Birth spacing in Dakar, Ouagadougou and Nairobi, 1978-2010: trends, associated factors and impact on fertility decline

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Abstract

One hypothesis to explain the specific pattern of demographic transition in Africa is that of a trend towards longer birth intervals facilitated by modern contraception and linked to high levels of poverty across the continent. We test this hypothesis in Dakar, Ouagadougou and Nairobi using data from the Demographic and Health Surveys conducted between 1990 and 2010, and from the 1978 World Fertility Survey in Dakar and Nairobi. We find that in 2010, the probability of a birth interval of more than 42 months increased everywhere by between 60% and 200% with respect to 1990. This lengthening was more marked in Nairobi and Ouagadougou, where, unlike Dakar, long birth intervals are linked to contraceptive use. Long spacing is practiced in all contexts by the most educated and wealthy "elites", at median and advanced ages. However, it is also observed among the poorest populations in Nairobi. Birth spacing is the most important factor of fertility decline between 1978 and 2010 – ahead of first birth postponement and family size limitation – in Nairobi, and is the leading factor, alongside postponement, in Dakar.

Keywords: fertility transition, spacing, contraception, Dakar, Ouagadougou, Nairobi, sub-Saharan Africa

Introduction

The rapid fertility declines observed in the 1970s and 1980s in Latin America and Asia can be attributed to the diffusion of birth control and permanent contraception (long-term methods) (Freeney, 1994; Hirschman and Young, 2000; Juarez and Gayet, 2015). The declines observed in Europe one century earlier were also due to family size limitation (Knodel, 1977). The fertility transition in sub-Saharan Africa began in the 1980s, with the mean number of children per woman falling from 6.7 in 1980-85 to 5.1 in 2010-15 (United Nations, 2015). Fertility in Africa remains high in comparison to Latin America and Asia, where women had 2.3 children on average in 2015.

The African pattern of transition is still a disputed question. Based on the experience of Nigeria, Caldwell et al. (1992) posit that patterns of fertility decline in sub-Saharan Africa will differ from those of Europe, Asia and Latin America, with a decrease in births at all stages of reproductive life (postponement, spacing, limitation). They also postulate that modern contraceptive methods will be adopted at these different stages, resulting in a fertility decrease. They give two reasons for this difference. First, fewer constraints on premarital sexuality should facilitate marriage postponement and premarital contraceptive use. Second, the specifically African custom of spacing births by means of traditional methods (abstinence and breastfeeding) should simplify the shift towards modern contraception.

For Caldwell et al. (1992), the particularities of the African fertility transition can thus be seen as an adaptation of long-standing reproductive practices to new constraints and opportunities linked to economic changes and family planning programmes. Timaeus and Moultrie (2008, 2012) have a similar viewpoint, but – like Johnson-Hanks (2007) – they argue that current changes tend to reflect the precarious living conditions prevailing across the continent at the start of its transition: as African women and couples do not know what the future holds, they prefer to reduce their fertility by spacing births rather than stopping them, it could be important to have a child later. Modern contraception simply helps them to apply this form of reasoning. However, Timaeus and Moultrie (2008, 2012) make a distinction between birth "postponement" for whatever reason (including poverty and uncertainty about the future) and "spacing" (which, for them, is a practice undertaken solely to protect the health of mother and child).

This "Malthusianism of poverty" (Cosío-Zabala, 1999; Talnan et al., 2008) – here in a "spacing" version – diverges from the classical theories of fertility decline. Economic approaches explain the secular decline in family size (in Africa or elsewhere) as a response to the transition from a farming economy to an industrial and service economy which modifies the costs and benefits of children, resulting in a "quality-quantity trade-off" (Becker and Lewis, 1973; Becker and Tomes, 1976). The fertility decline thus begins among the elites before spreading gradually to the entire population. Likewise, sociologists and historians theorize the fertility decline as a strategy of social mobility and investment in human capital that affects the social classes, one after the other, during the process of industrialization (Ariès, 2014; Dumond, 2014). Trends observed over recent decades in sub-Saharan Africa generally appear to corroborate these classical theories: fertility is now relatively low among the most educated and well-off urban populations, but often remains pre-transitional elsewhere (Kravdal, 2002; Bongaarts, 2003; Gurmu and Macer, 2008; Shapiro and Gebreselassie, 2009; Assefa and Semahegn, 2016).

While useful for analysing overarching trends, these classical perspectives tend to give a homogeneous and deterministic vision of fertility trends across the continent. Current theorists of reproduction (Mason, 1997; Johnson-Hanks et al., 2011; Doyle, 2013), by contrast, focus on the wide variety of local cultural and economic contexts that influence fertility trends and overlay central tendencies. In other words, even though the classical theories provide a generally accurate prediction of overall tendencies, the diversity observed at local level is remarkable. For example, in certain contexts (West and Central Africa) traditional contraception appears to be preferred over modern contraception among the higher socioeconomic groups (Johnson-Hanks, 2002; Rossier and Corker, 2017).

Combining these three theoretical viewpoints (that of Caldwell, that of the classical theories of fertility decline and that of the diversity of contexts) we make the following hypotheses: 1) birth spacing increases and contributes to the fertility decline observed in urban Africa, alongside family size limitation and postponement. 2) Contrary to the social uncertainty hypothesis of Timaeus-Moulrie and Johnson Hanks, and in line with the classical theories of fertility decline, we also posit that birth spacing and spacing contraception have become widespread mainly among higher socioeconomic groups, those groups which also practice family size limitation. 3) However, contrary to Caldwell and the classical theories of fertility, but in agreement with Johnson-Hanks, we emphasize the diversity of situations. We posit that the role of spacing in African fertility reduction varies from one context to another and that birth control strategies other than modern contraception may be used by individuals to increase the intervals between births.

The available data indicate that fertility in Nairobi, the capital city of Kenya (East Africa), fell below three children per woman in the late 1990s. According to the World Fertility Survey (Cross et al., 1991), the estimated total fertility rate (TFR) in Nairobi was 6.1 children per woman in 1977-78. By 1998, it had fallen to 2.6 (NDPD et al., 1999), and has remained relatively stable since then. This fertility decline has been accompanied by a large increase in modern contraceptive use; in 2014, the prevalence rate was 58.3% among all women aged 15-49 (KNBS and Macro Inc, 2015). In Dakar, the capital city of Senegal (West Africa), fertility fell from 6.5 children per woman in 1978 (Direction de la Statistique and Institut International de la Statistique, 1981) to 3.7 in 2006-10 (ANSD and Macro International Inc., 2012) despite low modern contraceptive prevalence (21% in 2010). In Ouagadougou, the capital city of Burkina Faso (West Africa), the estimated TFR in 2006-10 was 3.3 children per woman, with a modern contraceptive prevalence rate of 33% (INSD and Macro International Inc., 2012).

While numerous studies have analysed fertility differences among the countries of Africa, few have compared cross-national disparities in urban fertility. This paper focuses on Dakar, Ouagadougou, and Nairobi, all three of which are "low" fertility cities where women now have around three children on average. These three capital cities differ from each other in a number of ways. Senegal and Burkina Faso are French-speaking countries of West Africa where family planning programmes were initiated later than elsewhere and where the contraceptive transition is more recent. In Burkina Faso, a family planning policy was first adopted in 1985 (Ministère de la Santé (2012), cited by Bougma et al, 2015). In 2012, the country relaunched the national family planning programme (created in 1986) with a view to increasing contraceptive prevalence by around 1.5% per year so as to limit the population to 39 million by 2050 (Zan, 2016). It was not until 1990 that Senegal, more influenced by Islam than Burkina Faso, first implemented its national family planning programme (Senegalese Ministry of Health and

Social Welfare (1990); cited by Diallo, 2014; Petit and O'Deye, 2001). The increase in contraceptive prevalence thus began a few years later than in Burkina Faso. Kenya is an English-speaking country of East Africa and a pioneer in the field of population policy. Contraceptive prevalence is much higher than in the other two countries. Kenya had already begun to promote family planning in the early 1980s. After the Cairo conference of 1994 it adopted a sexual and reproductive health strategy to combat HIV/AIDS more effectively, and in 2003 implemented a sexual health policy for adolescent girls (Oranje and Zulu, 2015). This paper compares trends in birth spacing and its determinants over three decades in these three cities, each characterized by a specific policy context, and quantifies the role of spacing in the fertility decline in two cities (Dakar and Nairobi) for which longer data time series are available.

Data and methods

The data used in this paper are drawn from four Demographic and Health Surveys (DHS) conducted between 1992 and 2010 in Senegal, Burkina Faso and Kenya. More recent data are available for Kenya alone in 2014 and for Senegal in the Continuous-DHS, but in this latter case the sample size is limited. Data from the 1977-78 World Fertility Survey (WFS) in Senegal and Kenya are also used. Burkina Faso was not included in that survey. Note that the WFS includes fewer socioeconomic variables than the DHS. In each case, attention will focus on the capital city of each country.

The object of this analysis is the interval between successive births calculated in increasing order of birth date, with a missing value entered for the woman's first birth. This first interval was defined by McDonald (1984) as the period between marriage and first birth; all women are considered here. The interval between the last birth and the survey date is also omitted from the analysis, although not all the women surveyed have completed their childbearing. Timaeus and Moultrie (2008, 2013) and Moultrie et al. (2012) have shown that using DHS data to analyse spacing (completed intervals only) results in selection bias since all women aged 15-49 are considered, some of whom will have further births after the survey. This selection effect can be reduced by taking account of variables strongly correlated with spacing. We adopt this solution here, taking account of birth order, mother's age and survey date.

The data were reweighted such that the sum of weights gives the sample size. Our analysis is divided into two stages. First, we examine the lengthening of birth intervals and their determinants using only DHS data for the decades 1990-2010. We then study the impact of this lengthening on fertility, this time including the WFS data; the study thus covers four decades, 1970-2010, but only two capitals, Dakar and Nairobi. The analyses were performed using R statistical software. In what follows, the methods are described successively for these two stages.

Spacing trends and underlying factors: Dependent variable

We first analysed birth intervals in terms of averages to detect the associated factors, then with continuous hazard rate of births in closely intervals we implemented some determinants of lengthening. Finally, we subdivided birth intervals into classes like Conde-Agudelo et al. (2006, 2012) in order to develop the determinants of each class. But here we use four classes instead of three. These classes are: short birth interval (less than 24 months), medium interval (24-41 months), long interval (42-59 months) and very long interval (60+ months). This breakdown takes account of the different ways in which birth spacing is classified in the literature.

Independent variables

Using data from the 1986 DHS in Senegal – a context of low modern contraceptive prevalence – Sow (1994) identified the determinants of birth intervals for births occurring in the three years preceding the survey. He identified the following factors:

- Mother's age at birth divided into three classes: below 20, 20-29 and 30+. These age classes limit age reporting errors but also ensure that the third class includes a large enough number of births, childbearing being less frequent at older ages.
- Parity reached: spacing behaviours may change above a certain parity. For example, couples may take longer to conceive when they already have a certain number of children.
- Sex of child: The duration of breastfeeding may differ for boys and girls, depending on the way the child's needs are perceived by the mother or by society in general.
- Place of residence: not relevant in our case
- Woman's educational level
- Partner's occupation
- Ethnicity
- Marital status: note that the woman's marital status is recorded at the time of the survey and is only a proxy of marital status at the time of the birth.

Here we use the household's standard of living rather than the spouse's occupation, given that both married and unmarried women are included. The standard of living is based on the tercile of the wealth index in the DHS data. In Senegal the missing index for 1992 was calculated using the DHS methodology (Rutstein, 2015). Sow (1994), for his part, did not consider the role of modern contraception, whose prevalence was low at the time. Given that we have no precise information on contraceptive practice during the intervals between births, we use information on possible past contraceptive use, a variable that we call "ever use of modern methods". Again contrary to Sow (1994), we consider that the mother's religion may influence spacing behaviour; for example, Islam institutionalizes 40 days of post-partum abstinence. Religion in Senegal's multivariate analysis will be excluded for missing data in 1990s. Sex of the child, marital status, religion and ethnicity are considered as control variables.

