The Impact of Women's Schooling on Fertility and Contraceptive Use: A Study of Fourteen Sub-Saharan African Countries

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This article examines the relationship between female schooling and two behaviors—cumulative fertility and contraceptive use—in fourteen Sub-Saharan African countries where Demographic and Health Surveys (DHS) have been conducted since the mid-1980s. Average levels of schooling among women of reproductive age are very low, from less than two years to six. Controlling for background variables, the last years of female primary schooling have a negative relation with fertility in about half the countries, while secondary schooling is associated with substantially lower fertility in all countries. Female schooling has a positive relationship with contraceptive use at all levels. Among ever-married women, husband's schooling exerts a smaller effect than does female schooling on contraceptive use and, in almost all cases, on fertility. Although the results suggest commonalities among these Sub-Saharan countries, they also reveal intriguing international differences in the impact of female schooling, which might reflect differences in the quality of schooling, labor markets, and family planning programs, among others.

There is considerable debate in the literature as to whether high fertility and high desired family size in Africa are caused by low levels of economic development that favor large families (see World Bank 1984, 1986), or by unique cultural features (see Caldwell and Caldwell 1987, 1990). Without denying the possibility that cultural traits may contribute to higher demand for children in Africa than in other developing regions, most studies have found differentials in current or total fertility by socioeconomic class, even in high-fertility countries

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(see Cochrane and Farid 1990 and United Nations 1987, for example). Among the factors thought to be the most conducive to the high demand for children are high child mortality and low levels of female schooling.

This article estimates the relationships between female schooling and fertility and between female schooling and contraceptive use in fourteen Sub-Saharan African countries where Demographic and Health Surveys (DHS) were conducted from the mid-1980s to the early 1990s. Multivariate analysis of the determinants of fertility and contraceptive use allows a precise exploration of the relationship with women's schooling, while controlling for variables like age, area of residence, wealth, ethnicity, and religious affiliation. Results across the countries, for both national and subnational samples, are compared and form the basis for future research to explain international differences.

Section I describes the posited relationships between women's schooling and fertility and between women's schooling and contraceptive use and summarizes the evidence to date on these relationships in Sub-Saharan Africa. Section II presents the empirical model and describes the data sets. Section III provides descriptive statistics—both from the data sets and from outside sources—on economic and demographic indicators for the fourteen countries under study. Section IV describes the results for determinants of fertility, and section V describes the results for the determinants of contraceptive use. Section VI reviews the results and proposes areas for additional research.

I. Women's Schooling, Fertility, and Contraceptive Use

Women's schooling is posited to result in lower fertility and, by inference, higher contraceptive use, through four main channels.

- *Wage effects*. By raising the opportunity cost of women's time in rearing children, schooling raises the "price" of children (who are time-intensive) as well as the wage that women can earn in the work force. The wage benefits of schooling may also induce women to get more schooling, thereby delaying the onset of childbearing. This is likely to result in lower fertility and higher rates of female participation in the labor force.
- *Higher demand for child schooling*. Women with more schooling may develop higher aspirations for their own children's schooling. These aspirations may lead them to have fewer children and to invest in more schooling per child. This is the quantity-quality tradeoff observed in other parts of the world but examined only recently in Sub-Saharan Africa (Kelley and Nobbe 1990; Montgomery, Kouamé, and Oliver 1995). There are many initiating factors for this tradeoff, including the levels of wages and employment expected by graduates and the quality and price of schooling.
- *Lower child mortality*. Women with more schooling are likely to be more effective in producing healthy children, which lowers child mortality. As the "wedge" between live births and surviving children is narrowed, couples find that they can have fewer children to reach a target number of surviving

children.[1] In a cross-national study, Schultz (1994) found that fully half of the effect of female schooling in lowering fertility was operating through its effect in lowering child mortality.

- *More effective use of contraception.* Educated women can learn about and use contraception more effectively than uneducated women, reducing the number of unanticipated pregnancies.

It has been suggested that female schooling can indirectly raise fertility by improving maternal health, reducing pathological sterility, and reducing the duration of breastfeeding and its contraceptive benefits (Alam and Casterline 1984; Bongaarts, Frank, and Lesthaeghe 1984; Casterline and others 1984; Cleland and Rodriguez 1988; Cochrane 1979, 1988; Jejeeboy 1992; and World Bank 1984). Female education is also thought to facilitate fertility decline by increasing the bargaining power of women, allowing them greater control over their destiny, and improving husband-wife communication (Jejeeboy 1992; United Nations 1987).

There have been several studies of the differentials in aggregate measures of fertility between urban and rural areas and among women according to their level of schooling, using data from the World Fertility Survey (WFS) (Alam and Casterline 1984; Cleland and Rodriguez 1988; Cochrane 1988; Cochrane and Farid 1990; and United Nations 1987). The total fertility rate (TFR) is the number of children a woman would have in her lifetime if she bore children according to current age-specific fertility rates. Table 1 presents differentials in the TFR by area of residence and female education for African countries that participated in the more recent DHS. The TFR measured in these fourteen countries is very high—generally in the range of six to seven children. However, in every country it is significantly lower in urban than in rural areas.

One reason for these urban-rural differentials is the concentration of women with secondary and higher levels of schooling in urban areas. Women who have completed primary schooling or who have some secondary schooling universally have a lower TFR than women without schooling. The differential between the fertility of women with primary schooling and those with no schooling is smaller and sometimes follows an unanticipated direction: in Burundi, Cameroon, Kenya, and Nigeria, women with some primary schooling actually have a higher TFR than those with no schooling. Note, however, that the TFR for those who completed the primary cycle is substantially lower than for women with no schooling in all cases, including Kenya and Nigeria. Results that indicate a positive relation between some primary schooling and the TFR cast doubt on the effectiveness of less-than-complete female primary schooling in lowering fertility, suggesting that schooling does not have a depressing effect on fertility until the secondary level (Cleland and Rodriguez 1988; Cochrane 1979, 1988; United

1. See Benefo and Schultz (1994) and Pitt (1995) for evidence of the relation between female schooling and child mortality in Sub-Saharan Africa.

Table 1. *Total Fertility Rates for Women Age 15–49, by Residence and Education, Fourteen Sub-Saharan African Countries*

		Residence			Education			
Country	*Year*	*All*	*Urban*	*Rural*	*None*	*Primary*[a]	*Completed primary*	*More than primary*
Tanzania	1991–92	6.3	4.0[b]	6.6[c]	6.5	6.4[d]	6.0	4.2
Uganda	1988–89	7.3	5.7	7.5	7.7	7.2[d]	7.3	6.7/5.1[e]
Burundi	1987	6.8	5.3	6.9	6.8	7.2	—	5.5
Mali	1987	6.7	6.1	7.0	6.8	6.2	—	n.a.
Niger	1992	7.4	6.7	7.5	7.5	6.3[f]	—	—
Nigeria	1990	6.0	5.0	6.3	6.5	7.2[d]	5.6	5.1/4.2[g]
Kenya	1993	5.4	3.4	5.8	6.0	6.2[d]	5.0	4.0
Ghana	1993	5.5	4.0	6.4	6.7	6.1	—	4.7/2.9[e]
Togo	1988	6.6	4.7	7.0	6.8	5.7	—	4.5
Zambia	1992	6.5	5.8	7.1	7.1	6.8	—	4.9
Zimbabwe	1988	5.5	4.1	6.2	7.0	6.0	—	3.8
Senegal	1992–93	6.0	5.1	6.7	6.5	5.7	—	3.8
Cameroon	1991	5.8	5.2	6.3	6.2	6.4	—	4.5
Botswana	1988	5.0	4.1	5.4	6.0	5.2[d]	4.6	3.3

n.a. Not applicable.

— Not reported.

Note: Countries are listed in order of 1991 gross national product (GNP) per capita, from lowest to highest (see table 2).

a. In Botswana, Kenya, Tanzania, Uganda, Zambia, and Zimbabwe, primary schooling includes seven years of instruction. For all other countries this figure is six years. Unless otherwise noted, primary refers to any primary schooling, including completed primary.

b. The figure for Dar es Salaam is 4.0; for other urban mainland, 5.6; for Zanzibar, 6.4.

c. Mainland only.

d. Some primary.

e. First figure is for middle school, second is for secondary and higher in Ghana and secondary 4 and higher in Uganda.

f. Any schooling (primary or more).

g. First figure is for some secondary, second is for completed secondary and higher.

Source: DHS country reports, available from IRD/Macro International, Inc., Calverton, Md. Following are countries and publication dates of each report: Botswana (1989); Burundi (1988); Cameroon (1992); Ghana (1994); Kenya (1994); Mali (1989); Niger (1993); Nigeria (1992); Senegal (1994); Tanzania (1993); Togo (1989); Uganda (1989); Zambia (1993); and Zimbabwe (1989).

Nations 1987; World Bank 1984). However, these patterns are not apparent in the relation between women's education and contraceptive use: in African countries covered by the DHS, women with more schooling are also increasingly likely to be practicing contraception (Castro Martin 1995). In fact, even bivariate studies of the correlates of contraceptive use conducted in the 1960s found that use increased with levels of male and female education (see Cochrane 1979, table 5.6).

The comparison of aggregate measures of fertility and contraceptive use by socioeconomic status is a useful starting point for analysis, but has many shortcomings. First, the two-way comparisons do not simultaneously control for other factors that influence fertility and contraceptive use. Income, for example, may be highly correlated with schooling but may have an opposite (positive) effect on fertility (Ainsworth 1989, 1990; Farooq 1985; National Research Council

1993). Failure to control for these other correlated variables may confound the independent effects of schooling, other policy variables, and exogenous factors like ethnicity.

Second, the total fertility rate does not represent the completed fertility of any individual or cohort of women; rather, it is the number of children a woman would have over her reproductive lifetime if she were to bear children at prevailing age-specific fertility rates. Thus, cohort effects of schooling on the timing of births over the life cycle are not reflected in the comparisons of TFR for schooled and unschooled women. As a larger share of each successive cohort is educated, the relation between schooling and fertility for any given cohort is likely to change.

Third, the policy objective is to lower aggregate measures of fertility by influencing individual decisions on the number of children. At the individual level, the policy objective is therefore to influence cumulative and completed fertility.

Finally, if there are any nonlinearities in the relationship between policy variables and fertility, they will not necessarily be reflected in, and cannot be studied with, aggregates like the total fertility rate (Anker 1985; Schultz 1992). For these reasons, multivariate analysis of individual data may yield greater insights on the likely impact of policies, such as female schooling, on cumulative fertility.

A number of multivariate studies have examined the relation between female schooling and cumulative fertility in Sub-Saharan countries, controlling for the woman's age, area of residence, and sometimes her religion, ethnic group, and household income (see Ainsworth, Beegle, and Nyamete 1995, table 2). Six studies that controlled for household permanent income—using proxies such as husband's schooling, husband's income, household consumption, land ownership, and cattle—found either a significant negative relation (Ainsworth 1989; Okojie 1990, 1991; Snyder 1974) or no relation (Anker and Knowles 1982; Farooq 1985) between women's schooling and cumulative fertility at low levels of female schooling. At higher levels, female schooling was correlated with substantially lower fertility. Burafuta and Shapiro (1992) found a positive relation between primary schooling and fertility in Burundi, but secondary schooling was associated with lower fertility relative to women with no schooling. They were, however, unable to control for income. Shapiro and Tambashe (1994) found similar results in Kinshasa, Zaire, while controlling for "economic status." Fairlamb and Nieuwoudt (1991) found a large and significant negative effect of the years of female schooling on children ever born, but the results were confounded by endogenous regressors, and the study had no control for exogenous income.

Ahn and Shariff (1994) found that seven or more years of schooling reduce the progression to first birth in Togo and Uganda. Husband's education had a positive relation with cumulative fertility in four studies that did not have any other measures of income (Okojie 1990, 1991; Snyder 1974; United Nations 1987), but had a negative relation when women's education and a proxy for household permanent income were controlled for (Ainsworth 1989). A United Nations (1987) study of twelve African countries in the World Fertility Survey found a negative relation between schooling and fertility for women with ten or more years of schooling and who had been married for at least three years. For levels of schooling less than ten years, the relationship was cited as positive. However, the statistical significance of the coefficients on lower years is not reported and female schooling was significant in only five to six of the countries. Husband's schooling at all levels had a positive relation with fertility, but was significant in only six of the countries.

