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The Possible Effects of Child Survival on Women's Ages at First Union and Childbirth in Sub-Saharan Africa

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Abstract. Improvements in child survival may lead to lower fertility through several pathways. To date, most studies have focused on the physiological and replacement effects, whose impacts are known to be modest in size. Few have examined the potentially more important insurance effect on fertility within union, and almost none have considered the possible relationship between child mortality and marriage, which could also grow out of an insurance strategy. In this study, we use data from 21 sub-Saharan African countries to assess the relationship between child mortality and young women's ages at first marriage and childbirth. The results show that lower levels of mortality are strongly associated with later marriages and first births, even after controlling for the effects of a large number of other variables. The implications of the findings are discussed and alternative explanations for this relationship are presented.

Key words: demographic transition, fertility, infant mortality, nuptiality, sub-Saharan Africa

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Résumé. La baisse de la mortalité des enfants peut conduire à une diminution de la fécondité par l'intermédiaire de plusieurs mécanismes. Jusqu'à présent, la plupart des recherches se sont concentrées sur les mécanismes physiologiques et de remplacement dont on connaît le faible rôle. Peu de travaux ont examiné l'effet d'assurance, potentiellement plus important, sur la fécondité dans le mariage et il n'existe pratiquement aucune étude sur la relation possible entre mortalité infantile et nuptialité, qui pourrait aussi dériver d'une stratégie reproductive d'assurance. Nous utilisons ici les données de 21 pays d'Afrique sub-saharienne pour évaluer la relation entre mortalité infantile et âge des femmes à la première union et à la première naissance. Plus la mortalité des enfants est basse, plus l'âge des femmes au premier mariage et à la première maternité est élevé, même après avoir pris en compte le rôle d'un grand nombre de facteurs confondants. Les diverses explications possibles de cette relation sont énumérées, et les implications des résultats sont présentées.

Mots clés: Afrique sub-saharienne, transition démographique, mortalité infantile, nuptialité, fécondité

1. Introduction

The notion that a lasting decline in mortality, especially that of children, is a key determinant of the fertility transition is an old idea in demography. In the past few years, a number of prominent demographers have forcefully reiterated this idea, often stressing that the mortality impact is undervalued by many population researchers and that a number of potentially important linkages between mortality and fertility remain little studied (e.g., Casterline, 1999; Cohen and Montgomery, 1998; Cleland, 1995; Mason, 1997; Chesnais, 1986). In addition, two recent studies using pooled cross-sectional and time-series aggregate data have found surprisingly strong associations between mortality and fertility (Galloway et al., 1998; Behrman et al., 1999). Several intervening pathways have been identified in the child mortality-fertility relation (Cohen and Montgomery, 1998). This paper explores the possibility that one such pathway operates through changes in marriage patterns and the start of women's reproductive lives. Using data from 21 sub-Saharan Africa Demographic and Health Surveys, the research presented here tests the strength of the association between infant and child mortality, on the one hand, and women's ages at first marriage and at first birth, on the other.

The survival prospects of children have substantially improved in sub-Saharan Africa over the past forty years. The estimated infant mortality rate in the region fell from 167 per thousand in 1960–1965 to less than 100 per thousand in 1995–2000. Over the same period, life expectancy rose from about 41 to 49 years, although all of this increase occurred prior to 1990 (United Nations, 2001; see also Hill, 1993). These advances have not occurred uniformly and there exist enormous differences in child survival prospects across the continent. Reductions in fertility are a more recent phenomenon and, while increasingly widespread, they have generally been modest in size. Total fertility for sub-Saharan Africa fell from a high plateau of between 6.6 and 6.8 over the 1950 to 1985 period, to 5.8 in 1995–99 (United Nations, 2001). Among 21 countries with DHS data from 1996–99, only four had total fertility below 5.0: South Africa (a TFR of 2.9), Zimbabwe (4.0), Ghana (4.5) and Kenya (4.7).[1] As with mortality, fertility levels vary greatly across the region and, even in countries where fertility remains high, urban residents and women with secondary or higher levels of schooling tend to have considerably fewer births (Cohen, 1998; Kirk and Pillet, 1998).

Early formulations of the demographic transition emphasized marriage as a central institution regulating fertility in pre-transitional societies (Notestein, 1945; Freedman, 1963). The Princeton Project, which analysed historical data from more than 600 European provinces, found that nuptiality patterns accounted for two-thirds of the differences in overall fertility, with fertility within marriage explaining

the rest (Coale and Treadway, 1986). These findings support earlier work by Hajnal (1953, 1965), which showed the importance of marriage as a check on fertility. In historical Africa, age at marriage also varied over time and appears to have been an important mechanism for regulating fertility (Cordell, 2000). In more recent times, increases in women's age at first marriage have been observed at the start of the fertility transition, often in advance of reductions in marital fertility, in North Africa, Asia, the Middle East, Russia and Australia, although not in Latin America (Fargues, 1988; Lesthaeghe et al., 1989; Adlakha et al., 1991; McDonald et al., 1980; United Nations, 1990; Casterline, 1994; Chojnacka, 1995; Cohen, 1998; Rosero-Bixby, 1996; Moreno and Singh, 1996; see also Guzman, 1994).

In sub-Saharan Africa, traditional marriage patterns are conducive to high fertility. With few exceptions, marriage is universal and often remains tightly controlled by the kinship group (Locoh, 1988, 1995). Women's age at first marriage is significantly lower in the region, by about three years, than in other parts of the developing world (Adlakha et al., 1991; see also United Nations, 1990, 2000a; Lesthaeghe et al., 1989; Westoff et al., 1994; Hertrich and Pilon, 1997; Cohen, 1998). However, in recent decades it appears to be increasing in many countries, and several researchers have argued that this is an important factor inhibiting fertility in the region (Jolly and Gribble, 1993; Adlakha et al., 1991; Westoff, 1992; Pison et al., 1995; Chojnacka, 1995; see also Cohen, 1998; Mahy and Gupta, 2001). Women's age at first birth has also tended to rise, although generally to a lesser extent (Mahy and Gupta, 2001). Unplanned premarital pregnancies are becoming more common, weakening the link between marriage and fertility (Lesthaeghe et al., 1989; Garenne and Halifax, 2000; Cohen, 1998; United Nations, 2000b).[2] In nearly all sub-Saharan African societies, marriage nonetheless remains the socially recognized start of the family-building phase of a woman's life, and the vast majority of births continue to occur within union.

