FERTILITY DECLINE AND BIRTH INTERVALS: IS AFRICA DISTINCT?

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ABSTRACT

Caldwell *et al.* (1992) argued two decades ago that fertility decline in sub-Saharan Africa would be distinctive from a comparative historical perspective. One element in the Caldwell *et al.* argument is a more prominent role for changes in birth-spacing behaviors. The recent research of Moultrie and Timeaus has supported Caldwell *et al.*'s argument, and they have proposed that "birth postponement" is a crucial and exceptional feature of African declines. We assess these and related arguments by analyzing trends in birth interval distributions in six non-African and two African societies that have experienced substantial fertility decline during the past three decades. We also examine recent birth interval distributions in thirty-two sub-Saharan African countries. Our principal conclusions are: (1) The lengthening of inter-birth intervals is a feature of fertility declines in most contemporary societies, with increases in median interval lengths ranging from six months to two years. We believe this phenomenon has generally gone unnoticed by scholars. (2) African declines to date have been characterized by the lengthening of inter-birth intervals, as Moultrie *et al.* have demonstrated. However, in light of our first conclusion, this recent African experience is by no means "exceptional". (3) The potential contribution to African fertility decline of further lengthening of intervals is difficult to assess. On the one hand, African societies with moderate levels of fertility (mainly in southern African) are now characterized by relatively long inter-birth intervals; this could be a pathway for other African societies to follow. On the other hand, from a multi-regional perspective birth intervals in pre- and early-decline Africa societies are already rather long on average, raising some doubts whether many African societies have the potential for an increase in inter-birth intervals of sufficient magnitude (e.g. > one year) to result in meaningful fertility decline.

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I. Introduction

From the earliest efforts to understand African reproductive regimes up to the present, birth-spacing patterns and practices have received considerable attention. Early ethnographic research documented the existence of explicit norms about birth-spacing and, more specifically, post-partum practices (breastfeeding and abstinence) that appeared to be widely observed. Quantitative demographic evidence for a limited number of African societies was first assembled in Page and Lesthaeghe's (1981) landmark volume, which was soon followed by more extensive quantitative evidence in the eight African World Fertility Surveys conducted from 1977 - 1982. This research confirmed that post-partum practices which lengthened inter-birth intervals was the major explanation for the rather moderate levels of pre-transition fertility in most African societies. This research also demonstrated that birth-spacing varied widely within sub-Saharan Africa; in particular, in general birth intervals were shorter in East Africa societies than in West Africa.

More recently birth-spacing has figured prominently in discussions of African fertility decline – the prospects for near-term decline, and the likely character of African fertility declines. In their highly influential article nearly two decades ago, Caldwell *et al*. (1992) propose that the fertility transition in sub-Saharan Africa will assume a different character than transition in other major regions, due to three existing features of African reproductive regimes: (1) weaker restraints on pre-marital and ex-marital sexuality; (2) less marital stability; and (3) more felt need for birth-spacing. Inferring from these distinctive features, Caldwell *et al.* conclude that African women's demand for contraception will be rather uniform across age and parity, in contrast to other regions (Asia in particular). This leads to a prediction that fertility decline in African societies will occur at all ages, in stark contrast to the transition from natural to controlled fertility in other regions that was dominated by adoption of family limitation practices at higher parities and later ages. Subsequent ethnographic and qualitative research has, in a very general fashion, reinforced Caldwell *et al*.'s argument: Bledsoe *et al.* (1998) and Johnson-Hanks (2004) provide evocative descriptions of the deliberate effort that African women invest in birth-spacing (in Gambia and Cameroon, respectively), as motivated by various economic, social, and health concerns; and Agadjanian (2005) and Johnson-Hanks (2004, 2007) argue that birth control (in Mozambique and Cameroons, respectively) is not motivated by conscious family-limitation goals, rather simply by a desire to avoid a pregnancy (and the resulting additional child) in the present uncertain and inauspicious moment.

The most ambitious and creative pursuit of these themes is offered by the very recent research of Moultrie and Timeaus (Timeaus & Moultrie 2008, Moultrie & Timeaus 2010, Moultrie *et al.* 2011). Moultrie and Timeaus propose a distinct motivation for birth avoidance which they term "postponement", consisting of a desire to avoid a birth in the present without any fixed plans for a birth in the future (as would be the case for conscious birth-spacing motivation). While birth-spacing motivation, as defined by these authors, is dependent on the duration since the most recent birth (or, alternatively, age of the youngest child), postponement is independent of both parity and duration since the most recent birth. There are then, according to these authors' framework, three fundamental motivations for birth avoidance: birth spacing, birth postponement, and birth limitation. Moultrie and Timeaus go on to argue that the three motivations express themselves in distinct duration-patterns of the birth hazard (i.e. hazard of another birth following a birth). In empirical analysis these authors find evidence of birth postponement in South African data (Timeaus & Moultrie 2008), indeed they argue that birth postponement made a major contribution to fertility decline in South Africa during the 1980s and 1990s. In subsequent work, Moultrie *et al.* (2010, 2011) have applied the same techniques to DHS data from 25 sub-Saharan African countries. They conclude:

> Birth intervals have lengthened in every country examined. This analysis uncovers a distinctive and previously undocumented pattern of childbearing that is prevalent across sub-Saharan Africa. After allowing for time trends in birth interval length, the lengthening of birth intervals in almost every country varies little by women's age or parity. Moreover, in several countries, birth intervals are now too long to be explicable by birth spacing contingent on the age of women's youngest child. Rather, women are postponing births for other reasons. These findings offer empirical support for the Caldwells' assertion that the decline in fertility in sub-Saharan Africa will follow a different pattern from that observed elsewhere. (Abstract, Moultrie *et al.* 2011)

In short, birth postponement is now a widespread phenomenon in sub-Saharan Africa and has the potential to substantially reduce fertility in the region, and its occurrence varies little by stage of the reproductive career (indexed by either age or parity).

The authors also claim, citing European evidence and presenting analysis of birth history data from four non-African countries (Peru, Egypt, Vietnam, Philippines), that birth postponement has made little contribution to fertility declines in other settings. Therefore "the sub-Saharan African fertility transition is currently being driven by postponement and is following a fundamentally different path from earlier fertility transitions" (Moultrie *et al.* 2011). We note that this strong conclusion is based on minimal reference to the large literature on fertility decline in the West (Europe and North America) and limited analysis of contemporary fertility declines. Indeed, we are struck by the neglect of the historical decline in the West in the recent literature on African fertility decline; this leaves African researchers

vulnerable to formulating arguments about African exceptionalism that lack empirical foundation. To a lesser extent the same neglect of historical evidence on the West characterizes the literature on fertility decline in other regions (Asia, Latin America). In addition, to our knowledge the literature on these other non-Western regions does not contain rigorous examination of the contribution (or non-contribution) of birth-spacing to the declines that have occurred, in contrast to the recent research on fertility decline in Africa cited above.

This paper is a first (and rudimentary) effort to assess how birth interval distributions change over the course of fertility decline. We address three questions:

- Over the course of fertility declines in regions other than Africa, have birth interval distributions remained relatively stable or changed?
- In fertility declines to date in Africa, is there evidence of a lengthening of birth intervals?
- Given existing birth interval distributions in Africa, what is the potential for fertility decline via lengthening of inter-birth intervals?

These questions clearly place our research in the same territory as the recent research of Moultrie *et al*. Below we will specify the differences in methodology that set our research apart from theirs.

II. Method and Data

II.a. Method

A basic premise guides our choice of methodology: levels of fertility, viewed from either a cohort or period perspective, are a function of three fundamental parameters of the reproductive career, namely:

- Timing of the initiation of childbearing
- Length of inter-birth intervals
- Timing of the cessation of childbearing

This is the conventional "starting, spacing, stopping" categorization, and we see no reason to discard it.

Note that if all couples engage in deliberate parity-dependent behavior – e.g., terminating childbearing after two births – *and* this is entirely successful (i.e. no contraceptive failures), then cohort fertility is fully explained by stopping behavior[1], with period fertility discrepant only due to tempo dynamics and heterogeneity among cohorts. But stopping behavior is hardly universal in pre- and mid-

[1] Women falling short of childbearing goals must also be accounted for. In birth histories this will appear as cessation of childbearing at a certain parity. Only with attitudinal information can it be ascertained whether the achieved parity is less than the target number of children.

transition societies, and, moreover, in no society are birth control efforts perfectly successful. Therefore starting and spacing behavior can have substantial bearing on fertility levels and trends. And, of particular interest in this research, changes in birth intervals over time can contribute to trends in fertility.