Cox model

After estimating in bi-varied analysis the factors favourable to the spacings lengthening, we developed the determinants of this lengthening using the Cox model like Van Bavel (2004a) on historical data from Leuven in Belgium. Here we model the speed of the occurrence of next birth, not the probability of a next birth (Van Bavel, 2004a). The duration variable is the birth intervals, limited to women with at least two children, these data are uncensored. The hazard ratio wich is the exponential of the regression coefficient will be interpreted. For a given category of an independent variable, the ratio below one indicates that the higher the category, the longer the time until the next birth and a ratio above one indicates the opposite.

Multinomial logit model

The determinants of medium, long and very long spacings are implemented using the generalized multinomial logit model that is written:

$$(1)\quad p_{ji} = P(y_i = j|x_i) = \begin{cases} \frac{\exp(x_i\beta_j)}{1+\sum_{k=1}^{m}\exp(x_i\beta_k)}, & j = 1, \ldots\ldots, m \\ \frac{1}{1+\sum_{k=1}^{m}\exp(x_i\beta_k)}, & j = 0 \end{cases}$$

Where j represents the spacing category, i the individual, and p_{ji} is the probability of observing the spacing category j for individual i, given the independent variables x_k cited in the sub-section above. The parameters β_j are estimated using the maximum likelihood method. If $\widehat{\beta_{jk}}$ is the coefficient estimated for j with respect to a reference level of 0 (by convention) for x_k (or for one of its levels if it is a factor), then $\exp(\widehat{\beta_{jk}})$ is the risk ratio between those exposed and those not exposed to j for x_k (or between different modalities if it is a factor) relative to the reference modality.

We use several tests to check that the model is correctly specified. First, to test for overall significance, we use the likelihood ratio test (LR test) which compares the final model with the model which verifies the following null hypothesis:

$$(2)\ H_0:\ \beta_{kj} = 0\ \ \forall\, k = 1 \ldots K \text{ et } j = 1..m$$

We then use the Wald test to verify the homoscedasticity assumption whereby the dispersion of residuals is constant across the entire spectrum of values. Last, we test the independence of irrelevant alternatives assumption (IIA) which specifies that the ratio of probabilities associated with the choices between two spacing categories is independent of the others. It is this assumption that assumes the application of the generalized multinomial logit model.

Effect of spacing on fertility: McDonald's model

After measuring the effect of the selected explanatory factors on birth spacing, we will seek to measure its impact on fertility decline. Here we will use WFS and DHS data, so our analysis will be limited to Nairobi and Dakar. We will use McDonald's model (1984) modified by Knodel (1987).

The equation below was proposed by Knodel (1987); it is a simplification of McDonald's model (1984).

$$(3)\ C = 1 + \frac{(L-F)}{I},$$

Where C = mean number of children per fertile woman; L = mean age at last birth; F = mean age at first birth and I = mean birth interval of women with at least two children. Here, the mean age at the first and last birth are weighted means and the last birth was estimated on women aged 40-49. Unfortunately, in the DHS there are no data series for women who have completed their reproductive lives that would limit the bias linked to births occurring – albeit less frequently – after age 40. We do not distinguish between spacing contraception (Leridon, 1988) and spacing. Consequently, some very long birth intervals preceding the last birth that may be an attempt at family size limitation or linked to the fertility decline are attributed to the spacing effect. Moreover, as pointed out by Van Bavel (2004), some lengthened intervals entail a decrease in age at last birth that will be counted as a limitation effect. Likewise, we ignore the fact that birth intervals may be shorter when a limitation strategy is adopted. However, McDonald argues that while this aspect may reduce the spacing effect, it is offset to a certain extent by the preceding effect.

To estimate the effect of a parameter on fertility decline between two dates, we calculate C at the start and end of the period while maintaining constant the values of the other parameters and varying that of the parameter concerned. The difference from 1 of the ratio between the end and start values of C gives the proportion by which the parameter has been reduced. We will assume that the effects are similar on the total fertility rate (TFR).

Results

Mean spacing trends by socioeconomic and demographic characteristics in Dakar, Ouagadougou and Nairobi, 1978-2010

Figure 1 shows the mean spacing (weighted) between births to women aged 15-49 recorded in the various DHS surveys between 1990 and 2010 in Senegal, Burkina Faso and Kenya, but also in the WFS of Senegal (1978) and Kenya (1977-78). In Dakar, the mean birth interval rose from 30.3 months in 1978 to 31.4 months in 1992-93 and 35.5 months in 2010-11 (an increase of 5 months in 30 years); in Ouagadougou it rose from 32.7 months in 1993 to 39.5 months in 2010 (7 months in 20 years); and in Nairobi it increased from 27.0 months in 1978 to 32.3 months in 1993 and 39.1 months in 2009 (12 months in 30 years). While the birth interval was significantly longer in Dakar than in Nairobi in 1978 (30 versus 27 months), 15 years later it was the same in both cities, and by 2010 the relationship was reversed. The mean birth interval in Ouagadougou is not statistically different from that of Nairobi, but has always been higher than that of Dakar.

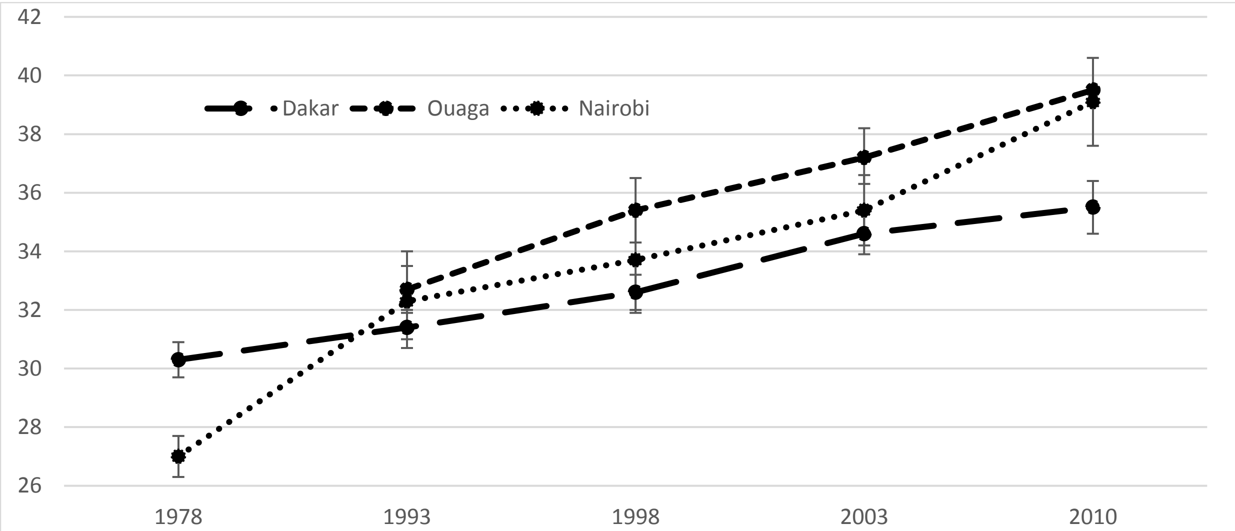

Figure 1. Mean birth intervals in Dakar, Ouagadougou and Nairobi, 1978-2010
Source: WFS 1978 in Senegal and Kenya; DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.

Mean spacing trends by demographic and socioeconomic characteristics in Dakar, Ouagadougou and Nairobi

Mother's age: Over the period 1990-2010 (all DHS surveys), mean birth intervals increased significantly with mother's age at birth in all three cities, and this finding remains unchanged if data from the late 1970s are included (Table 1). In Dakar, the interval is 25.3 months for women under 20, 32.2 months for those aged 20-29, and 36.9 months for those aged 30-49 (all DHS surveys); in Ouagadougou, the intervals are 25.6, 34.6 and 40.8 months, respectively, and in Nairobi they are 25.4, 35.1 and 43.1 months, respectively. The birth intervals are statistically identical for women below age 20, whatever the city or survey year (even in WFS). For women aged 20-29 and 30-49, on the other hand, the increase in Dakar is significant, at 4.1 and 7.7 months, respectively, between 1978 and 2010. In Ouagadougou, the mean birth interval increased by 6.5 months for ages 20-29 and 7.7 months for ages 30-49 between 1992 and 2010. In Nairobi, it increased by 13 months for women aged 20-29 and by 12 months for women aged 30-49 between 1978 and 2009. The lengthening of birth intervals is thus more pronounced at ages 30-49 than at ages 20-29 in Dakar and Ouagadougou, but similar for both age groups in Nairobi.

Parity: On average, between 1990 and 2010 (all DHS surveys), the mean birth interval increased from the second child, although the difference is not significant in all contexts, then decreased through a selection effect for children at very high parities (only women with short birth intervals can have very large numbers of children) (Table 1). In Dakar, it rose from 32.9 months between the first and second child to 33.8 months between the fifth and sixth, before falling again. In Ouagadougou, it increased from 35 months between the first and second child, to 36.8 months between the fourth and fifth, then decreased. In Nairobi, it increased from 35.4 months between the first and second child to 37 months between the third and fourth, then started to fall. Looking at trends over time, the (non-significant) increase in birth interval with birth order is only visible in Dakar in the 1990s. In the 2000s, as in the 1970s, lengthening appears to be identical, whatever the parity. In Ouagadougou, the general observed trend appears to remain stable over time, even though the difference between birth orders is not significant at each date. In Nairobi, the general pattern is similar to that of Ouagadougou. In other words, in all contexts, the birth interval increased (significantly) with time, whatever the specific birth order, and with little difference between birth orders, except for high birth orders, where there was no change (non-significant) over time; this is the case after the fifth birth in Dakar and Ouagadougou, and after the third birth in Nairobi.

Sex of child: The interval following a birth is not affected by the child's sex. In all three capitals, birth intervals are statistically identical after male and female births (Table 1). Neither are there any differences over time: all intervals increase, but with no significant difference by sex.

Education: Mean spacing increases in all three cities with level of education (Table 1). In Dakar between 1992 and 2010, mean birth intervals (all DHS surveys) were 32.4 months for women with no education, 33.6 months for women with primary education and 35.6 months for those with secondary or higher education. In Ouagadougou, the respective figures are 34.2, 36.0 and 39.2 months, and in Nairobi, 29.4, 33.9 and 38.3 months. These mean birth intervals are statistically different (separate confidence intervals) by educational level in all three cities. Moreover, birth intervals increased over time for women with all levels of education, except for those with no education in Nairobi, for whom the interval decreased in the DHS of 2003 and 2009; but this is doubtless linked to the small numbers of women in this situation (Table A1). In Dakar, for women with no education the interval increased by 3.2 months between 1978 and 2000, by 8.4 months for those with primary education and by 10.4 months for those with secondary or higher education. In Ouagadougou, between 1992 and 2010, the increases were 4.7, 7.3 and 11.1 months, respectively. In Nairobi, between 1978 and 2009, the interval increased by 9.2 months for women with primary education and by 17.8 months for those with secondary and higher education. In the late 1970s in Dakar and Nairobi, women with no education seemed to have spaced birth more widely (non-significant) than educated women. However, this difference was reversed in the early 1990s and the gap then widened year on year, with a lengthening of intervals for the most educated women.

