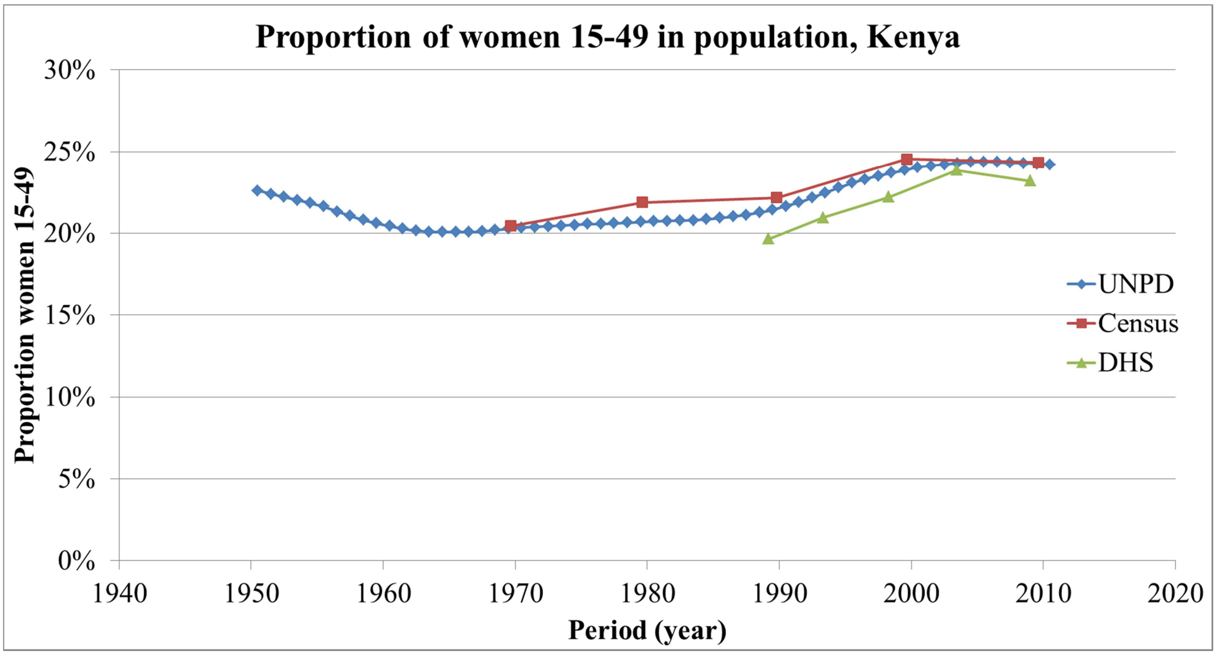
Figure 1: Trends in the population of Kenya: 1948-2009



3. 2) Proportion of women aged 15-49 years

The proportion of women aged 15-49 years in the population showed some inconsistency, especially in the sample data of the 1979 census, where it was higher than expected, and much higher in the raw file before extrapolation. The UNPD estimates are more regular, and indicated a downward trend from 1950 to 1965, then an increase afterwards until 2005, followed by a plateau. With the exception of the 1979 census, the values of the proportions of women aged 15-49 years were consistent with the UNPD estimates. The DHS data also indicated a rise from 1988 to 2003, followed by a decline in 2008. So, the UNDP series was used for the whole period. Note that a change from 20% to 25% in the proportion of women has a large impact on the GFR, in the same proportion (20%).

