Levels and Patterns of Male Fertility in Sub-Saharan Africa

What can we learn from the Demographic and Health Surveys?

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1. Introduction

Male fertility has been neglected in demographic research (Coleman, 2000; Greene and Biddlecom, 2000; Zhang, 2011). Although the role of men in fertility decisions has received increased attention since the 1990s (DeRose, and Ezeh, 2005; Greene and Biddlecom, 2000; Zulu, 1997), the patterns, levels, changes and determinants of male fertility have remained an understudied research area (Zhang, 2011). Reasons for the lack of studies include the lack of data, data quality issues, the larger and less clearly defined age range of reproduction among males (Estee, 2004; Greene and Biddlecom, 2000; Paget and Timæus, 1994; Ratcliffe et al., 2000; Zhang, 2011). Yet, measuring male fertility is important in several respects. Given the key aspect of reproduction in people's lives and in human societies, the knowledge of even simple facts about male fertility is part of the broader knowledge of human populations. The analysis of male fertility can complement the analysis of female fertility, and their determinants may differ (Zhang, 2011). Finally, analyzing male fertility is also justified on methodological grounds. For instance, age-specific male fertility rates are useful in indirect estimates of male adult mortality with orphanhood data (Paget and Timaeus, 1994; Masquelier, 2010).

Despite the relative lack of research, empirical evidence on patterns and levels of male fertility was produced in a variety of contexts (Zhang, 2011; Estee, 2004; Brouard, 1977; Lognard, 2010). From these studies, it is well established that the age pattern of male fertility is different from that of females: the curves of age-specific fertility rates look similar, but the age span is larger among males, and the rates are typically lower at young ages and higher at higher ages among males (Brouard, 1977; Donadjé, 1992; Lognard, 2010; Paget and Timaeus, 1994; Pison, 1986; Zhang, 2011). The intensity of fertility also varies across gender. In monogamous settings, total fertility rates among males and females tend to be close to each other, but differences in age at childbearing and differences in mortality explain that total fertility rates are often higher among males (Estee, 2004; Zhang, 2011). In specific circumstances affecting gender balance (e.g. wars, high male or female migration), total fertility rates may be very different between males and females (Brouard, 1977). In polygynous societies, as in many sub-Saharan African countries, total fertility rates tend to be much higher among males than among females (Pison, 1986; Donadjé, 1992; Ratcliffe et al, 2000). Pison (1986) found a total fertility rate of 11.2 children among male Bande Fulani in Senegal (6.7 among females)

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and Ratcliffe et al. (2000) found a TFR of 12.0 in Rural Gambia (6.8 among females). Although some studies on male fertility have been done in sub-Saharan Africa, most have been conducted at the local level (Pison, 1986; Ratcliffe et al., 2000) or at the sub-national level (Donadjé, 1992). In Zhang's analysis of male fertility levels across 43 countries (Zhang, 2011), only one (very specific) country from sub-Saharan Africa was included (Mauritius).

Data on male fertility sub-Saharan Africa has been largely untapped. Approximately 100 men's surveys have been conducted in sub-Saharan Africa as part of the DHS program (www.measuredhs.com), many of them with some questions on male fertility[2]. Household questionnaires also contain valuable data for measuring male fertility. To my knowledge, only a handful of studies have used data on male fertility in DHS (Blanc and Gage, 2000; Ezeh, Serroussi and Raggers, 1996; Johnson and Gu, 2009; Macro international, 1997), and none of these have computed fertility rates. They either report mean number of children ever born (or living children) by age, or distributions of males by number of children ever born. Even if the data available on males are much less detailed than data from women's birth histories (Blanc and Gage, 2000), it potentially allows measuring levels and patterns of male fertility in a large number of countries.

This paper is mainly methodological and descriptive. Its objectives are:

(1) To evaluate to what extent - and with which methods - the DHS data in sub-Saharan Africa can be used to measure levels and patterns of male fertility.
(2) To provide a broad overview of male fertility levels and patterns in Sub-Saharan Africa.

First, I present the type of data on male fertility collected in DHS in sub-Saharan Africa, and I discuss three methods (two indirect methods and one direct method) that can be used to compute period age-specific fertility rates with these data. In the next section, the three methods are compared among males in four sub-Saharan African countries, and are also compared to direct estimates among females. In the third part of the paper, the selected method (the own children method) is used to compute age-specific male fertility rates in about thirty sub-Saharan African countries. As expected, male fertility is higher and later than female fertility, and is also very diverse. Four patterns of male fertility are found, and are related to the prevalence of polygyny and to the levels of female fertility.

2. Data & Methods

The data come from the Demographic and Health surveys conducted in sub-Saharan Africa (www.measurehs.com). Three types of data available in DHS can be used to measure period male age-specific fertility rates. They come either from the men's survey or from the household survey.

- Date of birth of the last child (men's survey)

[2] Excluding AIS and KAP surveys, 86 men's surveys were conducted as part of Standard DHS.

- Number of children ever born (men's survey)
- Listing of children in the household, and father's line number (household survey).

These data and how they can be used to compute recent fertility and fertility trends are described below. The three methods have – to our knowledge – only been used to estimate female fertility. Applying these methods to male fertility necessitates addressing specific issues.

2.1. Date of last birth (DLB)

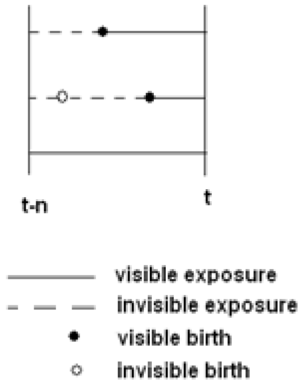
The date of last birth was collected in about a quarter of men's surveys in sub-Saharan Africa. It was frequently collected in the late 1990s, but was collected in a limited number of surveys in the 2000s. In some cases, only the year of the last birth was recorded, while in others, both the month and year of the most recent birth were collected. In a few countries (e.g. Burkina Faso), this question was asked in several consecutive surveys.

