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Estimates of Excess Adult Deaths Due to HIV/AIDS in Kenya

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Approved by

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Contents

Abstract

Using data from the 1989 and 1999 population and housing censuses of Kenya, this paper estimates the total number of intercensal adult deaths due to HIV/AIDS. It also investigates patterns of adult mortality due to HIV/AIDS by age, sex and education level. Results show higher mortality among people with secondary or higher education than those with little or no education. This pattern is true for both men and women. Higher mortality for women than men is observed during the study period. This research is the first to use census data to demonstrate differential mortality due to AIDS by education level in sub-Saharan Africa.

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Introduction

HIV/AIDS is a major public health problem in many parts of the world. Globally, about 40 million people are living with the virus. This pandemic disproportionately affects sub-Saharan Africa. Constituting only one-tenth of the world's population, sub-Saharan Africa hosts more than 60 percent of the people with the virus (UNAIDS/WHO 2005). One of the devastating consequences of AIDS is the associated huge death toll among the sexually active adult population. As a result of heavy mortality due to this epidemic, life expectancy in sub-Saharan African countries has been declining. For instance, Arndt and Lewis (2000) forecast that by 2008, the overall life expectancy in South Africa will fall from its pre-epidemic high of 65 years to only 40 years. A reduction in life expectancy is true in all countries where the epidemic matures. Although an increase in vertical transmission of the virus from mother to child has been witnessed in the recent past, the predominant mode of HIV transmission in sub-Saharan Africa is still heterosexual contact. As a result of a strong association between sexual contact and HIV transmission, people in reproductive age groups are heavily affected by the pandemic.

Although AIDS is one of the leading causes of adult mortality in sub-Saharan Africa (Timæus and Jasseh 2004), little to no research has been done to estimate the number of adult deaths due to AIDS. Using data mainly from epidemiological sentinel sites, several studies have indicated a relatively higher adult mortality due to AIDS (Pictet et al. 1998; Doctor and Weinreb 2003). A few studies also showed similar results using population surveys (Timæus and Jasseh 2004; Blacker 2004). Sentinel studies cover small areas purposely selected and primarily focused on monitoring patterns and trends of mortality due to AIDS. Surveillance studies are mostly interested in investigating micro-level factors that put people at high risk. The most common sources of data that furnish information to these studies are antenatal clinics (ANC) and hospital records. It is common knowledge that data generated from ANCs and other sentinel surveillance sites do not represent the whole population. This poses a major problem in understanding the situation of the epidemic at the national level. For instance, use of health services can be influenced by place of residence (urban vs. rural), differences in social strata (rich vs. poor), and differences in HIV serostatus (HIV+ vs. HIV-). This indicates that data from hospital-based surveys may not be representative of the general population. Empirical studies confirm such claims. For instance, Fylkesnes et al. (1997) report that HIV prevalence estimates from sentinel surveillance data understate the level of HIV prevalence among women aged 15-34.

Similarly, ANC sentinel sites are biased toward women who are sexually active, married and pregnant women. The effect of HIV infection on suppressing fecundability diminishes the chance of HIV+ women visiting an ANC. Because most surveillance systems that generate data about the epidemic in sub-Saharan Africa are based on childbearing women and are meant to monitor trends of infection from sequential cross-sectional surveys of the same population, Fylkesnes et al. (2001) argue that such estimates are not primarily designed to provide national representative measures. Realizing inherent potential biases associated with estimates from sentinel sites when applied to the general population, it is crucial to use representative data for the whole population to provide robust estimates or to validate results from sentinel sites. Salomon and Murray (2001) argue that there is a need to clarify the relationship between sentinel data from pregnant women and the epidemiology of HIV and AIDS in the general population.

A review of the relevant literature indicates that hardly any research has been done to estimate the volume of adult deaths due to AIDS in the general population, primarily due to the lack of appropriate data at the population level. The few studies that use population data to analyze adult mortality in the era of HIV/AIDS are limited in analyzing adult mortality differentials by sex and age (Blacker 2004). However, several studies from sentinel sites consistently report that education has a strong association with HIV infection (Ayiga et al. 1999; Carael and Holmes 2001; Ntozi et al. 1997; Kapiga et al. 1994) and hence can be inferred to deaths due to AIDS.