For the purposes of demographic analysis of reproduction, the birth-spacing phenomenon of interest is length of inter-birth intervals. A woman's reproductive career consists of a period prior to the first birth, a series of inter-birth intervals, and a period following a last birth. There are two important implications of this perspective. First, it does not recognize the distinction that Moultrie and Timeaus make between "birth spacing" and "birth postponement". This is a motivational distinction, and while there are many good reasons for understanding birth control motivation (whether these concern starting, spacing, or stopping), the motivational underpinnings are ancillary to the demographic analysis of fertility change. That is, the essential questions a demographic analysis should address is whether inter-birth intervals have remained stable or changed, and how the latter has contributed to fertility change. Why the intervals have remained stable or changed is a separate question, which to be sure is of enormous interest. But we share Johnson-Hanks' (2007) qualms about inferring motivation from behavioral patterns alone.

Second, at issue is the length of inter-birth intervals, i.e. the elapsed time between births. Therefore it is crucial to generate estimates that pertain to closed intervals. All birth histories consist of a final open interval, and this final interval should be regarded differently than preceding closed intervals in research that adheres to the starting/spacing/stopping distinction. Analysis that does not separate the two types of intervals confuses *parity progression* and the *pace of childbearing*. In our view these are conceptually distinct: fertility may decline because parity progression falls and/or because the pace of childbearing slows. The design of the analyses by Moultrie *et al.* does not make this distinction cleanly[2], rather it is emergent in the duration-pattern of the hazard in their regression modeling and hence heavily dependent on the validity of the regression model and the validity of the authors' interpretation of the estimated duration-patterns.[3]

The design of our analysis is as follows. Following convention, we label inter-birth intervals according to the birth order of the birth that terminates the interval (i.e. the 2nd interval is the elapsed time between the birth of the 1st child and the birth of the 2nd child). Multiple-birth outcomes (twins, triplets) are treated as one birth outcome, but all births figure into the reckoning of birth order. We examine birth intervals initiated in the period 13-132 months preceding the survey interview. We estimate a "birth

[2] With the exception of a brief examination of median closed birth intervals in a final section in Timeaus & Moultrie (2008).

[3] Because parity progression and pace of progression are not cleanly distinguished, we find Moultrie *et al.*'s (2011) comparison of patterns in Africa vs. other regions difficult to interpret.

function" (Rodriguez and Hobcraft 1980) – the complement of the survivor function, i.e. duration-specific proportions having transitioned to the next birth -- via Kaplan-Meier and making use of uncensored *and* censored (i.e. open intervals at the survey interview) intervals. The birth function is indexed by single months of elapsed time since the previous birth.

To implement the distinction between parity progression and pace of childbearing, we normalize the Kaplan-Meier birth function by setting the birth function at 120 months to 1.0. That is, if we designate the birth function at duration t as $B(t)$, then the normalization is simply

$$B(t)^* = B(t) / B(120)$$

where $B(t)^*$ is the normalized birth function. We regard $B(t)^*$ as an estimate of the distribution of inter-birth intervals for intervals that close within ten years.[4] In this paper we extract from $B(t)^*$ just one indicator, namely the median birth interval, defined as the duration t at which $B(t)^*$ attains 0.50. (Other quantiles have been calculated and will be examined in further analysis.) In this paper we present three sets of median birth intervals: for 2nd intervals, for 3rd intervals, and for intervals of all orders pooled. We focus on lower-order intervals (2nd and 3rd) because until fertility declines to low levels in post-transition societies, most women who bear children experience at least the 2nd interval, and in pre- and mid-transition societies the 3rd interval as well. Higher-order intervals, in contrast, are increasingly selective on fecundability (and volitional factors as well) as fertility declines, and this varying selectivity can easily confound efforts to estimate trends in birth-spacing behavior (van Bavel 2004).

The analysis includes an examination of the association between inter-birth interval and aggregate fertility. For the latter we rely on the period total fertility rate (TFR), calculated for the period 1-36 months preceding the survey interview using standard demographic methodology (i.e. summation of age-specific rates, themselves age-specific ratios of births to woman-months of exposure).

We apply sampling weights are applied in the calculation of both the birth function and the TFR.

II.b. Data

We analyze birth histories collected in the World Fertility Survey (1975 – 1980) [WFS] and the Demographic and Health Survey (1987 to present) [DHS] programs. Both survey programs obtained full

[4] The choice of 120 months is based on an extensive examination of inter-birth intervals of all orders from all of the WFS and DHS surveys which we possess (~230 surveys). While in most surveys a lower value – 108 months or even 96 months – would capture virtually all of the transitions represented by the birth function, there are a few surveys in which 5% or more of the increase in the birth function occurs after eight or nine years. Hence we are conservative and choose 120 months as the normalizing duration.

birth histories from women ages 15-49 (ever-married women only in some surveys, women of all marital statuses in most surveys).

There are two portions to the analysis. The first examines trends in inter-birth intervals. For this, we purposively select eight countries that have experienced substantial fertility decline during the past four decades, represent societal diversity, and have a long series of surveys stretching back to the late 1970s:

Country	Survey Years
Philippines	1978, 1993, 1998, 2003, 2008
Indonesia	1976, 1987, 1991, 1994, 1997, 2002, 2007
Bangladesh	1975, 1994, 1997, 2000, 2004, 2007
Egypt	1980, 1988, 1992, 1995, 2000, 2003, 2005, 2008
Colombia	1976, 1986, 1990, 1995, 2000, 2005, 2010
Peru	1977, 1986, 1991, 1996, 2000, 2007-08
Ghana	1979, 1988, 1993, 1998, 2003, 2008
Kenya	1978, 1989, 1993, 1998, 2003, 2008

In all eight countries the first survey is WFS and the remaining are DHS.

The second portion of the analysis examines recent cross-country variation in the length of inter-birth intervals in sub-Saharan Africa. For this purpose, we examine the most recent DHS survey conducted from 1998 to the present. Surveys in thirty-two countries are available, as listed in Table 2 (which shows the date of the survey).

III. Results

III.a. Fertility decline and inter-birth intervals

As noted above, our analysis of stability/change in inter-birth intervals over the course of fertility decline is confined to eight purposively-selected countries. In all eight countries, the analysis spans three decades (and nearly 35 years in the case of Colombia). Over this period all eight countries have experienced large declines in the TFR, ranging from 1.8 births (Philippines) to 3.4 births (Kenya). Even so, at the last survey the TFR varies from replacement level (Colombia) to nearly five births per woman (Kenya).

Trends in the median birth interval are presented in Table 1 and Figures 1a – 1c. The first finding that emerges – and perhaps the most important finding from this research – is that all of these fertility declines have been characterized by substantial lengthening of inter-birth intervals. Consider the 2nd and 3rd intervals; the amount of increase (months) in the median from the first to the last survey is as follows:

Country	2nd	3rd
Philippines	7	8
Indonesia	24	23
Bangladesh	12	16
Egypt	7	15
Colombia	23	14
Peru	22	17
Ghana	6	5
Kenya	8	7

There is, to be sure, considerable cross-country variability. In general, the increases in the median birth interval are sharper in those countries with more advanced fertility declines (Indonesia, Bangladesh, Colombia, and Peru). However, this cross-country variation in the amount of increase should not obscure the principal finding: in contemporary fertility declines, inter-birth intervals have lengthened, minimally by six months and in some countries by as much as twenty-four months. In some countries the lengthening of inter-birth intervals is of such magnitude that, arguably, it should be viewed as a revolutionary change in the structure of the reproductive career. And yet we are not aware of any pieces in the international research literature that has highlighted this feature of the fertility declines that have occurred during the past five decades.[5]