Two approaches can be used to compute fertility rates from last birth data (Schmertmann, 1999). The traditional approach consists in transforming the time since last birth into a binary variable indicating whether a birth occurred in the last year or not. As discussed by Schmertmann (1999), this approach discards useful information about births and exposure in earlier years, and unnecessarily limits the number of years of exposure for the computation of rates. The second approach uses the principle of backward recurrence times (Allison, 1985) to compute fertility rates from *visible birth histories* (Schmertmann, 1999). Visible birth histories are histories starting from the date of last birth until the time of the survey. Under the assumption that the fertility rates are constant within age groups over a defined period of time (e.g. 3 years), fertility rates are computed as the ratio of the number of visible births (last births) in an age group in that period and visible exposure in that age group in that period (Schmertmann, 1999).

$$\lambda_i = \frac{number\ of\ visible\ births\ in\ age\ group\ j}{visible\ exposure\ in\ age\ group\ j} \qquad \text{(Eq. 1)}$$

Visible exposure (denominator) in each age group is measured as the sum of the duration (for each woman) spent in the age group between the date of the survey and the date of last birth, or the date of the start of the period if no birth occurred in the period (Schmertmann, 1999). Visible exposure is represented by continuous lines on Figure 1. The number of visible births (numerator) is the number of last births that occurred during that period (black dots on Figure 1).

Figure 1 : Illustration of visible and invisible exposure, and visible and invisible births with data on data of last birth (adapted from Schmertmann, 1999).



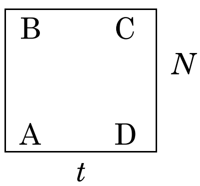
When the dates of last births are collected in month and year, the computation of exposure is straightforward. When only the year of the last birth is available, the month of birth is imputed using a uniform distribution. When this information is available in two or more surveys, fertility trends can also be measured.

2.2 Children ever born and the crisscross method (CC)

Data on the number of children ever born has been collected in approximately two thirds of men's surveys in sub-Saharan Africa. In early men's surveys, data were collected on the number of living children, but since the mid-1990s, the question refers to the number of children ever born. Although this type of data is rather crude and refers to cohort fertility, period age-specific fertility rates can be computed in a simple way when two surveys are available.

The idea to compute age-specific fertility rates from the comparisons of average parity by age in two surveys or censuses was developed by Coale et *al.* (1985). Schmertmann (2002) simplified the method, and showed that age-specific fertility rates could be estimated from such data with a simple formula (that he coined 'crisscross'). The fertility rate (λ) between two exact ages (x and x+n) over a period of any length t (not necessarily five years), illustrated on Figure 1, is estimated using Eq. 2.

Figure 2 : Illustration of Lexis diagram and formula for estimating fertility rates with the crisscross approach (adapted from Schmertmann, 2002).



$$\lambda = \left(\frac{1}{2n} + \frac{1}{2t}\right).(C - A) + \left(\frac{1}{2n} - \frac{1}{2t}\right).(B - D) \qquad \text{(Eq. 2)}$$

Where A, B, C and D are the mean number of children ever born at exact ages and dates defined by the corners of the Lexis diagram[3], t is the time interval between the two surveys, and n is the width of the age group. Although this is illustrated by a square on Figure 2, t and n need not be equal. When three or more surveys are available, the method can potentially be used to measure fertility trends.

2.3 Household data and own children method (OC)

Data collected in the household roster of Demographic and Health Surveys can also be used to estimate male fertility with the own children method (Cho, 1973; Cho, Retherford and Choe, 1986; United Nations, 1983). Although the own children method has, to my knowledge, only be used to estimate female fertility, it can be adapted to male fertility.

The general idea of the standard own children method is (1) to link the surviving children with their mother, (2) to classify the children by single year of age and single year of age of mother, (3) to reverse-project the children in order to estimate the number of births by year, and (4) to reverse-project the female population in the years preceding the survey to estimate the denominator of the rates. A critical step in the own children method is to link the children and their mothers. For children living with their mothers, this is straightforward with DHS data because the line number of the mother (and father) of each surviving child is available since the 1990s. Unmatched children (whose mother died or who do not live with their mothers) need to be redistributed by (estimated) age of the mother (United Nations, 1983). Two other essential steps are the estimation of the survival probabilities to reverse-project children and females. Indirect estimates of mortality and model life tables are generally used. Despite the fact that several assumptions are needed for unmatched children and reverse projections, research in a variety of contexts has shown that the own children method performs well (Avery et al. 2013; Cho, Retherford and Choe, 1986). Avery et al. (2013) have even suggested that the own children estimates may be better than direct estimates from birth histories[4].

The detailed exposition of the standard own children method is available in several books (Cho, Retherford and Choe, 1986; United Nations, 1983). In this paper, I present the way the method is adapted and implemented for estimating male fertility. Some of the changes to the original method are related to the fact that I work on male fertility, some others are more general and could also be used for female fertility. The general idea of the adapted method is to recreate data that are similar to birth history data[5]. The data are available at all stages as an individual data file. The final data set is a sample of adult males, to which surviving children have been linked.

The following steps are used.

[3] The number of children ever born at exact ages is estimated by smoothing the series of mean CEB by completed age. In this paper, restricted cubic splines are used..

[4] Their point is that the direct estimates may be overestimated because of a selection bias (the women interviewed for the birth histories have a higher fertility than others).

[5] See Luther and Cho (1988) for a similar idea among females.

1) Dropping children whose father is not alive

The logic of the approach is to keep only the children that could have been declared in a birth history, had the data been collected through birth history among males. These children are those whose father is still alive. In contrast, I keep children whose father's survival status is unknown.

2) Matching children and their fathers

As mentioned before, a critical step in the own children method is to link the children to their mother or father. As for mothers, matching children with their fathers when they live in the same household is straightforward in most DHS, given that the line number of the father is available for children whose father lives in the same household. When a child is matched to his/her father, the age of the father is known. However, the percentage of unmatched children is usually quite high. In the countries of Table 1, between 11% (Burkina Faso) and 40% (Zimbabwe) of the children do not live in the same household as their fathers, and can thus not be matched with their fathers. The number of children whose father is not alive is usually much lower (around 2%, except in countries very much affected by HIV AIDS). As explained before, the children whose father is not alive are dropped. Unknown survival status is also usually low, but above 2% in a few countries (the same countries where mortality is high).