Multivariate studies of Sub-Saharan Africa at the individual level have shown a consistently positive relation between female schooling and contraceptive use in Sub-Saharan Africa.[2] In comparing the determinants of contraceptive use over time using data from the 1977–78 Kenya Fertility Survey and the 1989 Kenya Demographic and Health Survey, Njogu (1991) found that educated women at all levels are significantly more likely to use contraception compared with women with no education, and that the impact of education rises with its level. An unpublished study of contraceptive use in Ouagadougou, Burkina Faso, showed similar positive effects of women's literacy and schooling on ever use of modern contraception (Fenn, McGinn, and Charbit 1987). All levels of schooling, including primary schooling, significantly raised the probability of contraception among a sample of nonpregnant women in Kinshasa, Zaire (Shapiro and Tambashe 1994). Similar results were found for a sample of all women of reproductive age in Burundi (Burafuta and Shapiro 1992). Castro Martin's (1995) results indicated, even at low levels of female schooling, statistically significant effects on contraceptive use among currently married women in ten African countries. Beegle (1995), Feyisetan and Ainsworth (1994), Oliver (1995), and Thomas and Maluccio (1995) found strong effects of female schooling on contraceptive use when controlling for the availability (in Tanzania), quality (in Nigeria), and price of family planning services (in Ghana and Zimbabwe). In multivariate studies in other regions, women's education has a uniformly direct relation with contraceptive use and husband's education also has a direct but less powerful relation (Castro Martin 1995; Cochrane 1979).

These studies suggest a negative but nonlinear relation between women's schooling and fertility and demonstrate the potentially confounding effects of other variables correlated with schooling (such as household income) in interpreting the results. However, many of the studies included potentially endogenous regressors in the analysis of fertility, variables such as the age at first birth, child spacing intervals, child schooling, and women's labor force participation (Snyder 1974); contraceptive use, breastfeeding, child survival, and the desired level of child schooling (Anker and Knowles 1982); and age at marriage (United Nations 1987). In multivariate analysis of contraceptive use, endogenous regressors have included fertility,

2. The National Research Council (1993) study conducted a multivariate analysis of the determinants of contraceptive use in sixty-eight regions of Sub-Saharan Africa using as regressors mean completed female schooling, urban residence, the percentage of women in polygamous unions, and the percentage of women who practiced Muslim and traditional religions. The results confirmed the very strong effect of female schooling relative to other factors.

women's labor force participation, current enrollment status (Burafuta and Shapiro 1992; Castro Martin 1995; and Shapiro and Tambashe 1994); marital status (Fairlamb and Nieuwoudt 1991; Fenn, McGinn, and Charbit 1987; Shapiro and Tambashe 1994); and fertility intentions (Fairlamb and Nieuwoudt 1991; Njogu 1991; Shapiro and Tambashe 1994). Decisions concerning marriage, timing of first births, child schooling, and labor force participation are jointly determined with fertility. Their inclusion will lead to biased results.

An additional problem is that most of the studies used samples of currently married women. By conditioning on marriage, they have not captured the full effect of socioeconomic variables on fertility (through delayed marriage) or contraceptive use (before marriage). Further, since marriage and childbearing could be thought of as a joint decision, studies that use married samples have introduced a potential sample selection bias in favor of women with higher demand for children. Snyder (1974) and Chernichovsky (1985) studied an even more selective sample—women with children. Shapiro and Tambashe (1994) studied contraceptive use in a sample of nonpregnant women and Castro Martin (1995) in a sample of currently married nonpregnant women. United Nations (1987) studied marital fertility in a group of women married for at least three years.

We seek to avoid many of these pitfalls by using a common set of exogenous regressors on samples of all women, regardless of marital status. Further, by examining similar specifications, results can be compared across countries using the most up-to-date data.

II. Empirical Model and Data Sets

The empirical model of fertility determinants regresses a measure of cumulative fertility—children ever born to each woman—on a set of independent variables that are assumed to be exogenous to fertility decisions but that influence either the demand for or supply of children. This reduced-form model of fertility determinants can be written as

$$y = \beta_0 + \beta_{11}x_1 + \beta_{12}x_1^2 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \mu$$

where y is the dependent variable, children ever born; β_0 is an intercept; x_1 is the woman's age, entered in quadratic form to control for biological factors affecting the supply of births; x_2 is the woman's schooling, in various specifications; x_3 indicates urban residence; x_4 is the woman's ethnic group; x_5 is the woman's region of residence; x_6 is the woman's religion; and x_7 is a group of variables proxying the household's income or wealth. The empirical models for contraceptive use are identical, except for the dependent variable, which is a dichotomous (dummy) variable that takes on the value zero or one, indicating current use of modern contraception.

To examine in more detail the nonlinearities of schooling effects and fertility, the results from four different specifications of female schooling are presented: (a) years of completed schooling as a linear term; (b) years of completed schooling in quadratic form (schooling and schooling squared); (c) linear splines for the level of schooling reached—lower primary (one to three years), upper primary (four to six years or four to seven), lower secondary (seven to ten years or eight to ten) and higher levels (eleven years and more); and (d) dummy variables for individual years of completed schooling.[3] Relationships for the national sample as well as for urban and rural subsamples are presented here. Results by cohort are presented in Ainsworth, Beegle, and Nyamete (1995).

The choice of independent regressors has been influenced by the availability of information in the data sets. The analysis uses data from fourteen Sub-Saharan African countries collected by the DHSs in the late 1980s and early 1990s. The DHS samples are large—from 3,000 to 9,000 women aged fifteen to forty-nine. The large size of the samples is important because in many countries only a small proportion of women have had any schooling (fewer than a third of women in Burundi, Mali, and Senegal, for example). There are, unfortunately, no measures of household income or consumption in the DHS data sets. We use instead four variables that serve as proxies for income and wealth: household ownership of a radio, a television, or a bicycle, and the quality of housing. The latter is a dichotomous variable that indicates whether the floor of the household's residence is cement, tile, polished wood, or parquet; the default categories are mud, sand, or clay in most countries.

The number of children ever born is censored from below at zero, and can take on only zero or positive integer values. Under these conditions, least squares regression coefficients are inconsistent and, when the dependent variable and regressors are normally distributed, are biased downward in proportion to the degree of censoring in the sample (Greene 1981). Depending on the data set, roughly a quarter of the women in the samples (ranging from 16 percent in Mali to 30 percent in Burundi) have had no live births. Although there are econometric models capable of dealing with this problem, we have opted to use the easier-to-interpret ordinary least squares (OLS) estimation for the fertility regressions.[4] This censoring problem does not arise for the contraceptive use regressions, in which the dependent variable is dichotomous. Maximum likelihood logit is used in estimation of the parameters (Maddala 1983).[5]

3. In six countries the primary cycle is completed in seven years (Botswana, Kenya, Tanzania, Uganda, Zambia, and Zimbabwe). In these instances the upper primary and lower secondary variables are set equal to four to seven and eight to ten years, respectively. Cameroon has a dual system, with those in the Francophone areas completing primary schooling in six years, and those in the Anglophone areas in seven years. The upper primary school spline used in Cameroon is set to reflect incomplete or complete primary schooling for the system in which the woman was enrolled.

4. The Tobit model, for example, takes into account the censoring of the dependent variable at zero, although not its integer nature. A Poisson count model takes into account both the censoring and integer nature of the dependent variable, and the coefficients would be unbiased, even if the mean and variance of the dependent variable are not equal (as is implied by the Poisson model). For all subsamples except young women and possibly urban women, Tobit and Poisson models produce results identical in sign and significance and very similar in magnitude to OLS coefficients (Ainsworth 1989).

5. Standard errors in both the fertility and contraceptive use regressions are corrected for heteroskedasticity and cluster effects.

A second censoring issue involves the inclusion of women who have not completed their fertility. One way of dealing with this problem would be to predict the completed fertility of younger women on the basis of the determinants of fertility found among women who had already completed or nearly completed childbearing. However, in most African countries this would restrict the analysis to an older sample of women (over forty) that has had very little schooling. Further, we anticipate that the relation between schooling (as well as other independent variables) and fertility may be changing over time. As the aggregate proportion of schooled women increases, the quality and price of schooling change, family planning becomes more widely available to younger women, and other socioeconomic conditions (such as income) evolve. To account for the fact that women in the samples have been exposed to the risk of pregnancy for differing amounts of time and for the fact that fecundity over the fifteen-to-forty-nine age range rises with age, peaks, and then declines, we control for the woman's age and age squared.

A third censoring issue of unknown magnitude, relevant to both the fertility and contraceptive use regressions, is the possibility that some of the younger women in the sample may not have completed their schooling. The DHS data sets did not record whether the women in the sample were currently enrolled in school. However, given the limited amount of schooling in all of the national samples at the primary and especially the secondary level, we do not anticipate that upper censoring of the completed schooling variable is a major problem in this analysis.

III. Descriptive Statistics

The fourteen Sub-Saharan African countries included in this study span the continent in terms of their geographic location, colonial heritage, and level of economic development. Half of the countries are West African, four are in Eastern and Central Africa, and three are in Southern Africa. Five countries are French-speaking (Burundi, Mali, Niger, Senegal, Togo); eight are English-speaking, and Cameroon uses both as official languages. The countries range in size from Botswana, with slightly more than one million people, to Nigeria, the largest country in Sub-Saharan Africa, with a population of nearly 100 million (table 2). Most of these countries have very low incomes; as shown in table 2, seven had incomes per capita of less than US$400 in 1991. Among the twelve countries for which data are available, eight had negative rates of growth of gross national product (GNP) per capita in the 1980s, and for two others GNP per capita grew at less than 1 percent a year. Scribner (1995) has characterized the population policies of most of the countries in this study, including policies on family planning, child health, and women's legal status.

There are wide divergences in female enrollment and infant mortality rates. As recently as 1990, for example, female primary enrollments represented only 17 percent of primary-age girls in Mali, 21 percent in Niger, and only

Table 2. *Economic and Social Indicators, Fourteen Sub-Saharan African Countries*

Country	*GNP per capita, 1991 (U.S. dollars)*	*Growth rate of GNP per capita, 1980–91 (average annual percent)*	*Population, mid-1991 (millions)*	*Population growth rate, 1980–91 (average annual percent)*	*Urban population (percent)*	*Infant mortality rate, 1991*[a]	*Female gross primary enrollment ratio, 1990*	*Female gross secondary enrollment ratio, 1990*
Tanzania	100	–0.8	25.2	3.0	34	115	63	4
Uganda	170	—	16.9	2.5	11	118	63[b]	—
Burundi	210	1.3	5.7	2.9	6	107	64	4
Mali	280	–0.1	8.7	2.6	20	161	17	4
Niger	300	–4.1	7.9	3.3	20	126	21	4
Nigeria	340	–2.3	99.0	3.0	36	85	63	17
Kenya	340	0.3	25.0	3.8	24	67	92	19
Ghana	400	–0.3	15.3	3.2	33	83	67	31
Togo	410	–1.3	3.8	3.4	26	87	80	10
Zambia	420[c]	—	8.3	3.6	51	106	91	14
Zimbabwe	650	–0.2	10.1	3.4	28	48	116	46
Senegal	720	0.1	7.6	3.0	39	81	49	11
Cameroon	850	–1.0	11.9	2.8	42	64	93	21
Botswana	2,530	5.6	1.3	3.5	29	36	112	47

— Not available.

Note: Countries are listed in order of 1991 GNP per capita, from lowest to highest.

a. Per 1,000 live births.

b. 1992 data.

c. 1990 data.

Source: World Bank (1992, 1993, 1995).

half of the primary-age girls in Senegal (table 2). By comparison, the inclusion of over-age girls in primary enrollments in Botswana and Zimbabwe raises their gross female primary enrollment rates to over 100 percent. In only three countries—Botswana, Ghana, and Zimbabwe—do female secondary enrollments equal or exceed 30 percent of the women in that age group. Perhaps not coincidentally, demographers believe that fertility decline is under way in two of these three countries—Botswana and Zimbabwe (van de Walle and Foster 1990). Infant mortality rates (IMRs) also show great variation. Botswana and Zimbabwe have IMRs lower than 50 per 1,000, but six countries have rates greater than 100 per 1,000 (table 2). Despite these differences in economic and social indicators, levels of fertility and population growth rates in the fourteen countries are high and remarkably similar. With the exception of four countries, population growth rates were between 3 and 4 percent per year during the 1980s. Recall from table 1 that the total fertility rates were between 5.0 and 7.4 children per woman.

