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Rising cohort fertility in sub-Saharan Africa: 1900-1950

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Abstract

Trends in cohort fertility were reconstructed from census and survey data for some 30 African countries for women born before 1950. Results show major rises in more than half of the countries, and smaller increases in the other half. Fertility increases are correlated with a marked decline in infertility in many countries, and with a moderate increase in age at first marriage in some others. Reasons for the changes in these two proximate determinants of fertility level are explored. Infertility appears correlated with the control of trypanosomiasis in some of the countries of the "infertility belt". In other countries it seems to be correlated with better standards of living. Dynamics of fertility level are discussed in light of other potential determinants, and of the colonial history of public health.

Introduction

The fertility transition, that is a change from high to low levels of fertility and natality, has drawn a lot of attention from analysts in the 20th century, because of its wide demographic and ecologic implications. Less research has been done on what was happening before the onset of fertility decline, primarily because fertility was assumed to be at steady and high "natural fertility" levels. However, natural fertility does vary greatly for a variety of reasons, both biological (infertility or low fertility due to diseases or poor nutrition) or social (late marriage, post-partum taboos, etc.). [Henry, 1961; Leridon and Menken 1979; Bongaarts and Potter, 1983; Garenne & Frisch, 1994]

The case of sub-Saharan Africa has drawn the attention of scholars already in the 1960's, when the first series of census and survey data were becoming available [Brass et al, 1968]. The data analyzed in "*The Demography of Tropical Africa*" pertain to a period before the onset of fertility decline in Africa. Demographic analysis of African data at that time focused on data quality, possible misreporting of births and deaths, and adequacy to preconceived models, in particular to stable population models. In the recent period (1990-2008), and primarily because of a new wealth of data brought by the WFS (World Fertility Survey) and the DHS (Demographic and Health Survey), the main focus has been on the emerging fertility decline, which seems to have started almost everywhere [Blacker 2007; Caldwell et al. 1992; Cleland et al. 1994; Cohen 1998; Gaisie, 1996; Gould & Brown 1996; Kirk and Pillet 1998; Garenne & Joseph, 2002, Lestaeghe & Jolly, 1995; Mbacke, 1994; Moultrie & Timaeus 2003; Ngom & Fall, 2005, Shemeikka et al. 2005; United Nations 2001]

The aim of this paper is to revisit the period before the fertility decline, and to document cases of fertility increases preceding the fertility decline, a phenomenon that remains poorly documented [Dyson & Murphy 1985 and 1986; Dyson 1988]. Indeed, sub-Saharan Africa underwent major changes since 1880, which is not only the date of the beginning of colonization but also the beginning of modern public health, and a time of major innovations in agricultural production, as well as of the spread of cash economy worldwide. In particular, the control of infectious and parasitic disease was already advanced by 1930, and continued thereafter, with major possible implications for infertility due to infectious and parasitic diseases. Similarly, the availability of more diverse foods, and the development of modern transportation for agricultural products lead to major improvements in nutrition. Last, some key behaviors with respect to fertility also changed in the first half of the 20th century, in particular age at marriage under the pressure of spreading monotheist religions.

In addition to documenting trends in fertility in the first half of the 20th century, an attempt is made to relate these changes to two of the main proximate determinants of fertility: the changes in the prevalence of infertility and the changes in age at first marriage. This study is part of a larger effort to document fertility trends in Africa in the 20th century [Garenne & Joseph, 2002; Garenne 2008].

Data and methods

Census data

The first source of data for this analysis was African censuses, where the mean number of children ever born (CEB) by 5-year age group is often reported. The CEB by age group at time of census was converted into cohort estimates of children ever born by age 40. For women aged 35-39, 40-44, 45-49, and 50+ a correction factor was applied to convert it into CEB at the age 40. These coefficients were 1.077, 0.955, 0.912, and 0.900. The estimates for each 5-year age groups were applied to a corresponding average year of birth. For instance, the CEB among women age 50-54 applied on average to a cohort born 52.5 years before the census date.

WFS/DHS data

The second source of data was the WFS/DHS surveys. In this case, only women under age 50 are included. The procedure was the same as for women under age 50 in censuses. However, here one could calculate directly the mean CEB by age 40, by removing the births that occurred beyond age 40 for the 40-49 year old women. A main advantage of WFS/DHS data is the possibility of calculating CEB by single year birth cohort, and the main shortcoming is the small sample size in each cohort. In order to compensate for small sample size, linear trends were applied to smooth out the erratic values of the point estimates. When several WFS/DHS surveys were available for the same country, they were merged together by yearly birth cohort, adding the births and the women in the surveys in order to recompute the mean number of children ever born.