The connection between fertility decline and inter-birth intervals is examined more directly in Figures 2a – 2c. These figures plot joint trends for the eight countries in the median birth interval (y-axis) and TFR (x-axis, reverse-scaled). The lines are upward sloping to the right, reflecting the fact that birth intervals lengthen as fertility declines. Cross-country variability in the steepness of the slope is indicative of cross-country variability in the extent of birth interval change in relation to TFR decline: a steeper slope indicates relatively more lengthening of birth intervals as compared to the amount of fertility decline, and a gentler slope indicates relatively less lengthening of birth intervals as compared to the amount of fertility decline. Indonesia stands out for its steep slope, especially once the TFR fell to about 3.0. Similarly, the Latin American declines also show a rather steep slope once the TFR fell to 3.5-3.0. In these countries, Figures 2a – 2c suggest that longer inter-birth intervals have made a major contribution to the fertility declines (a formal decomposition would be required to quantify this). Gentler slopes are evident in Philippines, Bangladesh, and the two African countries (Ghana and Kenya). In these countries,

[5] Moultrie *et al*. (2011) analyze trends in birth intervals in sub-Saharan Africa in some detail, and supplement this with equivalent analysis of trends in four other countries (Peru, Egypt, Vietnam, Philippines). A major conclusion from their analysis is that birth intervals are lengthening in Africa, and they also note a similar trend in the four other countries. But their main concern in the inter-regional comparison is not trends *per se* but rather the patterning by age and parity – they detect no patterning in the sub-Saharan African countries, whereas differentials by age and parity differentials are evident in the four other countries (and in historical European data as well).

Figures 2a – 2c suggest a somewhat lesser contribution of longer inter-birth intervals to the fertility decline to date. But the finding of a lengthening of inter-birth intervals over the course of fertility decline stands.

A closer examination of Figures 2a – 2c leads to another conclusion that will require further analysis for confirmation: inter-birth intervals appear to increase more sharply at the later stages of fertility decline. Evidence for this is the relatively smaller birth interval increase in the two African countries, and the increase in the slope in other countries (e.g. Indonesia, Colombia, Peru) once they reach mid-transition. This conclusion is consistent with the argument that, going forward, longer birth spacing can make a major contribution to African fertility declines.

III.b. Variation in inter-birth intervals in sub-Saharan Africa

But an expectation that increases in inter-birth intervals can lead to meaningful fertility decline in sub-Saharan Africa must take into account existing distributions. We assume that the potential for intervals to lengthen is inversely related to current average lengths; further lengthening will be harder to achieve, everything else being equal, where intervals are already rather long. Pre-transition African reproductive regimes – especially reproductive regimes in Central and West Africa – have often been portrayed as typified by long birth spacing (a consequence of strict observance of long breastfeeding and/or long post-partum abstinence) (Page and Lesthaeghe 1981).

Median inter-birth intervals for thirty-two African countries according to the most recent DHS survey are shown in Table 2. As a basis for evaluating these medians, we note that the median 2nd interval is no larger than 30 months at the earliest survey in all of the six non-African countries shown in Table 1. By contrast, quartiles for the median 2nd intervals in Table 2 are as follows:

	Interval Length
1st quartile	30
Median	33
3rd quartile	36

That is, only one-quarter of the thirty-two African countries in Table 2 have a median 2nd interval of 30 months or less, and in one-quarter of these countries the median 2nd interval is 36 months or greater. This is consistent with the common view that pre- and early-transition African reproductive regimes are characterized by relatively long inter-birth intervals, a circumstance which in itself acts against the potential for longer birth-spacing to contribute more to African fertility decline than has been the case in other regions.

Arguing against this pessimistic appraisal of the potential contribution of longer birth spacing to African fertility decline are the extremely long average inter-birth intervals observed in those African countries with moderate levels of fertility, most notably South Africa (median 2nd interval = 47 months in 1998), but also Lesotho (median 2nd interval = 43 months in 2009, Namibia (median 2nd interval = 43 months in 2006), Swaziland (median 2nd interval = 40 in 2006), and Zimbabwe (median 2nd interval = 41 months in 2005). The point is made more dramatically in Figures 3a – 3c, which plot the median interval length against the TFR. The association between interval length and the TFR is truly impressive; for example, the product-moment correlation is -0.87 for the 2nd interval (Figure 3a). From this very tight association between inter-birth intervals and the level of fertility in Africa one might infer that extending intervals is a viable route to fertility decline.

However, we note that the countries with very long average inter-birth intervals – South Africa, Lesotho, Namibia, Swaziland, Zimbabwe --are all located in southern Africa; possibly this is a phenomenon that will be confined to this sub-region. Ghana provides evidence to the contrary: Ghana has the most advanced fertility decline outside of southern Africa, and it shows a median 2nd birth interval of nearly 40 months in its most recent survey (2008), suggestive of a shift toward the long inter-birth intervals typical in southern Africa. And yet, were the lengthening of intervals to become a significant force toward fertility decline in Ghana (and elsewhere in West Africa), a steepening of the slope in Figures 2a – 2c would be expected (indicative of an acceleration of the increase in birth intervals as fertility declines). But no marked steepening is apparent for Ghana in Figures 2a – 2c, just a rather slight increase in the slope in Figure 2a. In short, on the crucial question of whether longer inter-birth intervals can serve as a main mechanism for African fertility decline, the empirical evidence presented in this paper offers a mixed message.

IV. Summary and Concluding Remarks

This research has addressed three questions.

First, *over the course of fertility declines in regions other than Africa, have birth interval distributions remained relatively stable or changed?* The answer is that in the six countries examined, inter-birth intervals have lengthened, in some instances by as much as two years on average. This is a central feature of contemporary fertility declines that we believe is not widely recognized.

Second, *in fertility declines to date in Africa, is there evidence of a lengthening of birth intervals?* The answer is yes; our research supports the conclusion of Moultrie *et al*. (2008, 2010, 2011) that longer

birth spacing has made a major contribution to fertility decline in a sub-set of African societies. In particular, we observe a lengthening of average inter-birth intervals in both Ghana and Kenya.

Third, *given existing birth interval distributions in Africa, what is the potential for fertility decline via lengthening inter-birth intervals?* On this question, we find the evidence decidedly mixed. On the one hand, the country-level association in Africa between inter-birth interval and TFR is extremely strong: those countries with moderate levels of fertility have long inter-birth intervals, exceeding 40 months on average. From this one might infer that extending inter-birth intervals is a viable pathway to African fertility decline. On the other hand, to this point the joint circumstance of moderate fertility and long inter-birth intervals is confined to southern Africa countries. Moreover, throughout the continent inter-birth intervals are lengthy as compared to birth intervals at the onset of fertility decline in Asia and Latin America. As a consequence, for the lengthening of birth intervals to become a principal direct mechanism for fertility decline in Africa – for example, increases of twelve to twenty-four months on average (as observed in some Asian and Latin American societies) – this would require a transition to average inter-birth intervals that are truly exceptional from a comparative perspective.

This paper is our initial exploration of the role of birth spacing in fertility decline, with special attention to sub-Saharan Africa. In further research, we will investigate trends in Africa in more depth, with some attention to proximate determinants (post-partum behaviors, contraception). The potential contribution of contraception to the lengthening of birth intervals seems to be in dispute: Moultrie *et al.* credit contraception for a substantial portion of the increase to date in birth intervals in Africa, whereas the literature review of Yeakey *et al.* (2009) is decidedly ambivalent about the impact of contraception on birth spacing. Fertility declines in other regions will continue to provide a backdrop for our research on trends in birth spacing in Africa. We have yet to investigate patterns by age and parity, in order to pursue the argument of Moultrie *et al.* (2011) that the lengthening of birth intervals in regions other than Africa adheres to age- and parity-patterns that are not found in Africa. Claims for African exceptionalism – in the present, or posited for the future -- should be based on an accurate understanding of the demographic features of the reproductive revolution that has occurred in other regions during the past five decades.

References

Agadjanian, V. 2005. "Fraught with ambivalence: reproductive interntions and contraceptive choices in a sub-Saharan fertility transition". *Population Research and Policy Review* 24: 617-645.

Bledsoe, C., F. Banja and A. G. Hill. 1998. "Reproductive mishaps and western contraception: an African challenge to fertility theory". *Population and Development Review* 24(1): 15-57.

Caldwell, J. C., I. O. Orubuloye and P. Caldwell. 1992. "Fertility decline in Africa: a new type of transition?" *Population and Development Review* 18(2): 211-242.