Table 1. Percent distribution of surviving children (aged 0-4) by status of father in selected surveys (unweighted)

	Status of father				
	Not alive	Unknown survival status	Alive not in the household	Alive in the household	Total
Zimbabwe 2010-2011	4.9%	2.3%	40.0%	52.8%	100.0%
Niger 2006	1.8%	0.0%	22.6%	75.6%	100.0%
Senegal 2010-2011	1.6%	0.0%	35.3%	63.1%	100.0%
Rwanda 2010	2.2%	0.8%	23.9%	73.0%	100.0%
Lesotho 2009	9.1%	4.7%	30.6%	55.6%	100.0%
Ethiopia 2010	2.3%	0.1%	17.7%	79.9%	100.0%
Burkina Faso 2010	1.3%	0.0%	11.3%	87.4%	100.0%
Cameroon 2011	2.2%	0.4%	31.4%	66.0%	100.0%

In the standard own children approach, unmatched children by age (U_x) are redistributed by age of mother (U_{xa}) using the same distribution by age of the mother as among matched children.

$$U_x^a = U_x \cdot \frac{C_x^a}{\sum_{a=15}^{a=49} C_x^a}$$

C_{xa} is the number of (matched) children by age (x) and age of mother (a). This number divided by the total number of children aged x provides the proportion of children aged x by age of mother a, among all children aged x. Applying this proportion to the number of unmatched children aged x gives the distribution of unmatched children aged x (U_x) by age of mother a (U_x^a). Although this is usually viewed as a reasonable assumption among females, it is less the case among males. First, the percentage of unmatched children among males is much higher than among females. As a result, if the distribution by age of father of unmatched children is different from the distribution of matched children (for children of the same age x), the impact on rates will be greater than among females. In addition, the age distribution of father is potentially much larger than the age distribution of mothers. The differences between matched and unmatched children are thus also potentially larger. A specific treatment is thus required.

In this paper, I conceptualize this issue as a missing value problem: the age of the father is unknown for unmatched children. A natural solution to missing values is to use imputation methods (Allison, 2001). I use random imputation to estimate father's age, based on the age of the child and the age of the mother[6]. A truncated regression model is used. The principle is to regress the age of father on the age of the mother and the age of the child, and to predict the missing values of age of father by taking a random value from the residual distribution of the dependent variable, and adding it to the predicted value of age at father from the regression model (Allison, 1999)[7]. Age of the mother may itself be missing, even though missing values are much less frequent (around 10%). In such cases, age of mother at birth is imputed first[8], using random hot deck imputation based of the age of the child and the place of residence. Age of the mother at the survey is computed as the sum of age of mother at birth and age of the child. The imputed value of mother's age is used to impute father's age when both ages are missing. Using this imputation method, the distribution of imputed age of fathers differ from the distribution among children whose father's age is known.

3) Randomly attributing unmatched children (whose father is alive) to a male

The next step is to "find a father" for unmatched children, who has the same age as the imputed age of the father. To do this, I randomly select a father among all the males available in the household data set (whether they are already father or not) of the same age as the imputed age of the father. This approach assumes that the fathers of unmatched children are all living in the population covered by the survey, i.e. the fathers do not live abroad. This assumption could be relaxed, for instance by creating additional males to which children could be matched, and removing them and the children matched to these males from the data. If a substantial percentage of males live abroad without their children, the denominator (fathers) is underestimated, and rates will be overestimated.

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[6] Random imputation of father's age solely based on the child's age is similar in spirit to considering that the age distribution of the fathers among matched and unmatched children are equal. In contrast, taking into account mother's age allows improving the imputation. Other information could potentially be included (e.g. place of residence, household structure) but have not been used in this paper.

[7] Random hot deck imputation cannot be used in this case because some cells of the table by age of mother and age of father are empty. For this reason, age of father is estimated using a regression model, considering a linear relationship between age of father and age of mother and age of child.

[8] Instead of imputing age at the date of the survey, I impute age at birth of the child, in order to facilitate constraining age at birth to be within specified boundaries. Age at the time of the survey is derived from age at birth and age of the child.

4) Retro-projection of surviving children

Only surviving children are listed in the household data. Surviving children of completed age x must be retro-projected to estimate the number of births x years before the survey. In the typical applications of the own children method, model life tables are used, because direct estimates of child mortality are not available. In this context however, direct estimates of survival probabilities can be computed from female birth histories. These estimates are used to retro-project births. The final individual data set is available in the following format. The first male (1 5), aged 40, had 5 children, aged 1, 4, 5, 6, 7 and 9 years old. These are surviving children only. To estimate births, each child aged x is weighted by the inverse of the survival probability to age x[9].

Figure 3 : Illustration of individual data file for the adapted own children method.

Male_id	Male_age	Age_at_birth	ch_age	inv_surv
1 5	40	39	1	1.084192
1 5	40	36	4	1.140393
1 5	40	35	5	1.132711
1 5	40	34	6	1.181364
1 5	40	33	7	1.15425
1 5	40	31	9	1.188
1 6	33	33	0	1.037027
1 7	28	.	.	.
1 8	24	.	.	.

Male_id : identification of male
Male_age: male completed age at the date of the survey
Age_at_birth : age of the father at birth of child
Ch_age: child's completed age at the time of the survey
Inv_surv: inverse of survival probability of child to completed age.

5) Table of birth and exposure

The next step consists in transforming the individual data file into a table of births and exposure, from which rates are computed. Exposure is computed as the sum of the time spent by the males in each age group over the last 5 years. The total number of births in each age groups is obtained as the weighted (by the inverse of the survival probability) sum of births by age group at the father at the birth of the child. Births are the weighted sum The method is similar to the one described in Schoumaker (2012). The file is first transformed into a person period data file, and the data is then aggregated by age groups.