WFS/DHS data also provide information on some critical proximate determinants, such as infertility and age at first marriage, as well as on numerous socio-economic correlates. In this paper we focus on infertility and age at marriage, the two leading factors of rising fertility.

Infertility

Infertility was defined as the probability of not having had any live birth by age 40. This definition differs from other definitions such as "marital infertility", or "marital sterility", that is the probability of not having any live birth within 7 years of marriage while not using contraception, used by other authors [Frank 1983; Larsen & Raggers, 2001]. It includes at the same time sterility (the biological incapacity to deliver a live birth), and cases of voluntary infertility (by abstinence or contraception); the latter however appears to be rare in Africa, at least compared with Western Europe where it can be as high as 10% to 25%. Calculations were done by yearly birth cohort, for women 35-49 at time of survey, infertility rates by age 40 being calculated directly for women age 40-49, and using a conversion factor for women age 35-39.

Age at first marriage

The median age at first marriage was calculated by yearly birth cohort, for all cohorts for which it was available in WFS/DHS surveys. Here, the median age was calculated as the age at which half of the cohort is ever married. Therefore, it differs somewhat from the formal median age which takes into account only those who ever marry, or who marry by age 50. In theory, it would have been more accurate to consider the proportion of women who were never married by age 40, but this would have led to a far more restrictive time dimension of the process. By using the median age at first marriage, which is indeed closely related with the proportion who will eventually marry, one uses the full range of information available, for some of the 25 yearly birth cohorts concerned (age 25-49 at time of survey). More details on this method can be found elsewhere [Garenne, 2004].

Multivariate analysis

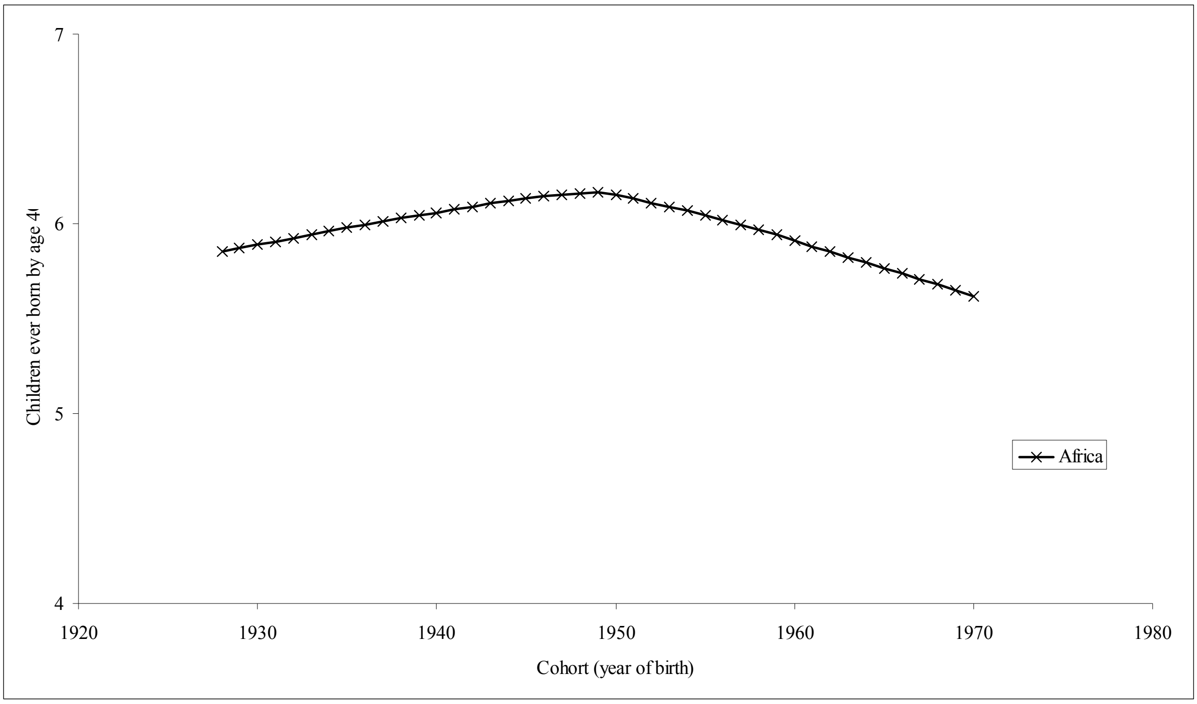
To identify the most salient factors of the cohort fertility changes, two regression models were built. The first links the fertility level with the levels of the explanatory variables. The second model links the changes in cohort or period fertility with the changes in proximate determinants after fitting the trends in the dependent and independent variables. Both were simple linear regression models, fitted with ordinary least square. Note that the second model has a typical longitudinal approach, therefore its results differ markedly from cross-sectional models, which are the most widely used in demography. All regression analyses were done using the statistical package SPSS-11.