In this paper we attempt to estimate the volume and pattern of adult mortality due to AIDS by taking into account sex, age and educational distribution of the population. We use data from the 1989 and 1999 population and housing censuses of Kenya. For this study, we defined the adult population to be aged 20 to 69. We excluded people aged 15 to 19 because these people are likely to be in school in the intercensal period and could have transited from primary to secondary level between 1989 and 1999, which complicates interpreting the survivorship ratio by education. Under such circumstances, a change in the survival ratio is not only due to mortality but also due to a change in the education level, assuming negligible migration in the intercensal period. While analyzing the relationship between education and HIV infection, a clear understanding of the mechanism by which education operates to influence HIV infection is crucial, especially to form appropriate categories for the education variable. It is important to note that the relationship between education and HIV deaths has been changing over the years and has been mediated by earning capacity, skill and knowledge. Empirical studies in sub-Saharan Africa show that people in the most advanced social groups were affected most by HIV/AIDS (Over 1992; Kapiga et al. 1994; Ndongko 1996; UNAIDS 1998). Plausible reasons for higher HIV infection among people in the higher socio-economic groups include that people in such groups may have greater disposable income, increased leisure time, increased ability to travel and increased opportunity to use commercial sex workers. In the absence of widely available HIV/AIDS information, which was a reality in the early days of the epidemic (i.e., in the first decade after the emergence of the disease), social and educational status are strongly linked through respect and earning capacity. In other words, during this period, the association between education and HIV infection was mediated through earning capacity or respect that a highly educated person would command. Several studies in sub-Saharan Africa show that the epidemic affects more people in the most advanced social group. In this sense, education and HIV/AIDS were related through social status in the early period of the epidemic.

In the recent past (in the second decade of the epidemic), however, the nature of association between education and HIV infection has changed. There is a good deal of evidence that indicates a negative association between education and HIV infection. Education increases access to health information, which transmits knowledge and skills necessary to avert infection. For instance, condom use and decline in multiple sexual partners were strongly associated with educational status (Fylkesnes et al. 2001; Lagarde et al. 2001a, 2001b; Zellner 2003). This suggests that well-educated people would respond to HIV prevention messages to adopt healthy behavior, when available.

Given that we are interested in adult mortality due to AIDS in the early period of the epidemic, a meaningful category for the education variable must distinguish between the economic positions of the people. Therefore, we created two categories: no or low level of education, and high (secondary or higher) level of education, which better characterize the social status.

Source of Data

The study uses data from the 1989 and 1999 population and housing censuses of Kenya. Both censuses were conducted exactly 10 years apart and covered all parts of the country. A five percent random sample data for each census was obtained from the Integrated Public Use Microdata Series (IPUMS)[1] web site. We extracted age, sex and education variables from each census data set. During the 1989 census, people aged six years and above were eligible for questions on education, whereas in the later census, people aged five years and above were eligible for questions on education. Because we are interested in adult mortality, the change in the starting age does not affect our analysis. The questions used in both censuses are identical with slight changes in the categories for education. Therefore, we use data on age, sex and education. We constructed the education variable from the question: What is the highest level completed? Responses are grouped into two categories: No or low education, and secondary or higher education. The former comprises people with no education (illiterate) and people with primary (standard 1-8) education. The latter comprises people with more than primary education (having more than at least Form 1 education).

Looking into the data we observe differences between the censuses in the reporting of age and education. Data from the 1999 census have no missing values for age and education, whereas data from the 1989 census show that of those people aged six years and older, 0.1 percent and 4.5 percent have failed to report their age and education, respectively. Because observations with missing values create irregularity in analyzing survival ratios, we first prorated the missing values for age according to the distribution of people who stated their age. Second, assuming that the distribution of people whose education level is missing is the same as those whose education level is known, we distributed people whose information on education is missing in the two education categories that we created, based on the observed age and education

[1] IPUMS is a database dedicated to collecting and distributing census data from around the world. The web site is http://www.ipums.umn.edu/. It was developed by the Minnesota Population Center of the University of Minnesota, USA. The data was downloaded on June 25, 2005.

categories. Intercensal census survival cohort analysis was performed after the missing values were prorated.

Methodology

Statistics on deaths due to AIDS are hardly available in sub-Saharan Africa. In the absence of such statistics, an estimation of deaths due to AIDS is unreliable. However, both censuses include questions on the survival of parents (if a respondent's mother or father is alive or not). However, estimates from these questions may portray a mortality level that includes the effects of AIDS.