Descriptive statistics for the fourteen DHS data sets and the year of data collection are presented in table 3. Only four of the data sets are nationally self-weighted samples that achieved total coverage (Ghana, Senegal, Togo, and Zimbabwe). Thus, the unweighted sample statistics for other countries may not be nationally representative. A description of the sample design and coverage of the fourteen surveys is in appendix table A-1. The average woman in the samples in table 3 was twenty-seven to twenty-nine years old and, with the exception of Botswana, Ghana, and Zimbabwe, had three or more live births. Except for Botswana, Kenya, and Zimbabwe, fewer than 10 percent of the sampled women were using a modern method of contraception.[6] Levels of urbanization in the samples were highest in Botswana, Cameroon, Mali, Nigeria, Senegal, and Zambia, where 40 percent or more of sampled women were living in urban areas. In Botswana, Cameroon, Mali, Niger, and Nigeria, urban women were oversampled. National levels of urbanization are reported in table 2.

Women of reproductive age in these samples had very little schooling. The highest levels of schooling are for women in Zimbabwe, where the average woman in the sample had completed six years of schooling and where only 13.6 percent of the sample had no formal schooling. In Burundi, Mali, Niger, and Senegal, levels of schooling are lower: mean schooling was less than two years, and roughly three-quarters or more of the women had received no schooling. Since the DHS oversampled urban women in Burundi, Mali, and Niger, these statistics overstate the true levels of education at the national level.

Figure 1 shows the distribution of women according to their years of completed schooling. Countries are ordered from lowest to highest 1991 GNP per capita. Even in countries with relatively higher per capita incomes, like Senegal, a very large share of women have had no schooling. In fact, the French-speaking

6. Modern methods include female sterilization, vasectomy, pill, intrauterine device (IUD), injectable contraceptives, condoms, spermicides, and diaphragm.

Table 3. *Demographic and Health Survey Sample Statistics, Fourteen Sub-Saharan African Countries*

Country	Year	Sample size	Mean number of children ever born	Women using modern contraceptives (percent): Currently	Women using modern contraceptives (percent): Ever	Women living in urban areas (percent)	Mean years of female schooling	Distribution of women by years of schooling (percent): 0	1–3	4–6	7–10	11 or more
Tanzania	1991–92	9,001	3.15	5.2	12.5	20.0	4.16	35.2	5.6	53.4[a]	2.4[b]	3.4
Uganda	1988–89	4,727	3.40	3.4	9.6	20.4	3.67	34.5	17.0	35.8[a]	7.5[b]	5.3
Burundi	1987	3,943	3.00	2.3	4.2	15.9	1.37	74.2	7.2	13.4	3.7	1.6
Mali	1987	3,188	3.83	2.0	5.1	41.9	1.22	80.5	4.0	8.0	5.9	1.7
Niger	1992	5,854	3.78	4.6	8.8	38.8	1.04	83.1	2.3	8.1	5.3	1.1
Nigeria	1990	8,734	3.20	5.2	12.1	40.2	3.72	51.7	4.2	19.9	10.5	13.7
Kenya	1993	7,490	3.17	24.7	43.5	15.3	5.91	17.3	7.2	42.4[a]	20.6[b]	12.6
Ghana	1993	4,562	2.91	9.3	29.5	37.7	5.34	35.4	5.9	11.6	40.0	7.2
Togo	1989	3,351	3.21	3.4	10.7	35.2	2.31	58.8	10.1	19.1	10.4	1.6
Zambia	1992	7,004	3.13	6.7	22.1	47.6	5.37	18.4	11.3	48.4[a]	16.4[b]	5.4
Zimbabwe	1988–89	4,179	2.96	27.2	48.4	33.3	6.04	13.6	10.5	45.4[a]	16.6[b]	13.9
Senegal	1992–93	6,322	3.31	4.5	6.2	41.7	1.80	73.4	3.3	13.7	6.6	3.1
Cameroon	1991	3,862	3.00	5.4	19.9	56.6	5.07	33.4	6.5	22.9[c]	24.5[c]	12.7
Botswana	1988	4,356	2.44	31.8	56.8	51.7	5.85	20.8	7.0	43.3[a]	21.6[b]	7.3

Note: Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2). Statistics are for the unweighted working samples used in the analysis. See appendix table A-1 for sampling strategies in each country.

a. Includes four to seven years of primary schooling.

b. Includes eight to ten years of schooling.

c. In Cameroon, part of the country adheres to a six-year primary school cycle, and another part adheres to a seven-year cycle. The four-to-six category includes those who attended four to seven years in the seven-year cycle, and the secondary category represents seven to ten years or eight to ten years of schooling, depending on which system the woman attended.

Source: DHS data.

Figure 1. *Distribution of Women 15–49 by Years of Completed Schooling*

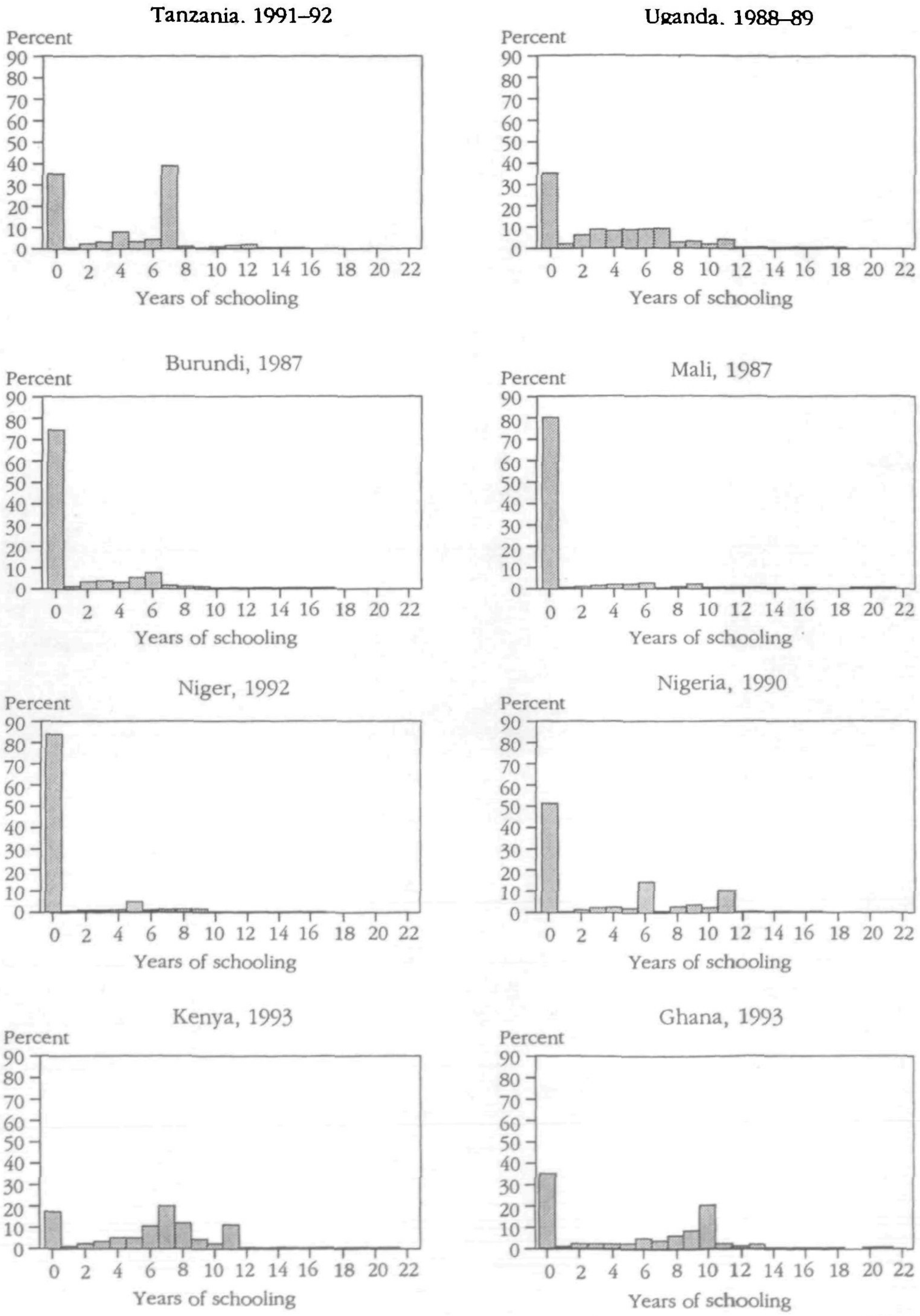

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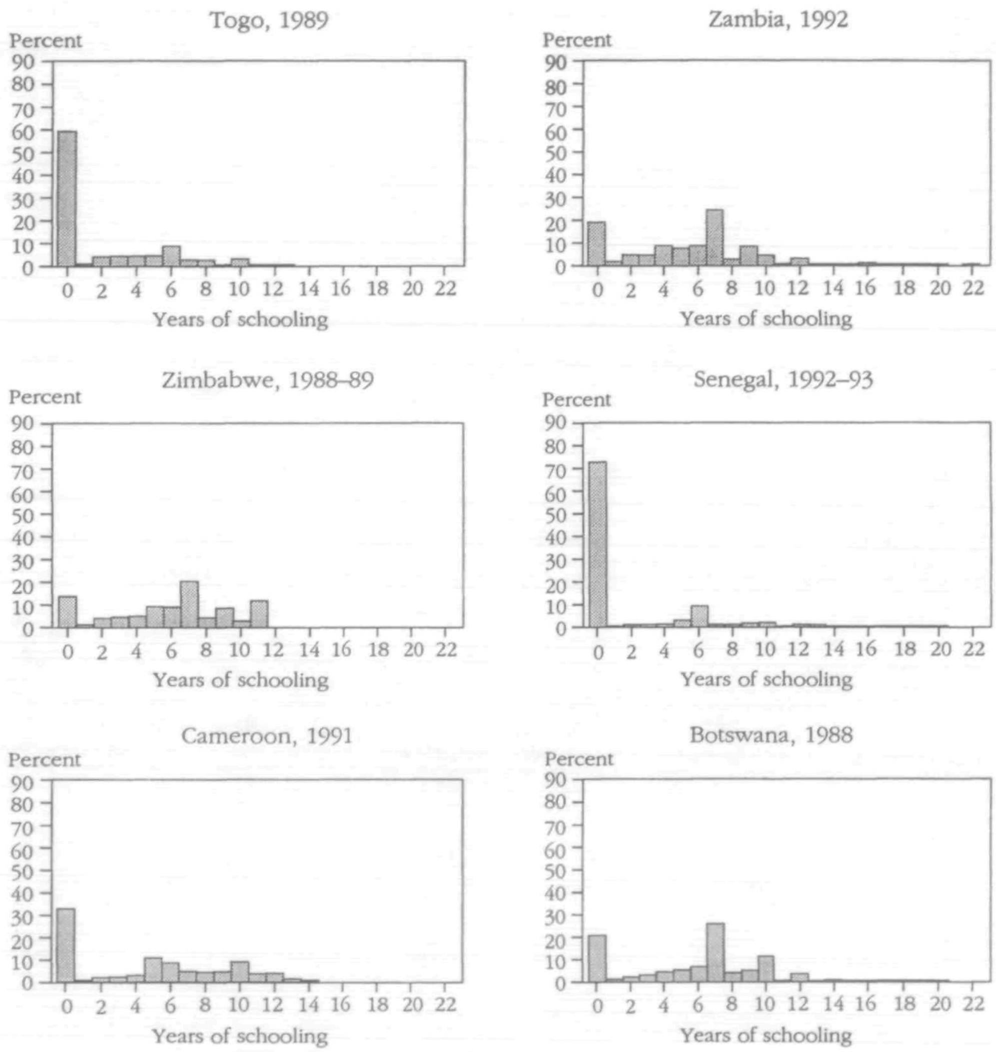
Figure 1. *(continued)*



Note: Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.
Source: DHS data.

and Sahelian countries have by far the lowest schooling of women of reproductive age. But even in Ghana and Nigeria, thought to have strong educational policies in the past, 35 and 50 percent of all women in these samples, respectively, have had no schooling. In Tanzania, once thought to have achieved universal primary education, about 35 percent of women never attended school. Of course, figure 1 groups together women of many different birth cohorts. When the distribution of schooling is compared across cohorts, substantial progress has been made in raising female schooling over time in Botswana, Cameroon, Ghana, Kenya, Tanzania, Zimbabwe, and Zambia. However, in Burundi, Mali, Niger, and Senegal there has been little or no change in the level of female education over time.[7]

The distribution of schooling among educated women is often uneven. In Ghana, for example, about 35 percent of women had no schooling, and about 25 percent had exactly ten years. In Botswana, Kenya, Nigeria, and Zimbabwe, "spikes" are observed in the distribution at seven years of schooling. The lumpiness of the distribution of schooling in some of these data sets—including the relative scarcity of observations with less than complete primary schooling—is important to consider in interpreting the regression results. While the mean level of schooling may be two to three years, very few women are commonly found with exactly that number.