Results

Trends in cohort fertility

The reconstruction of cohort fertility trends from WFS/DHS data indicate an increase followed by a decline in cohort fertility, measured by the cumulated family size by age 40: CFS(40), with a maximum around cohort 1950. For the average of the selected countries, the estimated level rose from 5.9 children for women born in 1930 to 6.2 children for women born in 1950, then declined to 5.6 children for women born in 1970 (Figure 1).

Figure 1. Reconstructed trends in cohort fertility, 31 African countries



These are small changes for the continent as a whole, hiding larger or divergent changes in some of the countries. For instance, in some countries the fertility increase from the 1930 cohort to the 1950 cohort exceeded one child: Benin (+1.23), Cameroon (+1.19), Chad (+1.31), Namibia (+1.26). For some other countries changes were of smaller magnitude, while in others, the same cohorts underwent a fertility decline: Ghana (-0.36), Kenya (-0.36), Malawi (-0.48), Rwanda (-0.62), Togo (-0.68).

The 1930-1970 cohorts were those covered by the WFS/DHS surveys, so that trends prior to 1930 were not documented. However, they could be compared with census data on the mean number of children ever born, classified by birth cohort. In countries with low numbers of children ever born, which were also the countries with high levels of infertility, many of the changes occurred prior to the 1930 cohort. Trends in cohort fertility documented in the WFS/DHS surveys were compatible with trends in census and survey data in most cases, which cross-validates both sources. Major increases in children ever born were seen in various parts of Africa: in the infertility belt (Central African Republic, Congo, Gabon), in the Sahelian areas (Chad, Niger), in Coastal West Africa (Liberia), in Eastern Africa (Mozambique, Zambia,) and in the islands (Comoros, Madagascar). In a few countries, the increase in cohort fertility was very small and hardly significant: Burundi, Ghana, Guinea, Lesotho, Malawi, and Rwanda. Despite some erratic patterns in the census data, no evidence was found of a major incompatibility in trends between census and survey data and WFS/DHS data.

Trends in infertility

Major changes in infertility occurred in sub-Saharan Africa in the first part of the 20th century. The reconstruction from WFS/DHS data indicate a drop in the proportion of infertile women from 8.1% among women born in 1930 to 3.1% among women born in 1957-1958, followed by a small rise for cohorts who had not yet reached age 40 at the last survey (Figure 2). Despite the overall decline in infertility for the earlier cohorts, there were major differences between countries. Major drops in absolute value occurred in the countries mostly affected by infertility in the early part of the 20th century: Cameroon (-10.1%), Central African Republic (-10.9%), Congo (-8.1%), Gabon (-6.3%), Mozambique (-8.8%), Niger (-5.5%), Tanzania (-13.7%).

Increases in infertility in the later period occurred in some of the "infertility belt" areas (Congo, Mozambique), in the late marriage areas (Lesotho, Namibia, South Africa), as well as in a variety of countries (Ethiopia, Ghana, Mali, Rwanda, Senegal and Tanzania). These recent increases deserve a separate study, and are beyond the scope of this paper.