The method is used to compute age-specific fertility rates for a recent period (5 years). Fertility trends can be computed from several consecutive surveys, and could also be estimated from a single survey over the last 15 years (Cho, Retherford and Choe, 1986).

2.4 Potential strengths and weaknesses of the three methods

Table 2 tentatively summarizes the main advantages and limitations of each method and of the data that are used. These data suffer from several potential problems, some of

[9] This contrasts with the method of Luther and Cho (1988), which consists in inserting additional (deceased) children in the dataset.

them specific to males, and some more general. As with most data on births/children, some births/children may be omitted. Births may be omitted if the child deceased shortly after its birth; children not living with their fathers may also be omitted. Some births may be also displaced (or children older than they are), which may lead to underestimating fertility.

Table 2. Comparisons of three methods for computing male age-specific fertility rates.

	Date of last birth	Crisscross	Own children
Availability of data	Limited, not available in most recent DHS. Age range is limited (usually 15-59)	Limited. Two surveys with similar questions needed. Age range is limited (usually 15-54)	Widely available (virtually all DHS since the 1990s) Whole age range available
Assumptions	Assumption of constant rate		No migration
Complexity of computation	Straightforward	Relatively direct	More complex
Data quality issues	Sensitive to accuracy of date of last birth. Some births may not be known to fathers (omissions).	Sensitive to differential omissions across surveys.	Possibly sensitive to high levels of out migration of fathers. Possible impact of imputation of age of father. Possibly sensitive to omissions and displacements of children.

3. Comparisons of methods

In this section, I evaluate how the three methods perform for measuring recent fertility, in four countries where data allow comparisons[10]. In addition, the three methods are also compared among females in the same four countries, in which direct estimates of fertility rates can be computed with birth histories.

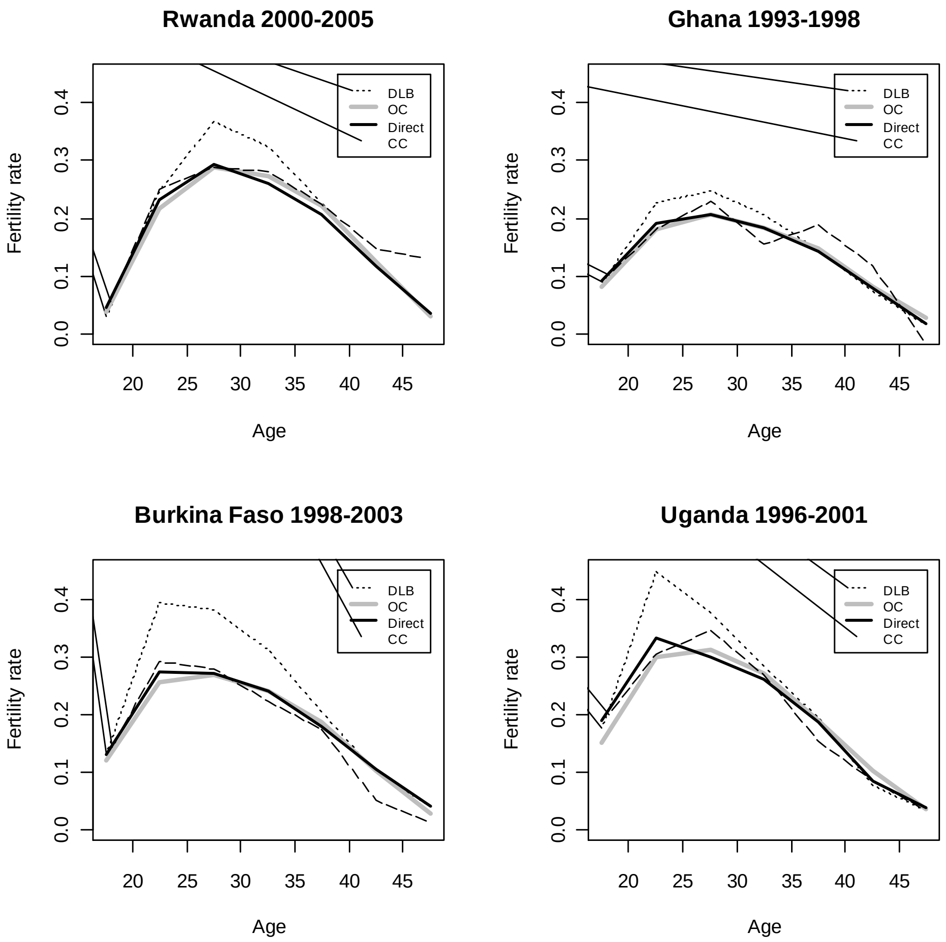
3.1 Levels and age patterns of fertility among females

Figure 4 shows age-specific fertility rates among females estimated with four methods. The direct method (birth history data) and the own children method (OC) provide very close estimates, echoing results from previous research. The crisscross (CC) method also seems to perform relatively well, even though the rates are more volatile than direct estimates and own children estimates. Given that the crisscross method relies on CEB in successive surveys, results are sensitive to differential quality across surveys. Finally, the estimates obtained with the date of last birth (DLB) are much higher than estimates with other methods in the four countries. In summary, the estimates of the own children

[10] Methods could be compared pairwise in an additional number of countries, and – among females – in all the countries. This is not yet available.

method are closest to the direct estimates, and the date of last birth method is – in these four countries - the least satisfying.