IV. Women's Schooling and Fertility

The OLS regression results for three of the four specifications in the fourteen countries are pictured in figure 2. On the basis of the regression coefficients, predicted children ever born is plotted against women's years of schooling, while controlling for age, age squared, area of residence, ethnicity, religion, ownership of durable goods, and quality of housing. The straight line in each graph represents the linear specification of female schooling, in which the slope is constrained to be constant. In all of the countries, the linear specification is sloped downward, showing that increased schooling is generally associated with lower fertility.

However, the descriptive statistics suggest that the relation between female schooling and fertility is nonlinear. The broken lines in figure 2 represent the predictions from a quadratic specification of female schooling (schooling and schooling squared), and the small circles represent the prediction of a specification allowing a dummy variable for each individual year of schooling. These two specifications show that at low levels of schooling the relation between female schooling and fertility is weak or nonexistent, but that with the completion of primary schooling the relation is clearly negative. This makes sense, since it is difficult to believe that less-than-full primary schooling could result in basic

7. For the distribution of schooling in urban and rural areas and by cohort, refer to annex 2 of Ainsworth, Beegle, and Nyamete (1995).

Figure 2. *Predicted Cumulative Fertility by Female Schooling Using Three Specifications*

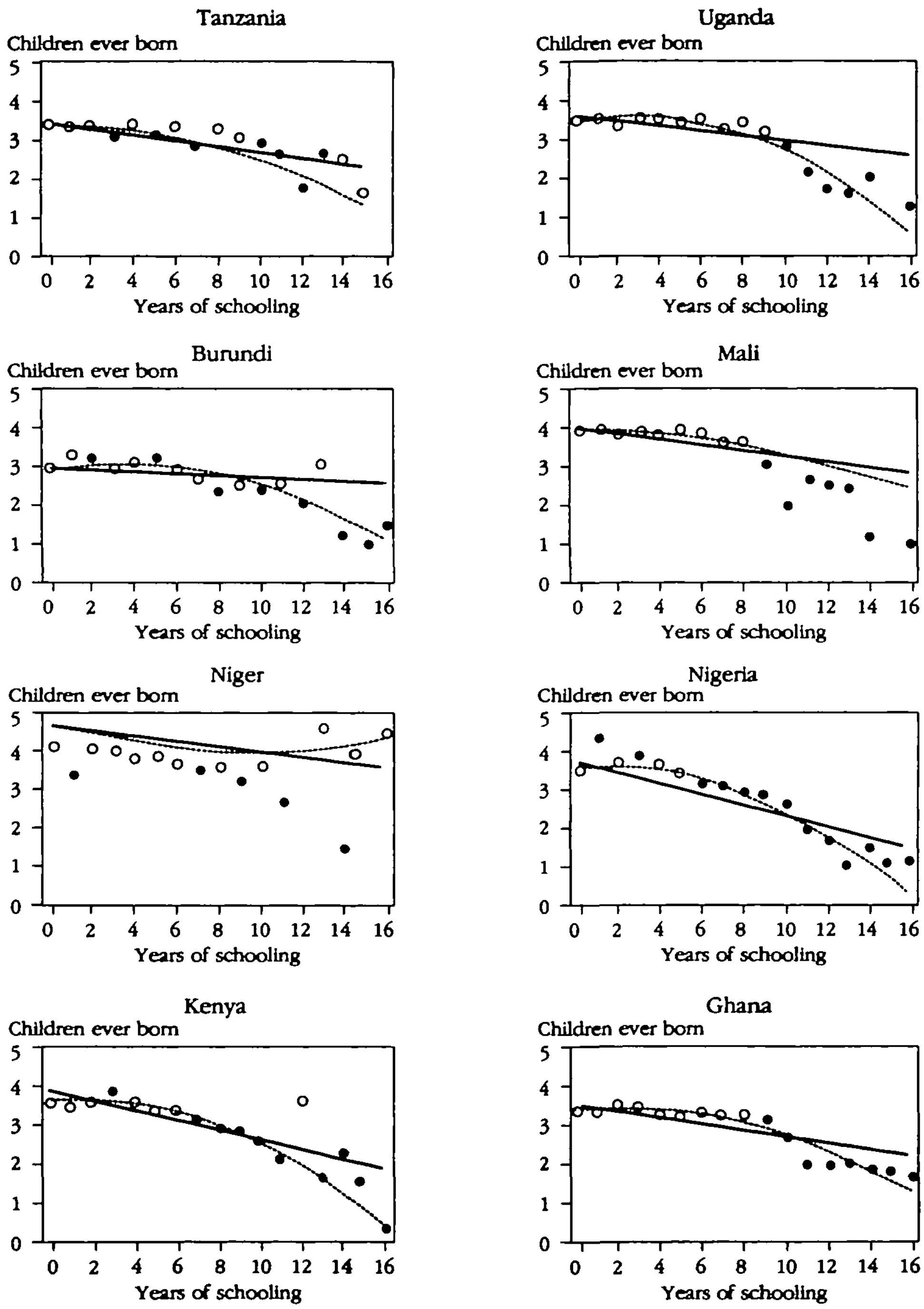
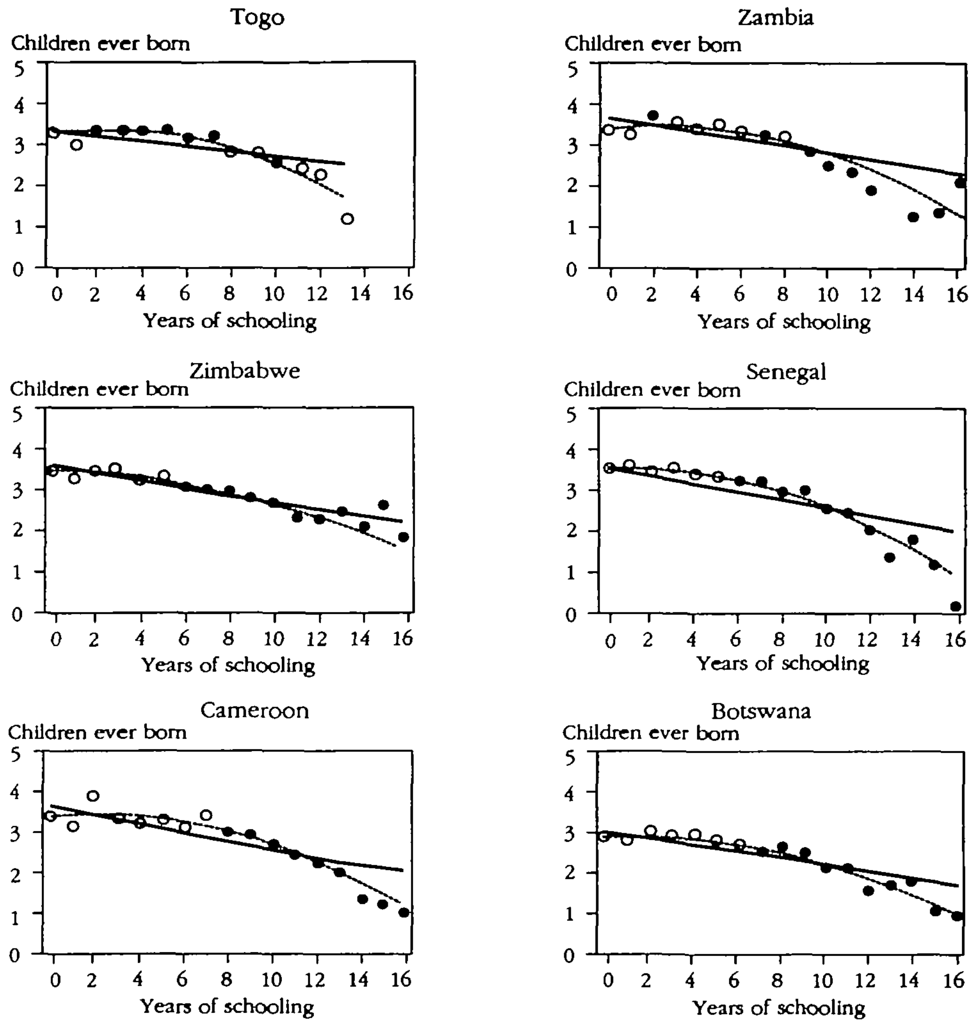


Figure 2. *(continued)*



Note: The graphs show predicted number of children ever born from ordinary least squares regressions using three different specifications of female schooling: the straight line in each graph represents a linear specification; the broken line represents the predictions from a quadratic specification (schooling and schooling squared); and the circles represent the prediction of a specification that allows a dummy variable for each individual year of schooling. In the latter, solid circles represent statistically significant coefficients (at the 5 percent level or less). Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.

Source: Authors' calculations from DHS data.

Table 4. *The Impact of Women's Schooling on the Number of Children Ever Born, Fourteen Sub-Saharan African Countries*

		Level of schooling (years)			
Country	*Years of schooling*	*1–3*	*4–6*	*7–10*	*11 or more*
Tanzania	–0.075**	–0.124	–0.324**	–0.255*	–1.201**
Uganda	–0.060**	–0.027	–0.022	–0.271*	–1.419**
Burundi	–0.024	0.182	0.141	–0.366**	–0.823**
Mali	–0.069**	–0.009	–0.027	–0.516**	–1.483**
Niger	–0.060**	–0.269	–0.280*	–0.736**	–0.178
Nigeria	–0.134**	0.319**	–0.298**	–0.722**	–1.626**
Kenya	–0.126**	0.173	–0.257**	–0.671**	–1.464**
Ghana	–0.079**	0.094	–0.104	–0.447**	–1.431**
Togo	–0.061**	–0.005	–0.055	–0.483**	–1.209**
Zambia	–0.092**	0.207*	–0.045	–0.546**	–1.520**
Zimbabwe	–0.102**	–0.022	–0.365**	–0.646**	–1.184**
Senegal	–0.102**	–0.002	–0.283**	–0.667**	–1.816**
Cameroon	–0.116**	–0.005	–0.174	–0.465**	–1.412**
Botswana	–0.086**	0.068	–0.222**	–0.521**	–1.245**

* Significant at 5 percent level.

** Significant at 1 percent level.

Note: Coefficients were estimated using ordinary least squares (OLS). For years of schooling, the specification was linear; for level of schooling, the specification used dummy variables to estimate the effect on the number of children born of raising female schooling from zero years to each level. Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2).

Source: Authors' calculations, DHS data.

literacy and numeracy or could substantially alter the opportunity costs of women's time. Also recall that most women are in the "no schooling" category or in the complete primary schooling category. Thus, some of the dummy variables for individual years of schooling at both incomplete primary and secondary levels represent very few women and are not individually statistically significant. However, a few outliers can greatly distort the relationship, as in the case of Niger. In fact, given how few women obtained higher levels of schooling in the Sahelian countries, the curves for very high schooling levels must be viewed with skepticism.