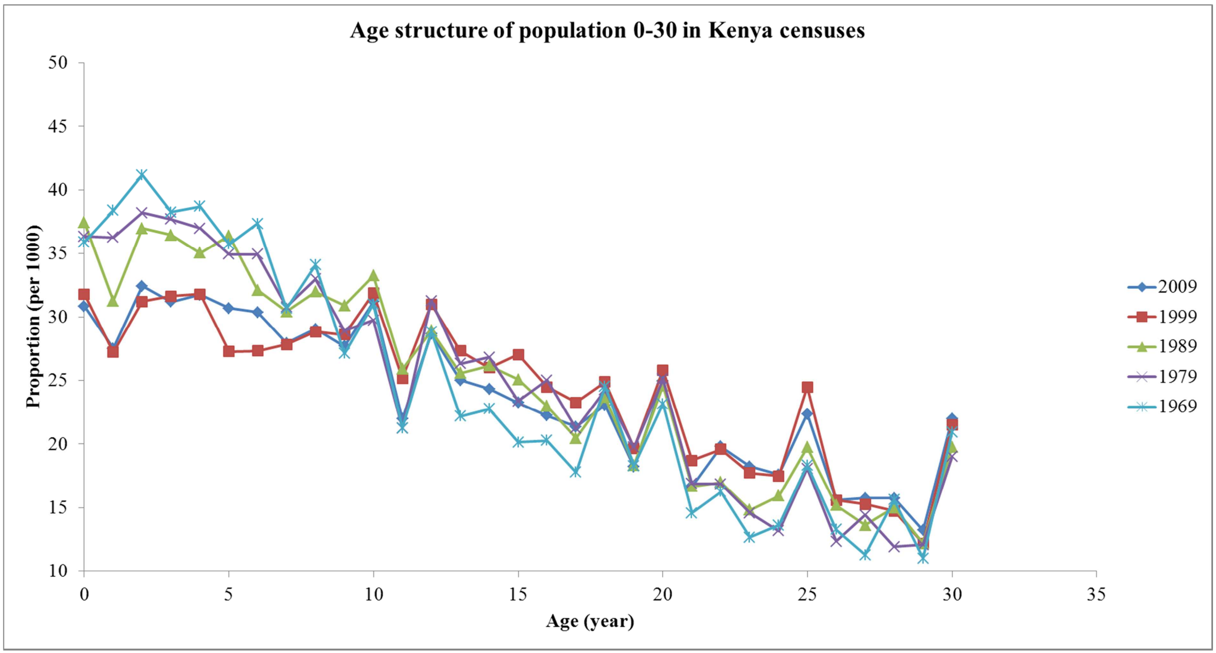
Figure 2: Proportion of women aged 15-49 years in the population of Kenya



3.3 Age structure in Kenyan censuses

The age structures were erratic in all Kenyan censuses, even for persons under the age of 30 years. (Figure 3) The first problem was age heaping at ages 10, 12, 18, 20, 25 and 30 years. The second problem was a deficit of infants and toddlers (age 0 and 1), also in all the five censuses. Furthermore, the 1999 census showed a deficit of children age 5-8 years. These erratic patterns have serious consequences for the backward projections, in particular the age group 0-1 could not be used.

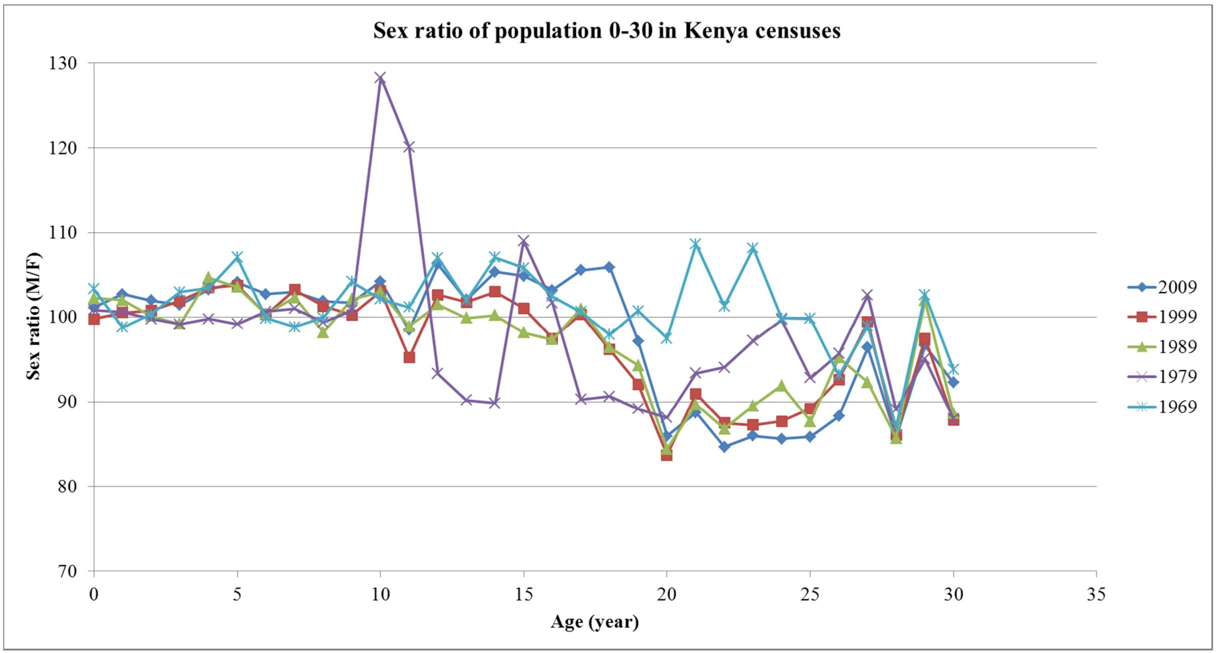
Figure 3: Age structure of the population aged 0-30 in Kenyan censuses