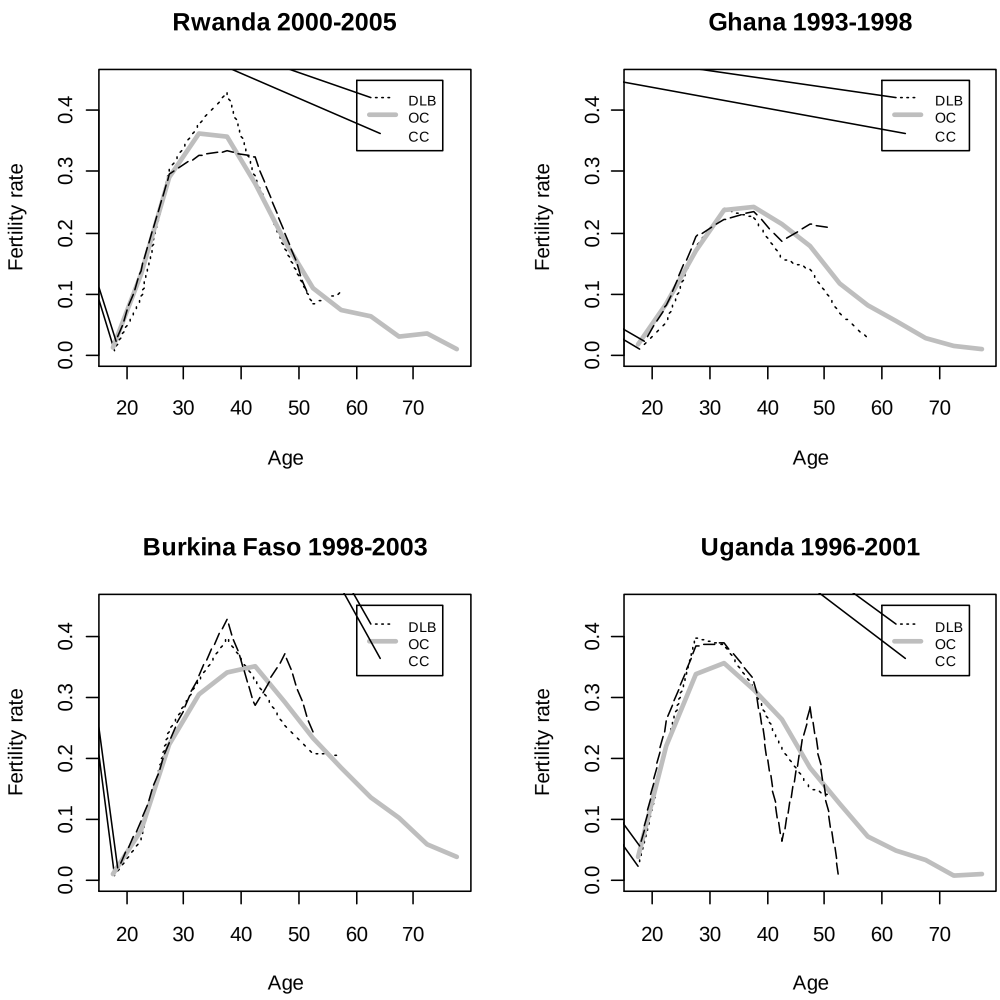
Figure 4 : Age-specific female fertility rates estimated with four methods in four sub-Saharan African countries (data source: DHS women's surveys and household surveys)



3.2 Levels and age patterns of fertility among males

Male age-specific fertility rates among males are estimated with three methods in the same four countries (Figure 5). Figure 6 also compares male TFRs (15-54) computed with the three methods in the four countries. Except in Ghana, where the DLB method is clearly below the other methods, the estimates from the three methods are surprisingly close to each other. Figure 5 also indicates a relatively good consistency between methods (except erratic values for the CC method). The own children method has the most regular curve, and also covers the largest age range. In contrast, the crisscross method may behave erratically (especially in Uganda and Burkina Faso), probably reflecting differential data quality across surveys. The date of last birth estimates are not very different from the own children estimates. Contrary to what is observed among women, the DLB estimates are not higher than other estimates among males. This may result from a mixture of overestimation (as among females), and underestimation due to the fact that males may not be aware of some of their children.

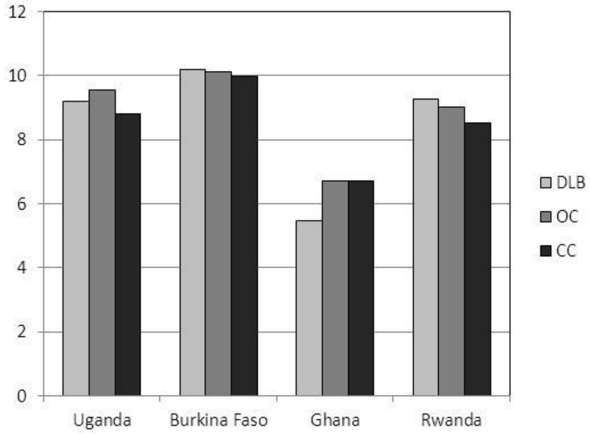
Figure 5 : Age-specific male fertility rates estimated with three methods in four sub-Saharan African countries (data source: DHS men's surveys and household surveys)



CC: Crisscross; DLB : Date of last birth; OC : Own children

All in all, these results suggest that the male TFRs are measured with reasonable precision with the three methods, and that at least two methods (OC and DLB) provide plausible estimates of age-specific male fertility rates. Given the various advantages of the OC method (wide availability of data, large age range, regular curves, high consistency among females), the method is used for describing levels and patterns of male fertility. An additional possible advantage of the own children method is that the children are reported regardless the father is aware of his/her birth. In contrast, the other two methods rely on the males' declarations.

Figure 6 : Total fertility rates (15-54) estimated with three methods in four sub-Saharan African countries (data source: DHS men's surveys and household surveys)



DLB : Date of last birth; CC: Crisscross; OC : Own children

4. Male fertility in sub-Saharan Africa

In this section, I apply the own children method to compute male age-specific fertility rates and TFRs (15-79) in 29 sub-Saharan African countries. I use the most recent surveys in all the countries where a DHS has been conducted since the year 2000, and for which data are publicly available (see Table annex 1).

4.1 Levels and age patterns of male fertility

Figure 7 shows age-specific male fertility rates in the 29 sub-Saharan African countries. Male fertility rates vary considerably across countries. At age 30, rates range from around 150‰ to more than 400‰. In many countries, male fertility rates remain high well after age 50. For instance, rates are above 100‰ at age 55 in one third of the countries. Figure 8 further shows that the TFR ranges from less than 4 children (Lesotho) to more than 12 children (Niger). Mean age at fatherhood varies from a little over 35 years to almost 45 years in Niger, confirming that the age at fatherhood is much higher than age at maternity (on average around 10 years higher).