This paper begins with a review of the theorized effects of child mortality on the timing of women's entry into their reproductive lives. The data and methods used in the study are then presented, followed by the empirical results. The last section is a discussion of the implications of these findings.

2. How might reductions in child mortality affect the start of women's reproductive lives?

The effects of improvements in child survival on women's ages at first marriage and first birth, to the extent that they have been studied, have usually been treated as part of a broader set of relations between mortality and fertility. In the words of Notestein (1945: 39): "Any society having to face the heavy mortality characteristic of the premodern era must have high fertility to survive. All such societies are therefore ingeniously arranged to obtain the required births. Their religious doctrines, moral codes, laws, education, community customs, marriage habits, and family organizations are all focused toward maintaining high fertility". With falling

levels of child mortality, the need for motivating behaviours conducive to high fertility lessens, social norms and other institutions supporting high fertility may gradually change, and young adults and couples may increasingly be allowed more latitude in terms of age at marriage and the pace of childbearing (e.g., Preston, 1978). This paper seeks to verify whether child mortality is negatively related to women's ages at first marriage and at first birth in sub-Saharan Africa.

The theoretical literature has emphasized three ways by which improvements in child survival and health might motivate individuals and families to alter their reproductive behaviours: the replacement effect, the insurance (or hoarding) strategy and the quality-quantity tradeoff.[3] The replacement effect is a response mechanism to the death of one's own children and its impact can occur only after women have begun to have children. For this reason, this mechanism can have little impact on the timing of marriages or first births. In contrast, the insurance effect is based on the idea that couples desire to have a certain amount of surviving children (or, at least, a minimum number) and, in their reproductive decisions, they take into consideration the risks of losing a child. In high mortality contexts, couples following an insurance strategy will seek to accumulate a stock of offspring in anticipation of potential future child deaths. Moreover, if the consequences of having too few children are more serious than having too many, couples may tend to "aim high" in their fertility behaviour. While this strategy is usually presented as affecting fertility within marriage after the start of the fertility transition, it can also act at the level of couples, families and perhaps communities by altering the start, and thus the length, of a woman's reproductive life. To date, few studies have attempted to measure the magnitude of the insurance effect within union and almost none have examined the possible impact of child mortality on women's ages at marriage and at first birth.[4] Finally, as child mortality falls and child health improves, the average cost to parents to obtain a *surviving* child decreases (as expenses "lost" on children who then die disappear) and the expected returns to investments in child quality rise. This, it is argued, will incite parents to alter their fertility (and potentially delay marriage) and child schooling behaviours (Schultz, 1981).

Lloyd and Ivanov (1988, and in United Nations 1987) hypothesized that a fall in children's mortality can trigger a radical change in people's mentality and thereby fundamentally alter their health and fertility strategies and behaviours. In essence, they argue that, in very high mortality environments, the degree of uncertainty is such that any conscious family-building strategy runs a high risk of failing. In this situation, the society develops mechanisms – circumscribed marriage and fertility behaviours supported by social norms, religious doctrines, a sharing of the costs and benefits of children within the broader family, etc. – to ensure an adequately high level of fertility for its survival. This results in a "natural fertility" regime, where efforts to control fertility are mostly limited to marrying at an acceptable age and attempting to maintain appropriate birth-spacing intervals. As mortality levels fall, couples and families eventually grow to realize that they

can actively control their environment and successfully engage in family-building strategies, inducing simultaneous changes in health and reproductive behaviours.[5] This *transition effect* is viewed by some demographers as an extension of the insurance strategy to the societal level. If such a transition does occur, it means that there may be little fertility and marriage response to child mortality reductions at high levels of risk, followed by a potentially large "catch-up" response at more moderate levels. This transition would be accompanied by a change in the locus of reproductive (and conceivably marriage) decision-making over time, from socially prescribed behaviour to more individual and couple-level reproductive strategies and decisions.

Changes in child mortality can also alter the demographic, economic and familial contexts, and these in turn may affect marriage and fertility patterns. One example is the marriage squeeze, which appears to have led to later women's age at marriage in South Asia.[6] sub-Saharan Africa is characterized by large age differences between spouses, where men's average age at marriage is usually 5–10 years above that of women (United Nations, 2000a). In the absence of counterbalancing fertility reductions or migration flows, reductions in child mortality results in an increase in the number of eligible women for each of the somewhat older men on the marriage market after a lag of 15–20 years. A possible outcome of this is a rise in women's ages at marriage.[7]

Population growth caused by falling mortality can produce other effects operating at the family, community and national levels. For families, it has been argued that the growing number of surviving children can disrupt the traditional family organization, by increasing the resource demands made by children and young adults – needs that can no longer be met through a sharing of the burdens of children across the wider family – and more generally by altering the relationship between the family elders and the younger generation (e.g., Casterline, 1999). One outcome of this development may be changes in reproductive strategies and behaviours. Population growth at the household level can lead to an increased fragmentation of family resources, in particular land-holdings at the time of inheritance, resulting in later ages at marriage and lower marital fertility (e.g., Vanlandingham and Hirschman, 2001).[8] The economic value of child labour may also fall as complementary resources such as land become increasingly scarce, and institutions (e.g., land tenure systems and their enforcement) evolve in response. In addition, fears over the possible detrimental effects of population growth on economic development and the environment have led to much greater priority being put on family planning programs by both international and national institutions (Chesnais, 1997).

Finally, traditional rules governing marriages may result in a mortality-marriage/fertility relationship (Randall and LeGrand, 2000). In some societies girls can be promised in marriage from an early age and, if a promised daughter dies, a younger sister may be called upon to replace her. This would tend to lead to earlier ages of marriage for women in higher mortality contexts. In a similar vein,

other researchers have argued that, because of "Malthusian" marriage rules, higher mortality has led to earlier marriages and higher fertility levels in historical Europe (Lee, 1977).

3. Data

Demographic and Health Survey (DHS) data from 21 sub-Saharan African countries were pooled together to create the data set used in the analysis. These data sets are: Burkina Faso (DHS I; data collected in 1992 and 1993), Burundi (I; 1987), Cameroon (II; 1991), Central African Republic (III; 1994/95), Cote d'Ivoire (III; 1994), Ghana (III; 1993), Kenya (III; 1993), Liberia (I; 1986), Madagascar (II; 1992), Malawi (II; 1992), Mali (I; 1987), Namibia (II; 1992), Niger (II; 1992), Nigeria (II; 1990), Rwanda (II; 1992), Senegal (II; 1992/93), Tanzania (II; 1991/92), Togo (I; 1988), Uganda (III; 1995), Zambia (II; 1992), and Zimbabwe (III; 1994). These countries encompass a broad spectrum of the demographic, cultural, and socioeconomic situations that exist in the region. Only one data set per country was included in the pooled data to avoid possible biases from autocorrelation. Data from the second half of the 1990s were not used in this study. This was a period when the long-term trend towards lower mortality ceased and even reversed itself in many countries in the region (United Nations, 2001). Insofar as the effects of falling and rising mortality may be asymmetric and the fertility response to mortality is likely to be beset with lags and other non-linearities, the use of more recent data would have complicated the analysis.