3.4 Sex ratios in Kenyan censuses

The age-specific sex-ratios also show serious abnormalities. (Figure 4) For children under 10 years of age, they tend to be rather high around age 5, except in the 1979 census where they are rather low. For infants and toddlers, sex-ratios are around 102, which is consistent with the sex-ratio at birth in Kenyan DHS data. [See Garenne, 2002 and 2004 for details] Above age 10 years, age-specific sex-ratios tend to be erratic and abnormal. The worst case is that of the 1979 census, which shows very low values between 12 and 22 years, and major peaks at age 10, 11 and 15 years. These are mainly due to the erratic weights used for extrapolation: for instance, the weights vary for females from 16.43 at age 9 to 13.22 at age 10, but only from 16.52 to 16.55 for males at the same ages, creating an imbalance between the sexes. Sex-ratios are also abnormally low after age 18, except in the 1969 census where they were corrected by the weighting system. In the raw data file (the IPUMS sample) the sex ratio at age 19-28 was 120.3 in the 1969 census (abnormally high), but only 61.7 in the 1979 census (abnormally low). Therefore, cohorts above age 18 were not used in the backward projections because of the large errors for young adults.

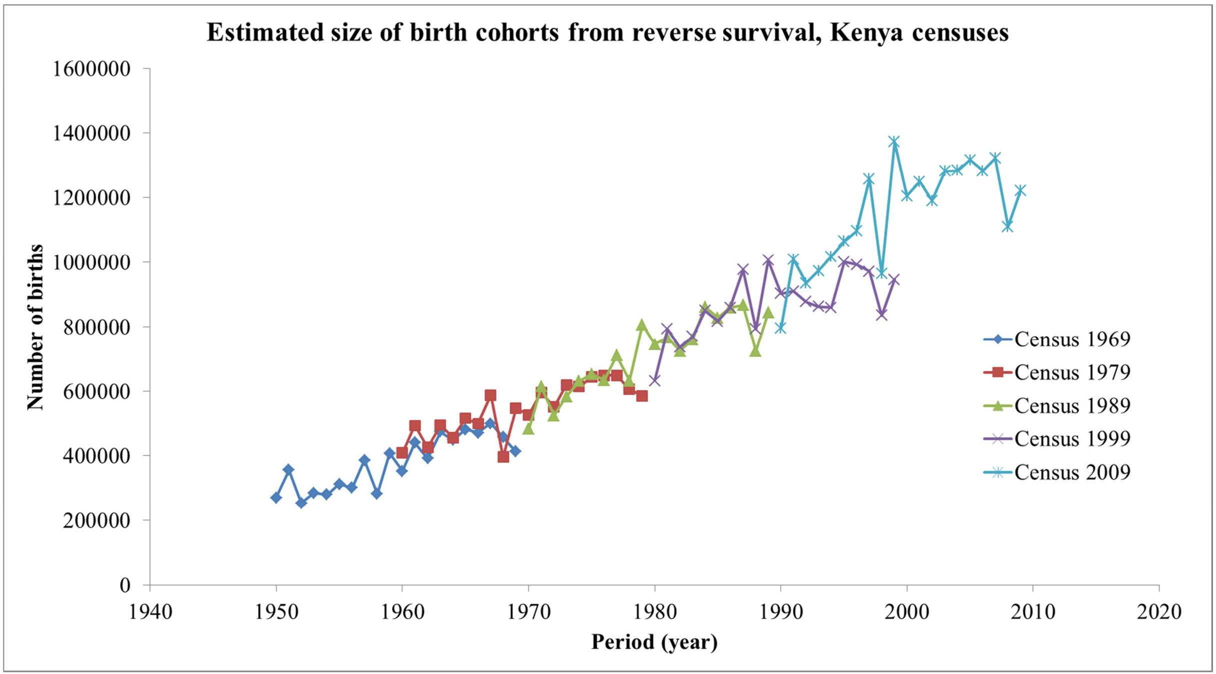
Figure 4: Age-specific sex-ratios in Kenyan censuses (extrapolated data)