Table 4 shows regression coefficients for the linear specification and for a specification not shown in figure 2, which used dummy variables representing four different levels of schooling—one to three years, four to six years, seven to ten years, and eleven or more years.[8] The coefficients are interpreted as the effect on the number of children ever born of raising female schooling from zero to that level. All other explanatory variables (age, age squared, urban residence, region, ethnicity, religion, ownership of durable goods, and quality of housing) were also entered in the regressions when available.[9]

8. For countries with a seven-year primary cycle, the levels entered are one to three, four to seven, and eight to ten years.

9. The following data sets did not have the full set of independent variables: ethnic group was missing for Botswana, Burundi, Cameroon, Nigeria, Tanzania, Uganda, and Zambia; region was missing for Botswana; and religion was missing for Burundi and Senegal.

The number of years of female schooling is significant and negatively related to cumulative fertility in thirteen of the countries, despite their different levels of female schooling and economic characteristics. With the exception of Senegal, the largest linear female schooling coefficients occur in countries in which the samples have large shares of women with postprimary schooling (Cameroon, Kenya, Nigeria, and Zimbabwe; refer to table 3). However, Ghana has the largest share of sample women with postprimary education (47 percent; see the last two columns in table 3) and the linear relation there is relatively small.

The results for the levels-of-schooling specification in table 4 indicate that lower primary schooling (one to three years) is not related to cumulative fertility in twelve countries and has a positive relation in two (Nigeria and Zambia). In half of the countries, women with four to six years of primary schooling have 0.2 to 0.4 fewer children ever born, compared to women with no schooling, and in the other half there is no relationship. On average, controlling for covariates, women in the samples with seven to ten years of schooling had from 0.2 to 0.7 fewer children ever born, and women with eleven years of schooling or more had 0.8 to 1.8 fewer children ever born, compared with women with no schooling.

Much has been made in the literature of the sometimes-observed positive relation between a few years of schooling and fertility. This is often explained as inadvertent outcomes of changes in proximate determinants of fertility. A positive relation would imply that even one year of primary schooling is sufficient to induce a quite large change in behaviors and outlooks that indirectly affect fertility. The realities of primary schooling in most Sub-Saharan countries—in terms of poor infrastructure, extremely limited availability of reading and instructional materials, inadequate teacher training and salaries, and the resulting high absenteeism and dropout rates—cast doubt on this interpretation (Lockheed and Verspoor 1991). Literacy is certainly not achieved in a single year of schooling and, under the circumstances that prevail, may not even be achieved until completion of primary school. A more plausible explanation is that the (small group of) women who completed only a few years of schooling are those who became pregnant, whose families wanted them to get married, or who simply could not keep up and therefore stopped their schooling.

Another plausible explanation for the sometime nonrelation between primary schooling and fertility or a positive relationship is the exclusion of variables like household income from the regressions. If, as incomes rise, parents want more children, holding wages and other prices constant, then higher incomes should be associated with higher fertility. If there is a strong association between schooled women and higher incomes, and if income is not properly controlled for, then the schooling coefficients may be absorbing both the negative schooling and positive income effects, which cancel out. This would also imply that the coefficients on women's schooling are underestimates of the negative relation with fertility. This was found to be the case in Côte d'Ivoire, where omitting income from fertility regressions notably weakened the schooling coefficient in magnitude (Ainsworth 1989). The controls for household assets—durable goods and quality of housing—may not have completely alleviated this problem in this study.

By the later years of primary schooling, however, some degree of literacy should have been achieved, even for women who did not complete primary school. Thus, we expect a negative relation in these cases. However, the last years of primary schooling are associated with lower fertility in only half of the countries and have no association in the other half. Understanding why this relation exists in some countries and not others is important to policymaking. It might reflect differences in the quality of instruction or differences in labor market conditions across countries, for example. Part of the explanation may also lie with complementarity between schooling and the availability of family planning services; Botswana, Kenya, and Zimbabwe have the strongest family planning programs and also show negative relations between female primary schooling and fertility.

The strong negative association between women's higher secondary schooling and cumulative fertility evidenced in figure 2 and table 4 persists across all of the countries in the sample, regardless of their level of development, distribution of schooling, or intensity of family planning programs. (Niger is an exception; fewer than 0.1 percent of women had eleven or more years of schooling.) These results suggest that, with or without easy access to family planning, highly educated women do manage to lower their fertility. When supplies are scarce, highly educated women have the greatest access to contraceptive services by virtue of their education and probable income levels. However, in three countries with more active family planning programs, even women with only primary instruction are able to lower their fertility.

There is no obvious relation between the size of the linear schooling coefficients in table 4 and GNP per capita. This is not surprising, because cumulative fertility is likely to reflect past levels of income. Nigeria's income levels, for example, are vastly lower now than they were during the oil boom of the 1970s. In addition, GNP per capita hides differences in the distribution of income that may account for differential effects of schooling. Within countries, the regression results for ownership of assets revealed a negative relation between income and fertility in Botswana, Ghana, Tanzania, and Togo, but a positive relation in Nigeria. Results for other countries were ambiguous (see Ainsworth, Beegle, and Nyamete 1995).

Urban and Rural Samples

In the Botswana, Cameroon, Mali, Nigeria, Senegal, and Zambia data sets, 40 percent or more of women were living in urban areas. The least urbanized samples are in Burundi, Kenya, Tanzania, and Uganda, with 20 percent or fewer women in urban areas. Figure 3 shows predicted cumulative fertility using a linear spline specification of female schooling at zero to three, four to six , seven to ten, and eleven or more years of schooling, in urban and rural areas (Greene 1993). The

Figure 3. *Predicted Cumulative Fertility by Female Schooling in Urban and Rural Areas*

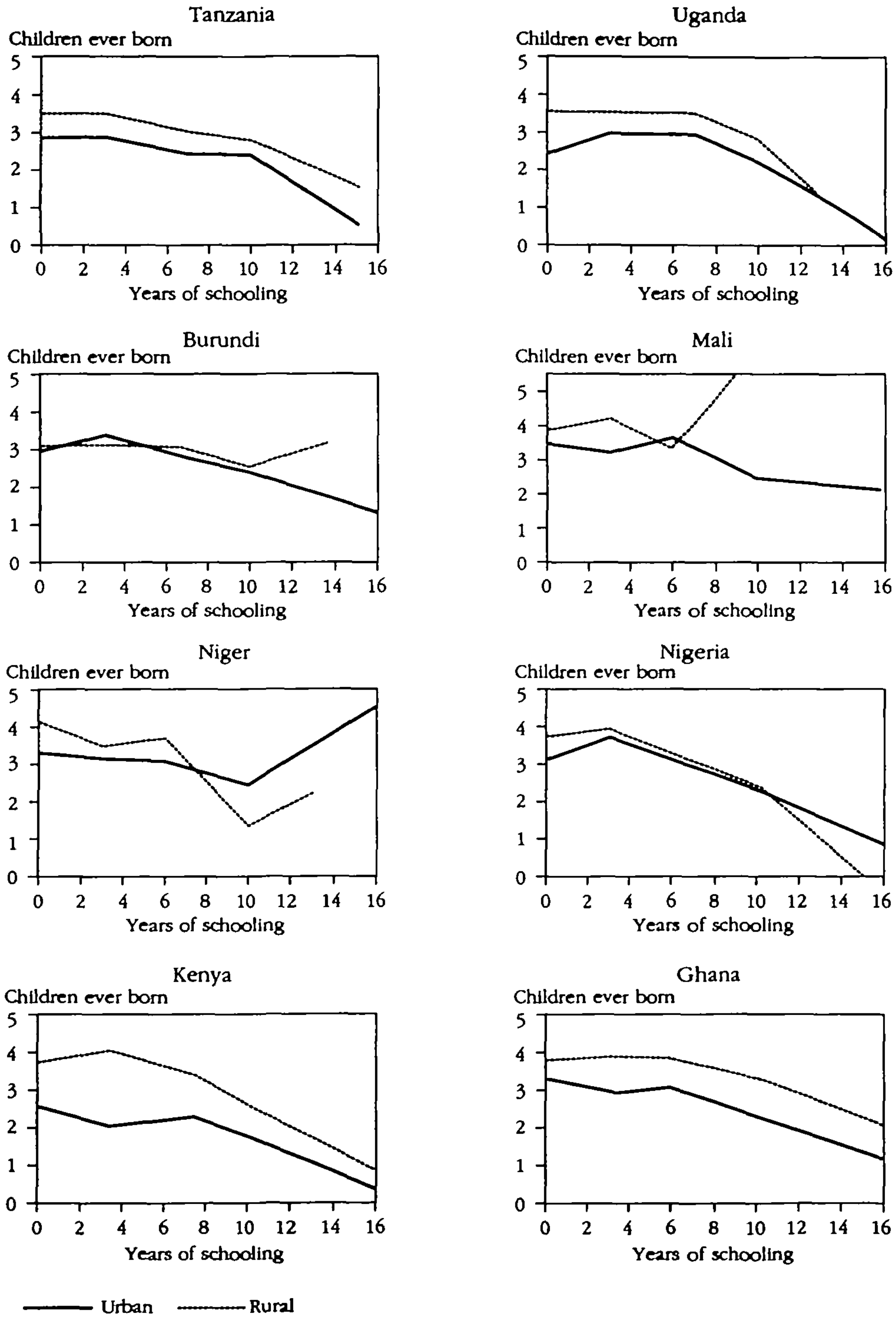


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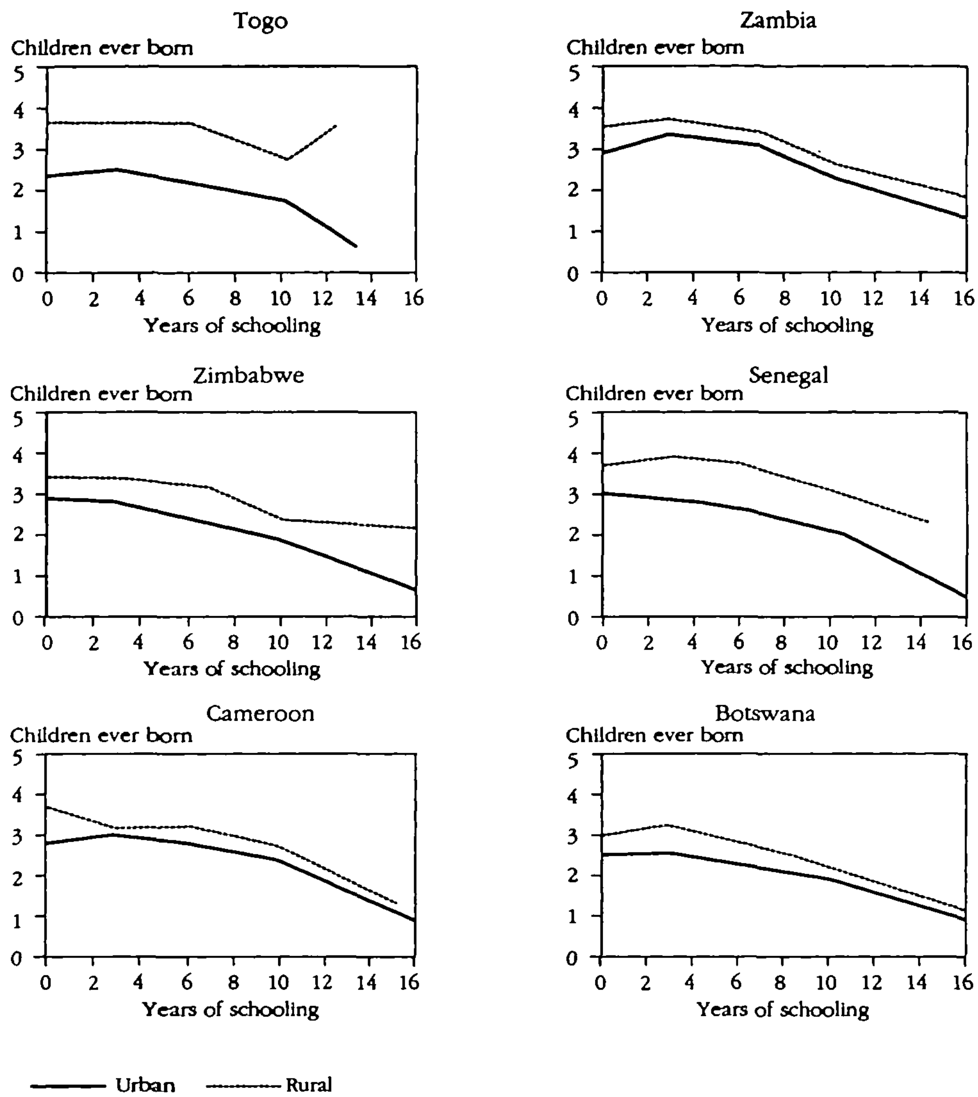
Figure 3. *(continued)*



Note: The graphs show predicted cumulative fertility using a linear spline specification of female schooling with segments for 0-3, 4-6, 7-10, and 11 or more years of schooling. Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.