Level of wealth: Birth intervals also appear to increase with level of wealth in the three capitals (Table 1). In Dakar between 1992 and 2010 (all DHS surveys) the mean birth interval was 32.6 months for the poorest women, 33.0 months for women in the median category, and 34.1 for the wealthiest women. In Ouagadougou the respective intervals are 34.4, 34.8 and 37.0 months, and in Nairobi 35.3, 35.9 and 35.6 months. In Dakar and Ouagadougou, the mean interval is longer (significant) for the wealthiest women than for the poorest, but there is no significant difference between the wealthiest and those in the median category. For the poorest women in all three cities, birth intervals are very similar (non-significant differences). In Ouagadougou and Nairobi, the birth intervals of women in the median and wealthiest categories are similar, but significantly longer than those of equivalent women in Dakar. Over time, between 1992 and 2010 in Dakar, the mean birth intervals of the poorest women did not change, contrary to those of women in the median and wealthiest categories, which increased by 3.1 and 8.2 months, respectively. In Ouagadougou, between 1993 and 2010, birth intervals increased significantly for women in all wealth categories (contrary to Dakar where it stayed the same for the poorest women): by 5.5 months for the poorest, 8.8 months for the median category and 8.8 months for the wealthiest. In Nairobi, as in Ouagadougou, there was also a significant increase between 1992 and 2009: 7.2 months for the poorest women, 6.9 months for the median category and 5.6 months for the wealthiest. Between 1992 and 2010, the association between level of wealth and birth spacing generally follows the same pattern as level of education in Dakar and Ouagadougou, with the wealthiest women having the longest birth intervals, while in Nairobi the differences between economic classes are small and non-significant.

Contraception: In all DHS surveys, women in Nairobi who have ever used contraception have longer birth intervals than the others (36.3 months versus 32.5 months). There is no significant difference, however, in Dakar (33.5 versus 32.8 months) and Ouagadougou (35.4 versus 35.3 months) (Table 1). Examining changes over time, we see that in the early 1990s there was no significant difference in spacing between contraceptive ever-users and never-users in all three cities. In Dakar the situation was still the same in 2010. Unlike Dakar, the difference in Nairobi has been significant since the early 2000s (in the late 2000s the long interval for never-users is due to the small numbers concerned) and in Ouagadougou it became significant in the late 2000s. However, between 1990 and 2010, birth intervals increased significantly over time in all contexts and for all women, whatever their history of contraceptive use. In Dakar they increased by 5 months for ever-users and by 2.7 months for never-users, in Ouagadougou by 8.2 months and 5.8 months, respectively, and in Nairobi by 6.9 months and 4.5 months, respectively.

Marital status, religion and ethnicity: Spacing by marital status (at the time of the survey) appears to vary across different contexts. In Ouagadougou and Nairobi, there is no significant difference between women with or without partners; the same applies in Dakar, but only in the late 2000s. Likewise, mean birth intervals are statistically identical between Christians and Muslims in Dakar (36.7 versus 35.0 months) and Ouagadougou (35.7 versus 35.0 months) but have been significantly longer among Christians in Nairobi (36.3 versus 29.3 months) since the early 2000s. Only in Nairobi does religion appear to make a difference. Last, the effect of ethnicity (cultural group) varies by city. In Dakar, the Joola/Mandinka/Soninké appear to have adopted longer birth intervals before the others. This is also the case for the minority ethnic groups in Ouagadougou in the late 2000s, and the Kikuyu in Nairobi in the 1990s and 2000s.

To summarize the results of the bivariate analysis, the wider birth spacing observed in the three cities between 1990 and 2010 appears to concern mainly the most educated and wealthy women who use contraception (with smaller differences in Dakar), at median and advanced reproductive ages and with relatively small numbers of children. Birth limitation (a practice which mainly concerns social groups with a high and medium standard of living) thus seems to be associated with longer birth intervals in all three cities; the women who do not limit family size (who have more than 3 or 5 children, depending on the city) are also those who have not adopted longer birth intervals. The only exceptions to this systematic association between advantaged groups and longer birth intervals are poor women in Nairobi, who have also adopted wider birth spacing. Last, we note that the trend towards longer birth intervals observed in the last three decades has been much more pronounced in Nairobi and Ouagadougou than in Dakar, where modern contraception was adopted later and was not widely used to space births during the observation period.

Table 1. Mean interval (months) between births by socioeconomic and demographic category

Variables	Category	Overall (T1, T2, T3, T4)			Td		T1			T2			T3			T4		
		Dakar	Ouaga	Nairobi	Dakar	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
Education	None	32,4 [31,9-32,8]	34,2 [33,7-34,6]	29,4 [27,4-31,4]	30,8 [30,1-31,4]	27,5 [26,1-28,8]	31,2 [30,6-31,8]	32,0 [31,4-32,6]	33,4 [29,3-37,5]	32,3 [31,4-33,3]	35,3 [34,3-36,3]	34,9 [24,9-44,9]	33,4 [32,3-34,4]	36,5 [35,0-38,1]	28,0 [25,4-30,6]	34,0 [32,8-35,2]	36,7 [35,6-37,8]	24,3 [19,5-29,1]
	Primary	33,6 [32,9-34,2]	36,0 [35,2-36,8]	33,9 [32,8-34,9]	28,4 [26,8-30,0]	27,2 [26,2-28,2]	31,3 [30,2-32,4]	33,5 [32,4-34,7]	30,7 [28,7-32,8]	31,9 [30,7-33,0]	34,1 [32,4-35,8]	32,6 [30,3-34,8]	34,8 [33,4-36,1]	37,3 [34,9-39,7]	34,4 [32,8-36,1]	36,8 [35,2-38,5]	41,2 [39,3-43,0]	36,6 [34,2-39]
	Secondary +	35,6 [34,6-36,6]	39,2 [38,1-40,3]	38,8 [37,6-40,0]	27,4 [24,5-30,5]	25,2 [23,3-27,2]	32,8 [31,0-34,5]	35,2 [33,4-36,9]	34,6 [31,2-	34,5 [32,6-36,4]	37,2 [35,1-39,2]	34,9 [32,3-37,6]	38,5 [36,3-40,7]	39,0 [36,6-41,4]	38,6 [36,7-40,5]	37,8 [35,4-40,2]	46,3 [44,0-48,6]	42,3 [40,2-44,4]
Standard of living	Low	32,6 [31,9-33,1]	34,4 [33,8-35,0]	35,3 [34,1-36,5]			31,6 [30,6-32,4]	31,9 [31,1-32,8]	31,5 [28,8-34,3]	32,5 [31,4-33,6]	35,2 [33,8-36,5]	34,1 [30,9-37,3]	34,1 [32,7-35,4]	36,7 [34,8-38,6]	34,1 [32,7-35,4]	32,8 [31,5-34,2]	37,2 [35,9-38,6]	39,3 [36,8-41,8]
	Medium	33 [32,4-33,6]	34,8 [34,1-35,4]	35,9 [34,6-37,3]			31,3 [30,4-32,2]	32,2 [31,4-33,1]	32,2 [29,2-35,2]	33,2 [32,0-34,4]	34,4 [33,1-35,7]	34,1 [31,2-37,0]	34,2 [32,9-35,4]	36,6 [34,7-38,6]	34,2 [32,9-35,4]	34,4 [32,9-35,9]	39,0 [37,4-40,6]	39,3 [36,4-42,2]
	High	34,1 [33,4-34,7]	37 [36,3-37,7]	35,6 [34,3-36,9]			31,6 [30,6-32,5]	34,0 [33,0-35,0]	33,4 [30,6-36,2]	32,0 [30,8-33,2]	36,6 [35,1-38,1]	32,7 [30,0-35,5]	35,9 [34,4-37,5]	38,3 [36,3-40,3]	35,9 [34,4-37,5]	39,8 [38-41,6]	42,8 [41,0-44,6]	38,6 [36,3-41,2]
Ever use of contraceptives	No	32,8 [32,3-33,3]	35,3 [34,7-36,0]	32,5 [30,9-34,1]			31,6 [30,9-32,3]	32,2 [31,2-33,3]	32,2 [28,9-35,5]	32,8 [31,7-33,8]	35,5 [34,2-36,9]	31,7 [27,8-35,7]	34,5 [33,2-35,8]	36,2 [34,4-38,0]	30,9 [28,8-33,1]	34,3 [32,9-35,6]	38,0 [36,7-39,3]	36,7 [32,3-41,0]
	Yes	33,5 [33,0-34]	35,4 [34,9-35,9]	36,3 [35,5-37,2]			31,2 [30,4-32,0]	32,8 [32,2-33,5]	32,4 [30,5-34,3]	32,4 [31,5-33,3]	35,3 [34,3-36,2]	33,9 [32,1-35,8]	34,7 [33,7-35,8]	37,7 [36,3-39,2]	36,7 [35,3-38,0]	36,5 [35,3-37,7]	41,0 [39,7-42,2]	39,5 [37,9-41,2]
Mother's age	12-19	25,3 [24,6-26,1]	25,6 [24,7-26,5]	25,4 [23,9-26,8]	26,2 [24,9-27,5]	23,7 [22,3-25,1]	25,1 [23,9-26,3]	25,3 [24,0-26,5]	23,4 [21,2-25,6]	25,8 [24,2-27,3]	25,0 [23,1-26,8]	27,1 [23,6-30,5]	25,1 [23,8-26,4]	28,1 [24,9-31,3]	26,9 [23,8-29,9]	25,8 [23,7-27,9]	26,3 [24,1-28,4]	23,3 [21,0-25,7]
	20-29	32,2 [31,8-32,7]	34,3 [33,8-34,7]	35,1 [34,3-36,0]	30,0 [29,6-30,7]	26,9 [26,0-27,8]	30,7 [30,1-31,4]	31,7 [31,1-32,3]	32,7 [30,7-34,7]	31,6 [30,7-32,4]	34,5 [33,6-35,4]	33,0 [31,0-35]	33,8 [32,8-34,8]	35,8 [34,5-37,1]	34,1 [32,9-35,4]	34,1 [33,1-35,1]	38,2 [37,1-39,2]	39,7 [37,8-41,5]
	30-49	36,9 [36,2-37,6]	40,8 [40,0-41,6]	43,1 [41,2-45,0]	32,8 [31,5-34,0]	31,1 [29,0-33,2]	34,7 [33,6-35,7]	37,7 [36,5-38,9]	40,4 [35,4-45,3]	35,7 [34,4-36,9]	40,8 [39,0-42,6]	41,5 [36,9-46,2]	38,6 [37,1-40,1]	42,6 [40,2-45,0]	44,9 [41,7-48,0]	40,5 [38,7-42,4]	45,4 [43,4-47,3]	42,9 [39,7-46,1]
Marital status	In a union	33,0 [32,7-33,4]	35,4 [35,0-35,8]	35,4 [34,6-36,3]	30,2 [29,6-30,8]	26,6 [25,9-27,3]	31,2 [30,6-31,7]	32,7 [32,1-33,2]	32,6 [30,7-34,5]	32,3 [31,6-33,0]	35,5 [34,6-36,3]	33,6 [31,7-35,5]	34,6 [33,8-35,4]	37,6 [36,3-38,9]	35,1 [33,8-36,4]	35,6 [34,6-36,5]	39,6 [38,6-40,5]	38,5 [36,8-40,1]
	Other	34,7 [33,5-35,9]	35,0 [33,8-36,2]	36,2 [34,5-37,9]	33,1 [29,8-36,3]	29,8 [26,8-32,8]	33,9 [31,9-35,9]	32,9 [31,0-34,8]	31,5 [28,2-34,9]	35,1 [32,6-37,7]	34,8 [32,5-37,1]	33,9 [30,1-37,6]	35,1 [32,3-37,8]	35,26 [32,7-37,8]	36,4 [33,79-39]	35,2 [32,4-38,0]	39,2 [35,9-42,5]	42,7 [38,5-46,9]
Religion	Christian	36,7 [34,0-39,4]	35,7 [35,1-36,2]	36,3 [35,5-37,1]	28,4 [26,0-30,8]			32,6 [31,8-33,4]	31,9 [30,2-33,6]		35,7 [34,7-36,7]	33,8 [32,0-35,6]	38,1 [34,2-42,1]	37,8 [36,4-39,2]	36,6 [35,3-37,9]	34,3 [31,3-37,4]	40,8 [39,3-42,4]	40,0 [38,4-41,7]
	Muslim	35,0 [34,3-35,6]	35 [34,5-35,5]	29,3 [27,2-31,4]	30,5 [29,8-31,1]			32,7 [32,0-33,4]	34,1 [27,7-40,5]		34,6 [33,28-	34,3 [27,2-41,4]	34,5 [33,6-35,3]	36,0 [34,0-38,0]	26,0 [23,5-28,5]	35,6 [34,7-36,5]	38,9 [37,8-40,1]	29,9 [25,3-34,5]
Sex of child	Female	33,0 [32,5-33,5]	35,1 [34,6-35,7]	36,1 [35,0-37,1]	30,2 [29,3-31,0]	26,5 [25,6-27,5]	31,2 [30,4-31,9]	32,5 [31,7-33,2]	32,3 [30-34,7]	32,6 [31,7-33,6]	35,1 [34,0-36,2]	33,3 [30,9-35,7]	34,4 [33,3-35,5]	37,7 [36,0-39,4]	36,1 [34,5-37,7]	35,3 [34,1-36,6]	39,1 [37,8-40,4]	39,6 [37,4-41,7]
	Male	33,4 [32,9-33,8]	35,6 [35,0-36,1]	35,1 [34,0-36,1]	30,5 [29,6-31,3]	27,5 [26,4-28,6]	31,7 [31,0-32,4]	32,9 [32,2-33,6]	32,4 [30,0-34,7]	32,5 [31,6-33,5]	35,7 [34,5-36,8]	34,0 [31,6-36,4]	34,8 [33,7-36,0]	36,8 [35,3-38,3]	34,7 [33,0-36,3]	35,7 [34,4-37,0]	40,0 [38,7-41,2]	38,5 [36,3-40,7]

Source: DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.