3.5 Size of birth cohorts from backward projections

The sizes of birth cohorts obtained from backward projections in the five censuses were overall consistent. (Figure 5) Keeping all cohorts aged 0-18 years at time of census reveals the problems already noted: a deficit of the age group 0-1 year, the irregularities due to age misreporting, and the deficit of the age group 5-8 years in the 1999 census.

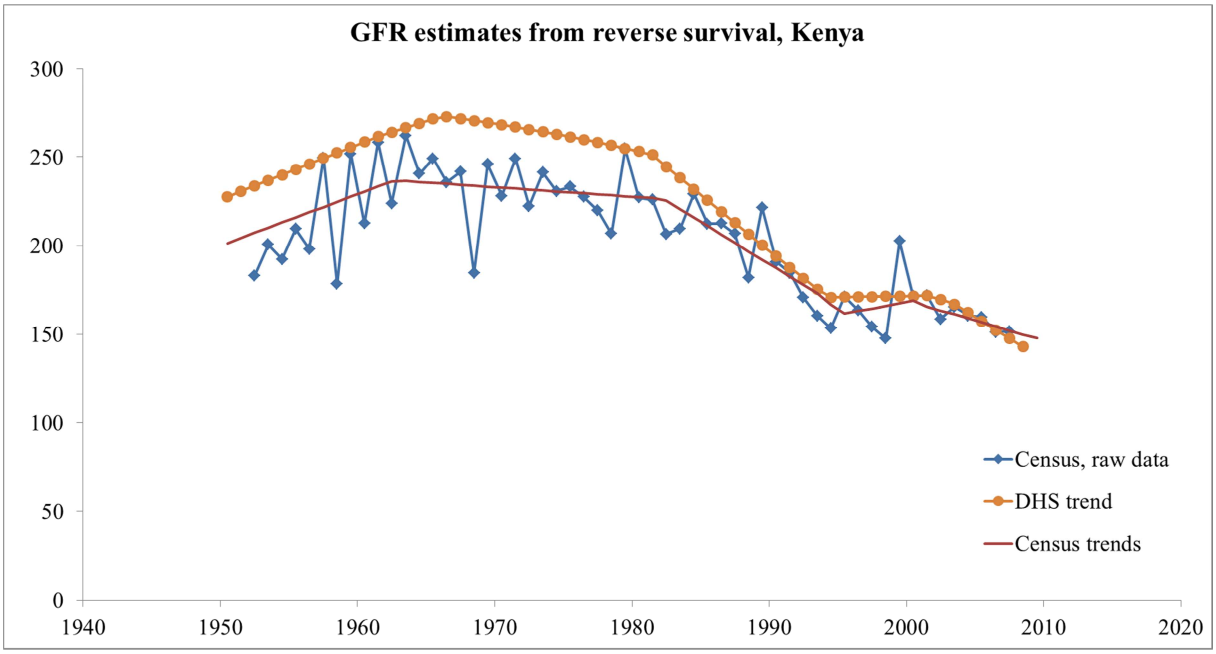
Figure 5: Estimated size of birth cohorts from reverse survival, Kenya censuses



3.6 GFR estimates from census data

Estimates of the GFR obtained by backward projection from census data indicate a complex series of temporal changes over the 1950-2008 period: increase in GFR in the 1950s, followed by a slow decline in the 1960's and 1970's, a faster decline in the 1980's and early 1990's, a stall for about 8 years, and resuming decline in the later years. These changes are almost identical to those found in the DHS surveys. The level of the GFR in the DHS surveys is higher from 1950 to 1990, but similar from 1990 to 2008. These two findings cross-validate each other, confirming the good consistency between census and DHS data obtained from different sources and with different methods.