Source: Authors' calculations from DHS data.

linear spline specification is jointly significant for all countries in urban and rural areas, with the exception of urban areas in Niger and rural areas in Burundi. However, specific segments of many of these curves are not statistically significant. The coefficients underlying figure 3 can be obtained from the authors.

In interpreting the results, it is important to keep in mind that 90 percent or more of rural women in Mali, Niger, and Senegal, and 64 percent of urban women in Mali and Niger, had no schooling. Thus, the results for higher-order splines are based on very few cases and the results are highly sensitive to outliers. With these caveats in mind, differences between urban and rural women within and across countries are nevertheless interesting. Fertility declines with increases in female schooling in both urban and rural areas, particularly after primary schooling. The early years of primary schooling are associated with higher fertility in urban Nigeria and Uganda, but are otherwise insignificant. In most of the countries, family planning services are not easily available in rural areas, yet very educated rural women (there are few of them) nevertheless have lower fertility. In fact, the differential between women with eleven or more years of schooling and those with no schooling is often greater in rural than urban areas (Cameroon, Kenya, Niger, Nigeria, Uganda, and Zambia) (see figure 3).

In general, at every level of schooling urban women have lower fertility than rural women. This may be due to a variety of factors, including more labor market opportunities, higher costs of children, and more readily available health and family planning services in urban areas. Nigeria is an important exception—at the highest levels of schooling, fertility declines more rapidly in rural areas and is in fact lower than in urban areas. Fertility in urban and rural areas also converges at higher levels of female schooling in Botswana, Kenya, and Uganda. When controlling for female schooling, differentials between urban and rural fertility are quite small in Botswana, Cameroon, Nigeria, and Zambia, but remain large in Ghana, Senegal, and Togo.

Results by Cohort

The relation between women's schooling and fertility may change over time. As female enrollment rates rise, a greater percentage of each successive cohort has had schooling. The level of schooling of the woman relative to the schooling of her cohort may alter the returns to schooling and thus the relation between schooling and fertility. Even if enrollment rates were to remain constant, changes in the quality and content of schooling over time might result in changes in the effectiveness of women's schooling in altering fertility behavior. Finally, over time other variables in the environment may also change, enhancing or detracting from the relationship. For example, making family planning more available might alter the effect of schooling on cumulative fertility by substituting for the schooling of poor women (lowering fertility even for women with no schooling) or by availing more educated women of the means to keep their fertility low.

Regressions run by cohort (ages fifteen to twenty-four, twenty-five to thirty-four, and thirty-five to forty-nine) reveal that the overall relation between women's schooling and cumulative fertility is negative in the youngest and middle-age cohorts in all of the countries and in the oldest cohort in more than half of the countries (results are available from the authors). The negative relation between schooling and cumulative fertility is almost always larger in the middle cohort than in the youngest cohort. The results suggest that the effect of women's schooling on fertility increases with the woman's age, and middle-aged educated women are not "catching up" with the fertility of others in their cohort to compensate for lower fertility while young. The association of partial or completed primary schooling with lower cumulative fertility is observed to a greater extent among the youngest cohort. However, Botswana, Ghana, and Zambia, which have relatively high levels of schooling, show no significant effect of primary schooling in any of the cohorts. The higher levels of schooling are associated with significantly lower fertility in all cohorts, even in countries with low levels of schooling in the older cohort.

Women's Schooling Compared with Men's

An issue of policy interest is the relative impact of men's and women's schooling on cumulative fertility. Because child rearing is not generally intensive in the time of the father in these countries, we do not expect higher education and earning capacity of husbands to raise the "price" of children, as does women's education. More often, husband's education is used as a proxy for household income, and it may be a better proxy for income than the ownership of durable goods, which are already controlled for. Inclusion of an income proxy may alter the size of the woman's schooling coefficients to the extent that they are correlated with income or husband's education. However, to examine these issues we must restrict ourselves to the sample of ever-married women in each data set. Depending on the country, the sample of ever-married women may be as small as 45 percent of the total sample (Botswana) or as large as 86 percent (Mali). The restricted sample, conditioned on marital status, can be expected to show a smaller schooling effect for ever-married women than for all women, because the influence of schooling on delayed age at first birth of the unmarried women in the sample will not be included. Table 5 presents the OLS regression results of children ever born on the linear specification of woman's schooling, with and without the husband's schooling.

The woman's schooling coefficients for the sample of ever-married women in table 5 (second column) are generally smaller than for the sample of all women in table 4, and in Uganda and Zimbabwe the difference is considerable. This result confirms the point made earlier that studies restricted to samples of ever-married women may understate the relation between female schooling and fertility.

In table 5, controlling for husband's education generally acts to reduce slightly the woman's education coefficient (column three). In four countries (Cameroon, Kenya, Nigeria, and Uganda) only the woman's schooling is associated with lower fertility; the coefficients on husband's schooling (column four) are not significant. When statistically significant, increases in the husband's schooling are associated

Table 5. *The Impact of Women's and Their Husbands' Schooling on Cumulative Fertility, Fourteen Sub-Saharan African Countries*

		Regression without husband's education	*Regression with husband's education*		*Percentage with no schooling*	
Country	*Sample size*	*Coefficient on woman's years of schooling*	*Coefficient on woman's years of schooling*	*Coefficient on husband's years of schooling*	*Ever-married women*	*Husbands*
Tanzania	6,593	–0.069**	–0.063**	–0.017*	42.5	27.7
Uganda	3,657	–0.034**	–0.031*	–0.006	40.1	18.0
Burundi	2,541	–0.015	–0.019	0.011	77.3	57.7
Mali	2,750	–0.062**	–0.045**	–0.026*	83.0	84.3
Niger	4,953	–0.007	0.012	–0.058**	87.6	89.2
Nigeria	6,912	–0.112**	–0.114**	0.002	62.5	53.4
Kenya	5,003	–0.106**	–0.098**	–0.015	23.1	13.0
Ghana	3,417	–0.078**	–0.063**	–0.047**	41.6	31.9
Togo	2,318	–0.054**	–0.042**	–0.022*	68.0	49.7
Zambia	5,115	–0.088**	–0.076**	–0.022**	21.2	11.1
Zimbabwe	2,755	–0.079**	–0.062**	–0.038**	16.3	12.4
Senegal	4,354	–0.096**	–0.073**	–0.034**	85.2	84.2
Cameroon	2,878	–0.111**	–0.100**	–0.014	41.3	36.3
Botswana	1,954	–0.094**	–0.070**	–0.044**	27.9	35.4

* Significant at the 5 percent level.
** Significant at the 1 percent level.
Note: The samples include only women who have ever been married. Coefficients were estimated using ordinary least squares (OLS) and a linear specification of the years of female and male schooling. Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2).
Source: Authors' calculations based on DHS data.

with lower fertility, but the negative association between women's schooling and fertility is stronger than the men's in all but one of the remaining countries. Only in Niger is the husband's education alone associated with lower fertility. Investments in women's schooling, therefore, are likely to have a greater impact on fertility than investments in men's schooling—and the effects of women's schooling are even greater in the sample of all women than in the sample of ever-married women.

V. Women's Schooling and Contraceptive Use

Contraceptive use is related directly to the demand for children. Therefore, all of the factors leading educated women to have fewer children should result in a positive relation between education and contraceptive use. In addition, educated women may be more likely to use contraception because information about the availability, correct use, side effects, costs, and so forth may be less difficult and costly for educated women to assimilate, and may make them more effective and satisfied users. Levels of current use of modern contraception in the DHS samples of all women used in the regressions are presented in table 6, for urban and rural women and for different levels of schooling. Both in our data and in virtually all tabulated results to date, urban women and women with more schooling (even those with primary schooling) have higher rates of contraceptive use

Table 6. *Women Currently Using a Modern Method of Contraception, by Woman's Residence and Education*
(percent)

Country	Year	Woman's residence: All	Urban	Rural	Woman's education (years): 0	1–6	7–10	11 or more
Tanzania[a]	1991–92	5.2	10.8	3.8	2.1	6.1	10.7	16.7
Uganda[a]	1988–89	3.4	10.7	1.5	1.0	2.8	9.6	15.6
Burundi	1987	2.3	11.5	0.5	0.8	4.9	9.7	19.4
Mali	1987	2.0	4.8	0.1	0.7	3.9	12.2	17.0
Niger	1992	4.6	10.9	0.7	3.3	10.0	13.5	15.2
Nigeria	1990	5.2	9.9	2.1	1.8	6.4	7.5	14.3
Kenya[a]	1993	24.7	32.2	23.3	17.0	23.1	24.4	42.1
Ghana	1993	9.3	12.5	7.3	3.8	9.8	11.8	20.7
Togo	1988	3.4	6.2	1.9	1.8	4.4	8.3	14.8
Zambia[a]	1992	6.7	10.9	3.0	2.7	4.8	11.4	28.2
Zimbabwe[a]	1988	27.2	33.6	24.0	23.5	27.8	23.3	33.0
Senegal	1992–93	4.5	9.0	1.3	2.2	8.4	13.6	18.8
Cameroon	1991	5.4	7.8	2.3	1.7	4.6	7.3	13.0
Botswana[a]	1988	31.8	38.1	25.0	18.7	30.4	39.9	54.3

Note: Unfortunately, these differentials are only produced in the DHS country reports for ever-married women. Thus these differentials in contraceptive prevalence rates have been calculated from the data used for analysis and are not weighted to compensate for oversampling. Countries are listed in order of 1991 GNP per capita, from lowest to highest (see table 2).

a. Primary schooling is one to seven years, and the next highest level is eight to ten years for these countries.

Source: Authors' calculations based on DHS data.

than rural and less-educated women (Castro Martin 1995; Jejeeboy 1992; National Research Council 1993).

Figure 4 shows the predicted relation between years of women's schooling and contraceptive use in the sample of all women, using a spline specification and holding the value of all other variables in the regressions at their means. These predictions are based on the results of logit regressions of current or ever use of contraception on the same set of independent regressors as in the fertility work: age; age squared; urban residence; female schooling; dummy variables for ownership of a bicycle, a radio, or a television; dummy variable for the quality of flooring; religion; region; and ethnic group. In order to maintain cross-country comparability, controls for the availability of family planning are not included here. Availability of family planning was collected in four of the DHS data sets (Kenya, Nigeria, Tanzania, and Zimbabwe) and has been analyzed by Beegle (1995) for Tanzania, Feyisetan and Ainsworth (1994) for Nigeria, and Thomas and Maluccio (1995) for Zimbabwe. Using Living Standards Survey data, Oliver (1995) has analyzed the impact of the availability of family planning in Ghana.

In all countries an increase in female education is significantly associated with an increase in current contraceptive use.[10] However, in many countries—

10. In Niger and Zimbabwe, the splines are jointly significant for current use at $p \le 0.05$, even though none of the individual coefficients were significant. However, the splines in the ever-use regression were not significant for Niger.