We use intercensal survival cohort analysis techniques to estimate adult mortality that is independent of the effect of AIDS. This method requires (a) the population to be closed, and (b) the data to be accurate or both censuses should be of similar quality in age reporting and coverage error (United Nations 2002). If no migration and no difference in data quality exist, the difference between the population aged x to x+5 in 1989 and x+10 and x+15 in 1999 is attributable to intercensal deaths. We calculated the 10-year survivorship for all age groups and estimated the corresponding level in the Coale and Demeny model life tables (Coale and Demeny 1983). The challenge was to select the level that can be free from the effects of AIDS. Literature from surveillance studies indicates that people in reproductive age groups are highly affected by the epidemic (Nunn 1989; Topouzis 1994; Ayiga et al. 1999; Ntozi et al. 1997). This implies that levels obtained from these age groups represent a mortality level contaminated by AIDS. This suggests that levels associated with older people are likely to represent an AIDS-free mortality level. However, survival estimates for older people tend to be erroneous because the reporting of age among the elderly population (60+ years) suffers from overstatement. Therefore, estimates for people aged 50-59 are less likely to be affected by AIDS and age misreporting errors. For each survival ratio computed from the cohort of people aged 50-54 and 55-59 in 1989, the corresponding mortality levels from the Coale and Demeny model life tables are estimated and compared with estimates from other sources to assess if any of these estimates can represent an AIDS-free mortality level for Kenya in the 1990s (see discussion below). Estimates from the cohort aged 55-59 show the mortality for Kenya to be too low. Therefore, a level estimated from the cohort aged 50-54 is considered to be applicable to the population of Kenya in the 1990s. In other words, if there were no deaths due to AIDS, the population of Kenya would enjoy a mortality condition as depicted by the level of the cohort aged 50-54 during the intercensal period.

Once the AIDS-free mortality levels for Kenya were estimated, the corresponding 10-year survival ratios for each age group, 20 years and older, were computed from the Coale and Demeny model life tables and used to forward-project the 1989 population by age group. The forwarded population represents the size of the population by age that would have survived (expected population) in 1999 if it had not been affected by mortality due to the epidemic during the intercensal period. The difference between the expected and the enumerated population in the 1999 census yields an excess death rate after accounting for the effect of age on mortality. As the Coale and Demeny model life tables were developed in the pre-AIDS era, the mortality conditions represented in the life tables do not include the effects of AIDS. Therefore, we argue that the excess mortality observed between the projected and enumerated population can be attributed to AIDS. This procedure was carried out separately for both males and females classified by education. The reliability of the estimated mortality levels is tested by comparing estimates from other sources. Prior to generating adult mortality levels, it is appropriate to assess the quality of the data and to assess the validity of assumptions.

Data Quality

Figure 1 shows the percentage distribution of a single age for the two periods. Generally, the percent declines as age advances. This is much clearer after the age of 10. However, it is evident that people prefer to report ages that end with 0 and 5. The incidence of heaping is higher for ages ending in 0. Visual assessment of the figure informs us that the problem of age heaping is similar in both years. The Blended Meyer technique (Meyers, cited in Shryock and Siegel 1980, p. 117), which assesses and quantifies the extent of age preference, confirms that the ages 0 and 5 are the most preferred digits in the order mentioned and that the extent of the preference is of the same magnitude in both censuses.