*Survey date: T1= 1992/93 in Dakar and 1993 in Ouaga and Nairobi; T2= 1997/98 in Dakar, 1999 in Ouaga and Nairobi; T3= 2005 in Dakar, 2003 in Ouaga and Nairobi; T4= 2010/11 in Dakar, 2010 in Ouaga and 2009 in Nairobi.

Table 1 (cont'd)

Variables	Category	Overall (T1, T2, T3, T4)			Td		T1			T2			T3			T4		
		Dakar	Ouaga	Nairobi	Dakar	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
Parity	2	32,9 [32,2-33,6]	35,0 [34,3-35,7]	35,4 [34,3-36,6]	30,5 [29,2-31,9]	26,8 [25,3-28,3]	30,6 [29,5-31,7]	32,3 [31,2-33,3]	31,7 [29,1-34,2]	33 [31,6-34,4]	33,5 [32,1-34,9]	34,1 [31,4-36,8]	33,5 [31,9-35,0]	36,1 [34,2-38,0]	34,2 [32,5-35,9]	36,0 [34,3-37,6]	39,6 [38,2-41,1]	40,0 [37,7-42,4]
	3	33,3 [32,5-34,0]	35,4 [34,6-36,2]	35,8 [34,4-37,3]	30,1 [28,7-31,5]	27,2 [25,5-28,8]	30,9 [29,8-32,0]	31,8 [30,7-32,9]	32,2 [28,8-35,6]	31,6 [30,0-33,1]	36,0 [34,3-37,7]	32,4 [29,3-35,6]	36,7 [34,9-38,5]	37,5 [35,2-39,9]	36,3 [34,0-38,6]	35,1 [33,4-36,8]	40,0 [38,2-41,8]	38,7 [36,0-41,4]
	4	33,2 [32,3-34]	35,6 [34,6-36,6]	37,0 [35-38,9]	29,9 [28,5-31,2]	25,8 [24,4-27,3]	31,9 [30,6-33,2]	33,0 [31,7-34,3]	36,1 [31,3-40,9]	31,7 [29,9-33,4]	35,7 [33,7-37,7]	35,3 [30,9-39,7]	34,7 [32,7-36,6]	39,1 [36,1-42,1]	37,5 [34,5-40,6]	35,7 [33,6-37,8]	39,1 [36,8-41,4]	37,3 [33,1-41,6]
	5	33,6 [32,6-34,5]	36,8 [35,6-38,0]	35,3 [32,6-37,9]	31,6 [29,8-33,5]	29,9 [27,5-32,3]	31,8 [30,3-33,2]	33,5 [32-35]	33,0 [27,2-38,9]	33,7 [31,8-35,7]	37,1 [34,6-39,6]	31,8 [26,6-37,1]	35,2 [33,0-37,4]	40,1 [36,6-43,7]	38,0 [33,4-42,7]	35,4 [32,7-38,2]	41,9 [38,7-45,1]	36,6 [31,2-42,0]
	6	33,8 [32,6-34,9]	34,8 [33,5-36,1]	34,9 [31,6-38,2]	30,2 [28,4-31,9]	28,1 [25,5-30,7]	31,8 [30,1-33,5]	32,8 [31,2-34,4]	29,5 [22,4-36,6]	34,3 [32,0-36,7]	36,1 [33,6-38,5]	35 [28,2-41,8]	34,3 [31,5-37,0]	34,5 [30,0-39,0]	32,3 [27,8-36,7]	36,4 [33,0-39,8]	38,4 [34,4-42,3]	43,2 [34-52,5]
	7	32,8 [31,5-34,1]	34,4 [32,8-36]	33,6 [28,6-38,6]	30,1 [28,3-31,8]	27,0 [24,2-29,7]	32,0 [30,0-34,0]	32,7 [30,8-34,7]	29,9 [21,7-38,2]	32,1 [29,9-34,3]	36,1 [32,2-40,1]	38 [17,6-58,4]	34,5 [31,2-37,8]	35,2 [30,4-40,0]	32,9 [25,9-39,8]	35,0 [30,5-39,4]	35,9 [31,6-40,2]	39,7 [26,6-52,7]
	8 et +	32,8 [31,7-34,0]	35,1 [33,6-36,7]	29,0 [24,6-33,3]	29,8 [28,2-31,4]	24,9 [22,6-27,2]	33,1 [31,3-34,8]	34,7 [32,8-36,5]	30 [20,9-39,1]	32,1 [30,2-33,9]	35,8 [32,5-39,2]	18 [16,0-20,0]	33,1 [30,5-35,7]	37,1 [31,5-42,8]	28,4 [21,8-35,0]	33,5 [28,8-38,2]	35,9 [30,7-41,0]	31,6 [26,4-36,8]
Ethnicity	Mandinka Soninke/Joola	34,0 [32,9-35,1]			31,3 [28,6-33,9]		32,2 [30,6-33,7]			31,4 [29,5-33,2]			35,3 [32,6-38,0]			39,9 [36,9-42,8]		
	Fulani	32,9 [32,1-33,6]			31,9 [30,2-33,6]		31,5 [30,2-32,8]			32,7 [31,3-34,2]			32,8 [31,2-34,4]			35,2 [33,3-37,1]		
	Serer	33,1 [32,1-34,0]			29,6 [28,1-31,1]		31,2 [29,9-32,6]			32,6 [30,4-34,8]			34,7 [32,8-36,7]			34,4 [32,1-36,6]		
	Wolof	32,8 [32,3-33,3]			29,9 [29,2-30,7]		31,2 [30,5-31,9]			32,4 [31,4-33,3]			35,0 [33,8-36,2]			34,9 [33,4-36,4]		
	Kamba			34,3 [32,6-36,0]		28,8 [27,0-30,6]			28,5 [26,2-30,9]			33,0 [29,8-36,2]			34,7 [31,9-37,6]			41,1 [36,3-45,9]
	Kikuyu			38,4 [36,9-39,9]		27,7 [26,4-29,1]			34,5 [30,5-38,5]			35,9 [32,8-39]			39,2 [36,7-41,7]			40,7 [38,2-43,3]
	Luhya			34,7 [32,9-36,5]		26,0 [24,3-27,7]			32,8 [28,2-37,4]			32,6 [28,5-36,7]			33,6 [31,1-36,1]			40,7 [36,1-45,4]
	Luo			34,3 [32,8-35,7]		25,7 [24,3-27,0]			31,9 [29,1-34,6]			30,0 [26,4-33,7]			35,2 [32,8-37,6]			37,0 [33,8-40,2]
	Somali/ Kalenjin/Kisii			31,2 [28,9-33,5]					39,7 [23,8-55,6]			36,9 [24,5-49,4]			28,3 [25,6-31,1]			33,3 [29,1-37,5]
	Mossi		35,1 [34,7-35,5]					32,6 [32,0-33,1]			35,3 [34,4-36,2]			36,5 [35,2-37,7]			38,9 [38,0-39,9]	
	Other	35,1 [33,8-36,4]	36,9 [35,9-37,9]	38,4 [35,6-41,2]	30,0 [28,3-31,8]	26,2 [23,5-28,9]	32,2 [29,6-34,8]	33,7 [32,3-35,1]	32,8 [27,2-38,3]	35,4 [32,2-38,7]	35,6 [33,8-37,4]	33,3 [27,3-39,4]	36,8 [34,0-39,6]	39,6 [37,0-42,2]	40,0 [35,3-44,5]	35,2 [33,1-37,3]	42,7 [40,4-45,1]	44 [38,3-49,7]

Source: DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.

*Survey date: T1= 1992/93 in Dakar and 1993 in Ouaga and Nairobi; T2= 1997/98 in Dakar, 1999 in Ouaga and Nairobi; T3= 2005 in Dakar, 2003 in Ouaga and Nairobi; T4= 2010/11 in Dakar, 2010 in Ouaga and 2009 in Nairobi.

Determinants of birth spacing lengthening in Dakar, Ouagadougou and Nairobi from the early 1990s to the late 2000s (all years included)

Table 2 gives the hazard ratios of the occurrence of a live birth in the closed intervals. These results are generally in line with the bi-variate analysis: the intervals increase from year to year, increase with age; high parity women space less; the most educated women have the longest spacing (not significant in Dakar). In Dakar, the difference in bivariate analysis between the categories of education began significant but low since the early 2000s, that could explain that cox's result. However, contraception (ever use) is not significant in any context and the level of wealth is only significant in Nairobi where the richest people space less compared to the poorest.

Tableau 2. Cox regression of the hazard of birth in closed birth intervals (all years included)

	Dakar	Ouaga	Nairobi
Survey date			
1992	1	1	1
1997	0.95* [0.9-1.01]	0.84***[0.78-0.89]	1.03 [0.9-1.19]
2005	0.84***[0.79-0.89]	0.8*** [0.74-0.87]	0.96 [0.85-1.09]
2010	0.82***[0.77-0.88]	0.72***[0.68-0.77]	0.86** [0.75-0.99]
Éducation			
None	1	1	1
Primary	1.01 [0.95-1.06]	0.95* [0.89-1.01]	0.86* [0.74-1.01]
Secondary and higher	0.96 [0.89-1.04]	0.91** [0.84-0.99]	0.75** [0.63-0.89]
Household standard of living			
Low	1	1	1
Medium	0.99 [0.94-1.05]	1 [0.95-1.07]	1.05 [0.95-1.17]
High	0.98 [0.93-1.04]	0.97 [0.91-1.04]	1.24** [1.1-1.39]
Marital status			
In a union	1	1	1
Other	0.89** [0.82-0.96]	1.04 [0.96-1.13]	0.83** [0.75-0.92]
Age			
12-19	1	1	1
20-29	0.5*** [0.46-0.55]	0.46*** [0.42-0.5]	0.47*** [0.41-0.54]
30-49	0.3*** [0.27-0.34]	0.24*** [0.21-0.27]	0.27*** [0.23-0.32]
Religion			
Christian		1	1
Muslim		1 [0.95-1.05]	1.25** [1.06-1.49]
Ethnicity			
Mande/Soninke/Diola	1		
Poular	1.06 [0.98-1.15]		
Serer	1.11** [1.01-1.21]		
Wolof	1.1** [1.02-1.18]		
kamba			1
kikuyu			0.99 [0.85-1.14]
luhya			0.99 [0.86-1.13]
Luo			1.04 [0.86-1.25]
Somali/kalenjin/kisii			
Mossi		1	
Autres	0.98 [0.89-1.09]	0.97 [0.91-1.04]	0.79** [0.65-0.96]
Ever-use of contraception			
No	1	1	1
Yes	1.03 [0.98-1.08]	1.01 [0.95-1.06]	0.96 [0.86-1.07]
Parity	1.09***[1.08-1.11]	1.11***[1.09-1.13]	1.12***[1.08-1.16]
Sex			
Male	1	1	1
Female	1.03 [0.98-1.08]	1.03 [0.98-1.08]	1.04 [0.96-1.13]
p-Likelihood ratio test	0	0	0
p-Proportional Hazards test	0.00367	0	

Number of intervals	7590	6427	2445

Determinants of medium, long and very long birth intervals in Dakar, Ouagadougou and Nairobi from the early 1990s to the late 2000s (all years included)

As indicated, the birth intervals were divided into four categories for the second multivariate analysis: short (less than 24 months), medium (24-41 months), long (42-59 months) and very long (60+ months). Short intervals are the reference category for the multinomial logit models, whose results are shown in Table 3. For the categories of the demographic and socioeconomic variables (taken individually), models 1 to 9 represent the relative risk ratios (RRR) of belonging to a spacing category after controlling for survey year; they measure the raw effects. The final model presents the net relative risk ratios, i.e. the RRRs calculated in the simultaneous presence of all the independent variables.