4. Methodology

Two logit regressions were estimated to examine the association between community-level infant and child mortality and a host of control variables on the marital and maternal statuses of women aged 15–22 at the date of the survey: their likelihood of ever having been married (including informal unions with coresidence) and their likelihood of having given birth to a child. In this analysis, we do not attempt to study the complex interactions between women's ages at marriage and at first birth; this is a subject that is better addressed with data from surveys and qualitative instruments dedicated to the issue.

The regressions allow for random intercepts at the cluster level, and dummy variables for each of the data sets provide for an additional fixed-effect at the country level. Alternative models were estimated with random intercepts at the community, rather than cluster, level with no appreciable change in the results. The Huber/White formula was employed to calculate robust significance levels, and sample weights were not used in the regressions. Some of the independent variables are measured at the level of the individual women and their families, others like mortality are defined at the community level, and still others – the set of country dummy variables – enter at the national level. Below, we explain how the

communities were defined and describe the variables used in the models, starting with the two dependent variables.

In the 21 countries, 445 communities were defined with an average of 261 women aged 15–49. To create these communities, countries were first disaggregated along regional boundaries and urban/rural type of residence.[9] In cases where the resulting populations were large, these were further split into ethno-linguistic subgroups – factors that have been shown to be important in past and contemporary fertility transitions (Coale and Watkins, 1986; Bongaarts and Watkins, 1996) – and then along religious lines. DHS sample clusters were rarely used in defining these communities, because of their insufficient size for estimating mortality rates and the lack of information in the data to allow us to readily regroup them into larger, contiguous areas.

4.1. FIRST UNION AND FIRST CHILDBIRTH

The decision to focus on young women's union and maternal statuses at the time of the survey, rather than on retrospective reports of age at first marriage and first childbirth for all women, was made to limit the extent of possible measurement error.[10] In DHS data, declarations of age at marriage (defined to cover all first cohabiting unions) and, to a lesser degree, age at first birth, are more complete for younger women. A woman's current status also does not rely on an accurate memory of past events and is less susceptible to recall errors. Moreover, in sub-Saharan Africa, marriage is often a long, drawn-out process rather than a well-delineated event occurring at a point in time, making it a difficult phenomenon to measure (Van de Walle, 1993; Lesthaeghe et al., 1989; Bledsoe and Pison, 1994; United Nations, 1990). Women may differ in how they report marital status over the marriage process: unsuccessful unions for which the marriage process was never completed may not be declared at all, while successful unions may be retrospectively reported as occurring early on. Again, these problems should be less severe for young women reporting current status than for retrospective declarations of age at marriage made by women of different generations. The two outcome variables take the value of one if a woman has ever been married or lived in union in the first regression, or if she had ever given birth to a child in the second regression, and zero otherwise. The regressions only consider the behaviour of women aged 15–22 who were regular residents of the surveyed households. The upper limit of this age range was chosen to reduce the effect of age heaping at age 20 and because educated women in urban areas are increasingly marrying in their twenties. When two or more young women were enumerated in a household, only one was randomly selected for the data set. Of those with complete information in the pooled data, 47% had been married and 41% were mothers by the time of the surveys.

4.2. INFANT AND CHILD MORTALITY IN THE COMMUNITY

The probability of children dying before their fifth birthday was calculated from birth history data collected from all women aged 23–49 who were regular residents of the surveyed households in each community. Children born to younger women, whose marriage and childbirth behaviours are the focus of this study, were not included in these calculations in order to avoid endogeneity biases in the form of reverse causality (more on this below). The mortality variable was reconstructed from monthly probabilities of death computed as the number of deaths below age five in each period divided by the total number of children-months lived below five in the same period.[11] The probabilities were then regrouped into seven mortality levels, which are represented by dummy variables in the regressions. The use of dummy variables, rather than a continuous measure of child mortality, was chosen to allow for possible non-linearities in the child mortality – marriage and child mortality – first birth relationships.

4.3. OTHER EXPLANATORY VARIABLES

At the level of individual women, dummy variables are used to capture their ages in single years at the date of the surveys (15–22), education (none, 1–4 years of school, 5+ years of school), religion (Muslim, Christian, other)[12], and rural-urban type of residence. Covariates at the community level are higher women's schooling (the proportion of women with 11+ years of education),[13] living standards (very low, low, medium, medium-high, high),[14] polygamy (the proportion of women currently living in union who have a co-wife), contraceptive use (the proportion of women currently using a modern method), and primary sterility.[15] Finally, a set of country dummy variables is included to control for unobserved or poorly measured factors concentrated at the national level. Such factors could include the implementation and effectiveness of national family planning or health programs, national laws and institutions that influence women's marriage and fertility behaviour, differences between the DHS data collection activities across countries (the quality of the translations of questionnaires into local languages, people's aversion to answering specific questions, etc.) and, to some extent, the cultural and religious characteristics of the countries that are imperfectly captured by the other covariates.

All of the community-level variables, including mortality, were calculated from information reported by women aged 23–49 at the time of the surveys – women whose marriage and first birth behaviours are *not* the focus of the regressions. This approach was used to avoid endogeneity in the form of reverse causation occurring at the level of individual women.[16] For example, while access to higher levels of schooling and thus to better employment opportunities may cause a woman to postpone marriage and childbirth, an unintended pregnancy or an excellent marriage prospect may also cause her to curtail her studies (e.g., Lloyd and Mensch, 1999). Secondary schooling can therefore be endogenous to the marriage and fertility

behaviours of young women. For this reason, own schooling attainment beyond grade five is replaced by the age-standardized proportion of older women in the community who have attained a high level of schooling this is a measure of educational opportunities that is largely exempt from the biasing effects of reverse causality.