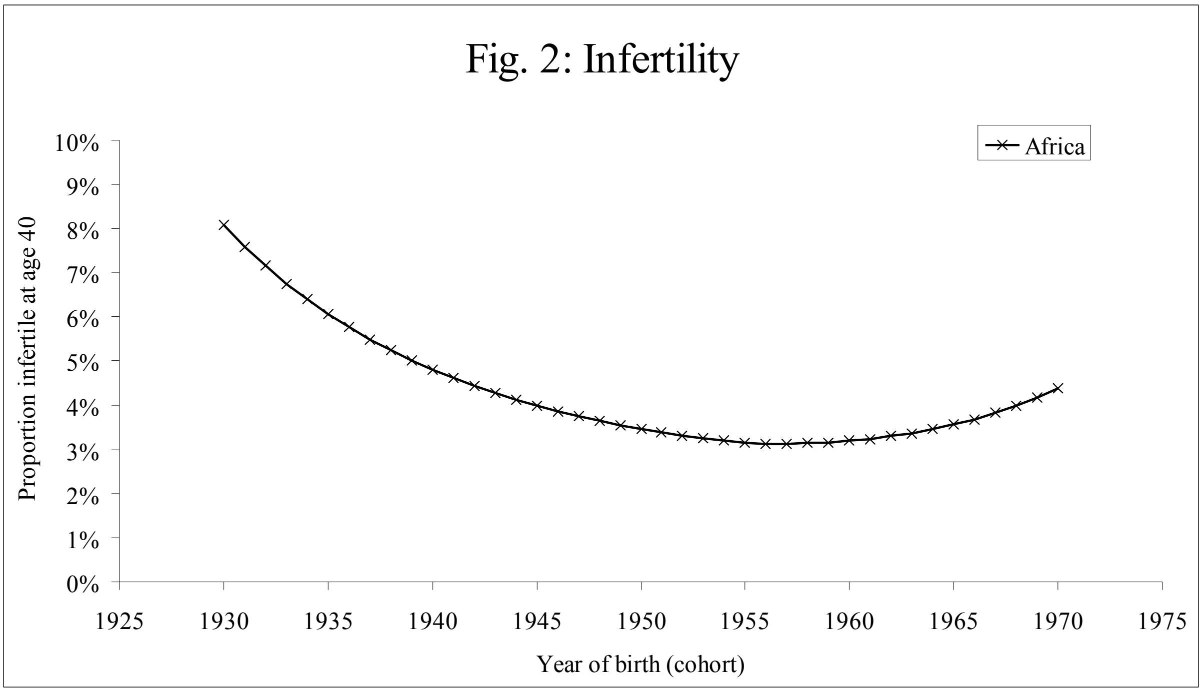
Observed at the level of the continent, the changes in infertility could by themselves explain the rise in cohort fertility. The formula linking the two variables can be derived from basic equations, assuming no change in fertility level for non sterile women:

$$\Delta Log(CFS) = \Delta Log(1 - p_0)$$

where p_0 designates the proportion infertile, and CFS the complete family size.

In this analysis the relative change in CFS was 0.044 and the relative change in proportion fertile was 0.049, values that are highly compatible. However, it should be noted that this would not apply to many of the countries, in particular those experiencing an early fertility decline. Indeed, from WFS/DHS data, the decline in infertility could explain the fertility decline in only seven of the countries investigated. The complex relationship between the decline in infertility and the rise in cohort fertility should be analyzed carefully country by country, taking into account confounding factors, and possibly erratic data.

Figure 2: Trends in infertility, 31 sub-Saharan African countries



Source: WFS/DHS data

<u>Infertility in WFS/DHS surveys and in Censuses</u>

The proportion of infertile women in WFS/DHS surveys was compared with census data on children ever born, using the proportion of women age 35 years and above who never had any live birth, classified by birth cohort. The comparison was done for the comparable cohorts, covered both by the censuses and by the WFS/DHS surveys in the same country. On the average for the 15 countries for which the comparison could be done, the infertility rate measured by WFS/DHS surveys tended to be about half of that estimated in censuses (3.3% versus 6.5%). In all 15 countries for which the comparison could be done, the WFS/DHS estimates were always lower, with a range of the risk ratio (Census/Survey) from 1.4 to 2.8. There are numerous reasons for which these estimates could differ. WFS/DHS surveys typically focus on regular households in which lives a woman in her fertile ages, whereas censuses aim at covering the whole population. Even ignoring institutions, infertile women could live in different types of household, or could avoid answering the fieldworkers for a DHS survey. Censuses could also over-estimate infertility because of poorer reporting to the question on children ever born compared with a full scale maternity history. Last, coding of infertile women might be a problem in some censuses when confused with “no answer”. This is why the study of infertility trends using census data to extrapolate our findings to earlier cohorts was not pursued any further.

However, the trends in infertility were similar in WFS/DHS surveys and in Census data. The most striking cases of a strong decline in infertility were those of central Africa: Congo, Cameroon, Central African Republic, Gabon, and Zambia, and two countries in Sahelian areas (Burkina Faso and Chad).