Demographic and socioeconomic determinants of medium, long and very long birth intervals

Mother's age: That multivariate analysis shows that the age group has a highly significant effect (raw and net) in all the cities and on all types of birth spacing (Models 4 and final model, Table 3). All other things being equal, relative to short intervals, women aged 20-29 and 30-49 in Dakar are 70% more likely and more than twice as likely, respectively, to have medium birth intervals (24-41 months) than those aged below 20. Relative to short intervals, women in Dakar aged 20-29 and 30-49 are more than five times and more than 14 times as likely, respectively, to have long birth intervals (42-59 months) than women aged below 20. In Ouagadougou, relative to short intervals, for women aged 20-29 and 30-49, the net risk of having medium birth intervals is more than three times and more than six times higher, respectively, than that of women aged below 20. For long intervals, the risk, all other things being equal, is more than seven times and more than 20 times greater, respectively, for women aged 20-29 and those aged 30-49. In Nairobi, the risk of adopting medium birth intervals is more than twice and more than 4 times greater, respectively, for women aged 20-29 and 30-49 with respect to women aged below 20. For long intervals, the risk is more than six times and more than 14 times greater, respectively, for women aged 20-29 and 30-49 in Nairobi (final model). For very long intervals, the high values observed are due to the smaller number of women age 12-19 with respect to the 20-29 and 30-49 aged groups. In Nairobi very long birth intervals (60+ months) increase with age (separate confidence intervals), while in Dakar and Ouagadougou, medium and long intervals become more frequent with age but not very long intervals, for which behaviours are similar at median and older ages.

Parity: In all contexts, the lower the parity, the higher the probability of long and very long birth intervals (models 8 and final model, Table 3). All other things being equal, there is no difference with respect to short intervals (contrary to the raw effects) in Dakar and Nairobi; in Ouagadougou (raw effect also significant), on the other hand, an additional child reduces the risk of a medium interval by 10%. In addition, all other things being equal, relative to short birth intervals, an additional child reduces the risk of a long interval by 10% in Dakar and Nairobi (non-significant raw effect), and by 20% (significant raw effect) in Ouagadougou. Last, with respect to short birth intervals, an additional child reduces the net risk of a very long birth interval (60+ months) by 20% in Dakar, and by 30% in Ouagadougou and Nairobi; none of the raw effects are significant.

Sex of child: There is no net difference by sex of child in the choice of medium, long or very long birth intervals in any of the cities. The raw effect of sex is significant, but only in Nairobi.

Education: The probability of longer birth intervals increases with level of education in Ouagadougou and Nairobi, but seems to remain identical across educational levels in Dakar (models 1 and final model, Table 3). While in Dakar there is no raw difference between educated and uneducated women in the risk of medium birth intervals (24-41 months), women with primary and secondary education have a higher raw risk of adopting long intervals (42-59 months) and very long intervals (60+ months). However, there is no net difference between educational categories in Dakar with respect to medium, long and very long intervals. Contrary to Dakar, the raw effect of education on medium intervals is significant in Ouagadougou; there is also a significant net difference (30% higher risk) between women with primary education and uneducated women for medium birth intervals. In Ouagadougou, the raw and net effects of education on long and very long birth intervals are significant. All other things being equal, relative to short intervals, women with primary and secondary or higher education in Ouagadougou all have a 30% higher risk of long birth intervals and a 50% higher risk of very long intervals. In Nairobi, while the raw effect of education is significant for medium birth intervals, as in Ouagadougou, the net effect is non-significant, as in Dakar. For long spacing, the raw effect is significant here too, but also the net effect, as in Ouagadougou. However, contrary to Ouagadougou, only women with secondary education have a net significant effect; their risk is double that of uneducated women. For long birth intervals in Nairobi, the raw and net effects are all significant, as in Ouagadougou. Hence, all other things being equal, relative to short intervals, the risk of very long birth intervals for women with primary and secondary education is almost twice as high, and more than twice as high, respectively, as that of uneducated women.

In short, it is only in Ouagadougou that women with primary education tend to opt for medium intervals (24-41 months) over short intervals (<24 months); in the other cities there is no significant difference. Long birth intervals (42-59 months) are associated with educated women in Ouagadougou, and with at least secondary education in Nairobi; there is no association in Dakar. Very long intervals (60+ months) are observed among educated women in Ouagadougou and Nairobi, and tend to increase with educational level, in Nairobi especially; in Dakar education has no effect on this type of interval.

Standard of living: The multivariate approach reveals that, unlike education, standard of living plays a limited role, all other things being equal. In Dakar, no significant raw effects are observed for medium (24-41 months) or long intervals (42-59 months) (models 2 and final model, Table 3). For very long intervals (60+ months) the raw effect is significant (the wealthiest women have a 50% higher risk), but the net effect is non-significant. In Ouagadougou, while the net effects of medium and long birth intervals are non-significant, as in Dakar, the raw effect on the risk of long intervals is significant (30% higher risk for the wealthiest women). For very long birth intervals in Ouagadougou, the situation is similar to that of Dakar, with a significant raw effect (the risk is doubled for the wealthiest women), but a non-significant net effect. For medium and long birth intervals, the situation in Nairobi is identical to that of Dakar, with no raw or net effect. For very long birth intervals, the raw effect of living standard is non-significant, contrary to the net effect; for women with medium and high living standards the risk of opting for a very long interval is 30% and 50% lower, respectively, than for poor women. In none of the cities do women in any standard of living category practice the most medium or long birth intervals, although wealthier women in Ouagadougou tend to have long intervals (non-significant). A non-significant preference for very long birth intervals among wealthy women is observed in Dakar and Ouagadougou. It is due certainly to the recent difference between categories in Ouagadougou (late 2000s) and no difference over time in Dakar until late 2000s observes in descriptive analysis. In Nairobi, on the other hand, the higher the standard of living, the lower the frequency of very long birth intervals.

Contraception: In that multivariate approach, modern contraception has a determining effect on length of birth interval in Ouagadougou but not in the other two cities. In Dakar, no significant raw or net effects of contraception are observed for medium (24-41 months) or long intervals (42-59 months) (models 7 and final model, Table 3). However, the raw effect (contrary to the net effect) on very long intervals (60+ months) is significant (ever-users of contraception have a 20% higher risk). In Ouagadougou, contrary to Dakar, the raw and net effects of contraception on the adoption of medium and long birth intervals are all significant. All other things being equal, relative to short birth intervals, ever-users of contraception have a 20% higher risk of adopting medium or long birth intervals. Contrary to Dakar where the raw effects, but not the net effects, are significant for very long intervals, none of the effects are significant in Ouagadougou. As in Ouagadougou, the raw effect of contraception on medium birth intervals in Nairobi is significant (the risk is 30% higher for ever-users of contraception), but there is no net difference, contrary to Ouagadougou. For long and very long intervals, the raw effects are significant for ever-users in Nairobi, with RRRs of 1.5 and 2.1, respectively, but no net difference is observed for very long intervals, as in the other cities. In short, in Dakar and Nairobi contraceptive status has no effect on the preference for medium, long or very long birth intervals. In Ouagadougou, on the other hand, medium and long intervals are more frequent among ever-users, although the situation is similar to that of the other two cities for very long intervals.

Marital status, religion and ethnicity: Medium birth intervals are more prevalent among women in a union (at the time of the survey) in Ouagadougou and Nairobi, while in Dakar women's behaviours are the same, whether or not they are in a union (final model, Table 3). Very long birth intervals are adopted by women not in a union in Dakar and Nairobi while in Ouagadougou there is no significant difference. With regard to religion, in Nairobi medium and long birth intervals seem to be preferred by Christians while in Ouagadougou there is no difference between Muslims and Christians. For very long birth intervals, there is no difference by religion in the two cities. Only in Nairobi are differences by ethnic group observed after controlling for the other factors. Compared to the Somali/Kalenjin/Kisii and to the Luhya, the Kamba more frequently have medium birth intervals. Long intervals are more frequent among the Kikuyu. The Somali/Kalenjin/Kisii stand out as the ethnic group in which very long birth intervals are most infrequent.

In short, the multivariate analyses of the characteristics associated with long and very long intervals (1990-2010, four surveys combined) are consistent with the descriptive analysis of lengthening mean birth intervals for different categories of women between 1978-1990 and 2010. The only new element is that very long birth intervals appear to be partly uncertain. In Dakar, among the variables of interest, very long birth intervals are significant only for age and parity, and in Ouagadougou for age, parity and education. In Nairobi, on the other hand, very long birth intervals are non-significant only for ethnicity and contraception.