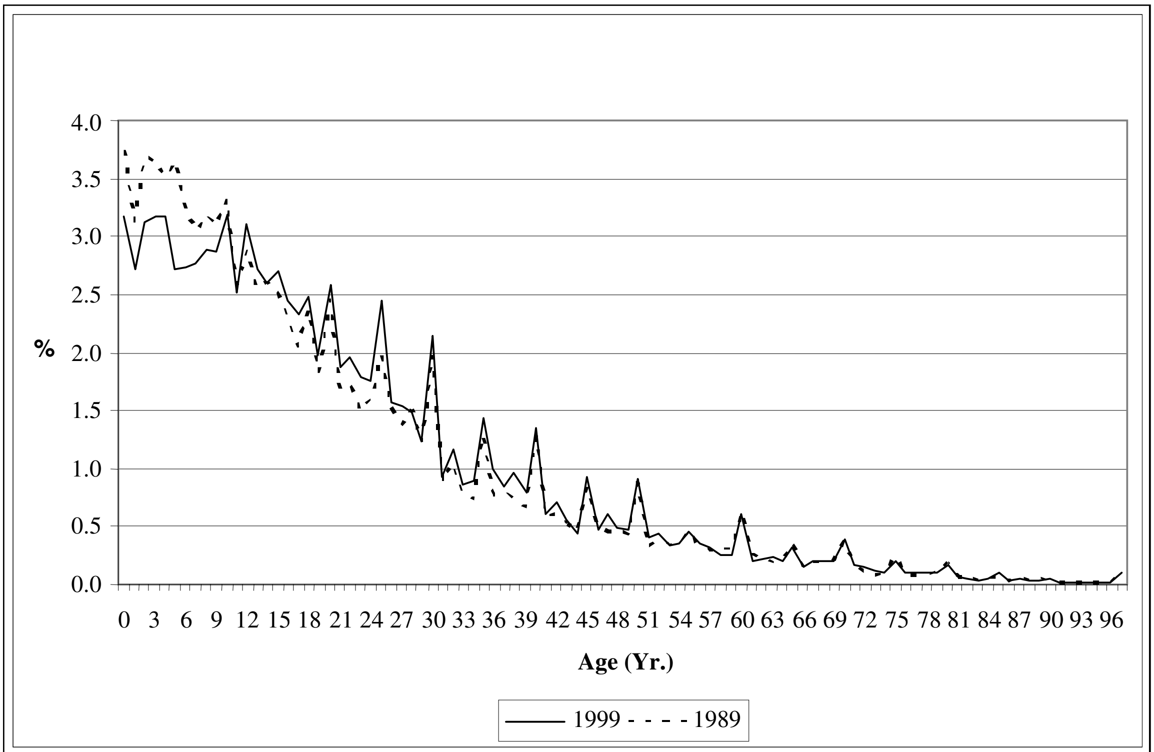

Figure 1. Percentage distribution of the population of Kenya by year of census.

We created conventional age groups. The proportion of people in the age group 0 to 4 is less than the proportion in the 5 to 9 age group. This could be due to declining fertility in the recent past. Fertility has been declining in Kenya since the 1980s (Central Bureau of Statistics 2002). The proportion of people in all age groups after age 10 steadily declines as age increases. This is true for both censuses.

Reporting of the education level also seems to be poor in the earlier census. In the 1989 data, 4.5 percent of the eligible population failed to provide their educational level. In the 1999 census, there are no individuals with missing information on the education level. Because the survivorship technique requires complete enumeration and accurate reporting of age, sex and education characteristics, those with missing information on age and education in the earlier census are distributed based on the observed age and education distribution.

Cohort survivorship ratios are calculated. Under normal circumstances, the survival ratio declines with age and cannot exceed a value of one. Table 1 shows that there are fluctuations in survivorship ratios and that sometimes, they even exceed one. These problems are observed for men aged 60+ and for women aged 40+ with secondary or higher education. Assuming that the data qualities between the two censuses are the same, such out-of-range survivorship values could be due to a transition from primary to secondary education or problems associated with the smallness of the sample in the age groups. The fact that these values are observed for older people suggests that it is less likely for many people as old as 40+ in 1989 to continue learning and to transit to the next education level in 1999. Noting that the proportion of women with a higher education is very small and is much less than the corresponding proportion for men, the out-of-range survival ratio could be due to differences in the reporting of age or education, or to undercounting in the two censuses. Apart from exceeding a value of one, the survivorship ratios fluctuate as age advances. This could be related to a number of reasons, such as poor reporting of age or, more importantly, the difference in mortality experience at different age groups.

Table 1. Ten years survival ratio by sex, age and education group, Kenya, 1989-1999.

	Males		Females	
Age group	No/Low Education	Secondary or higher	No/Low education	Secondary or higher
20-24	0.889	0.984	0.844	0.812
25-29	0.883	0.874	0.871	0.804
30-34	0.893	0.849	0.910	0.839
35-39	0.915	0.828	0.918	0.914
40-44	0.904	0.915	0.938	*
45-49	0.782	0.842	0.804	0.997
50-54	0.811	0.862	0.887	*
55-59	0.765	0.896	0.867	*
60-64	0.756	*	0.818	*
65-69	0.688	*	0.693	*
70-74	0.479	0.989	0.587	*
75-79	0.414	*	0.490	*
80-84	0.307	*	0.370	*
85+	0.307	*	0.451	0.692