Johnson-Hanks, J. 2004. "Uncertainty and the second space: modern birth timing and the dilemma of education". *European Journal of Population* 20: 351-373.

Johnson-Hanks, J. 2007. "Natural intentions: fertility decline in the African Demographic and Health Surveys". *American Journal of Sociology* 12(4): 1008-1043.

Moultrie, T. A. and I. M. Timaeus. 2010. "Stopping, spacing and postponing: patterns of fertility decline in Africa". Paper presented at the annual meetings of the Population Association of America, 15-17 April, Dallas, Texas.

Moultrie, T. A., T. S. Sayi and I. M. Timæus. 2011. "Birth intervals and fertility decline in Africa". Unpublished manuscript, University of Cape Town.

Page, Hilary J. and Ron J. Lesthaeghe (eds.). 1981. Child-Spacing in Tropical Africa: Traditions and Change. London: Academic Press.

Rodriguez, German and John N. Hobcraft. 1980. Illustrative Analysis: Life Table Analysis of Birth Intervals in Colombia. WFS Scientific Report no. 16. Voorburg, the Netherlands: ISI.

Timæus, I. M. and T. A. Moultrie. 2008. "On postponement and birth intervals". *Population and Development Review* 4(3): 483-510.

Van Bavel, J. 2004. "Detecting stopping and spacing behaviour in historical demography: a critical review of methods". *Population* (English Edition) 59(1): 117-128.

Yeakey, M. P., C. J. Muntifering, D. V. Ramachandran, Y. M. Myint, A. A. Creanga and A. O. Tsui. 2009. "How contraceptives use affects birth intervals: results of a literature review". *Studies in Family Planning* 40(3): 205-214.

Table 1. Trends in Median Birth Intervals[a] and Trends in Total Fertility Rate[b], Selected Countries

	Interval Order			TFR
	Second	Third	All	
Bangladesh				
1975	30	28	28	5.6
1994	34	33	32	3.4
1997	35	35	34	3.3
2000	39	39	36	3.3
2004	38	40	37	3.0
2007	42	44	39	2.7
Colombia				
1976	22	24	23	4.5
1986	28	32	28	3.2
1990	33	31	31	2.8
1995	35	34	32	3.0
2000	37	35	34	2.6
2005	40	38	37	2.4
2010	45	38	39	2.1
Egypt				
1980	24	27	27	5.0
1988	24	28	28	4.5
1992	25	29	28	3.9
1995	27	32	30	3.6
2000	28	36	33	3.5
2003	30	39	34	3.2
2005	30	39	34	3.1
2008	31	42	36	3.0
Ghana				
1979	33	33	33	6.2
1988	34	33	33	6.4
1993	36	35	35	5.2
1998	37	36	36	4.4
2003	37	38	37	4.4
2008	39	38	38	4.0

	Interval Order			TFR
	Second	Third	All	
Indonesia				
1976	30	30	30	4.3
1987	31	33	31	3.1
1991	34	36	34	3.0
1994	38	42	37	2.9
1997	45	45	40	2.8
2002	52	54	48	2.6
2007	54	53	50	2.6
Kenya				
1978	25	25	26	8.0
1989	27	28	28	6.7
1993	28	28	28	5.4
1998	32	32	31	4.7
2003	33	32	32	4.9
2008	33	32	32	4.6
Peru				
1977	22	25	25	5.3
1986	25	27	27	4.1
1991	28	29	29	3.5
1996	32	33	31	3.5
2000	36	36	34	2.8
2008	44	42	39	2.5
Philippines				
1978	22	25	26	5.1
1993	24	28	27	4.1
1998	24	28	27	3.7
2003	26	31	29	3.5
2008	29	33	30	3.3

a. Kaplan-Meier estimates for birth intervals initiated in the period 13-132 months preceding the month of interview. Birth function normalized to 1.0 at 120 months (see text).

b. For the period 1-36 months preceding the month of interview.

Table 2. Median Birth Intervals[a] and Total Fertility Rate[b]: Sub-Saharan Africa: Most Recent DHS

Country	Year	Interval Order			TFR
		Second	Third	All	
Benin	2006	33	33	33	5.7
Burkina Faso	2003	33	34	34	5.9
Cameroon	2004	30	30	30	5.0
Chad	2004	27	27	28	6.3
Congo	2007	30	30	30	6.3
Congo (Brazzaville)	2005	39	38	38	4.8
Côte d'Ivoire	1998	35	32	33	5.2
Ethiopia	2005	31	31	31	5.4
Gabon	2000	34	32	32	4.2
Ghana	2008	39	38	38	4.0
Guinea	2005	35	35	35	5.7
Kenya	2008	33	32	32	4.6
Lesotho	2009	43	47	43	3.3
Liberia	2007	36	34	35	5.2
Madagascar	2008	30	31	30	4.8
Malawi	2010	34	36	35	5.7
Mali	2006	29	29	29	6.6
Mozambique	2003	31	32	32	5.5
Namibia	2006	43	43	40	3.6
Niger	2006	28	28	29	7.0
Nigeria	2008	28	29	29	5.7
Rwanda	2008	29	31	31	5.5
São Tomé and Príncipe	2008	36	42	42	4.9
Senegal	2005	31	32	32	5.3
Sierra Leone	2008	32	33	33	5.1
South Africa	1998	47	44	43	2.9
Swaziland	2006	40	38	37	3.8
Tanzania	2010	33	34	33	5.4
Togo	1998	35	33	34	5.2
Uganda	2006	27	28	28	6.7
Zambia	2007	32	33	33	6.2
Zimbabwe	2005	41	44	42	3.8

a. Kaplan-Meier estimates for birth intervals initiated in the period 13-132 months preceding the month of interview. Birth function normalized to 1.0 at 120 months (see text).

b. For the period 1-36 months preceding the month of interview.