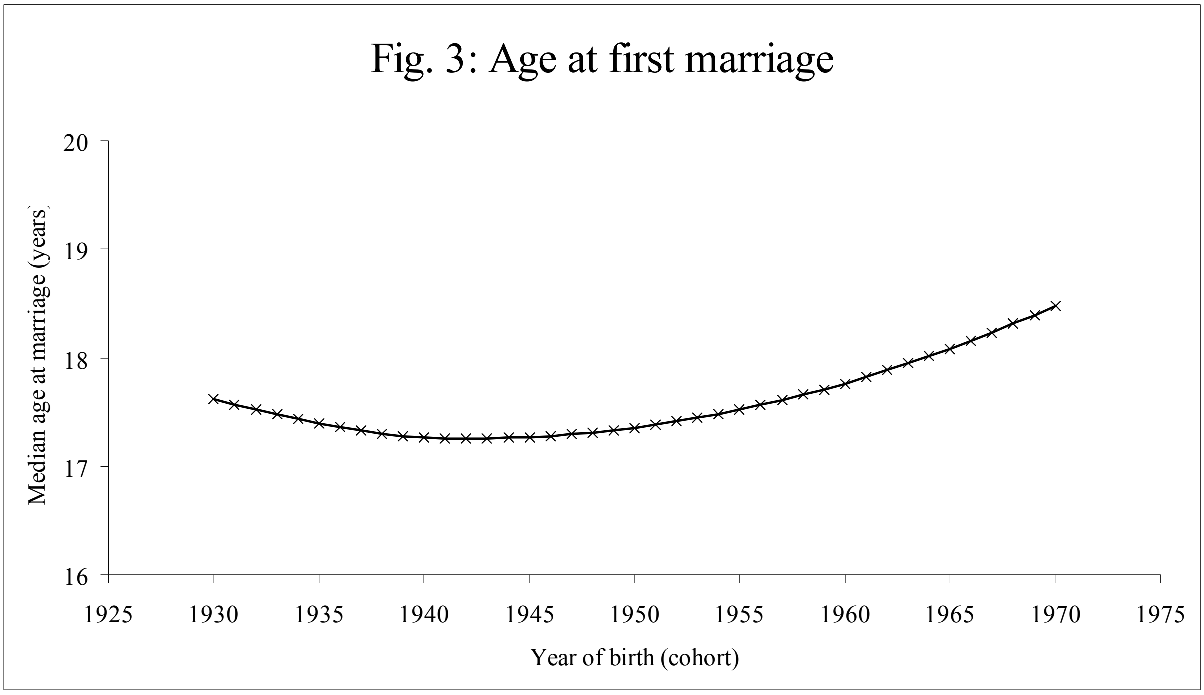
Level of infertility and family size

There was a negative correlation between level of infertility and family size at baseline (1930 cohort). When infertility exceeded 8%, CFS-40 was lower than 6.2 children, and when fertility was high (> 6.2), infertility was lower than 8%. However, there were also cases of countries with low family size (< 5 children) despite moderate levels of infertility (<6%), which were all in Southern Africa: Namibia, Botswana, South Africa and Lesotho, indicating that other factors were playing a role, and in particular late marriage.

Trends in age at marriage

The median age at first marriage also underwent changes over time, as well as the proportion of women who eventually marry. Reconstructed cohort trends from WFS/DHS data show a decline in median age at first marriage, from 17.6 years (1930 birth cohort) to 17.2 years (1942 birth cohort), followed by a rise to 18.5 years (1970 birth cohort) (Figure 3). Changes were remarkable in some of the countries, either ups or downs, and have been documented elsewhere [Garenne, 2004]. Trends in age at marriage were therefore compatible with the trends in cohort fertility for the continent as a whole, however this was not true for many of the countries investigated.

Figure 3: Reconstructed trends in age at first marriage, 31 African countries



Net effects of proximate determinants

To evaluate the net effects of proximate determinants, a regression model was run linking cohort fertility with the three determinants for which the full information was available (infertility, age at marriage and contraceptive use). Results show a low explanatory power of these determinants (Table 1).

Table 1: Net effect of proximate determinants of cohort fertility in linear regression Africa, 1930-1970 cohorts.

Variable	Beta Coefficient	Standard Error	T-test	P-value	Signif.	Net effect
Constant	10.8988	0.0873	124.85	0.0000	*	
Prop. Infertile	-1.7832	0.1332	-13.39	0.0000	*	+0.026
Age at marriage	-0.2428	0.0048	-50.76	0.0000	*	+0.099
Contraceptive use	-1.7661	0.0158	-111.86	0.0000	*	-0.222

If all the variables are significant and have the expected sign, they can account only for a small part of the changes. In this model, only contraceptive use appears to play an important role, with a net effect of -0.222 children for one standard deviation. The role of infertility appears underestimated by this procedure, probably because of the very high heterogeneity among the countries. Of course, infertility remains the obvious factor of low parity in many countries of the "infertility belt".