Table 3. Relative risk ratios of medium, long and very long birth intervals

Ref. Below 24 months	24-41 months			42-59 months			60+ months		
				Model 1					
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	0,9 [0,6-1,2]	1,5*** [1,2-1,8]	1,3** [1,1-1,6]	1,3 [0,8-2]	1,2 [0,9-1,6]	1,8*** [1,4-2,4]	0,8 [0,5-1,4]
T3	1,0 [0,9-1,9]	1,1 [0,9-1,3]	1,1 [0,8-1,4]	1,5*** [1,3-1,9]	1,7*** [1,3-2,2]	1,5* [1-2,2]	2,1*** [1,6-2,6]	2,2*** [1,6-3,08]	1,5* [1-2,4]
T4	1,1 [0,9-1,2]	1,3** [1,1-1,5]	1,1 [0,8-1,5]	1,9*** [1,5-2,3]	2,2** [1,8-2,8]	2,0*** [1,3-3,1]	2,2*** [1,7-2,9]	3,8*** [2,9-5,0]	2,0** [1,3-3,2]
Education									
None	1	1	1	1	1	1	1	1	1
Primary	1,0 [0,9-1,2]	1,3*** [1,1-1,6]	1,6** [1,2-2,2]	1,2* [1-1,4]	1,4** [1,1-1,6]	2** [1,2-3,2]	1,3** [1,1-1,6]	1,6*** [1,2-2,1]	2,3** [1,3-4,1]
Secondary and higher	0,9 [0,8-1,1]	1,3** [1,1-1,6]	1,7*** [1,3-2,4]	1,1 [0,9-1,4]	1,8*** [1,4-2,2]	3,5*** [2,2-5,6]	1,9*** [1,5-2,4]	2,7*** [2,1-3,5]	4,3*** [2,4-7,5]
				Model 2					
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	1,0 [0,7-1,3]	1,5*** [1,2-1,8]	1,32** [1,08-1,61]	1,6** [1,0-2,4]	1,3 [0,9-1,7]	1,9*** [1,5-2,5]	1 [0,6-1,7]
T3	1,0 [0,9-1,2]	1,1 [0,9-1,3]	1,1 [0,9-1,5]	1,6*** [1,3-1,9]	1,79*** [1,4-2,3]	1,7** [1,1-2,4]	2,2*** [1,7-2,8]	2,4*** [1,8-3,4]	1,8** [1,2-2,7]
T4	1,0 [0,9-1,2]	1,29** [1,08-1,53]	1,2 [0,9-1,7]	1,9*** [1,6-2,4]	2,4*** [1,9-2,9]	2,6*** [1,7-3,9]	2,4*** [1,8-3,1]	4,2*** [3,2-5,4]	2,7*** [1,7-4,1]
Household standard of living									
Low	1	1	1	1	1	1	1	1	1
Medium	1,1 [0,9-1,2]	1,0 [0,8-1,1]	0,9 [0,7-1,1]	0,9 [0,8-1,1]	1,0 [0,8-1,2]	1,0 [0,8-1,4]	1,2 [0,9-1,5]	1,1 [0,8-1,4]	0,9 [0,7-1,3]
High	1,0 [0,9-1,2]	1,1 [0,9-1,3]	0,9 [0,7-1,1]	1,1 [0,9-1,4]	1,33** [1,09-1,61]	1,2 [0,9-1,6]	1,6*** [1,2-2,0]	2,0*** [1,5-2,5]	1,0 [0,7-1,4]
				Model 3					
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	1 [0,7-1,3]	1,5*** [1,2-1,8]	1,3** [1,1-1,6]	1,6** [1,1-2,4]	1,3 [0,9-1,7]	1,9*** [1,5-2,6]	1 [0,6-1,7]
T3	1,0 [0,9-1,2]	1,1 [0,9-1,4]	1,1 [0,8-1,4]	1,6*** [1,3-1,9]	1,8*** [1,4-2,3]	1,6** [1,1-2,4]	2,1*** [1,7-2,7]	2,5*** [1,8-3,5]	1,8** [1,2-2,7]
T4	1,0 [0,9-1,2]	1,3** [1,1-1,5]	1,2 [0,9-1,6]	1,9*** [1,6-2,4]	2,3*** [1,9-2,9]	2,6*** [1,7-3,8]	2,3*** [1,8-3,0]	4,1*** [3,1-5,3]	2,7*** [1,7-4,2]
Marital status									
In a union	1	1	1	1	1	1	1	1	1
Other	1,0 [0,9-1,2]	0,8** [0,7-0,9]	0,8** [0,6-1]	1,0 [0,8-1,3]	0,9 [0,7-1,2]	1 [0,7-1,3]	1,5** [1,1-2,0]	0,8* [0,5-1]	1,1 [0,8-1,6]
				Model 4					
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	0,9 [0,7-1,3]	1,4*** [1,2-1,8]	1,3** [1,1-1,6]	1,5* [1,0-2,4]	1,2 [0,9-1,6]	1,9*** [1,5-2,6]	0,9 [0,6-1,6]
T3	1,0 [0,9-1,2]	1,0 [0,9-1,3]	1,0 [0,8-1,4]	1,6*** [1,3-1,9]	1,7*** [1,4-2,2]	1,5* [1-2,2]	2,1*** [1,7-2,7]	2,3** [1,7-3,3]	1,6** [1,1-2,4]
T4	1,0 [0,9-1,2]	1,3** [1,1-1,5]	1,1 [0,8-1,5]	1,9*** [1,5-2,4]	2,3*** [1,8-2,8]	2,2*** [1,5-3,4]	2,33*** [1,8-3,1]	4,0*** [3,1-5,2]	2,2*** [1,4-3,4]
Age									
12-19	**1**	1	1	**1**	1	1	**1**	1	1
20-29	1,7*** [1,4-2,0]	3,0*** [2,5-3,7]	2,4*** [1,8-3,1]	4,7*** [3,2-7,0]	4,6*** [3,3-6,4]	6,1*** [3,5-10,5]	14,5*** [5,3-39,6]	28*** [8,4-93,4]	7,6*** [3,5-16,7]
30-49	2,3*** [1,9-2,8]	4,0*** [3,2-5,1]	3,4*** [2,4-4,8]	8,7*** [5,8-13]	9,8*** [6,9-14,0]	9,3*** [5,1-17,0]	43,3*** [15,7-118,9]	102,3*** [30,5-343,2]	26,2*** [11,6-58,8]

Source: DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.

*Survey date: T1= 1992/93 in Dakar and 1993 in Ouaga and Nairobi; T2= 1997/98 in Dakar, 1999 in Ouaga and Nairobi; T3= 2005 in Dakar, 2003 in Ouaga and Nairobi; T4= 2010/11 in Dakar, 2010 in Ouaga and 2009 in Nairobi.

Table 3 (cont'd)

Ref. Below 24 months	24-41 months			42-59 months			60+ months		
					Model 5				
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1		1	1		1	1		1	1
T2		1,1 [0,9-1,3]	0,9 [0,7-1,3]		1,3** [1,06-1,6]	1,5* [1-2,4]		1,9*** [1,4-2,5]	1 [0,6-1,7]
T3		1,1 [0,9-1,3]	1,2 [0,9-1,5]		1,8*** [1,4-2,3]	1,7** [1,1-2,5]		2,4*** [1,69-3,28]	1,8** [1,2-2,8]
T4		1,3** [1,1-1,5]	1,2 [0,9-1,7]		2,4*** [1,9-2,9]	2,6*** [1,7-3,9]		4,3*** [3,3-5,5]	2,7*** [1,7-4,2]
Religion									
Christian		1	1		1	1		1	1
Muslim		1,0 [0,9-1,2]	0,5*** [0,3-0,6]		0,94 [0,8-1,1]	0,4*** [0,3-0,6]		0,8* [0,7-1,0]	0,3*** [0,2-0,6]
					Model 6				
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	1 [0,7-1,4]	1,5*** [1,2-1,8]	1,3** [1,1-1,6]	1,6* [1-2,4]	1,3 [0,9-1,7]	1,9*** [1,4-2,4]	1 [0,6-1,6]
T3	1,0 [0,9-1,2]	1,1 [0,9-1,3]	1,3* [1-1,7]	1,6*** [1,3-1,9]	1,8*** [1,4-2,3]	1,8** [1,2-2,7]	2,2*** [1,7-2,8]	2,3*** [1,7-3,3]	2,0** [1,3-3,0]
T4	1,1 [0,9-1,2]	1,3** [1,1-1,5]	1,4** [1,0-1,9]	1,9*** [1,6-2,4]	2,3*** [1,9-2,9]	2,8*** [1,9-4,2]	2,32*** [1,77-3,04]	4,1*** [3,1-5,3]	2,9*** [1,9-4,5]
Ethnicity									
Mandinka/Soninke/Joola	1			1			1		
Fulani	1,1 [0,9-1,3]			0,8 [0,6-1,1]			0,7** [0,5-1]		
Serer	1,1 [0,9-1,4]			0,9 [0,7-1,2]			0,8 [0,5-1,1]		
Wolof	1,2* [1-1,4]			0,9 [0,7-1,1]			0,9 [0,6-1,2]		
Kamba			1			1			1
Kikuyu			1 [0,7-1,3]			1,5** [1,0-2,3]			1,5* [1-2,3]
Luhya			0,7** [0,5-1]			1,2 [0,8-1,9]			0,7 [0,5-1,2]
Luo			1,1 [0,8-1,6]			1,2 [0,7-1,8]			0,8 [0,5-1,4]
Somali/Kalenjin/Kisii			0,4*** [0,3-0,6]			0,6** [0,4-0,9]			0,4*** [0,2-0,6]
Mossi		1			1			1	
Other	1,12 [0,87-1,43]	1 [0,8-1,2]	0,8 [0,5-1,2]	0,94 [0,68-1,3]	1,1 [0,9-1,3]	1,8** [1,1-3,1]	1 [0,7-1,5]	1,5*** [1,2-1,9]	1,5 [0,9-2,6]
					Model 7				
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,1-1,4]	1,1 [0,9-1,3]	0,9 [0,7-1,3]	1,5*** [1,2-1,8]	1,4** [1,1-1,7]	1,5* [1-2,3]	1,2 [0,9-1,6]	2*** [1,5-2,6]	0,9 [0,5-1,5]
T3	1,0 [0,9-1,2]	1,1 [0,9-1,4]	1,1 [0,9-1,4]	1,6*** [1,3-1,9]	1,9*** [1,4-2,4]	1,6** [1,1-2,4]	2,1*** [1,6-2,6]	2,5*** [1,8-3,41	1,7** [1,1-2,6]
T4	1,1 [0,9-1,2]	1,4** [1,1-1,6]	1,2 [0,9-1,6]	1,9*** [1,6-2,4]	2,5*** [2,0-3,1]	2,5*** [1,7-3,7]	2,3*** [1,7-3,0]	4,2*** [3,2-5,5]	2,5*** [1,6-3,9]
Ever-use of contraception									
No	1	1	1	1	1	1	1	1	1
Yes	0,9 [0,8-1,0]	1,3*** [1,1-1,5]	1,3* [1-1,6]	1 [0,8-1,1]	1,4*** [1,2-1,6]	1,5** [1,1-2]	1,2** [1,1-1,5]	1,2 [0,9-1,4]	2,1*** [1,4-3,1]

Source: DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.
*Survey date: T1= 1992/93 in Dakar and 1993 in Ouaga and Nairobi; T2= 1997/98 in Dakar, 1999 in Ouaga and Nairobi; T3= 2005 in Dakar, 2003 in Ouaga and Nairobi; T4= 2010/11 in Dakar, 2010 in Ouaga and 2009 in Nairobi.

Table 3 (end)