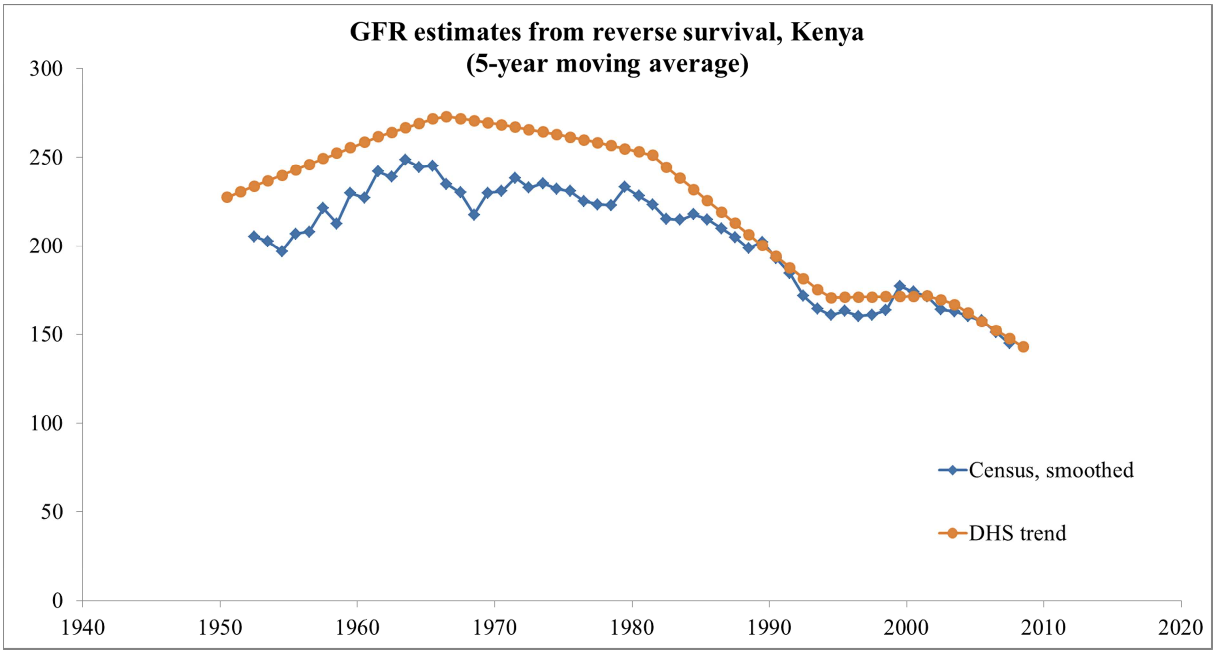
Figure 6. GFR estimates from reverse survival, Kenya



3.7 Smoothing census data

Census estimates of GFR were smoothed using a 5-year moving average. Most of the erratic patterns disappeared, and again the main trends were found consistent with the DHS trends. (Figure 7)

Figure 7: GFR estimates from reverse survival, Kenya (smoothed by 5-year moving average)



3.8 The fertility stall in Kenya

Restricting the data to the last three censuses (1989, 1999, and 2009) limits the trend analysis to the 1980-2008 period. This allows a closer look at the fertility stall. In census data, the fertility stall occurred between 1994 and 2003, within a year of the stall identified in the DHS data. The levels of the GFR before, during and after the stall were almost identical in the census data and in the DHS data. (Figure 8, Table 2) Figure 8 also displays the published values of the GFR in DHS reports, which refer only to the 3 years before each survey. Without the trend analysis, it would have been difficult to conclude to a stall, given the confidence intervals around the point-estimates, as noted earlier. [Garenne, 2011] However, the point-estimates of the GFR in the five DHS surveys appear very consistent with the trend analysis and with the census estimates for the same year, with the exception of the 1988 DHS point estimate found to be somewhat higher.