Figure 1a: Trends in Birth Interval Length

Second Birth Interval

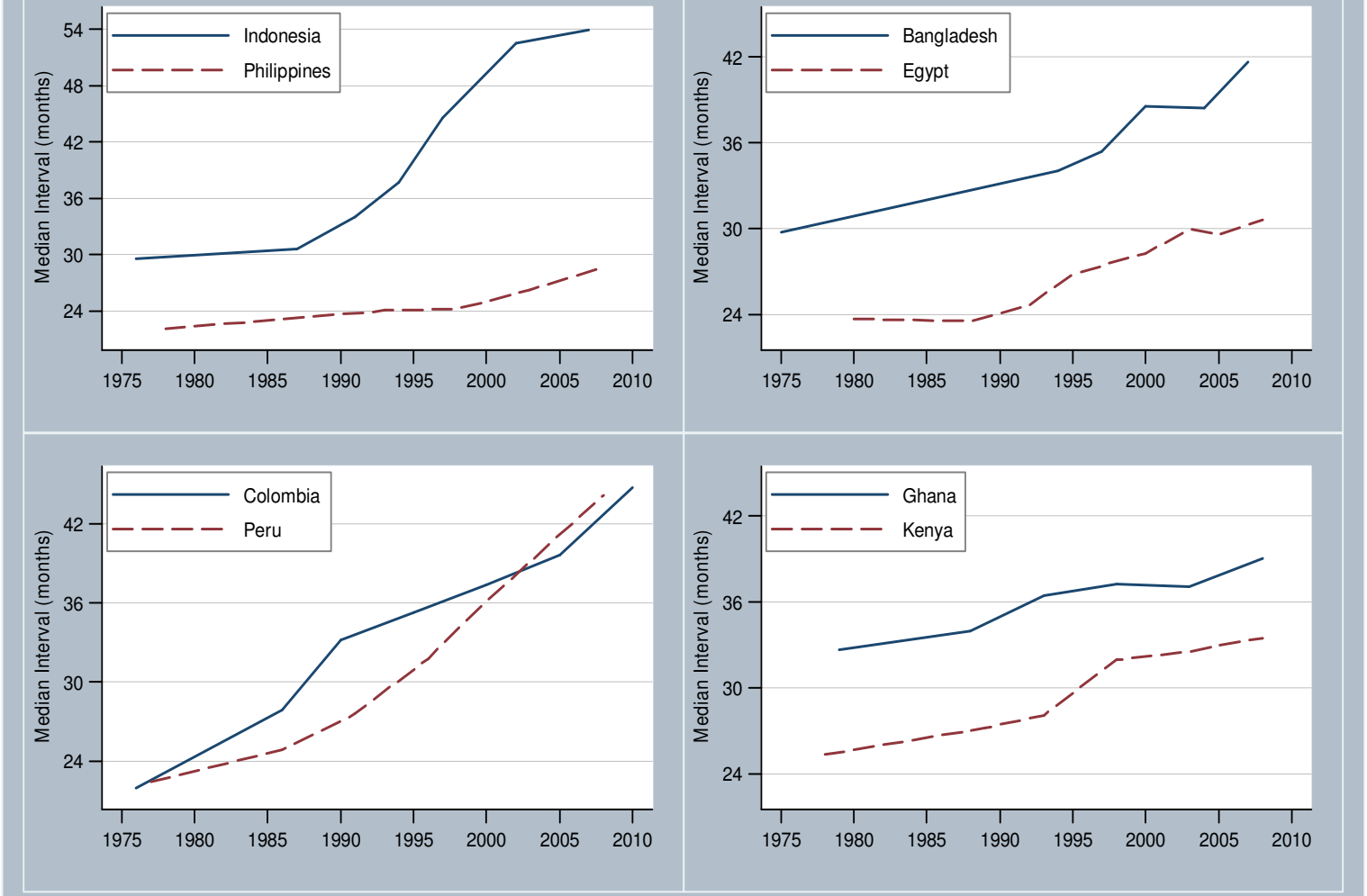


Figure 1b: Trends in Birth Interval Length

Third Birth Interval

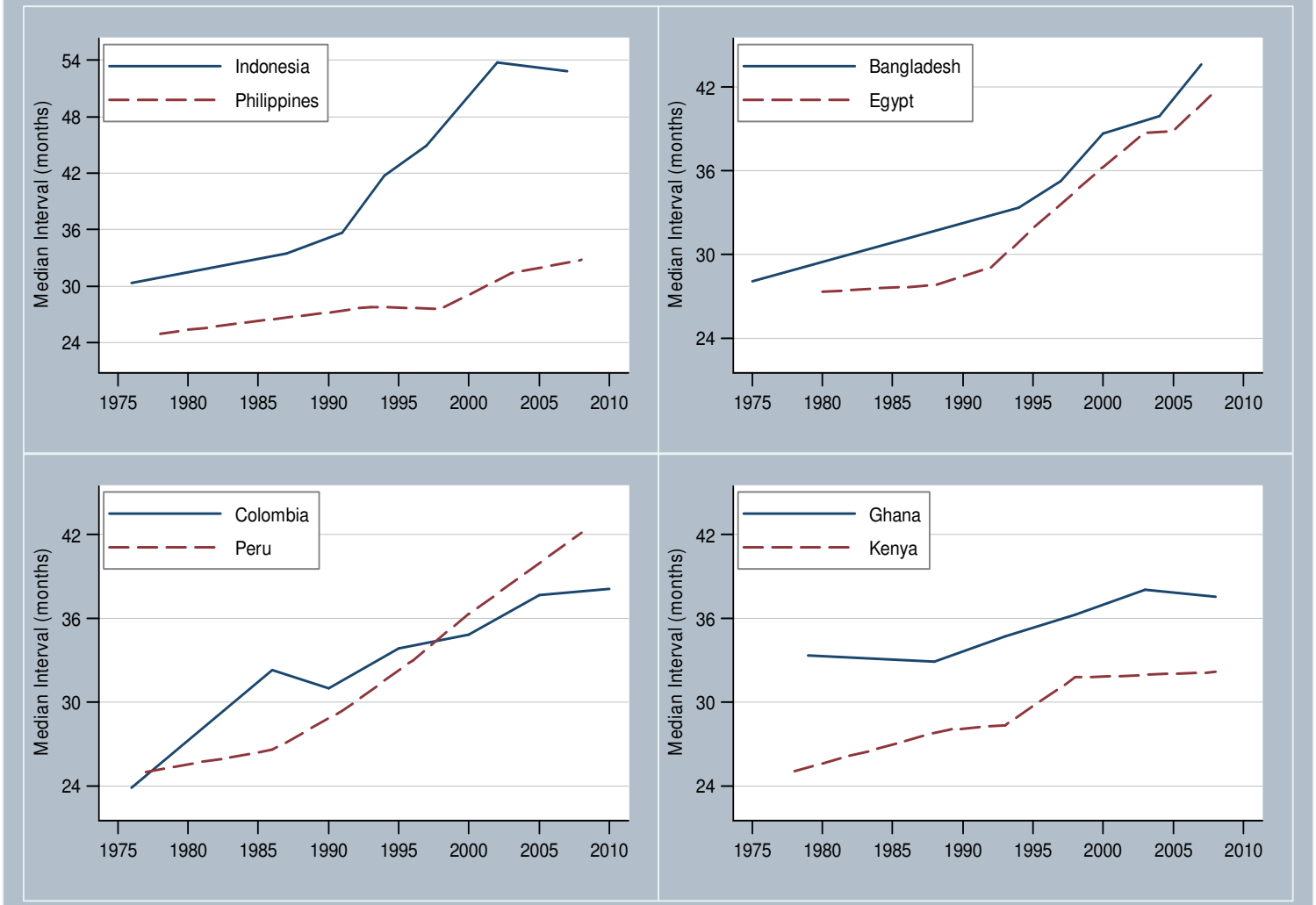


Figure 1c: Trends in Birth Interval Length

All Birth Intervals