Figure 4. *Predicted Current Use and Ever Use of Modern Contraception by Female Schooling*

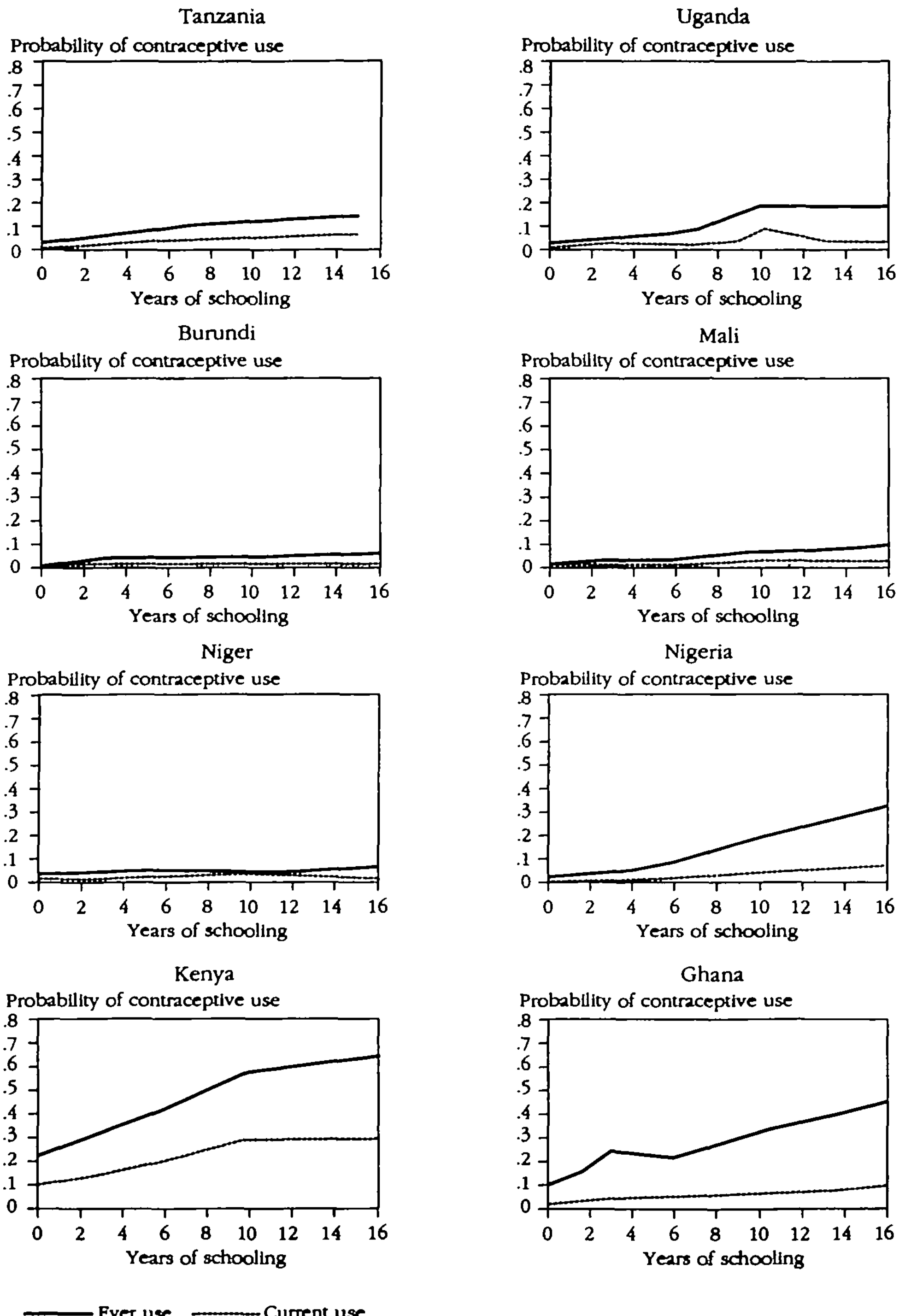


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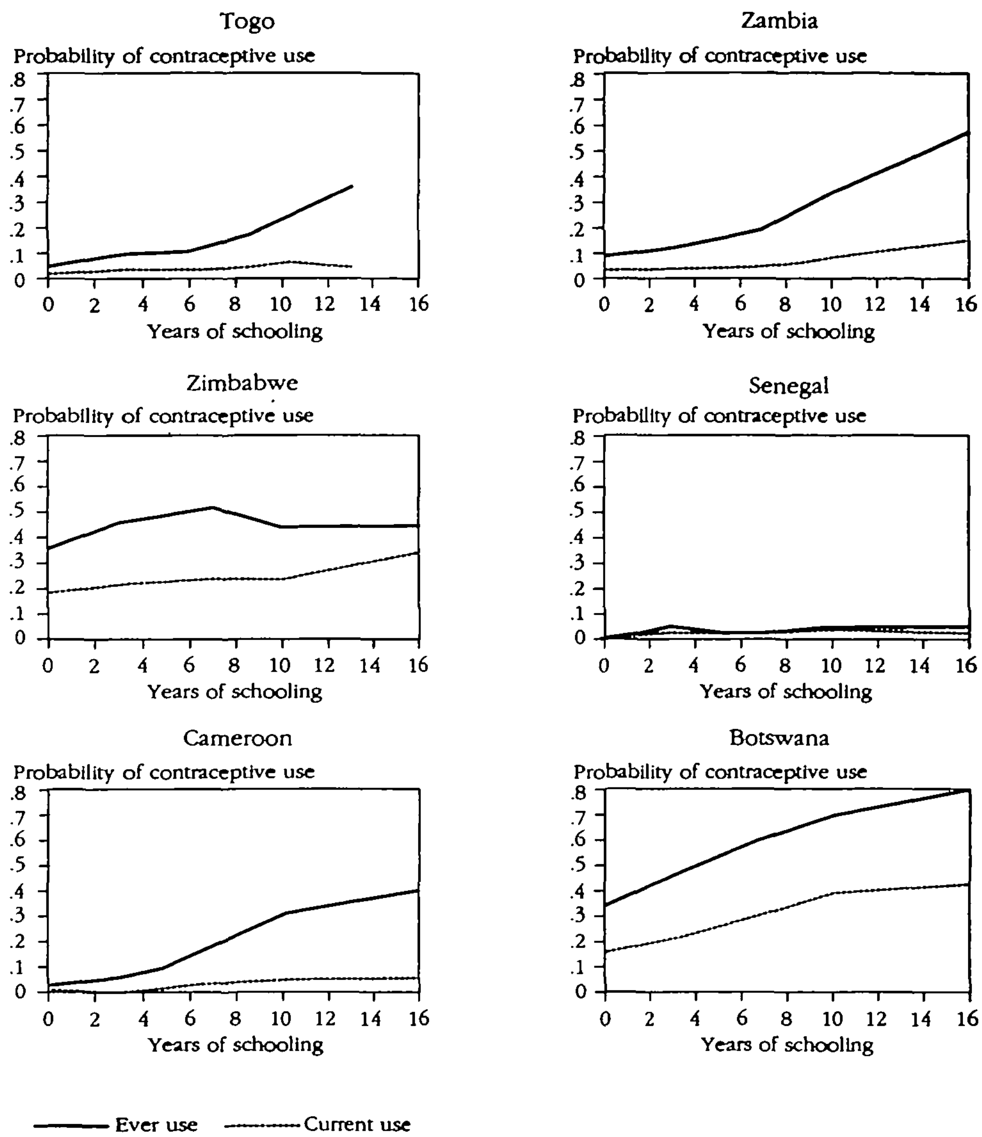
Figure 4. *(continued)*



Note: The predictions are based on logit regressions of current use and ever use of contraceptives, using a spline specification (0-3, 4-6, 7-10, and 11 or more years of schooling) and holding the values of all other variables in the regressions at their means. Countries are in order of 1991 GNP per capita, from lowest to highest (see table 2). For sample size for each country, see table 3.

Source: Authors' calculations from DHS data.

most with very low levels of female schooling and limited availability of family planning—both current and ever use are low, even among women with high levels of schooling. The major increase in current contraceptive use in Burundi, Ghana, Niger, Senegal, and Tanzania occurs at the early years of female schooling, and there is very little increase in contraceptive use with additional schooling beyond primary. In fact, even in countries where higher levels of female schooling show positive gradients (Botswana, Cameroon, Kenya, and Zambia), the slope of the relationship at earlier years of schooling is steeper. Only in Zimbabwe does the relationship between female schooling and current contraceptive use seem to steepen with increased schooling levels. However, it is important to remember that there are very few women with high levels of schooling in the majority of these countries. Thus, this last segment of the spline may be very sensitive to outliers and responsible for seemingly weaker (or contrary) results for higher levels of schooling in some of the countries. The education-contraceptive use gradient is steeper for ever use of contraception as education rises, with the exception of Niger (where there is no significant relation for ever use) and Senegal and Zimbabwe (where the relationship is basically flat for all but the early levels of schooling). The relationship between female schooling and contraceptive use does not seem to have any relation to the level of GNP per capita. For example, Senegal and Zimbabwe have the same GNP per capita, but the relationship is quite different in the two countries. Within countries, ownership of assets was associated with higher contraceptive use, particularly in Kenya, Nigeria, Tanzania, Zambia, and Zimbabwe (Ainsworth, Beegle, and Nyamete 1995).

These results represent the relationship between female schooling and contraceptive use at the time of the surveys, holding all other factors constant. However, they do not represent an immutable relationship or law unique and unchanging for every country. As the average level and quality of female schooling and the returns to education rise in countries like Burundi, Mali, and Niger, if the experience of other countries is a guide, their curves will very likely shift upward. Likewise, the steepness and height of the relationship should also be related to the availability of contraception. In Zimbabwe, for example, the slope of the curve is fairly flat. It may be that the greater availability of contraception mutes differentials in contraceptive use by education in Zimbabwe relative to Kenya, which shows sharp curvature upward. Figures for Zimbabwe and Botswana thirty years ago would have looked quite different than they do now, following major investments in female schooling and better contraceptive services.

Urban and Rural Samples

The effect of schooling on contraceptive use is generally greater in urban than in rural areas (not shown). At the mean level of female schooling in the samples, an additional year of schooling is associated with 0.4 to 2.6 percentage points increase in current contraceptive use in urban areas and 0.1 to 1.8 percentage points increase in rural areas. In urban areas the early years of primary schooling are associated with higher contraceptive use only in Mali. However, in nine of the countries the later years of primary schooling have an impact; among those for which this is not the case are countries with relatively high average schooling levels—Cameroon, Ghana, Zambia, and Zimbabwe. The only country for which higher levels of schooling do not significantly affect contraceptive use in urban areas is Zimbabwe. Possibly the relatively wider availability of contraceptives in urban areas of that country mutes differentials in contraceptive use by female schooling. Contraceptive use is so low in rural areas that regressions could be run on rural data from only eight countries. The early years of primary schooling are more likely to be associated with increased contraceptive use in rural areas than in urban areas.

Women's Schooling Compared with Men's

Table 7 classifies countries according to the relative strength of the relationship between the woman's and husband's schooling and current contraceptive use, among the sample of ever-married women. In half the countries, only the woman's schooling is a statistically significant determinant of current contraceptive use. This group includes countries with both the highest and lowest average levels of female schooling, income, and availability of contraceptives (for example, Botswana and Zimbabwe, as well as Mali and Niger). In six countries, both the woman's and husband's schooling are significant. However, in all of these countries the coefficient on the woman's schooling is greater in absolute value than the husband's schooling coefficient.

What can explain the unusual grouping of seemingly different countries? The countries for which only female schooling is a statistically significant determinant of contraceptive use are those for which husbands and wives have roughly equal probabilities of having received instruction. In Mali and Niger, for example, from table 5, the percentage of wives and husbands without any schooling is high and roughly equal, while in Cameroon and Zimbabwe the percentage is lower but still similar between husbands and wives. In Botswana, fewer husbands than wives have any schooling. The most important exception is Uganda, which has a spread of 22 percentage points between wives and husbands in the percent with any schooling. In the countries where both husband's and wife's schooling are significant determinants of contraceptive use, the differential between the percentage of husbands and wives with any schooling is generally greater. An important exception is Burundi, where the differential between the percentage of husbands and wives with no schooling is great, but neither is significant. Another important exception is Senegal, where there is basically no difference between the percentage of husbands and wives with no schooling, but both the wife's and husband's schooling coefficients are significant.