5. Results

The estimated coefficients and odds ratios for the two regressions are presented in Table I. The last two columns show the number of women in each group (or, for continuous variables, the mean value shown in parentheses) and the frequency distribution for these groups in the data. The overall fit of the regressions is good, and the estimated coefficients are mostly significant and in the expected directions. In both regressions, the explanatory variables operate in the same direction and, on the whole, at roughly the same magnitude. Table II shows the predicted probabilities for a woman with specific characteristics of ever having been in union, or having given birth to a child at the time of the survey, based on the regression results. The characteristics of the "reference woman" are: age 18, Christian, uneducated, living in a rural community in Tanzania with an infant and child mortality rate of between 167 and 199 per thousand, and where no women aged 23–49 are in a polygamous marriage, use modern contraception, have 11 or more years of schooling, or show evidence of primary sterility. These characteristics are then changed one-by-one, holding all other characteristics constant, and the statistics in Table II show how these changes affect the estimated probabilities of union and first birth.

The regression results pertaining to community-level infant and child mortality are first presented below. The estimated effects of the other covariates are then briefly discussed, as these are often of interest in and of themselves.

5.1. INFANT AND CHILD MORTALITY

The results show that lower levels of infant and child mortality are strongly and significantly associated with a lower likelihood of young women having been married (including informal unions), or bearing a child by the date of the surveys, indicating later ages at marriage and at first birth. The predicted marriage probability for a reference woman residing in a community with an infant and child mortality rate of 167–199 per thousand is nearly twice that of an otherwise identical woman living in a community with infant and child mortality of 67–99 per thousand. With respect to first births, the corresponding difference between the predicted probabilities is one and a half. The results also tentatively suggest that the relation between child mortality and women's first childbirth is non-linear, with mortality reductions associated with a greater change in women's age at first birth in communities where the infant and child mortality rate ranges from 100 to 200

Table I. Logit Regression Results for the Probabilities of Ever Having Been Married or Given Birth: sub-Saharan Women Aged 15–22 at the Date of the Survey

		Marriage/Union			Motherhood			# cases	Frequency
		Coeff.	O.R.	Signif.	Coeff.	O.R.	Signif.	(mean)	distrib. (%)
Infant and child	<67	–1.042	0.353	***	–0.486	0.615	***	2,296	6.83
mortality rate	67–99	–0.643	0.526	***	–0.476	0.621	***	3,974	11.83
(per 1000)	100–133	–0.425	0.654	***	–0.155	0.857	***	6,138	18.27
in the community	133–166	–0.168	0.845	**	–0.055	0.946		8,146	24.24
	(167–199)	—	—	—	—	—	—	6,056	18.02
	200–233	0.069	1.072		0.223	1.250	***	3,409	10.15
	234+	0.207	1.230	**	0.217	1.242	**	3,581	10.66
Woman's age	15	–2.324	0.098	***	–2.912	0.054	***	4,125	12.28
	16	–1.623	0.197	***	–1.785	0.168	***	4,375	13.02
	17	–0.755	0.470	***	–0.851	0.427	***	4,247	12.64
	(18)	—	—	—	—	—	—	4,610	13.72
	19	0.527	1.694	***	0.606	1.834	***	3,872	11.52
	20	1.149	3.154	***	1.148	3.151	***	4,919	14.64
	21	1.401	4.058	***	1.554	4.733	***	3,426	10.20
	22	1.835	6.266	***	1.965	7.133	***	4,026	11.98
Religion	(Christian)	—	—	—	—	—	—	19,505	58.05
	Islam	0.573	1.773	***	0.151	1.164	**	7,742	23.04
	Other	0.331	1.393	***	0.203	1.226	***	3,921	11.67
Woman's schooling	(None)	—	—	—	—	—	—	10,308	30.68
	1–4	–0.483	0.617	***	–0.108	0.897	*	5,384	16.02
	5+	–1.265	0.282	***	–0.629	0.533	***	17,908	53.30
Area:% with 11+ yrs. schooling		–1.483	0.227	***	–2.294	0.101	***	(0.072)	
Area: Living stds.	very low	–0.087	0.917		–0.181	0.834	***	8,564	25.49
	(low)	—	—	—	—	—	—	11,570	34.43
	medium	–0.037	0.964		–0.008	0.992		3,993	11.88
	medium-high	–0.031	0.970		–0.078	0.925		3,352	9.98
	high	–0.181	0.835		–0.308	0.735	**	6,121	18.22
Area:% polygamous unions		1.009	2.742	***	0.380	1.463		(0.296)	
Area:% using modern contraception		1.467	4.338	***	1.174	3.234	***	(0.116)	
Area:% primary sterility		2.555	12.872	***	1.974	7.198	***	(0.129)	

Table continued on next page.

Table I. Continued

		Marriage/Union			Motherhood			# cases	Frequency
		Coeff.	O.R.	Signif.	Coeff.	O.R.	Signif.	(mean)	distrib. (%)
Type of residence	(Rural)	—	—	—	—	—	—	21,655	64.45
	Urban	–0.219	0.803	*	–0.095	0.909		11,945	35.55
Country	Burkina Faso	–0.017	0.983		–0.413	0.661	***	1,796	5.35
	Burundi	–1.165	0.312	***	–1.350	0.259	***	977	2.91
	Cameroon	0.867	2.381	***	0.436	1.547	***	1,057	3.15
	Central African	0.526	1.692	***	0.025	1.026		1,552	4.62
	Cote d'Ivoire	–0.494	0.610	***	0.010	1.010		2,008	5.98
	Ghana	0.174	1.190		–0.190	0.827		1,153	3.43
	Kenya	0.089	1.093		–0.046	0.955		2,174	6.47
	Liberia	–0.632	0.532	***	0.068	1.070		1,437	4.28
	Madagascar	–0.131	0.877		–0.108	0.897		1,786	5.32
	Malawi	0.567	1.762	***	–0.096	0.909		1,455	4.33
	Mali	0.806	2.240	***	–0.263	0.769		781	2.32
	Namibia	–1.406	0.245	***	–0.219	0.804	*	1,353	4.03
	Niger	–0.006	0.994		–0.229	0.796		680	2.02
	Nigeria	0.157	1.170		–0.257	0.773	*	2,388	7.11
	Rwanda	–0.965	0.381	***	–1.154	0.315	***	1,783	5.31
	Senegal	–1.117	0.327	***	–0.628	0.534	***	1,479	4.40
	(Tanzania)	—	—	—	—	—	—	2,557	7.61
	Togo	–0.726	0.484	***	–0.604	0.547	***	912	2.71
	Uganda	1.019	2.770	***	0.472	1.603	***	2,184	6.50
	Zambia	0.661	1.936	***	0.402	1.495	***	2,191	6.52
	Zimbabwe	0.513	1.670	***	0.148	1.160		1,897	5.65
Constant term		0.049			–0.272		*		
Total number of observations		33,600			33,600				
Total married/mothers		15,665			13,725				
Pseudo R-squared		0.317			0.293				

Notes: Significance levels: ***0,1%; **1%; * 5%. Number of cases is shown only for dummy variables that define distinct subgroups of women; for continuous variables, mean values are instead presented in parentheses. Dummy variables labels shown in parentheses are the categories omitted from the regressions.