Accounting for the cohort fertility increase

In order to better account for the cohort fertility increase in some countries, trends were used for calculating changes in fertility in relation with changes in explanatory variables between the 1930 birth cohort and the cohort of peak fertility, which varied from country to country. Of course, only the countries in which cohort fertility increased were kept for this analysis, and the potential explanatory factors were the same as above.

A simple linear regression model was used to match the changes in fertility with the changes in the explanatory variables. The model revealed two basic factors explaining the rise in fertility: the decline in infertility (explaining 47% of the fertility increase), and the change in religious affiliation, namely the increase in proportion Christian (20%) and in proportion Muslim (22%). These changes in religious affiliation seem to be associated with earlier marriage and therefore higher fertility in the first part of the 20th century. Note that their effect changed later, and after 1950, affiliation with monotheist religions seemed more associated with increasing urbanization and education. Of course these average numbers should be considered with caution, and hide major differences by country, some in which all changes are explained by infertility, others in which social factors seem to have played the leading role.

The fertility increase before 1950 appears therefore to be due primarily to health factors largely independent from socioeconomic variables, and above all, primary infertility. If most cases of high levels of sterility were due to infectious and parasitic diseases (in particular trypanosomiasis and certain sexually transmitted diseases), trends in infertility had their own dynamics, and were the product of health policies and programs, largely independent from social dynamics [McFalls and McFalls, 1984].

Discussion

In this study, the main focus was on the evidence of rising fertility in many countries of sub-Saharan Africa for women born before 1950, and the consistency between census and WFS/DHS survey data. In most cases, the consistency was good, and both census data and WFS/DHS survey data indicated either a rise in fertility, or a steady fertility level. In a few cases, the census data were erratic or inconsistent. This could come from poor quality of the data collected in the field, but also of a poor coding of the unknown category, that this the women for who no answer was recorded, who could be either infertile women or women who were not interviewed. Coding these categories improperly is likely to have a major effect on mean number of children ever born.

For countries which underwent a rise in fertility, the main reason seems to be a corresponding decline in infertility (primary sterility). The early surveys conducted in Gabon and Congo clearly indicated large proportions of infertile women, which could be as high as 35% for women born in 1920-1924. Census data clearly indicate a regular decline in proportion infertile for later cohorts, with a low value of 3% for women born in 1960-1964. Of interest is that the proportion of infertile women rose for the cohorts 1980 (about 20%) to 1920 (about 35%). This outstanding pattern of infertility could be explained by a tropical disease. Trypanosomiasis is a disease which is not only very lethal, but also induces female sterility. During the first period of colonization, (1880-1920), there was clear evidence of expansion of trypanosomiasis, whereas in the next forty years (1920-1960), trypanosomiasis was brought under control (Mulligan & Potts, 1970). The pattern of change of female infertility matches almost exactly the pattern of spread and control of the disease, so that it is very tempting to conclude to the effect of sleeping sickness. If the geographical correspondence between trypanosomiasis and high levels of infertility has already been noted, the temporal correspondence has been poorly analyzed so far and deserves further attention. (Ikede, 1974).

Another cause of declining infertility has been the control of sexually transmitted infections, many of which are known to lead to infertility. Control of syphilis started early in colonial Africa, and continued after 1950 with the arrival of antibiotics. Some authors have argued that this was the leading cause of declining infertility in Africa, however it is unlikely to explain the large changes seen before 1950, that is for women born around 1920 [Retel-Laurentin, 1974].

Declining age at marriage for cohorts born 1950 has been poorly documented so far. It was argued that this is probably an effect of spreading Christian and Islamic religions [Garenne, 2004]. This however requires further research.

This analysis has consequences for demographic analysis. In particular, the P/F ratio adjustment technique, widely used in Africa, is based on the hypothesis of constant fertility. However, in case of rising fertility as well as in case of declining fertility, it is unlikely to apply, and could lead to inappropriate estimates.

Much remains to be analyzed on the fertility situation in African countries before 1950. Even if the data are not perfect, they can be analyzed in greater details. Pockets of infertility could be better documented, not only at national levels, but also at regional levels, which is sometimes possible when census reports provide a breakdown of the number of children ever born by administrative divisions. This could permit a finer analysis of what happened in the first half of the 20th century, and in particular on the effect of the control of infectious diseases.

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