The observation that women and their husbands have similar schooling levels in countries where only the woman's schooling is a significant determinant of contraceptive use would be consistent with a bargaining power explanation. That is, when husbands and wives have both been schooled or

Table 7. *Classification of Countries According to the Marginal Effects of a One-Year Increase in Female and Male Schooling on Current Use of Contraception and Female-Male Schooling Differentials*

	Husband's schooling			
Woman's schooling	*Significant*		*Not significant*	
Significant	Kenya	[10.2]	Botswana	[−7.5]
	Nigeria	[9.2]	Cameroon	[5.1]
	Senegal	[1.0]	Ghana	[9.7]
	Tanzania	[14.8]	Mali	[−1.3]
	Togo	[18.3]	Niger	[−1.6]
	Zambia	[10.1]	Uganda	[22.1]
			Zimbabwe	[3.9]
Not significant			Burundi	[19.6]

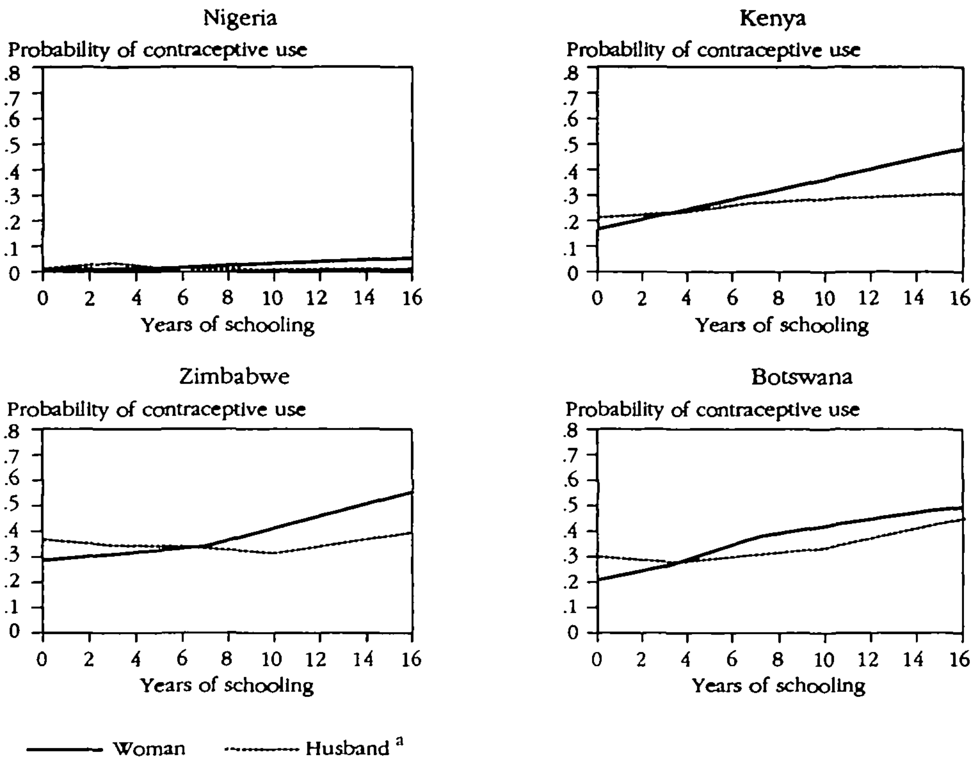
Note: Countries are classified on the basis of marginal effects of woman's and husband's schooling from a logit regression on the current use of contraception, using a linear specification of schooling. The samples include only women who have ever been married. Values in brackets are the difference in the percent of ever-married women and men with no schooling.

Source: Authors' calculations based on DHS data.

only the wife has schooling, then only the wife's schooling makes a difference for contraceptive use; when the husband is more likely to be schooled than the wife, both the husband's and the woman's schooling matters. However, in the latter instances, it is still the wife's schooling that has a larger impact on contraceptive use. This hypothesis and others deserve additional research at the micro level. However, it would not explain as well the differences in the impact of the husband's compared with the woman's education on fertility, presented earlier. Botswana, Ghana, and Zimbabwe all have a very high proportion of female-headed households (45 percent in Botswana, 37 percent in Ghana, and 33 percent in Zimbabwe), which might explain why husband's schooling is not significant (Ayad and others 1994; Ghana Statistical Service 1994). However, this is also true in Kenya (33 percent of households are female-headed), where husband's schooling still affects contraceptive use (Kenya Central Bureau of Statistics 1994).

The results for four countries are graphed in figure 5. The results for the countries not shown generally resemble those for Nigeria. In some countries the relative importance of female compared with male schooling in determining contraceptive use among ever-married women switches according to the level of schooling. The husband's schooling has a larger predicted impact at low levels of male and female schooling, but the wife's schooling has a stronger relation at higher levels of schooling. In Kenya this crossing point seems to be at about three years of schooling, but in Botswana and Zimbabwe it seems to be at about five years and six years, respectively, although husband's schooling is not statistically significant in the latter two countries. At higher levels of female schooling in Kenya and Zimbabwe, the slope of the relationship becomes quite steep for female schooling, but is flat for the husband's.

Figure 5. *Predicted Relation between Current Use of Contraception and Woman's and Husband's Schooling, Sample of Ever-married Women*



Note: The graphs show predicted contraceptive use for the sample of ever-married women in four countries, presented in order of 1991 GNP per capita, from lowest to highest (see table 2). Results for other countries generally resemble those for Nigeria.

a. Husband's schooling is not statistically significant in Botswana or Zimbabwe.

Source: Authors' calculations from DHS data.

VI. CONCLUSIONS

In this article we have analyzed the relations between female schooling and fertility and between female schooling and use of modern contraception in fourteen Sub-Saharan African countries where Demographic and Health Surveys have been conducted. Total fertility rates are high in these countries—ranging from a low of 5.0 in Botswana to as much as 7.4 in Niger. Modern contraceptive use is below 10 percent in all but Botswana, Kenya, and Zimbabwe. Despite rising female enrollments in many countries, the level of completed schooling among women of reproductive age is extremely low. In six of the countries, half or more of all women have never been to school. Average schooling is highest in Zimbabwe (six years); in four countries the average is less than two years.

We find strong support for the negative correlation between female schooling and cumulative fertility in virtually all of the countries, in both urban and rural areas. However, the relationship is nonlinear. The first three years of primary schooling have no relation with fertility in twelve of the fourteen countries. Children are unlikely to become literate in the first three years, and given the state of schooling systems on the continent, it is unlikely that a single year or two of schooling would be enough to radically transform a child's world outlook. Thus, we interpret the two instances of a significant positive effect of early primary schooling on fertility as evidence of some type of selectivity operating among those who dropped out with only a year or two of schooling, rather than as a schooling effect. The last years of primary schooling have a negative relation with fertility in about half of the countries and no relation in the remainder. Secondary schooling is universally associated with lower fertility, even in countries with less-vigorous family planning programs.

Jejeeboy (1992:3), reviewing the evidence on education and fertility primarily from the World Fertility Survey, characterized the evidence for "a uniformly inverse relationship" in the poorest countries as "shaky": "a little education appears to lead to higher fertility and we are likely to observe a curvilinear or reversed U-shaped relationship." In fact, she points to an inverted-U shape in ten of twelve African countries, implying that at low levels of schooling fertility rises. In this article, we use different and more recent data sets, control for many more factors simultaneously (including wealth), and use microanalysis of actual fertility (as opposed to the TFR). We find very limited evidence of a positive relation between female schooling and fertility in these countries, and at such low levels of schooling that we question the line of causation.

The most intriguing difference among the results for women's schooling and fertility is that for half of the countries upper primary schooling has a negative relation with fertility, and it has no effect in others. Could this reflect differences in the quality of instruction (with a time lag), differences in the labor markets that affect the returns to upper primary schooling, or perhaps differences in the availability of family planning? Unfortunately, exogenous measures of these explanatory variables are not among those available in the individual data sets. Internationally comparable data at the national level are hard to come by and are of varying quality. In additional country-level regressions (with a sample size of fourteen), the infant mortality rate, GNP per capita, percentage of female-headed households, and various representations of the distribution or average levels of female schooling were not statistically significant predictors of those countries in which four to six years of primary schooling has a negative relation with fertility. Additional research to explain these differences would be very useful to schooling and population policies.

Female schooling has also been found to greatly raise the likelihood of contraceptive use, even among women with primary schooling only. However, as with fertility, the relation is nonlinear. While women with higher levels of schooling are increasingly more likely to use contraceptives, an important finding is that often the marginal relation between an additional year of female schooling and contraceptive use is greatest at the primary schooling level. Again, understanding why this is observed in some countries and not others, and the relation of these results to the availability of contraception, could lead to new policy insights.

Another important difference to be explained across countries is the relative impact of male and female schooling on fertility and contraceptive use, among the sample of ever-married women. Husband's schooling has no significant relation with fertility in about one-third of the countries. In countries where both women's and men's schooling matter, women's schooling exerts a much larger negative effect on fertility than does men's schooling. The analysis also confirmed that female schooling effects are lower when the samples are restricted to ever-married women. This means that studies that are based on married women understate the effects of schooling on fertility and contraceptive use. Husband's schooling is associated with higher contraceptive use in only half of the fourteen countries. In cases where men's schooling is statistically significant, it generally exerts a smaller influence than female schooling. These results are additional evidence of the importance of investing in female education to lower fertility and raise contraceptive use. However, attempts to explain why only female schooling matters in some countries but both male and female schooling matter in others were not successful, either for fertility or contraceptive use.[11]

This study used multivariate analysis of cross-sectional data to examine marginal relationships—such as the relation in the cross-section of altering schooling by a small amount. However, the levels of female schooling in these countries are so low that more than just marginal increases in female schooling will be necessary. The multivariate regression results do not help us to infer the likely impact of large changes in female schooling—such as ensuring that the 40 percent of women with no schooling complete seven years of primary education. Further, other factors held constant in these regressions—like income—might also change as a result of large increases in schooling. The experience of Botswana, Kenya, and Zimbabwe—where major investments in schooling and family planning have been made in the past decade—may be better indicators of the likely effect of similar policies in other countries. These investments will improve the quality of life for women and children and enhance their future contribution to development, in addition to lowering fertility.

11. Regressors included GNP per capita, the infant mortality rate, the difference between the percentage of males and females with no education, the percentage of female-headed households, and various measures of the level and distribution of female schooling. Unfortunately, there are no good measures of exogenous availability of family planning services across countries that do not somehow incorporate actual levels of contraceptive use.

Table A-1. *Notes on the Sampling and Coverage of Data Sets from the Demographic and Health Surveys for Fourteen Sub-Saharan African Countries*

Country	*Description of oversampling and weighting*	*Coverage*
Botswana	Oversampling of urban areas by a factor of two. Self-weighted sample within urban and rural areas.	National
Burundi	Oversampling of urban areas by a factor of five. Self-weighted within urban and rural areas.	National
Cameroon	Yaoundé/Douala oversampled by a factor of two. Other urban areas are also oversampled. Self-weighted sample within each urban and rural stratum.	National
Ghana	No oversampling. Self-weighted.	National
Kenya	Oversampled rural areas in fifteen districts.	Excludes North Eastern province and four northern districts accounting for less than 4 percent of the national population.
Mali	Oversampled urban areas. Self-weighted within urban and rural strata.	100 percent coverage of urban areas; 90 to 95 percent coverage of rural areas. Nomadic rural population of Timbuktu and Gao excluded.
Niger	Oversampled Niamey by a factor of four and other urban areas by a factor of three, relative to rural areas.	All departments except pastoral areas of northern desert (zone of Arlit in the Agadez department, arrondissement of Bilma). Excluded population is less than 1 percent of national population.
Nigeria	Oversampled urban areas by a factor of two. Self-weighted sample within urban and rural strata.	National
Senegal	No oversampling. Self-weighted.	National
Tanzania	Stratified by urban or rural area and by region; different weights apply to each region and urban or rural areas.	National (Mainland and Zanzibar)
Togo	No oversampling. Self-weighted.	National
Uganda	Urban areas oversampled by a factor of three. Self-weighted within urban areas. South West Region and Luwero Triangle in Central Region oversampled in rural areas.	Excludes nine of thirty-four districts, with 20 percent of the national population.
Zambia	Oversampling of Luapula, North-Western, and Western provinces.	National
Zimbabwe	No oversampling. Self-weighted.	National

Source: DHS country reports.

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