Table II. Predicted percentages of sub-Saharan African women with specific characteristics having been married or having born a child by the time of the survey

		Marriage/Union			Motherhood		
		Prob.%	Ratio	Signif.	Prob.%	Ratio	Signif.
Baseline (see footnote)		51.21	1.00		43.25	1.00	
Infant and child	<67	27.03	0.53	***	31.92	0.74	***
mortality rate	67–99	35.57	0.69	***	32.12	0.74	***
per 1000	100–133	40.70	0.79	***	39.50	0.91	**
in the community	133–166	47.01	0.92	**	41.89	0.97	
	(167–199)	51.21	1.00	—	43.25	1.00	—
	200–233	52.94	1.03		48.78	1.13	***
	234+	56.36	1.10	**	48.62	1.12	**
Woman's age	15	9.32	0.18	***	3.98	0.09	***
	16	17.15	0.33	***	11.34	0.26	***
	17	33.03	0.65	***	24.55	0.57	***
	(18)	51.21	1.00	—	43.25	1.00	—
	19	64.00	1.25	***	58.29	1.35	***
	20	76.80	1.50	***	70.60	1.63	***
	21	80.99	1.58	***	78.29	1.81	***
	22	86.80	1.69	***	84.46	1.95	***
Religion	(Christian)	51.21	1.00	—	43.25	1.00	—
	Islam	65.05	1.27	***	47.00	1.09	**
	Other	59.38	1.16	***	48.29	1.12	***
Woman's schooling	None	51.21	1.00	—	43.25	1.00	—
	1–4	39.30	0.77	***	40.61	0.94	*
	5+	22.86	0.45	***	28.89	0.67	***
Area: 25% with 11+ years schooling		16.98	0.33	***	18.63	0.43	***
Area: Living stds.	very low	49.05	0.96		38.86	0.90	***
	(low)	51.21	1.00	—	43.25	1.00	—
	medium	50.29	0.98		43.06	1.00	
	medium-high	50.44	0.98		41.35	0.96	
	High	46.70	0.91		35.90	0.83	**
Area: 50% polygamous unions		63.48	1.24	***	47.96	1.11	
Area: 50% using modern contraceptn		68.62	1.34	***	57.81	1.34	***
Area: 25% primary sterility		66.54	1.30	***	55.52	1.28	***
Type of residence:	(Rural)	51.21	1.00	—	43.25	1.00	—
	Urban	45.74	0.89	*	40.93	0.95	
Country	Burkina	50.79	0.99		33.51	0.77	***
	Burundi	24.67	0.48	***	16.49	0.38	***
	Cameroon	71.42	1.39	***	54.10	1.25	***
	Central	63.98	1.25	***	43.87	1.01	
	Cote	39.05	0.76	***	43.48	1.01	
	Ghana	55.55	1.08		38.65	0.89	
	Kenya	53.43	1.04		42.12	0.97	
	Liberia	35.82	0.70	***	44.92	1.04	
	Madagascar	47.93	0.94		40.61	0.94	
	Malawi	64.91	1.27	***	40.92	0.95	
	Mali	70.16	1.37	***	36.94	0.85	

Table continued on next page.

Table II. Continued

		Marriage/Union			Motherhood		
		Prob.%	Ratio	Signif.	Prob.%	Ratio	Signif.
Country	Namibia	20.47	0.40	***	37.98	0.88	*
	Niger	51.06	1.00		37.74	0.87	
	Nigeria	55.13	1.08		37.07	0.86	*
	Rwanda	28.57	0.56	***	19.38	0.45	***
	Senegal	25.58	0.50	***	28.92	0.67	***
	(Tanzania)	51.21	1.00	—	43.25	1.00	—
	Togo	33.69	0.66	***	29.41	0.68	***
	Uganda	74.41	1.45	***	54.98	1.27	***
	Zambia	67.02	1.31	***	53.26	1.23	***
	Zimbabwe	63.68	1.24	***	46.92	1.08	

Notes: The "baseline" woman is 18 years old, Christian, has never been to school, lives in a rural area of Tanzania, and the community in which she lives had an under-five mortality rate within the range 167-199 per thousand during the period prior to the survey, a low socio-economic status index, no women 23-49 with 11+ years of education, no polygamy, no sterility, and no modern contraceptive use. Significance levels show the significance of the underlying coefficients shown in Table I.

per thousand than in communities with either higher or lower levels of mortality.[17] There is no evidence of significant non-linearity in the marriage regression results.

The following calculations were made to roughly gauge the size of the mortality impact on women's lifetime fertility, assuming that the coefficients reflect the true causal effects of child mortality on first marriage and childbirth. The estimated coefficients were first used to predict the median age at which a woman with the reference characteristics would have become married or given birth to a child, if she lived in a community with a relatively high infant and child mortality rate (the reference level, defined as 166–199 per thousand) and also in one with a more moderate rate (67–99 per thousand). For age at marriage, these were 17 years 11 months and 19 years 1 month, respectively, and for age at first birth, they were 18 years 5 months and 19 years 3 months. Trussell et al. (1979) estimated that, in natural fertility populations in which all childbearing occurs within marriage, the effect of delaying marriage by one year is to reduce a woman's lifetime fertility by about 5–6%. Using the differences in median ages at marriage calculated above, the reduction of infant and child mortality of 100 per thousand would decrease a woman's lifetime fertility on the order of 6–7%. In sub-Saharan Africa, where premarital pregnancies are increasingly common, this estimate probably represents an upper bound. If, instead, we use the difference in median age at first birth, the woman's estimated lifetime fertility would fall by 4–5%. The overall impact of such a decline in child mortality on *aggregate* birth rates and population growth, as opposed to an *individual woman's* lifetime fertility, may however be much larger, because of the young age structure of African populations – the disproportionate number of fertile women who are in their teenage years – and because of the effect of a longer time interval between generations.