Results

The cohort survivorship methodology provides an insight to the mortality level of a population by comparing the proportions of a cohort survivorship with the corresponding families of the Coale and Demeny model life tables. In the absence of migration and errors in the data, the survivorship ratio should always be less than one. The irregularities or out-of-eligible range of values in the survivorship signals the existence of errors in the data. Given that the survivorship value consistently exceeds one for all ages above 60 for men and above 40 for women with secondary education, the most plausible reason that leads to out-of-range values is a differential undercount in the two censuses. In other words, either the earlier census was underreported or the later census was overreported. A report from the Kenyan Central Bureau of Statistics (2002) indicates that the levels of undercounting during the 1989 and 1999 censuses were 5.8 percent and 2.7 percent, respectively. Undercounting for people aged 10 years or more constituted 5.2 percent in 1989 and 2.1 percent in 1999. This suggests that the level of undercounting among adults is of less importance, provided that the pattern across all ages is similar.

The Coale and Demeny model life tables assume that if no errors in the data exist, then the mortality levels estimated from each age group should indicate the same mortality schedule for a given population. However, the levels in each age group show substantial variation in our results. The differential AIDS experience by age, especially in the early days of the epidemic, could be the major reason for the divergence from expectation. The challenge of estimating mortality due to AIDS using the Coale and Demeny model life tables is to select two levels, one of which refers to a mortality schedule independent of the impact of AIDS and the other to a schedule that includes the general (with the impact of AIDS) mortality experience. Although previous studies are inconsistent as to who is most affected by the epidemic, it can be summarized that people in the broader age group 15 to 44 are affected the most by the epidemic (Nunn 1989; Topouzis 1994; Timæus and Jasseh 2004). Mortality levels generated from these groups are likely to include the effect of AIDS on mortality. Looking into the survivorship of the people aged 55 to 59, it is evident that estimates from this group suggest that mortality for Kenya is too low. Therefore, the only available estimate that can portray adult mortality conditions less affected by the pandemic is the one derived from the mortality experience of people aged 50 to 54.

The survival ratios for the age group 50-54 are 0.811 for men with no or low education, 0.862 for men with secondary or higher education, and 0.887 for women with no or low education. Survival ratios for women with secondary or higher education do not make sense after the age of 40. The corresponding model life table levels for families in the west and north are calculated. Using the west model, the corresponding levels are 17.43 for men with no or low education, 21.56 for men with secondary or more education, and 20.09 for women with no or low education. For women with secondary or more education, we assumed that the level (21.56) estimated for men with secondary or higher education is applicable. Using the north model, the corresponding levels are 14.65 for men with no or low education, 19.07 for men with secondary or more education, and 18.53 for women with no or low education. Following the same argument, for women with secondary or more education, we assumed that the level (19.07) estimated for men with secondary or higher education is applicable. The ten-year survivorship ratios implied by these models are used to project the 1989 population. Now we need to verify whether these levels derived from the mortality experience of people aged 50 to 54 can indeed represent a mortality schedule that adults in Kenya would have enjoyed, had AIDS not affected them.

Using child survival data from the 1969 population census and the north family of the Coale and Demeny model life tables, Anker and Knowles (1980) estimated a life expectancy at birth of 47.8 years in 1969 for both sexes. This value corresponds to a level of 12.73 in the north model life table. We observed an improvement in adult mortality in Kenya in the 1970s and 1980s; hence, the life expectancy was higher (57.5 years) in 1989 (Central Bureau of Statistics 1996).

Timæus and Jasseh (2004) attempted to estimate the level and trends of adult mortality for 23 countries in sub-Saharan Africa using data on the survival rates of relatives drawn from the Demographic and Health Surveys (DHS) conducted between 1992 and 2000. The data for Kenya came from the 1998 DHS. Using the orphanhood procedure, they produced a probability of dying between the ages of 25 to 35 and 25 to 40 for women, and between the ages of 35 to 50 for men. Using the sisterhood procedure, they produced a probability of dying between the ages of 15 and 60 for men and women. The period that each estimate refers to is also given. These estimates refer to the time between 1989 and 1995. Because the authors argue that the conventional use of model life tables to adjust and analyze adult mortality during the era of AIDS is highly questionable, they did not use the Coale and Demeny model life tables and hence, did not provide associated mortality levels from these model life tables.