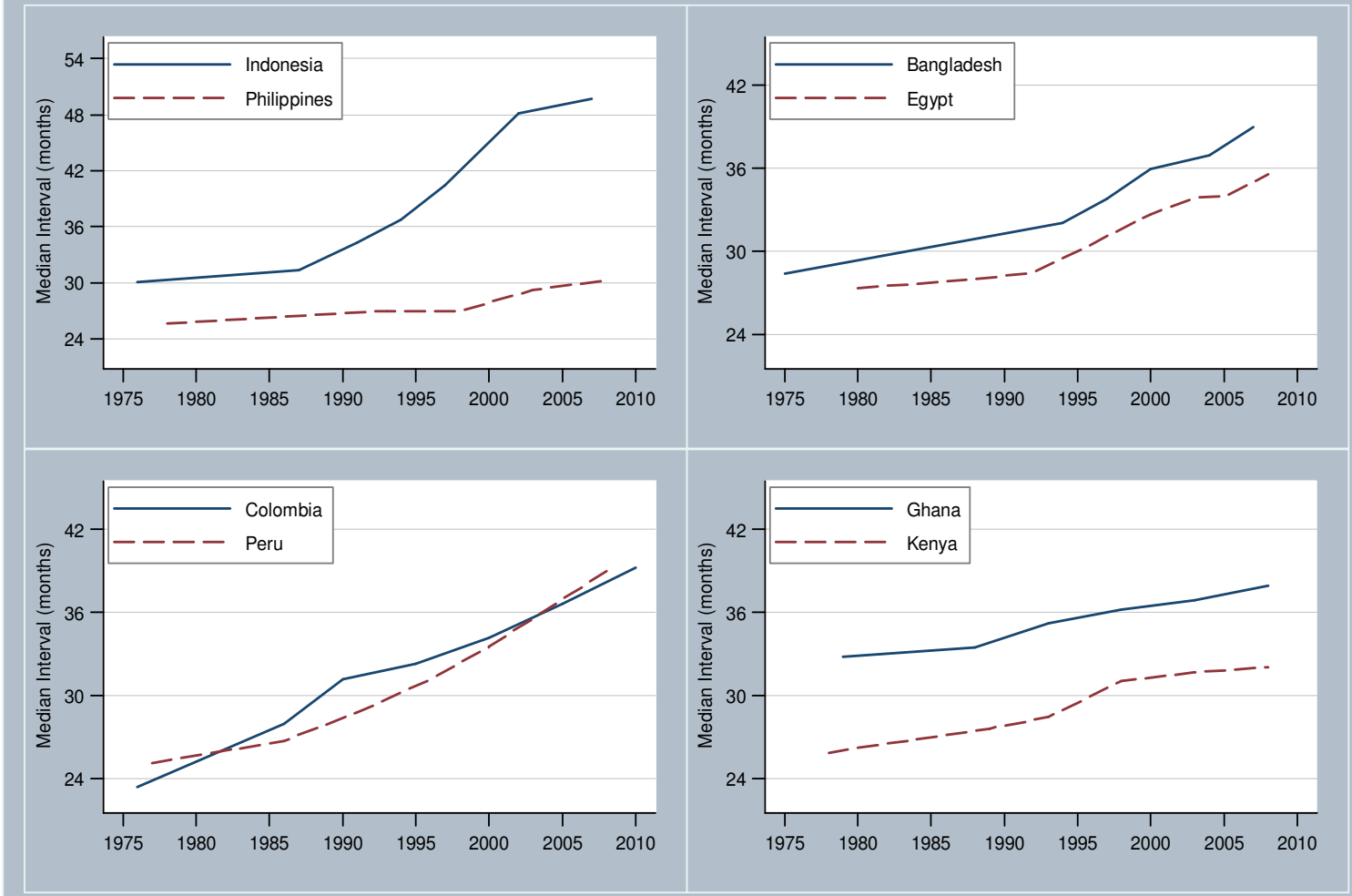


Figure 2a: Joint Trends in Birth Interval Length and Total Fertility Rate

Second Birth Interval

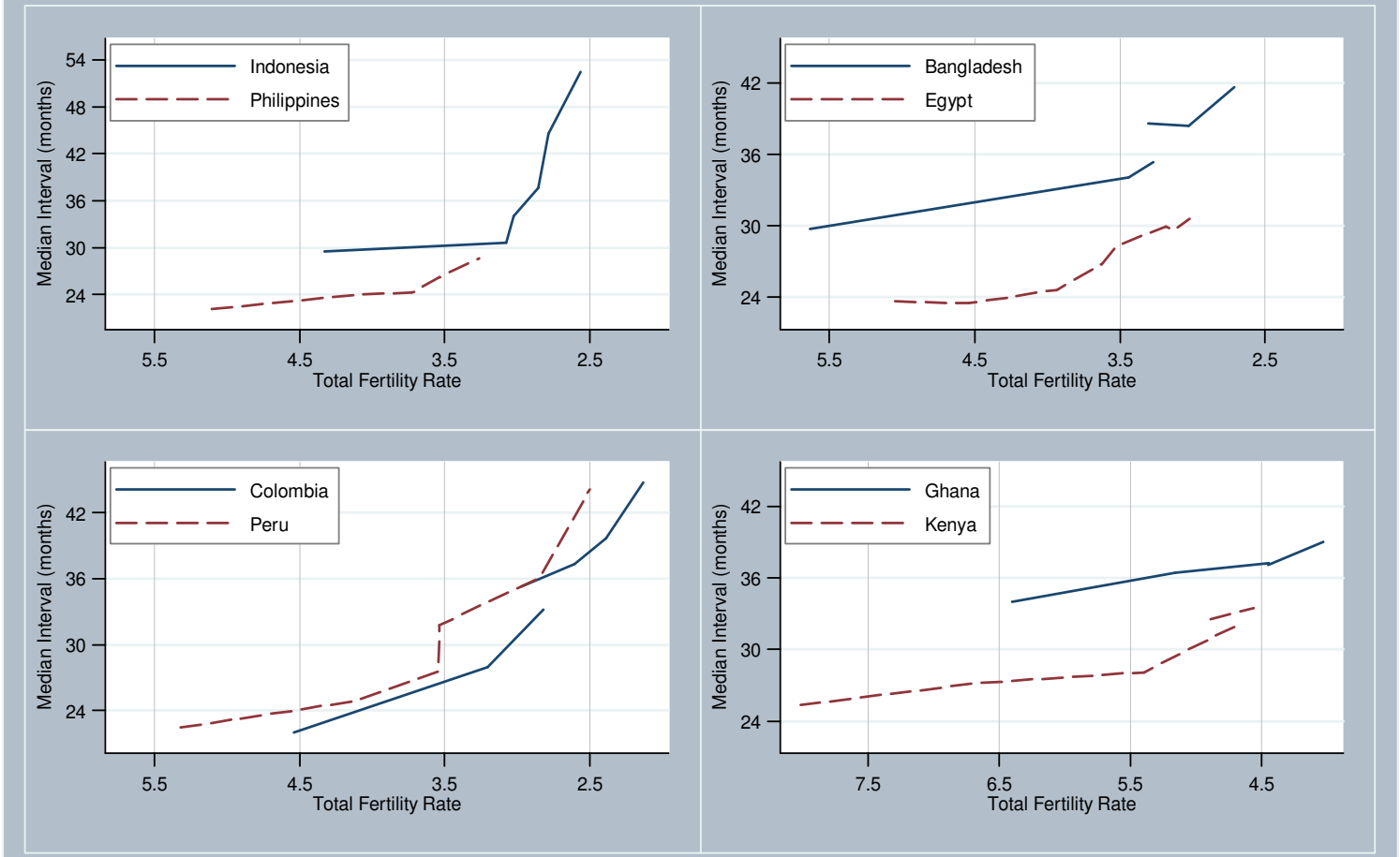


Figure 2b: Joint Trends in Birth Interval Length and Total Fertility Rate