5.2. EDUCATION

Of all of the covariates, women's schooling has the strongest estimated association to first union and childbirth. Reference women with five or more years of schooling are 60% less likely to be married and 30% less likely to have ever given birth by age 19 compared to women with no education (the odds ratios in Table I show a still stronger effect). If 25% of the women aged 23–49 in the community also have 11 or more years of education, these probabilities fall to 70% for marriage and 60% for first births. Women's education, at least at the level of secondary schooling or above, has been found to be associated with delayed marriages and first births in studies from across the world (Diamond et al., 1999). Many reasons have been cited to explain this relation: secondary and higher-level schooling may often be a mutually exclusive activity with raising children; well-educated women may have better employment opportunities motivating them to postpone marriage and childbearing; schooling may affect family size preferences, marriage aspirations and more broadly promote ideational change; the costs of raising children may be greater in communities with higher levels of education; schooling may lead to a weakening of parental lineage control over children's behaviours leading to delayed marriages and childbirth; and better educated women may have a greater ease of access to the means to control their fertility. The estimated effects of schooling on the start of women's reproductive lives may also be in part spurious, caused by other factors that affect both schooling and fertility (United Nations, 1987; Lesthaeghe et al., 1989, 1994; Diamond et al., 1999; Bledsoe et al., 1999; Lloyd and Mensch, 1999; Lloyd et al., 2000; Behrman et al., 1999; Eloundou-Enyegue, 1999).

5.3. LIVING STANDARDS AND URBAN/RURAL RESIDENCE

Community living standards and urban/rural type of residence should broadly capture characteristics of the labour market, the existence of public programs for old age support and a host of other "modernization" factors that are generally thought to affect reproductive behaviours. Yet neither of these variables is strongly related to women's marriage and first childbirth in the results. Living standards appear to have a non-linear association, with earlier ages at marriage and childbirth occurring in moderately developed areas and higher ages in both the wealthiest and most destitute communities. However, the estimated coefficients are small and differences are significant only in the first-birth regression. In contrast, place of residence is significant only in the marriage regression, where its estimated coefficient is again small: for women with the reference characteristics, the estimated probability of being married by age 18 is just ten percent lower for those who live in urban, versus rural, areas (Table II). A recent study by Behrman et al. (1999), based on pooled aggregate time series and cross-sectional data from 96 countries, similarly found a statistically insignificant relation between both per capita income

and urban/rural residence, and total fertility, after controlling for life expectancy at age one, schooling, religion and geographic latitude.

5.4. RELIGION

Christian women appear to marry much later but to begin having children only slightly later than Muslim women in sub-Saharan Africa, suggesting that premarital childbearing is more frequent among Christians, other things being equal. This result is consistent with the findings of Lesthaeghe et al. (1989), who found that Christians tend to marry later than Muslims in sub-Saharan Africa. They explained this pattern by the relationship between Christianity, schooling attainment, and the spread of Western ideals, "with its concomitant ideology favoring conjugal closeness [and] the individualization of marriage" (p. 240).

5.5. POLYGAMY

The estimated coefficients for polygamy are large and highly significant in both regressions. Compared to communities where all unions are monogamous, there is a 24% increase in the proportion of women who are married, and an 11% increase in the proportion that are mothers by age 18 in communities where 50% of older women are living in polygamous unions. Previous research has similarly found that women's marriage and first birth tend to occur relatively early in polygamous societies. Marital fertility levels may, however, also be low, due to the often large age differences between spouses and, perhaps, to a correlation between polygyny and sub-fecundity (Westoff et al., 1994; Van de Walle, 1993; Lesthaeghe et al., 1989; Pison, 1988).

5.6. CONTRACEPTION

The estimated probabilities of a young woman being married or having a child are larger in communities with a high prevalence of birth control, an unexpected finding. These effects are surprisingly strong, especially in the marriage regression: compared to non-contracepting areas, there is a 30% increase in the marriage probability in communities where 50% of the women aged 23–49 use modern contraception (Table II). Family planning is thought to be an important intervening factor in the mortality-fertility relationship, although its likely effect on the timing of women's entry into their reproductive lives is unclear (Lloyd and Ivanov, 1988; Mosk 1983: 46). One possible explanation for the results is reverse causation: societies in which women marry at younger ages having higher fertility and thus a greater incentive to use birth control, other things being equal. Another possibility is that access to contraception allows women to marry and start having children earlier than otherwise, as later in life they can more easily limit their births by post-

poning or ceasing childbearing, if desired. While this second argument is implicit in Malthusian models made for historical Europe, it strikes us as being implausible in the social context of sub-Saharan Africa.

5.7. PRIMARY STERILITY

Sterility was included in the regressions as a confounding factor operating on the supply side of fertility. In high sterility areas, young women (and their families) may seek to verify their fecundity by an early pregnancy, and worries about the risk of sterility may motivate them to maintain a rapid pace of childbearing and to continue "while the going is good". In many parts of Africa, the practice of spreading the burdens and gains of raising children among the wider family through mutual assistance, family obligations and child fostering should further reinforce the links between the prevalence of sterility and women's marriage and fertility behaviour. The regression results support these arguments: women are found to enter into marriage and motherhood much earlier in areas with higher levels of primary sterility. The extent of the association between sterility and both age at marriage and age at first birth may in fact be still larger, as the sterility variable used in the regressions captures only a part of the sub-fecundity in the population (see note 15).

5.8. COUNTRY OF RESIDENCE

Even after controlling for the other covariates, there remains a good deal of variation at the country level. This suggests that factors absent or imperfectly captured by other variables in the regressions – culture, religion, national institutions, differences between questionnaires or survey operations, etc. – and which are concentrated at the country level may be strongly related to the start of young women's reproductive lives. The case of Namibia, in particular, stands out. There, while women's age at first childbirth seems to be similar to that found in other countries, young Namibian women appear to marry much later if at all. This anomalous pattern of marriage and fertility has been documented by other studies (United Nations, 1990; Westoff, 1992; Westoff et al., 1994), and might reflect a growing prevalence of stable informal unions without coresidence as well as the effects of labour and refugee migration.

6. Discussion

In this study, random effects logit regressions estimated from DHS data from 21 sub-Saharan African countries have been used to examine the relation between infant and child mortality, measured for 445 communities, and the start of young women's reproductive lives. Lower mortality levels were found to be strongly and

very significantly related to later ages at first union and childbirth. A simulation exercise indicates that a decline in the community infant and child mortality rate of 100 per thousand would be associated with a moderate decrease in an individual woman's lifetime fertility in the order of four-to-six percent, assuming that the regression results reflect the true causal impact of mortality. The reduction in aggregate total fertility could potentially be larger, due to the young population age structure in sub-Saharan Africa and thus the relatively large numbers of women who are at the start of their reproductive lives. These results are consistent with a number of explanations for a child mortality-fertility/marriage link, including insurance behaviour, the transition effect, a marriage squeeze due to changes in the population age structure, and changes in the underlying familial and economic environments caused by population growth.