However, we argue that in the early period of the epidemic, not all age groups are equally affected by the epidemic. If a group less affected by AIDS is identified, use of the model life tables can still be appropriate. Therefore, we used the estimates for Kenya made by Timæus and Jasseh (2004) for 1989 and computed the corresponding mortality level from the Coale and Demeny model life table so that we could have a measure to check against our estimates (see Table 2). We computed the levels using both the north and west families of the Coale and Demeny model life tables. Although the authors have not provided detailed discussions for each country, they concluded that a) orphanhood and sibling procedures yield different results, where the former might understate mortality conditions and the latter might accurately estimate recent mortality conditions; and b) adult mortality increases in eastern Africa to which Kenya belongs. Therefore, estimates for Kenya from the sibling procedure are likely to reflect the recent mortality conditions which include the effect of AIDS. This argument seems plausible when estimates from sibling procedures are compared with results from previous studies.

Estimates from the Timæus and Jasseh (2004) study are based on data from the 1998 DHS, a time when the epidemic was sharply increasing. Compared with estimates (computed to be level 12.37) that Anker and Knowles (1980) provide for 1969, Timæus and Jasseh's estimates, derived from the sibling procedure for the 1989-1990 period, indicate an increasing mortality condition in the later period. As opposed to an improvement in adult mortality over time, such an increase implies an increase in mortality due to AIDS. Therefore, we disregard these estimates as they do not represent an AIDS-free mortality condition.

Table 2. Estimated probability of dying for adults from two different estimation procedures and implied mortality by sex, Kenya.

Orphanhood procedure									
	Women						Men		
		Level			Level			Level	
Year	$_{10}q^*_{25}$	West	North	$_{15}q^*_{25}$	West	North	$_{15}q^*_{35}$	West	North
1989	0.026	19.39	18.13	0.030	20.35	21.43	0.096	18.74	19.10
1994	0.050	15.68	15.43	0.053	18.27	18.45	0.134	15.35	14.71
Sisterhood procedure									
Year	$_{45}q^*_{15}$	West	North				$_{45}q^*_{15}$	West	North
1990	0.175	14.05	13.62				0.185	14.31	15.25
1995	0.262	9.64	8.81				0.292	8.90	8.73

* Probability estimates are drawn from Timæus and Jasseh (2004) but we computed corresponding mortality levels using the Coale and Demeny model life tables.

Using the orphanhood procedure, mortality estimates derived from the two samples of women (i.e., those aged 25 to 35 and 25 to 40 years) differ slightly. Broadly speaking, the AIDS-free adult mortality level for Kenya in 1989 lies between 19 and 21 for women if the west family model life table is used, and between 18 and 22 if the north family model life table is used. The level for men is about 19 for both family models. We believe that our estimates (around the level of 20 for women and between 17 and 22 for men if the west family model is used; and between 15 and 19 if the north family model is used for the two sexes), which are drawn from the age 50-54 survival ratios, could represent mortality conditions free from AIDS.

After mortality levels implied by survivorship probabilities of a cohort aged 50 to 54 were estimated, we computed adult deaths due to AIDS using survivorship estimates derived from the implied mortality levels and the west and north family model life tables (Tables 3a and 3b). The west family model life table portrays higher adult mortality due to AIDS. The tables show that young adults experienced heavy mortality for both sexes. This is consistent with results from previous studies (Nunn 1989; Ayiga et al. 1999). People under 40 years are highly affected. This is true for both men and women and for both education groups, with the exception of men aged 20 to 24, where there is no evidence of deaths due to AIDS. There are two possible explanations for this. First, in the intercensal period, more men improved their education level from primary to secondary, hence, the number of deaths due to AIDS is offset by gains in the education transition. Second, the effect of AIDS is masked by the correlation between school enrolment and risk of HIV infection. People in school have a lower risk of HIV infection than those who are out of school. Men aged 20 to 24 could still be in school, hence, the risk of dying from AIDS is low.

Table 3a. Estimated adult deaths due to AIDS by sex and age using the west family of the Coale and Demeny model life tables, Kenya.