Third Birth Interval

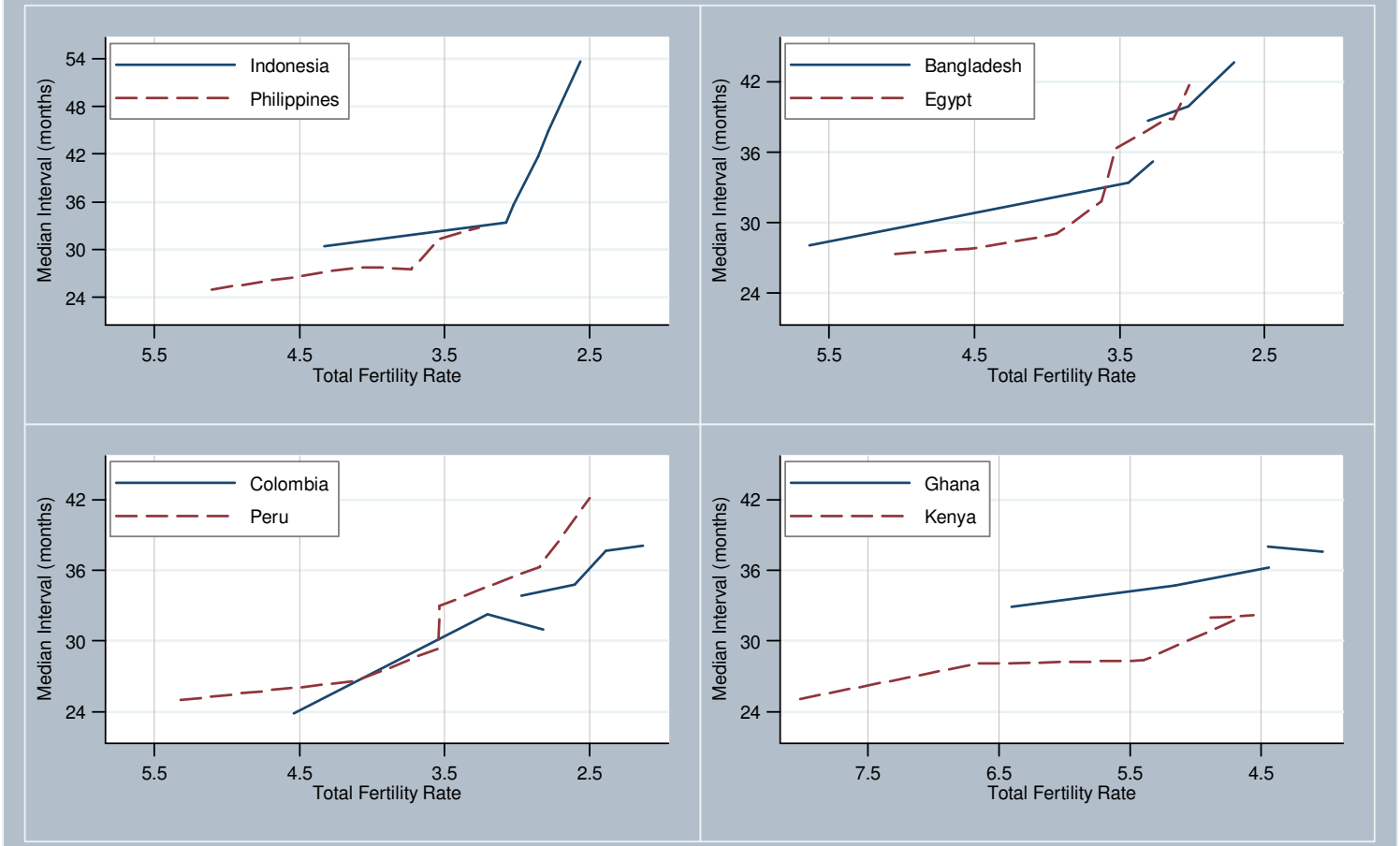


Figure 2c: Joint Trends in Birth Interval Length and Total Fertility Rate

All Birth Intervals

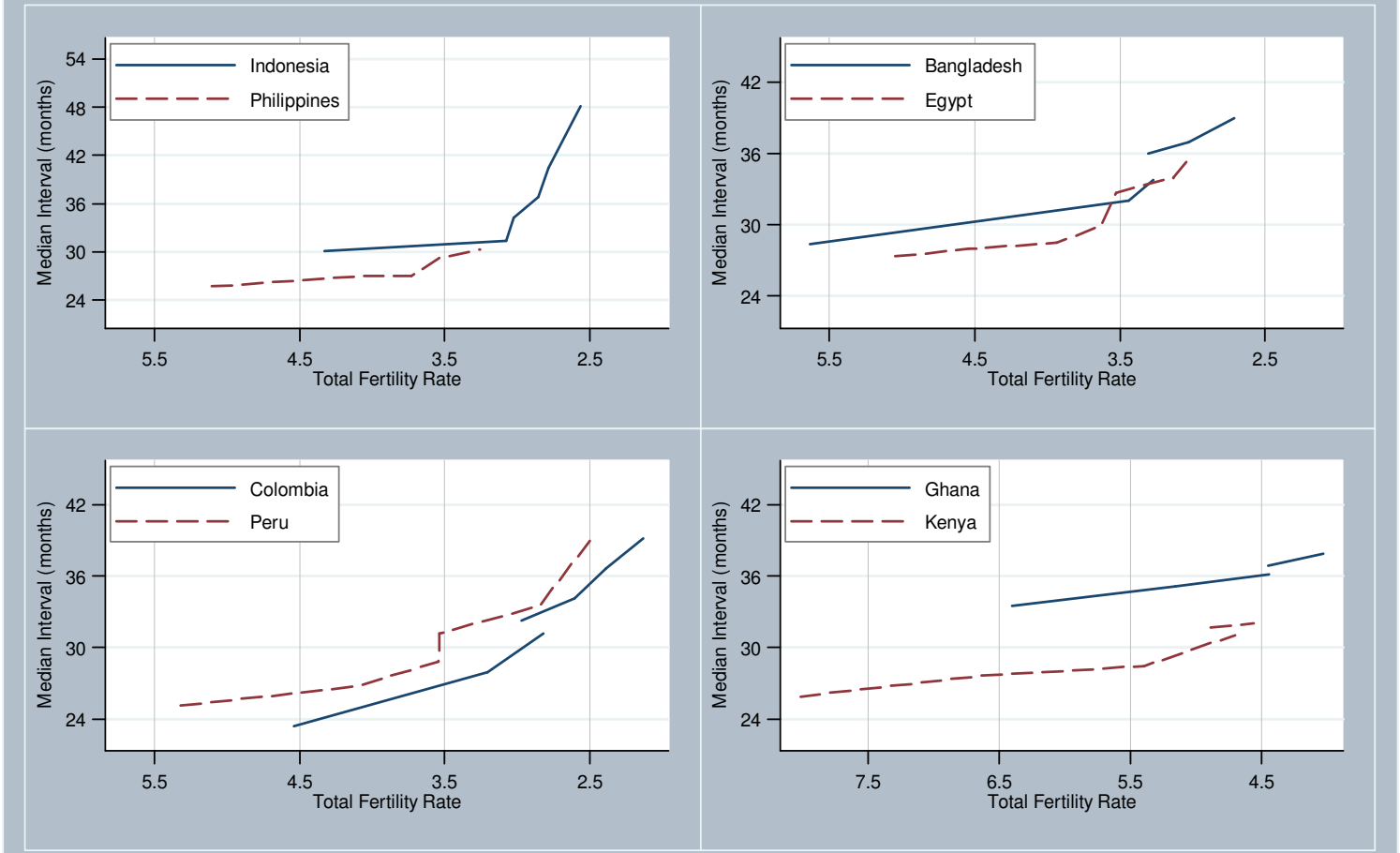
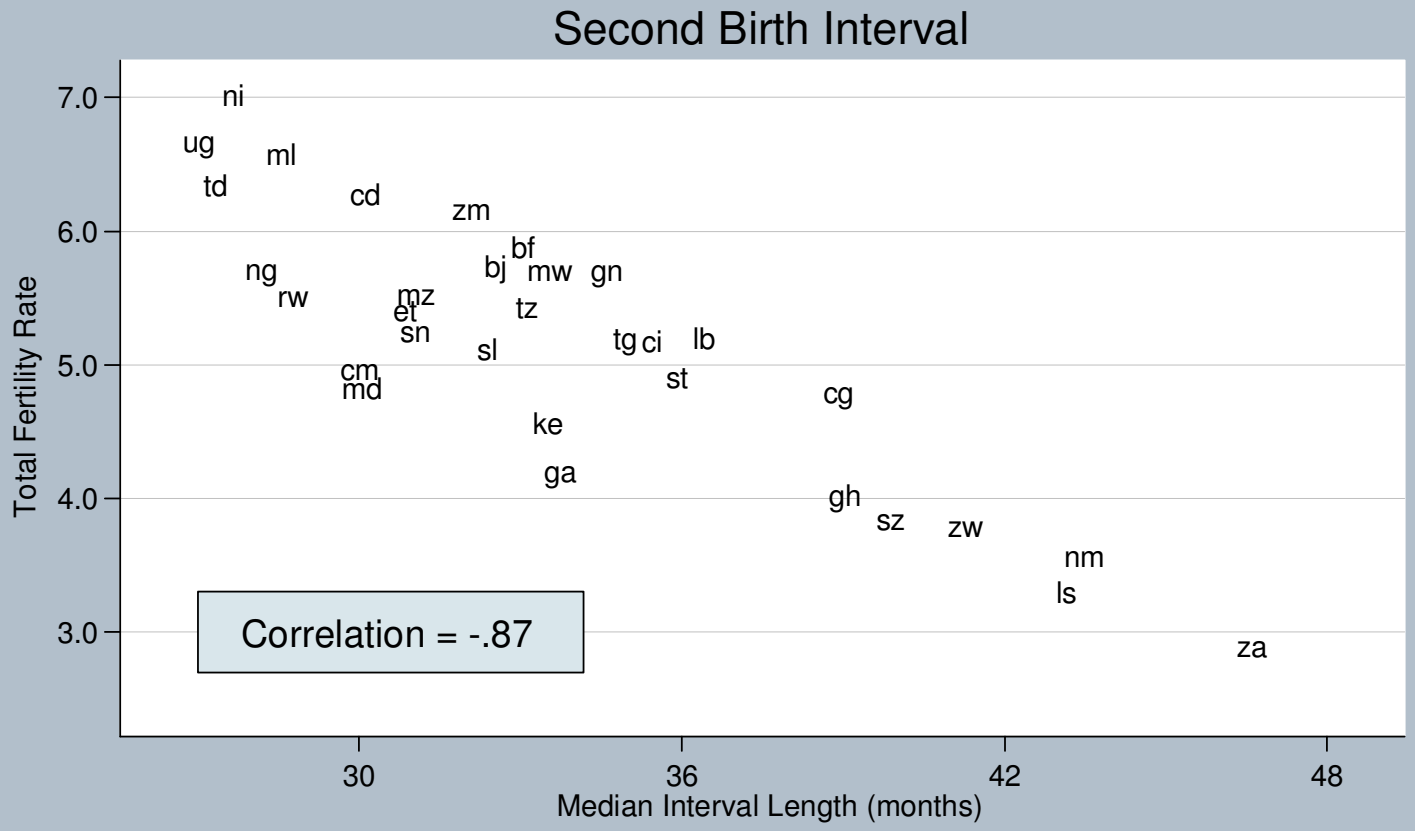
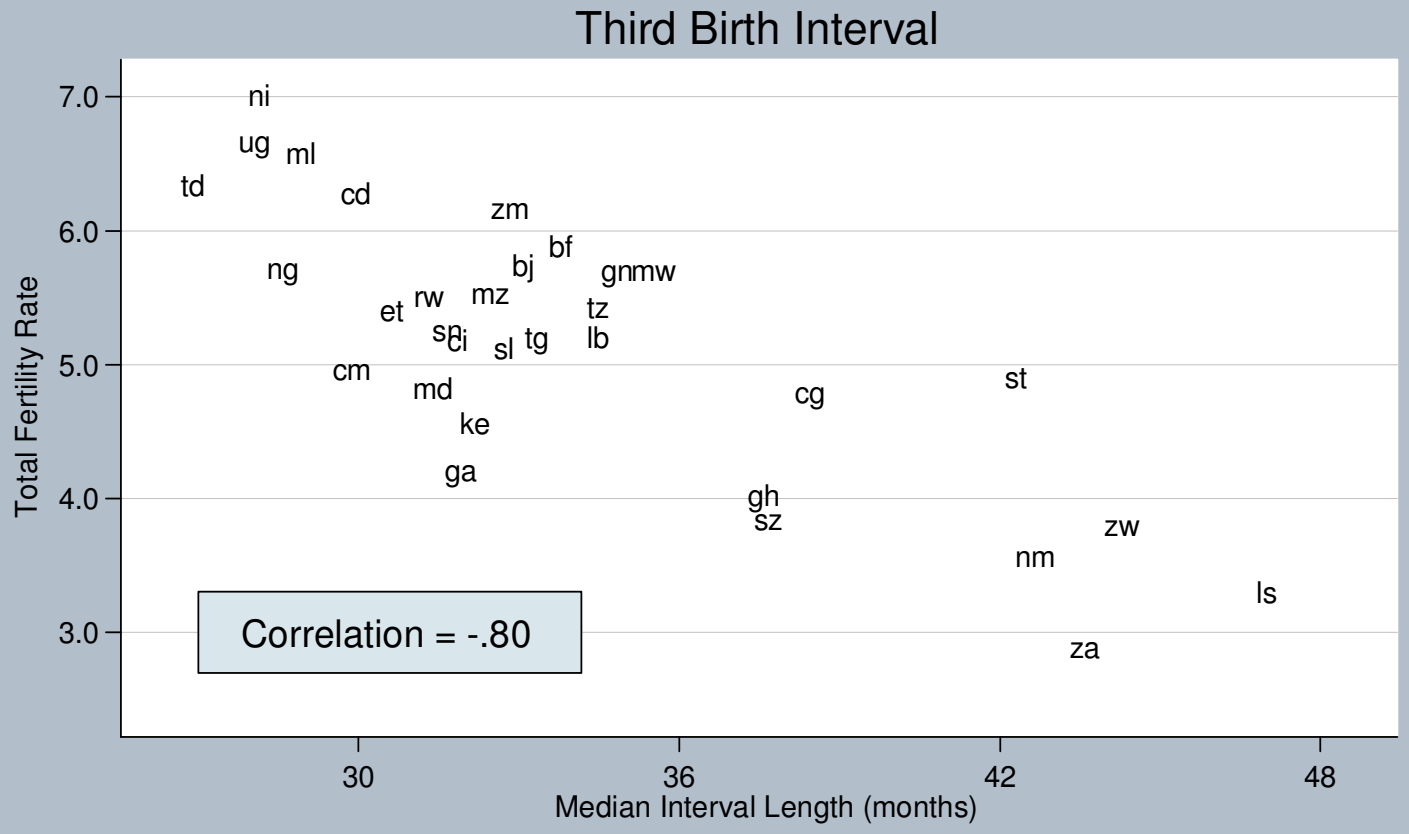