Ref. Below 24 months	24-41 months			42-59 months			60+ months		
Model 8									
Survey date	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	1 [0,7-1,4]	1,47*** [1,2-1,8]	1,3** [1,1-1,6]	1,6** [1,0-2,4]	1,3 [0,9-1,7]	1,9*** [1,5-2,5]	1 [0,6-1,7]
T3	1,0 [0,9-1,2]	1,1 [0,9-1,4]	1,2 [0,9-1,5]	1,6*** [1,3-1,9]	1,9*** [1,4-2,4]	1,6** [1,1-2,4]	2,2*** [1,7-2,8]	2,5*** [1,8-3,4]	1,8** [1,15-2,7]
T4	1,1 [0,9-1,3]	1,3** [1,1-1,6]	1,3 [0,9-1,7]	2*** [1,6-2,4]	2,4*** [2-3,0]	2,6*** [1,7-3,9]	2,3*** [1,8-3,1]	4,2*** [3,2-5,4]	2,7*** [1,7-4,1]
Parity	1,1*** [1,0-1,1]	1,1** [1,0-1,1]	1,1** [1,0-1,2]	1,1** [1,0-1,1]	1,1** [1,0-1,1]	1 [0,9-1,1]	1,01 [0,9-1,1]	1,0 [1-1,1]	1,0 [0,9-1,1]
Model 9									
Year	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,1 [0,9-1,3]	1 [0,7-1,31]	1,5*** [1,2-1,8]	1,3** [1,1-1,6]	1,6** [1,1-2,5]	1,3 [0,9-1,7]	1,9*** [1,5-2,5]	1 [0,6-1,7]
T3	1,0 [0,9-1,2]	1,1 [0,9-1,3]	1,1 [0,85-1,5]	1,6*** [1,3-1,9]	1,8*** [1,4-2,3]	1,6** [1,1-2,4]	2,1*** [1,7-2,8]	2,4*** [1,7-3,4]	1,8** [1,2-2,7]
T4	1,0 [0,9-1,2]	1,3** [1,1-1,5]	1,2 [0,9-1,6]	1,9*** [1,6-2,3]	2,3*** [1,9-2,9]	2,5*** [1,7-3,8]	2,3*** [1,8-3,0]	4,1*** [3,1-5,3]	2,7*** [1,7-4,1]
Sex									
Male	1	1	1	1	1	1	1	1	1
Female	1 [0,8-1,1]	1,0 [0,9-1,2]	1,2* [1-1,4]	1,0 [0,9-1,2]	1 [0,8-1,1]	1,2 [0,9-1,5]	0,9 [0,8-1,1]	0,9 [0,8-1,1]	1 [0,8-1,3]
Final model									
Ref. Below 24 months	24-41 months			42-59 months			60+ months		
Year	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi	Dakar	Ouaga	Nairobi
T1	1	1	1	1	1	1	1	1	1
T2	1,2** [1,0-1,4]	1,2* [1-1,4]	0,9 [0,7-1,3]	1,4*** [1,2-1,8]	1,4** [1,1-1,7]	1,3 [0,8-2,0]	1,2*** [0,9-1,6]	1,9*** [1,4-2,5]	0,7 [0,4-1,2]
T3	1,0 [0,9-1,2]	1,1 [0,8-1,3]	1,2 [0,9-1,6]	1,6*** [1,3-1,9]	1,6*** [1,2-2,1]	1,4 [0,9-2,1]	1,9*** [1,5-2,5]	1,9*** [1,3-2,7]	1,3 [0,8-2,1]
T4	1,1 [0,9-1,2]	1,2** [1,0-1,5]	1,2 [0,9-1,7]	1,8*** [1,4-2,2]	2,1*** [1,7-2,7]	1,9** [1,2-2,9]	1,9*** [1,43-2,5]	3,0*** [2,3-4,0]	1,6* [1,0-2,6]
Education									
None	1	1	1	1	1	1	1	1	1
Primary	1,0 [0,9-1,2]	1,3** [1,1-1,6]	1,2 [0,8-1,7]	1,1 [0,9-1,3]	1,3** [1,1-1,6]	1,6 [0,9-2,7]	1,1 [0,8-1,4]	1,5** [1,2-2,0]	1,9** [1,0-3,6]
Secondary and higher	0,9 [0,8-1,06]	1,1 [0,9-1,4]	1,1 [0,8-1,6]	0,8 [0,7-1,1]	1,3* [1-1,7]	2,2** [1,2-3,8]	1,1 [0,8-1,4]	1,5** [1,1-2,1]	2,6** [1,3-5,0]
Household standard of living									
Low	1	1	1	1	1	1	1	1	1
Medium	1,1 [0,9-1,2]	0,9 [0,8-1,1]	0,9 [0,7-1,2]	0,9 [0,8-1,1]	0,9 [0,8-1,2]	0,9 [0,6-1,2]	1,1 [0,9-1,4]	1,0 [0,8-1,4]	0,7* [0,5-1,0]
High	1,0 [0,9-1,2]	1 [0,8-1,2]	0,9 [0,7-1,2]	1,1 [0,9-1,3]	1,0 [0,8-1,3]	0,8 [0,6-1,2]	1,2 [0,9-1,5]	1,2 [0,9-1,7]	0,5** [0,3-0,8]
Marital status									
In a union	1	1	1	1	1	1	1	1	1
Other	1,1 [0,9-1,3]	0,8** [0,6-0,9]	0,8* [0,6-1,0]	1,1 [0,9-1,5]	0,9 [0,7-1,2]	1,2 [0,8-1,6]	1,7*** [1,2-2,3]	0,7 [0,5-1,1]	1,5** [1,1-2,1]
Age									
12-19	1	1	1	1	1	1	1	1	1
20-29	1,8*** [1,5-2,1]	3,3*** [2,7-4,1]	2,5*** [1,8-3,4]	5,5*** [3,7-8,2]	5,5*** [4,0-7,8]	6,5*** [3,7-11,5]	18,6*** [6,8-51,2]	38,3*** [11,5-127,8]	10,55*** [4,74-23,5]
30-49	2,7*** [2,1-3,5]	6,0*** [4,4-8,2]	4,0*** [2,6-6,3]	14,7*** [9,4-22,8]	20,9*** [13,7-31,9]	14,1*** [7,1-27,9]	110,5*** [39,4-310,2]	356,9*** [103,7-1228,6]	74,7*** [30,8-181,4]
Religion									
Christian		1	1		1	1		1	1
Muslim		1,1 [0,9-1,2]	0,7** [0,4-0,9]		1,0 [0,9-1,2]	0,5** [0,3-0,9]		1,0 [0,8-1,3]	0,6 [0,3-1,2]

Ethnicity									
Mandinka/Soninke/Joola	1			1			1		
Fulani	1,1 [0,89-1,3]			0,9 [0,7-1,1]			0,8 [0,6-1,1]		
Serer	1,1 [0,9-1,4]			0,9 [0,6-1,2]			0,8 [0,5-1,1]		
Wolof	1,2 [0,9-1,4]			0,9 [0,7-1,1]			0,8 [0,6-1,1]		
Kamba			1			1			1
Kikuyu			0,9 [0,7-1,3]			1,44* [0,95-2,19]			1,3 [0,9-2,0]
Luhya			0,6** [0,4-0,9]			1,25 [0,79-1,98]			0,8 [0,5-1,3]
Luo			1,1 [0,8-1,5]			1,28 [0,81-2,02]			1,0 [0,6-1,6]
Somali/ Kalenjin/Kisii			0,5*** [0,3-0,7]			0,86 [0,47-1,57]			0,5* [0,3-1,0]
Mossi		1			1			1	1
Other	1,1 [0,9-1,5]	1,0 [0,8-1,2]	1 [0,6-1,6]	1,0 [0,7-1,3]	1,0 [0,8-1,2]	2,2** [1,2-4,0]	1,1 [0,7-1,6]	1,2 [0,9-1,5]	1,7 [0,9-3,3]
Ever-use of contraception									
No	1	1	1	1	1	1	1	1	1
Yes	0,9 [0,8-1,0]	1,2** [1,0-1,4]	0,9 [0,7-1,2]	0,9 [0,8-1,1]	1,2** [1,0-1,5]	0,9 [0,6-1,2]	1,1 [0,9-1,4]	0,9 [0,71-1,13]	1,22 [0,79-1,89]
Parity	1,0* [0,9-1,0]	0,9*** [0,8-1,0]	1,0 [0,9-1,1]	0,9*** [0,8-0,9]	0,8*** [0,8-0,9]	0,9** [0,8-1,0]	0,8*** [0,7-0,9]	0,7*** [0,6-0,8]	0,7*** [0,6-0,8]
Sex									
Male	1	1	1	1	1	1	1	1	1
Female	1,0 [0,9-1,1]	1,0 [0,9-1,2]	1,1 [0,9-1,4]	1,0 [0,9-1,2]	1 [0,9-1,2]	1,1 [0,8-1,4]	0,9 [0,7-1,1]	1,0 [0,8-1,2]	0,9 [0,7-1,2]

Source: DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.
*Survey date: T1= 1992/93 in Dakar and 1993 in Ouaga and Nairobi; T2= 1997/98 in Dakar, 1999 in Ouaga and Nairobi; T3= 2005 in Dakar, 2003 in Ouaga and Nairobi; T4= 2010/11 in Dakar, 2010 in Ouaga and 2009 in Nairobi.

The model used to establish the determinants of the spacing categories is generally highly significant at 0.1% in all contexts (Table 4). At 5%, the homoscedasticity assumption is not met in Dakar (there may be missing explanatory variable) but is met in Ouagadougou and Nairobi. Last, the independence of irrelevant alternatives assumption (IIA) is met with a p-value of almost 1 in all contexts.

Table 4. Summary of hypotheses

	Dakar		Ouaga		Nairobi	
Hypotheses	Chi	p-value	Chi	p-value	Chi	p-value
Overall significance: LR Test	652,08	< 2,22e-16	852,84	< 2,22e-16	431,49	< 2,22e-16
Homoscedasticity Wald test	16,174	0,001044	*	*	*	*
IIA: Hausman-McFadden test	-10,948	1	-0,2169	1	-23,457	1
McFadden R^2	0,037		0,056		0,069	

* Non-reversible Matrix of the heteroscedastic model

Impact of spacing on fertility decline in Dakar and Nairobi

The above results show that birth spacing in the three capital cities, all currently characterized by low fertility, has lengthened in recent decades in conjunction with a "rapid" fertility decline. In this last section we will quantify the effect of lengthening birth intervals on the fertility decline in two cities (Dakar and Nairobi) between 1978 and 2010; no data series dating back to the 1970s are available for Ouagadougou.

Table 5 gives the results of applying McDonald's model, with the percentage contribution to fertility reduction between 1978 and 2010 of birth postponement, increased birth spacing and progressive family size limitation. The mean age at first childbirth increased by 2.6 years in Dakar and 2.9 years in Nairobi between 1978 and 2010 (Table 4). Age at last childbirth fell from 35.8 to 33.9 years (a drop of 23 months) in Dakar over the same period, and from 34.5 to 31.0 years in Nairobi (a drop of 30 months). As mentioned above, mean birth intervals rose from 30 to 35 months (increase of 5 months) in Dakar and from 27 to 39 months (increase of 12 months) in Nairobi.

McDonald's model estimates the number of children per fertile woman, i.e. those who have had at least one child; this number is, by definition, higher than the total fertility rate, which includes women who are still childless. The mean number of children per fertile woman fell from 7.8 to 5.3 (6.5 to 3.7 for the TFR) in Dakar between 1978 and 2010, while in Nairobi it fell from 8.3 to 4.0 (6.1 to 2.6 for the TFR) over the same period.

In Dakar, birth postponement has the strongest effect on fertility decline, causing a 13.6% reduction over three decades. Spacing is not far behind, with a 12.8% contribution, while family size limitation contributes 9.7%. In Nairobi, spacing has the strongest effect, making a 27% contribution to fertility decline, versus 19% for family size limitation via an earlier age at last childbirth, and a 15.7% for birth postponement. Spacing has thus played a role in both cities. While it ranks in second position in Dakar, the difference with respect to postponement is small (below 1%).

Table 5. Birth intervals, age at first and last birth of fertile women in Dakar and Nairobi, 1978-2010

Indicators	Dakar				Nairobi			
	Mean 1978	Mean 2010-11	Fertility induced by the variation	Fertility decline (%)	Mean 1977-78	Mean 2009	Fertility induced by the variation	Fertility decline (%)
Age at firth birth (years)	18,565	21,243	6,8	13,60%	18,211	21,125	7	15,70%
Age at last birth (years)	35,793	33,868	7,1	9,70%	34,53	30,985	6,7	19,10%
Birth interval (years)	2,525	2,958	6,8	12,80%	2,25	3,258	6	27,20%
Number of children per fertile woman	7,8	5,3			8,3	4		

Source: WFS 1978 in Senegal, WFS 1977-78 in Kenya, DHS 2010/-11 in Senegal, DHS 2009 in Kenya.

Discussion and conclusion

Caldwell et al. (1992) predicted that intervals between births would increase during the fertility transition in sub-Saharan Africa. Timaeus and Moultrie (2008, 2012) and Towriss (2014) have shown that this has indeed been the case for a number of countries in southern and East Africa. Our own analysis of three capital cities confirms that birth intervals have lengthened considerably in Ouagadougou and Nairobi, and to a lesser extent in Dakar. Fertility has declined sharply in all three cities over the last four decades. In addition, our quantification of the impact of birth spacing on fertility decline shows that – contrary to Europe in the past – the ongoing decrease in Nairobi is driven mainly by longer birth intervals and that in Dakar, the contribution of wider spacing is equivalent to that of postponement. These findings are consistent with those of Caldwell et al. (1992), Johnson-Hanks (2007), Timæus and Moultrie (2008, 2013) and Moultrie et al. (2012), who postulated that the African fertility transition would be different from that of other societies where family size limitation played a central role.

In certain respects, the lengthening of birth intervals has occurred in an identical manner in all three cities. It concerns all socioeconomic and demographic categories (except for the under-20s and high parities in all three cities, and the poorest women in Dakar). On average, the most educated women have longer birth intervals in Ouagadougou and Nairobi, while in Dakar the intervals are the same for all levels of education. In terms of household wealth, the wealthiest women have longer birth intervals, on average in Ouagadougou and Dakar, but no difference is observed in Nairobi. No significant differences between household wealth categories are noted in any context in the Cox model. That situation is due certainly to the recent differences between categories of wealth index, there are few cases with differences. We also observe that, according to DHS data, the ethnic groups with longer mean birth intervals are those with an advance in terms of fertility reduction (the Joola in Senegal, ethnic minorities in Burkina Faso, and the Kikuyu in Kenya). With regard to types of spacing, large variations are observed only in Nairobi, where long intervals (42-59 months) are associated with the Kikuyu, an “elite” cultural group in Kenya (Beguy and Mberu, 2015).