These results are unlikely to represent the pure, causal effects of mortality on women's entry into their reproductive lives, despite the inclusion of an unusually large number of covariates in the regressions. Changes in child survival, marriage patterns, and the timing of first births are only three aspects of a very complicated development or modernization process, one that is characterized by a large number of interactions, feedbacks and changes that occur simultaneously in many dimensions (McDonald et al., 1980; Van de Walle, 1993). A number of other factors may also influence health, marriage and fertility behaviours and these, in turn, may be affected by the consequences of changes in mortality, fertility and population growth; three examples are changes in family structure, women's roles and the capacity of governments to provide health and family planning services.

Child health care, schooling and reproductive and marriage behaviours are all choice variables that are related to family-building aspirations and the child quantity-quality transition. As such, they are likely to be especially closely linked, making it extremely difficult to disentangle their separate causes and effects. Improvements in child health and survival are associated with delays in the start of women's reproductive lives and also to a higher return on parental investments in education, both believed to lead to higher levels of schooling. Women's (and men's) schooling are associated with better child health and lower mortality risks, as well as to better access to family planning services and to changes in aspirations and norms with regard to marriage and the family. Better-educated parents are thought to be more likely to choose child quality over quantity: having fewer children and investing more in terms of health and schooling for each of them.[18] These parents are also likely to face higher opportunity costs related to childbearing than others. High fertility relative to mortality leads to population growth that makes it more difficult for families and governments to provide adequate health care and schooling, and can also destabilize traditional family organization. A large number of other connections between these (and other) variables are also plausible, meaning that the regression results should not be interpreted as estimates of simple, unidirectional causal linkages. It is worth emphasizing that simultaneity is not only

a problem for the study of the impact of child mortality on the start of women's reproductive lives; it also affects most statistical analyses focusing on one aspect of the development process, including the effects of maternal education on marriage, fertility and child health (e.g., Eloundou-Enyegue, 1999).

To the extent that the net effects of simultaneity are nonetheless small and the coefficients do, in fact, broadly reflect the causal effects of the independent variables, then the impact of community mortality on the start of women's reproductive lives are likely to be underestimated by this study. The time-diffuse nature of the effects of mortality on marriage and first births makes it difficult to capture the full impact of mortality reductions in a statistical analysis (Brass and Barrett, 1978). Mortality reductions are thought to act through a number of individual (or family) and community-level pathways, each with time lags of differing lengths, often beset with thresholds and other non-linearities, and probably of changing importance over the course of the demographic transition.

It is commonly argued that reproductive strategies focusing primarily on an ideal number of surviving children (including the insurance strategy) become important only after the start of the fertility transition (e.g., F. van de Walle, 1986, E. van de Walle, 1993, and for qualitative evidence from Africa, LeGrand et al., 2001). The data used in this study cover the period stretching from the late 1970s to the mid-1990s, a time when much of the region was just entering into the fertility transition and when new reproductive strategies may have been starting to emerge. The families and communities in our data may differ greatly in the ways and speed by which they perceive changes in their environment such as mortality declines, and in how they modify their marriage and fertility behaviours in response (Montgomery, 1998; Bongaarts and Watkins, 1996). A widespread transition in mentality with regard to family-building strategies, as hypothesized by Lloyd and Ivanov (1988), may occur only after an extended period of improvements in child survival. Traditional norms, marriage rules and institutions supporting high fertility may continue to affect people's marriage and first birth behaviours long after mortality has fallen. Mortality effects operating at the community level through changes in age structure or population growth may require even longer time lags.

The difficulty of capturing the relationship in our analysis is further compounded by the use of pooled cross-sectional data from many communities to capture one aspect of a dynamic development process that occurs over time. Indeed, Behrman et al. (1999) found that the estimated effects of mortality and health on fertility are larger, and women's schooling smaller, in regressions based on time-series data than in those based on pooled cross-sectional data, and they argue that their longitudinal results better reflect the real situation.

What then can we conclude? First, despite the limits of this analysis, the regressions do show a pronounced and highly significant association between child mortality and women's entry into union and motherhood in sub-Saharan Africa, one that is consistent with a number of theoretical predictions. At the very least,

this is an issue that deserves more attention by researchers, given the lack of other empirical studies on the subject to date. Two approaches with potential to get around the complications of simultaneity and selectivity are qualitative investigations of the hypothesized linkages between perceived child mortality risks and reproductive strategies, and statistical studies based on longitudinal data.

Second, sub-Saharan Africa appears to be following the pattern witnessed in a number of North African and Asian countries, where increases in women's age at marriage and first birth were observed during the initial phase of the fertility transition. In this study, infant and child mortality and women's schooling are the two factors that were both found to be strongly related to the start of women's reproductive lives and which have undergone considerable change over the past 40 years. These factors are also believed to be important determinants of marital fertility, and progress in women's education and in child survival may have played an important role in the onset of fertility declines that have been observed in several sub-Saharan African countries. However, in recent years economic recessions, political strife and the HIV/AIDS pandemic have resulted in a slow-down and even reversal of the long-term trend to improved child survival in many sub-Saharan African countries (United Nations, 2001; Timaeus, 1997; Barbieri and Vallin, 1996). In addition, primary school enrollment rates have stagnated and even fallen since the early 1980s in many countries in the region, and this has been accompanied by a slowdown in the growth of secondary school enrolment (UNESCO, 2000; Lloyd et al., 2000). The results of this study support the argument that these events, should they continue into the future, might reduce the pace or even forestall the emerging fertility transition in the region.

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Notes

[1] According to DHS data collected in the late 1980s, total fertility in three other southern African countries – Lesotho, Botswana and Swaziland – was 4.9 or 5.0, and it is likely that their fertility levels are still lower today.

[2] However, marriage in Africa is more often a process than a well-defined event occurring at a point in time, and this complicates the study of the trends in women's age at marriage and premarital preg-

nancies (Van de Walle, 1993; Cohen, 1998). This issue is presented in more detail in the methodology section.

[3] See Cohen and Montgomery (1998) and Randall and LeGrand (2000) for recent reviews of the possible pathways between child mortality and fertility outcomes.