Figure 7 : Age-specific male fertility rates (15-79) in 29 sub-Saharan African countries, own children method (OC) (data source: DHS household survey)

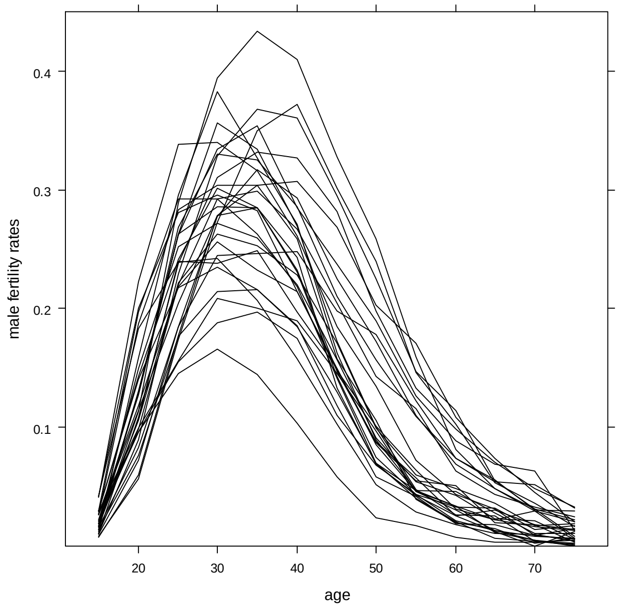
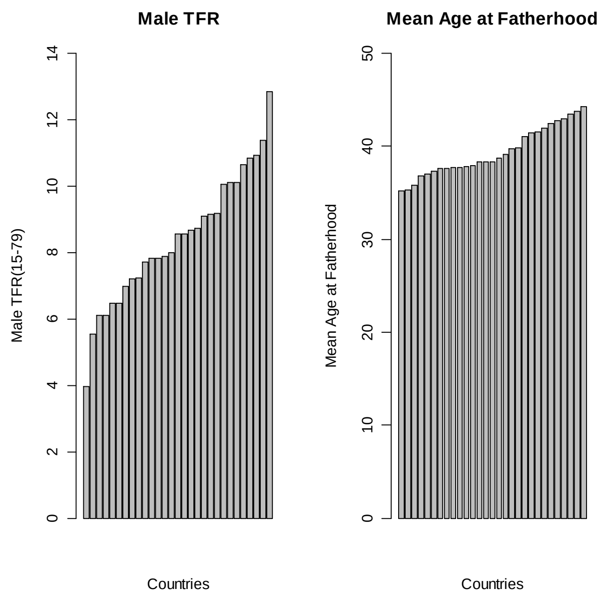


Figure 8 : TFR (15-79) and Mean age at Fatherhood in 29 sub-Saharan African countries, own children method (OC) (data source: DHS household survey)



4.2 Typology of fertility levels and patterns across sub-Saharan Africa

Cluster analysis is used to explore patterns of male fertility. Using the male TFR and mean age at fatherhood, 4 groups of fertility patterns are found (Figure 9; Table 3; Figure 10):

(1) A series of mainly Western African countries (10 countries, from Senegal to Cameroon), with very high fertility (>10 children on average) and late age at fatherhood (42.6 on average). No surprisingly, polygyny is widespread in these countries, and female fertility is also high.
(2) A group of countries with lower (but still high) fertility (around 9 children), and lower mean age at fatherhood (37.2). These are mainly central African and Eastern African countries (DR Congo, Mozambique, Uganda, Zambia, Malawi) with lower (but significant) polygyny, and high female fertility.
(3) A third group of countries, with medium fertility (7.4 children) and mean age at fatherhood at 38 years on average. This group includes a variety of countries, mainly in Eastern Africa (Ethiopia, Rwanda, Tanzania, Madagascar), but also in Western African (Liberia) and Southern Africa (Swaziland). On average, polygyny is lower, and female fertility is also lower.
(4) The fourth group of countries (average TFR at 5.6, mean age at fatherhood around 38 years) includes countries where male fertility has clearly declined (Ghana, Namibia, Lesotho, Zimbabwe and Gabon).

Figure 9 : Age-specific male fertility rates (15-79) in four groups of countries, own children method (OC) (data source: DHS household survey)