These findings run counter to the “social uncertainty” theory whereby in a context of socioeconomic instability, i.e. poverty, unemployment, poor infrastructure, disease, famine, etc., couples wait for the situation to improve before having an additional child (Johnson-Hanks, 2007; Timæus and Moultrie, 2008, 2013; Moultrie et al, 2012). Our results show, on the contrary, that longer birth intervals generally appear to be chosen by the “elites”. A small share of very long birth intervals appear to be distributed randomly, suggesting that long intervals do not always reflect a deliberate strategy, but rather, in some cases, a situation beyond individual control. However, our findings also confirm that very long intervals of 5 years and more are more frequent among poor women in Nairobi. Moreover in Cox multivariate analysis, the poorest have longer intervals than the richest. In this city, where the fertility transition has progressed faster than in the other two, the reproductive behaviours of the wealthier social groups have already spread to the poorest groups, with long birth intervals being observed among all social classes from the 1990s. The adoption of long intervals by the poorest people seems to follow a specific rationale, corresponding to the arguments of “social uncertainty” theory. In her qualitative research, Towriss (2014) showed that in Korogocho and Vivandani, two informal settlements in Nairobi, the trade-off between the “costs” and “benefits” of children is now an important factor and that the main reason for birth postponement is the prohibitive cost of raising a child. These disadvantaged populations seem to be applying a “Malthusianism of poverty”, in terms of both birth spacing and family size limitation.

The widespread availability and uptake of contraceptives in Nairobi, even among the poorest women (Oranje and Zulu, 2015) thus appears to facilitate a preference for long birth intervals in all social classes. However, our results show that ever-use of contraception is linked to the adoption of long birth intervals in Ouagadougou, but not in Nairobi or Dakar. The extensive use of contraceptives in Nairobi, and their lesser prevalence in Dakar at the time of our study may explain the similarity in the multinomial multivariate analysis between contraceptive ever-users and never-users in these two cities. In Senegal, contraceptive prevalence has been increasing since the early 2010s. Contraception “ever use” variable is not a good variable for this analysis, further investigations could be made with other contraceptive data. The

Senegalese government authorities have devoted considerable resources to promoting family planning and increasing contraceptive availability (Benson et al., 2018). In 2017, according to Continuous-DHS data, contraceptive prevalence among women in a union was estimated at 42.3% in Dakar (ANSD and Macro Int, 2018). Modern contraceptive use is also rising in Burkina Faso, with an urban prevalence (among women in a union) that increased from 33.4% to 44.4% between 2015 and 2017 (PMA2020/Burkina Faso). These developments in Dakar and Ouagadougou have probably increased birth spacing and contributed to the diffusion of long birth intervals among the different sociodemographic categories since 2010. The mean birth interval (calculated by the authors and not presented here) in Dakar based on the Continuous-DHS 2017 is no different (non-significant difference) from that estimated using DHS-2010-11. This may be linked to the small sample size, but also to the smaller number of births, given that fertility has decreased substantially since 2010 (a drop in TFR from 3.7 to 3.0 between 2010 and 2017). Unfortunately, we cannot yet use the new data available for Ouagadougou (PMA2020) to extend the analyses for this city as the relevant sub-sample is not representative of the capital.

Our analysis has revealed other differences in birth spacing between the cities. First, in Dakar and Ouagadougou, long birth intervals are now very frequent, at median and older ages especially; very long intervals remain rare. In Nairobi, older women also choose long intervals, and very long intervals are more common. As already stated, fertility levels in Dakar and Ouagadougou in the early 1990s were similar to that of Nairobi in the period 1984-88 (estimated at 4.5 children per woman at that time). Nairobi was thus more advanced in the fertility transition than the two other cities. This difference may explain the rapid diffusion in Nairobi of longer birth intervals of up to 5 years among women of median and older ages, and the emergence of a new behaviour in the form of birth intervals exceeding 5 years. In a context of rapid increase in contraceptive use, this same pattern may be observed in Dakar and Ouagadougou after 2010. With regard to religion, spacing behaviours in West Africa (Dakar, Ouagadougou) are similar across all religions while in Nairobi Christians have longer birth intervals, all other things being equal. This difference in Nairobi may reflect the role of missionaries in encouraging women to reduce their family size in East Africa (Doyle, 2013). In addition, the smaller disparities in spacing behaviour between the different socioeconomic groups in Dakar with respect to the other two cities and the generally shorter birth intervals may be explained by a preference in Dakar (at the time of the study) for birth control methods such as breastfeeding and post-partum abstinence which could not be included in this analysis. Indeed, complementary analyses confirm that traditional/natural methods are more widely used in Dakar than in the two other cities (result not presented).

This study is limited by the lack of information on the woman's characteristics (education, standard of living, contraceptive status, marital status) at the time of childbirth, some of which may change over time. It is also limited by the absence in multivariate models of breastfeeding, postpartum abstinence witch could be strongly correlated with spacing duration particularly in Dakar.

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Appendices

Table A1. Distribution (%) of birth intervals between 1978 and 2010 in Dakar, Nairobi and Ouagadougou (four DHS surveys and one WFS survey) by women's socioeconomic and demographic characteristics

Variables	Category	Overall (T1, T2, T3, T4)			Td		T1			T2			T3			T4		
		Dakar	Nairobi	Ouaga	Dakar	Nairobi	Dakar	Nairobi	Ouaga	Dakar	Nairobi	Ouaga	Dakar	Nairobi	Ouaga	Dakar	Nairobi	Ouaga
Survey date	T1*	36.03	16.07	42.94														
	T2*	22.48	16.85	23.07														
	T3*	23.44	40.61	12.01														
	T4*	18.06	26.46	21.98														
Education	None	56.78	10.51	63.06	82.45	32.84	66.14	19.85	67.28	52.69	2.18	64.64	50.42	14.40	56.67	51.46	4.17	56.65
	Primary	27.94	44.74	21.06	13.98	53.20	20.96	52.16	20.47	30.09	54.13	18.75	34.14	41.49	21.67	31.12	39.26	24.30
	Secondary +	15.28	44.74	15.88	3.57	13.01	12.89	27.99	12.26	17.21	43.69	16.61	15.44	44.11	21.67	17.42	56.57	19.05
Standard of living	Low	34.58	35.71	34.69	33.78	38.17	34.80	34.66	33.50	34.69	35.26	36.05	34.10	35.20	35.09	34.80	34.58	35.71
	Medium	33.85	32.31	33.29	33.20	28.75	32.83	33.67	32.77	33.96	34.42	32.02	32.82	34.62	34.62	33.75	33.85	32.31
	High	31.57	31.98	32.01	33.02	33.08	32.37	31.67	33.74	31.35	30.32	31.92	33.08	30.17	30.29	31.44	31.57	31.98
Ever use of contraceptives	No	46.55	18.85	34.57			57.49	25.70	25.30	43.79	11.89	39.03	37.68	23.06	36.54	39.65	12.67	46.92
	Yes	53,45	81,15	65,43			42,51	74,30	74,70	56,21	88,11	60,97	62,32	76,94	63,46	60,35	87,33	53,08
Mother's age	12-19	8.16	10.92	8.08	11.59	18.3	8.73	17.05	8.89	7.26	14.32	9.27	8.93	8.96	6.41	7.14	8.04	6.16
	20-29	59.71	68.38	64.57	61.03	64.0	60.99	67.18	64.73	58.61	68.20	63.24	57.94	71.40	65.77	60.79	64.61	64.99
	30-49	32.14	20.70	27.35	27.38	17.71	30.28	15.78	26.38	34.13	17.48	27.48	33.13	19.64	27.82	32.07	27.36	28.85
Marital status	In a union	90.43	78.90	89.60	95.16	88.0	90.98	75.32	91.90	91.16	77.43	86.72	89.44	78.05	83.21	89.72	83.31	91.60
	Other	9.57	21.10	10.40	4.84	12.0	9.02	24.68	8.10	8.84	22.57	13.28	10.56	21.95	16.79	10.28	16.69	8.40
Religion*	Christian	2.03	87.40	51.49	6.50	97.5	0.00	89.31	44.87	0.00	91.02	67.91	5.17	84.39	69.23	4.52	88.56	37.46
	Muslim	39.47	10.06	47.91	93.27	1.3	0.00	9.67	54.55	0.00	7.28	31.89	94.83	12.69	30.26	95.48	8.04	61.41
	Other	0.00	2.45	0.35	0.23	1.2	0.00	0.76	0.00	0.00	1.46	0.20	0.00	2.92	0.51	0.00	3.40	1.12
	Missing	58.51	0.08	0.25			100.00	0.25	0.57	100.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sex of child	Female	49.19	50.63	48.68	49.35	50.77	49.82	51.15	48.03	48.42	50.00	50.70	49.07	50.15	47.44	49.05	51.47	48.53
	Male	50.81	49.37	51.32	50.65	49.23	50.18	48.85	51.97	51.58	50.00	49.30	50.93	49.85	52.56	50.95	48.53	51.47
Parity	2	27.62	44.58	30.35	23.35	26.82	25.46	38.17	26.92	25.88	42.48	29.02	28.86	44.31	35.26	32.80	50.39	35.43
	3	21.03	25.81	23.12	19.13	21.23	20.31	24.17	21.86	19.91	27.43	22.88	21.73	26.69	23.46	22.59	24.11	25.77
	4	15.94	14.52	16.75	15.62	15.58	16.36	15.27	17.17	15.57	15.78	16.54	15.72	14.80	16.54	16.33	12.52	16.60
	5	12.29	7.61	11.02	12.76	11.54	13.00	8.91	11.65	12.12	7.52	11.41	11.34	7.25	10.13	11.88	7.73	9.80
	6	8.84	4.05	7.77	9.60	8.60	9.57	5.85	8.57	9.48	4.13	8.41	8.20	4.23	6.79	7.29	2.94	5.81
	7	5.97	1.96	5.09	7.55	6.25	6.68	3.56	6.02	6.79	1.94	5.27	5.67	1.91	4.62	4.37	1.08	3.78
	8 et +	8.29	1.47	5.90	12.0	9.99	8.62	4.07	7.81	10.25	0.73	6.47	8.48	0.81	3.21	4.66	1.24	2.80
Ethnicity	Mandinka/Soninke/Joola	11.91		0.00	7.72		13.15			12.70			9.26			11.88		
	Fulani	20.36			15.39		16.54			23.07			22.68			21.57		
	Serer	13.67			12.99		13.70			10.19			16.34			14.50		
	Wolof	45.78			52.02		52.23			47.48			41.55			36.30		
	Kamba		15.46			16.53		18.32			19.17			14.30			13.14	
	Kikuyu		29.53			37.77		25.70			36.89			25.08			34.00	
	Luhya		15.58			16.31		15.01			19.42			16.92			11.44	
	Luo		20.86			24.32		30.28			15.78			20.64			18.70	
	Somali/Kaleniin/Kisii		10.31					2.54			2.91			14.20			13.76	
	Mossi			80.47					82.01			77.52			76.15			82.91
	Other	8.16	8.26	18.45	11.88	5.07	4.27	8.14	15.48	6.56	5.83	22.48	9.83	8.86	23.85	15.74	8.96	17.09
	Missing	0.12	0.00	1.08			0.11	0.00	2.51	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00
Number of birth intervals		7599	2445	6497	1709	1361	2738	393	2790	1708	412	1499	1781	993	780	1372	647	1428
Number of mothers		2887	1792	2762	510	482	896	242	1040	581	259	600	732	715	378	678	576	744

Source: DHS 1990-2010 in Senegal, Kenya and Burkina Faso; authors' calculations.

*Survey date: T1= 1992/93 in Dakar and 1993 in Nairobi and Ouaga; T2= 1997/98 in Dakar, 1999 in Ouaga and Nairobi; T3= 2005 in Dakar, 2003 in Nairobi and Ouaga; T4= 2010/11 in Dakar, 2009 in Nairobi and 2010 in Ouaga