[4] We know of just three studies that use regressions to examine the effects of community-level child mortality on women's age at marriage. Reductions in infant and/or child mortality appear to have delayed women's age at marriage in Taiwan (Casterline, 1980; Schultz, 1980) and in Japan (Mosk, 1983, ch. 5). This was also the case for Sweden in the late 19th century but not in the 20th century (Mosk 1983, ch. 6). In addition, Hermalin and Van de Walle (1977) report that *départements* in 19th century France with longer life expectancies also had significantly higher women's singulate mean ages at marriage, even after controlling for the effects of several other variables. Galloway (1988) showed that increases in non-infant mortality resulted in higher marriage rates after a lag of about one year, in a study of nine countries and regions in historical Europe. Finally, a qualitative study by Randall and LeGrand (2000) of the Wolof people in Senegal found only weak evidence of perceived child mortality risks being a factor in marriage strategies and decisions.

[5] The transition effect is related to Van de Walle's (1992) theory of numeracy and to Coale's (1973) preconditions for the fertility transition. Like Lloyd and Ivanov, Van de Walle postulated the occurrence of a one-time shift in people's mentalities, for him in terms of desired fertility: the transition from non-numeric fertility preferences to a precise number of desired children. Such a transition might also be affected by a growing awareness by couples that they can control their destiny and, through their actions, obtain a specific number of surviving children. Castle (2001) criticizes these ideas in the African context; see also the discussions in LeGrand et al. (2001) and Watkins (2000).

[6] See Fernando (1975) for Sri Lanka, and Caldwell et al. (1983) and Mari-Bhat and Halli (1999) for India. In Bangladesh, the marriage squeeze appears to have engendered other types of changes; see Amin and Cain (1997).

[7] Chojnacka (1995). Even a modest marriage squeeze can give rise to large changes in marriage patterns, because the numbers of men and women on the marriage market are inelastic at least at the level of the subcontinent. Other outcomes include an increase in female celibacy, a decrease in men's age at marriage, and a growing prevalence of polygamous marriages and some types of informal unions. There is some evidence that, in sub-Saharan Africa, men's age at marriage has been increasing, not decreasing, at least in urban areas (e.g., Antoine et al., 1995). The frequency of polygamous unions seems to have remained fairly stable or been in decline in recent years (Kaufmann et al., 1988; Antoine and Pilon, 1998). However, some types of informal unions may be becoming more common (Antoine and Nanitelamio, 1990).

[8] It is plausible that the direct economic costs of population growth will be less obvious to populations in sub-Saharan Africa, where densities remain fairly low, compared to the densely populated societies of South Asia, and that this may result in a more time diffuse child survival – fertility/marriage relationship.

[9] When the resulting areas contained less than 150 women aged 15–49, we attempted to regroup the areas, for example, combining the rural areas of two adjoining regions. When available, the more detailed breakdowns for capital city, other cities, towns, and rural areas were used instead of the simple urban/rural dichotomy. When the variables required to define communities were not available in the data (e.g., the Botswana DHS, which was also not in the public domain), the data set was not included in this study.

[10] For a discussion of data problems concerning age at marriage and first birth, see Blanc and Rutenberg (1990), Gage (1995), Van de Walle (1993), Lesthaeghe et al. (1989), Westoff et al. (1994), and Arnold (1991). In any case, Lesthaeghe et al. (1989) found that the proportion married among women aged 15–19 is statistically very closely associated with Hajnal's singulate mean age at marriage.

[11] The smallest communities had data on only about 100 women. To reduce random fluctuations in the community-level mortality rates, the probabilities of dying for the 0–6 year and 7–12 year time periods prior to the dates of the surveys were averaged. These periods were chosen to avoid biases in the estimates that could be caused by a displacement of births from the fifth to the sixth year prior to the survey – a common problem for DHS data (Institute for Resource Development, 1990; Macro International Inc., 1993). The 12-year end-point used for estimating the mortality rates was chosen as a compromise between the need to have a sufficiently long time span to capture enough births and deaths for the calculation of reasonably accurate mortality rates and the desire to limit recall biases, known to increase with time in retrospective surveys.

[12] Christian is defined as Catholic and mainstream Protestant. The Burundi, Malawi, and Senegal DHS's used here do not have data on religion. Burundi and Malawi are predominantly Christian and all women there were defined as Christian. For Senegal, religion was imputed using the regional distribution of women by religion measured by an earlier DHS. For example, a woman living in urban areas of the Western region was defined as being 0.9368 Muslim, 0.0624 Christian, and 0.0008 other – the proportions measured by DHS I.

[13] The number 11 was chosen to avoid heaping problems, as it does not generally correspond to a diploma or certification year.

[14] The variable used is an index constructed from data on household possessions: drinking water source, toilet type, main wall material, electricity, radio, TV, refrigerator, bike, motorcycle, car. The values of these ten variables were summed for all women aged 23–49, giving an index ranging from 0 (destitute) to 10 (very rich) for each woman. The community average was then computed, standardizing for ages 23–31 and 32–49. Finally, five levels of community living standards were defined: 1 (very low), 1 to 1.99 (low), 2–2.99 (middle), 3–3.99 (middle-high), and 4+ (high).

[15] Sterility was measured by a childlessness estimator computed as the proportion of childless women currently in union who have been married for more than seven years and were married before age 20. This indicator is correlated with the "subsequently infertile" estimator, which could not be included in the regressions because of the widely varying levels of contraceptive use across the communities (Larsen, 1994).

[16] Many of the older women were living in the same households as the younger women, whose behaviours are the focus of this study. While the behaviours and characteristics of younger and older women residing together are likely to be related, endogeneity biases at the household level should be relatively small since the community variables are aggregates of data collected from all women of the relevant ages living in the community. Another aspect of endogeneity – simultaneity – is likely to be more of a problem. This concerns the likelihood that levels and changes in child mortality, marriage behaviour, women's and men's schooling and a host of other factors are closely intertwined as part of the complex social and development process, meaning that the estimated coefficients encompass more than simple, unidirectional causal effects. This issue is presented in detail in the discussion section of the paper.

[17] This non-linearity was not found to be statistically significant in a regression estimated to further explore this issue, in which the community mortality rates were captured by a cubic specification instead of a set of dummy variables.

[18] Highly educated women who are especially active in promoting their children's health may also be a very selective population subgroup, with distinctive behaviours that are rooted in difficult-to-observe underlying characteristics (Eloundou-Enyegue, 1999).

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