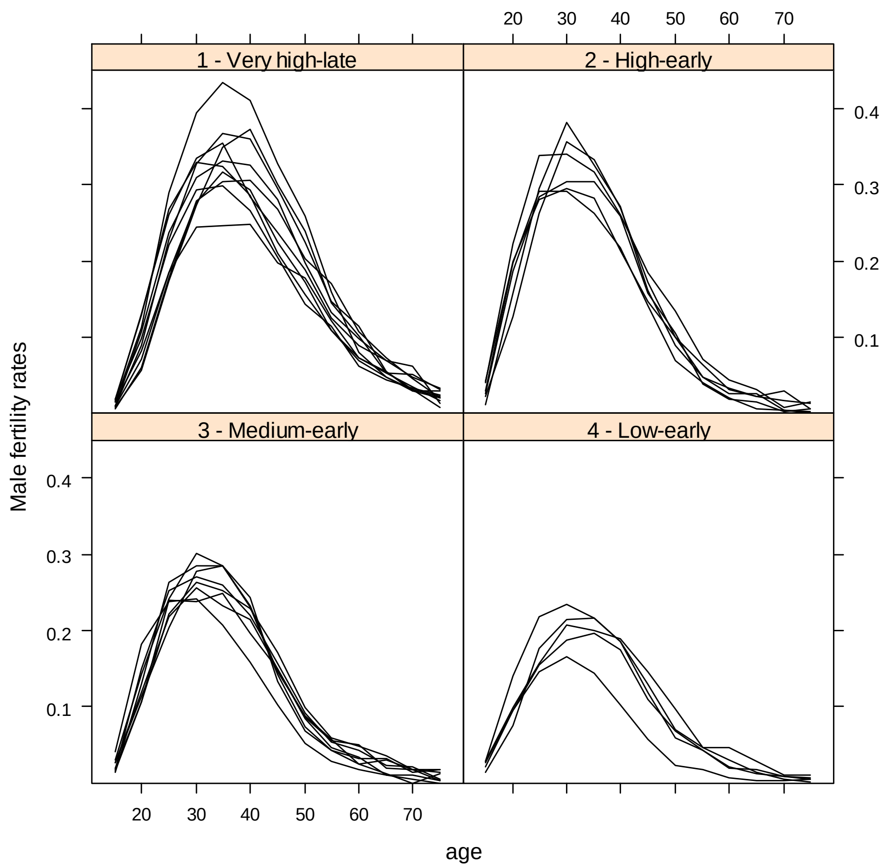
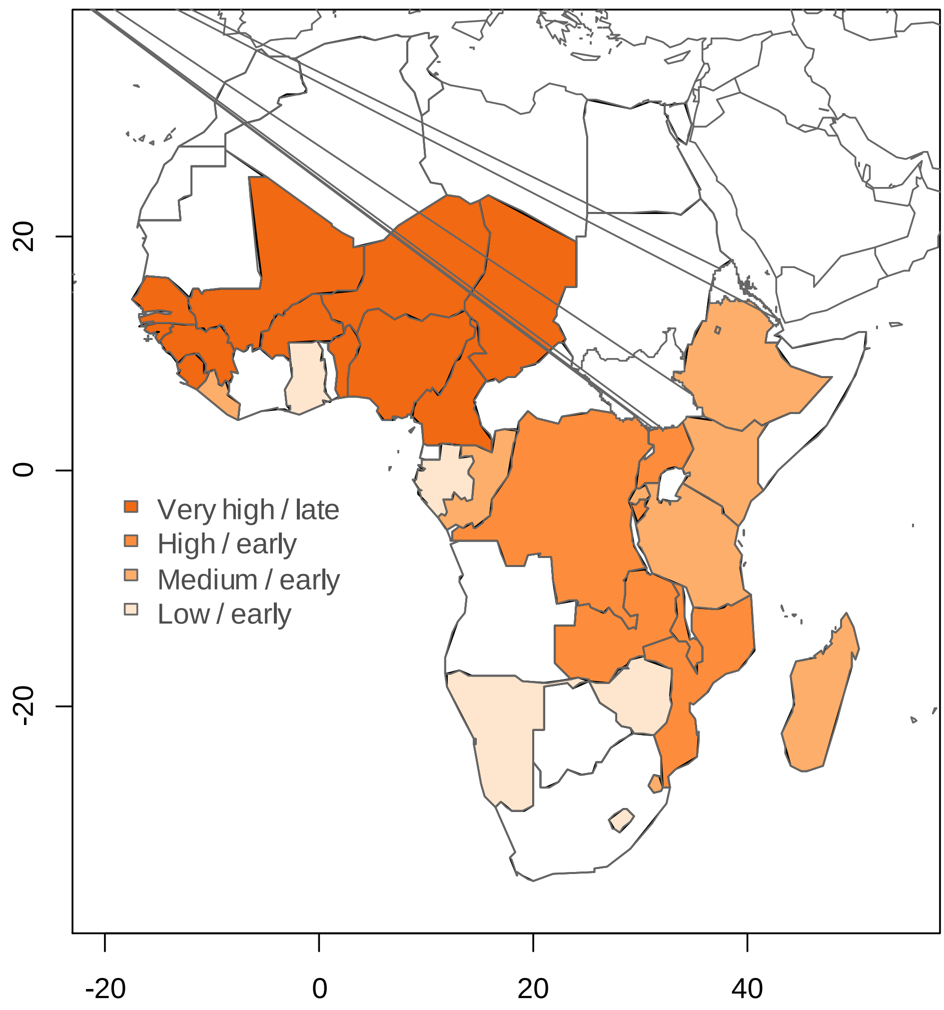


Table 3. Characteristics of the four groups of countries according to male fertility.

Group of countries based on level and age pattern of male fertility	Male TFR (average)	Mean age at fatherhood (average)	Female TFR (average)	Mean age at maternity (average)	Mean number of wives (average)	Number of countries
Very high, late	10.4	42.6	5.9	29.7	1.28	10
High, early	8.8	37.2	6.2	29.7	1.13	6
Medium, early	7.4	38.0	5.0	29.7	1.07	8
Low, early	5.6	37.8	3.9	29.6	1.07	5

Figure 10 : Map of the four groups of countries of male fertility patterns, own children method (OC) (data source: DHS household survey)



5. Conclusion

DHS data allow computing age-specific male fertility rates and male total fertility rates in different ways. The comparison of three methods suggests that estimates of male TFRs are similar across methods (among the few cases that could be compared), but that age-specific fertility rates are less consistent. In the end, the own children method is the preferred approach. It can be used to compute age-specific male fertility rates in a large number of countries, covers a large age range, and provides smooth and plausible estimates of age-specific fertility rates.

The application of the own children method to 29 countries shows that levels and age patterns of male fertility differ widely across the African continent. In some countries – with high levels of polygyny - male fertility is well above 10 children per man, and the mean age at fatherhood is above forty years. In most countries, the total male fertility rate is between 7 and 10 children, and the mean age at fatherhood between 35 and 40 years. A few countries are characterized by relatively low levels of male fertility; they are also characterized by relatively low female fertility and low polygyny. These descriptive analyses confirm that male and female fertility are very different. As expected, male fertility is higher and later than female fertility. Yet, male fertility is not always much higher than female fertility, and results from case studies in regions with high polygyny should not be generalized to Africa as a whole.

Further research will include methodological and substantive analyses. The impact of the assumptions of the own children method (e.g. null migration) and of the imputation methods for the age of father need to be tested in a variety of context. From a substantive point of view, the description and understanding of the diversity of male fertility patterns needs to be explored further. The analysis of male fertility trends and male fertility differentials is another possible field to explore, which may also trigger new methodological issues.