Figure 8: The fertility stall in Kenya

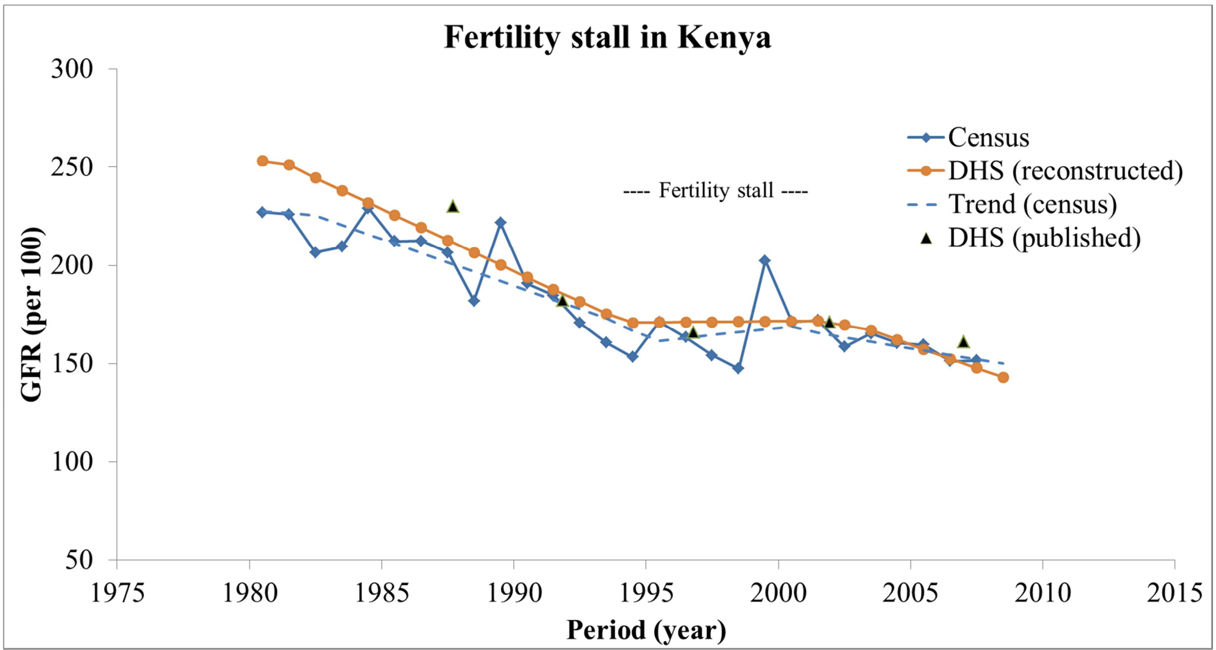


Table 2: Levels and trends in GFR from various sources at critical points

	GFR, per 1000 women 15-49		
Year	Census	DHS	UNPD
1950	204	227	229
1965	237	271	253
1994	166	171	170
2003	164	167	161
2008	138	143	155

Discussion

This analysis based on census data available in the IPUMS-international database revealed levels and trends in fertility, measured by the GFR, that were consistent with those obtained from maternity histories recorded in DHS surveys. Kenya enjoys a wealth of quality data on fertility, which validate independently the census data.

The quality of census data was not optimal, with serious problems of age misreporting, differential reporting of male and female adults, and under-reporting of infants and toddlers. Some of these problems came from the original data, others from the weights used for extrapolation in the 1969 and 1979 censuses. All these affected the yearly estimates of the GFR. However, despite the erratic patterns, significant trends could be identified, and found consistent with trends obtained from DHS data.

Some of the erratic patterns could be sorted out by smoothing the age structure by simple methods such as moving averages. More work could be done to improve the smoothing of the age structure by looking specifically into each age group and identifying the likely pattern of age biases. However, this would not sort out the issue of underreporting, especially that of young men.

Despite all the problems encountered, the census data enabled one to identify a period of fertility stall. More work could be conducted with African censuses to better document fertility trends and fertility stalls.

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