Figure 3a: Association between Birth Interval Length and Total Fertility Rate: Sub-Saharan Africa



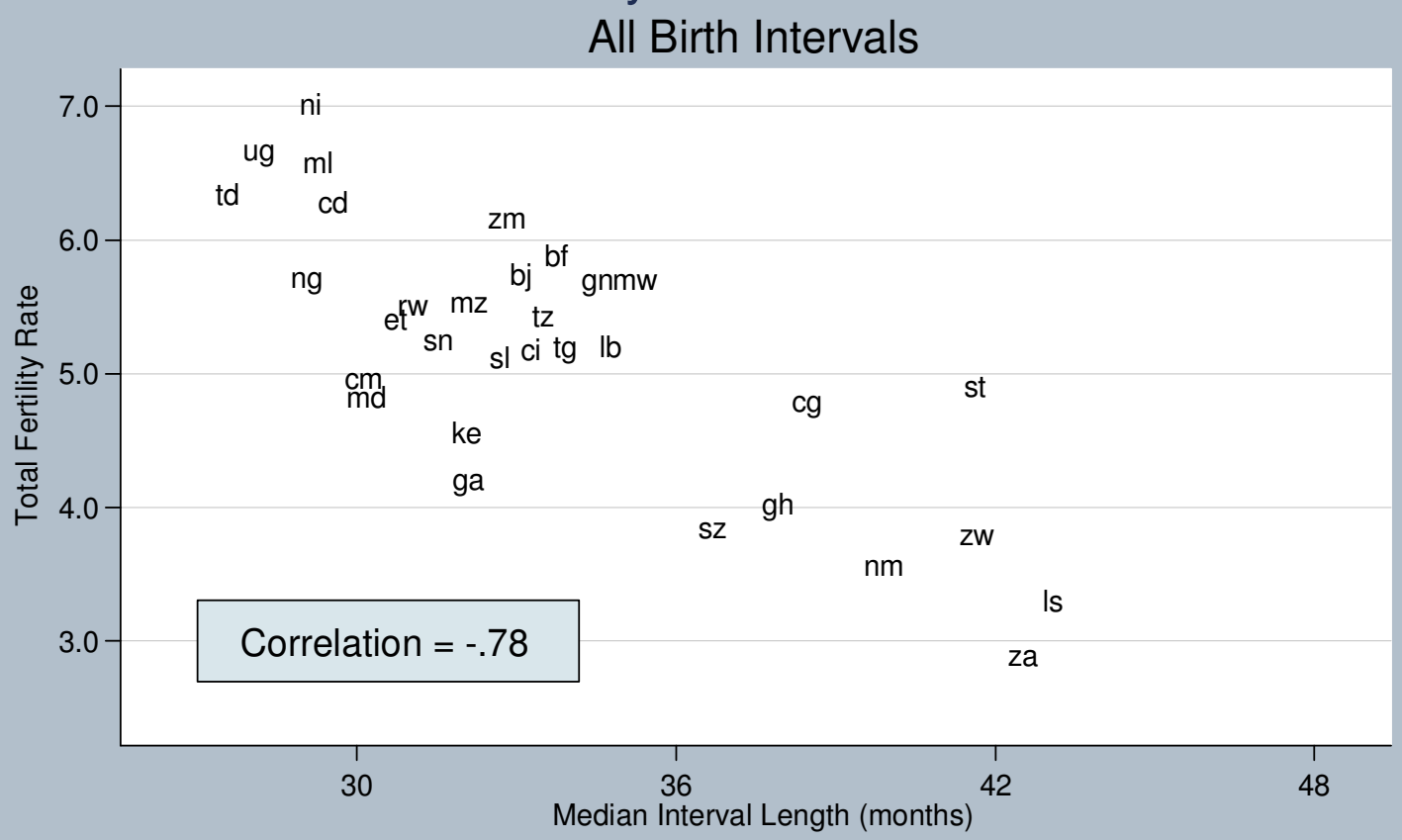
Most Recent DHS (n=32)

Figure 3b: Association between Birth Interval Length and Total Fertility Rate: Sub-Saharan Africa



Most Recent DHS (n=32)

Figure 3c: Association between Birth Interval Length and Total Fertility Rate: Sub-Saharan Africa



Most Recent DHS (n=32)