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Table annex 1: List of countries, surveys, age-specific male fertility rates, male TFRs and Mean age at fatherhood

Country	Year	Survey	Male TFR	Mean age at fatherhood
Benin	2006	BJ51	10.1	41.1
Burkina Faso	2010	BF61	10.9	42.9
Burundi	2010	BU61	9.2	37.8
Cameroon	2011	CM60	9.1	41.5
Chad	2004	TD41	10.8	41.9
Congo	2005	CG51	7.0	37.7
DR Congo	2007	CD50	8.7	37.7
Ethiopia	2011	ET60	7.7	39.9
Gabon	2000	GA41	6.1	38.7
Ghana	2008	GH5H	6.1	39.7
Guinea	2005	GN52	10.1	44.3
Kenya	2003	KE42	7.2	39.1
Lesotho	2009	LS60	4.0	35.2
Liberia	2007	LB51	8.0	38.0
Madagascar	2008	MD51	6.5	35.3
Malawi	2010	MW61	7.9	35.8
Mali	2006	ML41	11.4	42.8
Mozambique	2003	MZ41	8.6	37.4
Namibia	2005	NM51	5.5	38.3
Niger	2006	NI51	12.9	41.5
Nigeria	2008	NG52	9.1	42.4
Rwanda	2010	RW61	7.8	38.3
Senegal	2010	SN60	10.6	43.8
Sierra Leone	2008	SL51	8.7	43.4
Swaziland	2006	SZ51	7.2	37.7
Tanzania	2010	TZ62	7.8	38.4
Uganda	2011	UG61	10.0	37.6
Zambia	2007	ZM51	8.6	36.8
Zimbabwe	2010	ZW61	6.5	37.0

Table annex 1: List of countries, surveys, male TFRs and Mean age at fatherhood

		Age-specific male fertility rates												
Country	Survey	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79
Benin	BJ51	0.018	0.129	0.268	0.330	0.325	0.285	0.210	0.157	0.109	0.074	0.055	0.030	0.030
Burkina Faso	BF61	0.011	0.108	0.238	0.311	0.332	0.327	0.282	0.198	0.133	0.098	0.070	0.048	0.033
Burundi	BU61	0.012	0.158	0.295	0.383	0.327	0.271	0.162	0.089	0.047	0.034	0.022	0.029	0.006
Cameroon	CM60	0.019	0.098	0.220	0.293	0.299	0.267	0.204	0.143	0.115	0.063	0.043	0.033	0.024
Chad	TD41	0.017	0.130	0.262	0.334	0.354	0.285	0.237	0.190	0.126	0.089	0.069	0.063	0.013
Congo	CG51	0.027	0.118	0.218	0.256	0.232	0.214	0.149	0.085	0.046	0.034	0.011	0.005	0.000
DR Congo	CD50	0.022	0.127	0.263	0.357	0.334	0.269	0.172	0.100	0.048	0.026	0.026	0.004	0.001
Ethiopia	ET60	0.020	0.106	0.222	0.263	0.253	0.228	0.171	0.099	0.060	0.049	0.036	0.017	0.019
Gabon	GA41	0.028	0.099	0.156	0.208	0.200	0.190	0.145	0.097	0.046	0.030	0.013	0.004	0.002
Ghana	GH5H	0.014	0.076	0.176	0.214	0.216	0.185	0.130	0.070	0.047	0.046	0.028	0.010	0.010
Guinea	GN52	0.007	0.060	0.177	0.279	0.304	0.307	0.268	0.203	0.171	0.108	0.073	0.045	0.020
Kenya	KE42	0.016	0.107	0.240	0.238	0.249	0.197	0.149	0.087	0.055	0.051	0.020	0.018	0.014
Lesotho	LS60	0.021	0.096	0.145	0.166	0.145	0.103	0.058	0.024	0.017	0.007	0.003	0.003	0.004
Liberia	LB51	0.030	0.143	0.242	0.301	0.285	0.232	0.147	0.088	0.057	0.025	0.031	0.018	0.003
Madagascar	MD51	0.042	0.183	0.239	0.242	0.207	0.158	0.102	0.051	0.028	0.018	0.010	0.010	0.004
Malawi	MW61	0.029	0.197	0.292	0.292	0.263	0.218	0.141	0.070	0.040	0.020	0.006	0.004	0.002
Mali	ML41	0.011	0.089	0.229	0.329	0.368	0.360	0.294	0.225	0.147	0.114	0.055	0.031	0.022
Mozambique	MZ41	0.042	0.200	0.281	0.296	0.283	0.214	0.148	0.101	0.064	0.031	0.022	0.016	0.013
Namibia	NM51	0.027	0.096	0.155	0.188	0.197	0.175	0.110	0.068	0.044	0.021	0.013	0.008	0.007
Niger	NI51	0.016	0.113	0.289	0.395	0.434	0.410	0.328	0.259	0.159	0.081	0.048	0.031	0.008
Nigeria	NG52	0.009	0.072	0.184	0.277	0.317	0.293	0.225	0.173	0.110	0.069	0.048	0.029	0.020
Rwanda	RW61	0.013	0.130	0.263	0.286	0.285	0.231	0.143	0.074	0.043	0.032	0.032	0.014	0.017
Senegal	SN60	0.008	0.057	0.174	0.273	0.350	0.372	0.301	0.240	0.146	0.103	0.053	0.036	0.017
Sierra Leone	SL51	0.015	0.083	0.185	0.245	0.247	0.248	0.198	0.178	0.122	0.074	0.054	0.051	0.032
Swaziland	SZ51	0.026	0.114	0.204	0.278	0.285	0.243	0.133	0.069	0.042	0.026	0.012	0.000	0.012
Tanzania	TZ62	0.018	0.150	0.252	0.271	0.260	0.220	0.156	0.091	0.054	0.043	0.023	0.021	0.005
Uganda	UG41	0.041	0.222	0.339	0.340	0.317	0.261	0.185	0.134	0.072	0.044	0.031	0.009	0.015
Zambia	ZM51	0.026	0.188	0.284	0.304	0.304	0.259	0.158	0.106	0.040	0.020	0.015	0.002	0.007
Zimbabwe	ZW61	0.029	0.141	0.218	0.235	0.216	0.185	0.118	0.059	0.042	0.019	0.018	0.009	0.006