	No/Low Education						Secondary or Higher					
			Population						Population			
Age group (x) in 1989	Population (x) in 1989	Estimated survival ratio	Expected in 1999 (x + 10)	Enumerated in 1999 (x + 10)	Expected minus enumerated	% difference	Population (x) in 1989	Estimated survival ratio	Expected in 1999 (x + 10)	Enumerated in 1999 (x + 10)	Expected minus enumerated	% difference
						MALES						
20-24	549880	0.958	526846	489080	**-37766**	**-7.72**	345865	0.981	339460	340440	980	0.29
25-29	472258	0.951	448955	416800	**-32155**	**-7.71**	307534	0.977	300539	268900	**-31639**	**-11.77**
30-34	375242	0.938	351957	335020	**-16937**	**-5.06**	208482	0.968	201874	177000	**-24874**	**-14.05**
35-39	330468	0.918	303321	302420	**-901**	**-0.3**	132791	0.952	126421	110000	**-16421**	**-14.93**
40-44	294763	0.887	261561	266360	4799	1.8	77476	0.925	71684	70920	**-764**	**-1.08**
45-49	243963	0.842	205523	190660	**-14863**	**-7.8**	37337	0.884	33005	31420	**-1585**	**-5.04**
50-54	219003	0.778	170432	177620	7188	4.05	20094	0.823	16545	17320	775	4.48
55-59	168731	0.690	116372	129120	12748	9.87	10734	0.737	7912	9620	1708	17.76
60-64	146632	0.571	83758	110920	27162	24.49	5476	0.617	3377	6080	2703	44.46
65-69	112232	0.278		77240			2333	0.239		3320		
						FEMALES*						
20-24	729234	0.979	714279	615260	**-99019**	**-16.09**	288584	0.986	284500	234360	**-50140**	**-21.39**
25-29	638724	0.975	622998	556160	**-66838**	**-12.02**	211010	0.982	207169	169620	**-37549**	**-22.14**
30-34	481840	0.969	467072	438260	**-28812**	**-6.57**	97060	0.975	94641	81480	**-13161**	**-16.15**
35-39	410623	0.960	394088	377040	**-17048**	**-4.52**	44273	0.964	42678	40460	**-2218**	**-5.48**
40-44	347610	0.944	328210	326080	**-2130**	**-0.65**	18386	0.947	17404	18400	996	5.41
45-49	286986	0.920	264021	230840	**-33181**	**-14.37**	7279	0.920	6694	7260	566	7.80
50-54	238535	0.882	210374	211560	1186	0.56	3761	0.876	3293	4140	847	20.46
55-59	180818	0.821	148408	156700	8292	5.29	1885	0.803	1514	1920	406	21.15
60-64	167020	0.725	121116	136680	15564	11.39	951	0.689	656	2340	1684	71.98
65-69	117858	0.545		81620			284	0.271		1300		

* The survivorship ratio for females with secondary or more education is estimated using the level used for males with secondary or more education.

Table 3b. Estimated adult deaths due to AIDS by sex and age using the north family of the Coale and Demeny model life tables, Kenya.

	No/Low Education						Secondary or Higher					
Age group (x) in 1989	Population (x) in 1989	Estimated survival ratio	Population: Expected in 1999 (x + 10)	Population: Enumerated in 1999 (x + 10)	Expected minus enumerated	% difference	Population (x) in 1989	Estimated survival ratio	Population: Expected in 1999 (x + 10)	Population: Enumerated in 1999 (x + 10)	Expected minus enumerated	% difference
MALES												
20-24	549880	0.934	513501	489080	**-24421**	**-4.99**	345865	0.961	332408	340440	8032	2.36
25-29	472258	0.926	437532	416800	**-20732**	**-4.97**	307534	0.958	294607	268900	**-25707**	**-9.56**
30-34	375242	0.914	343041	335020	**-8021**	**-2.39**	208482	0.952	198484	177000	**-21484**	**-12.14**
35-39	330468	0.895	295883	302420	**6537**	**2.16**	132791	0.942	125057	110000	**-15057**	**-13.69**
40-44	294763	0.868	255763	266360	**10597**	**3.98**	77476	0.924	71606	70920	**-686**	**-0.97**
45-49	243963	0.827	201832	190660	**-11172**	**-5.86**	37337	0.897	33508	31420	**-2088**	**-6.65**
50-54	219003	0.766	167799	177620	9821	5.53	20094	0.858	17239	17320	81	0.47
55-59	168731	0.676	114051	129120	15069	11.67	10734	0.795	8538	9620	1082	11.24
60-64	146632	0.550	80679	110920	30241	27.26	5476	0.702	3845	6080	2235	36.76
65-69	112232	0.172		77240			2333	0.54		3320		
FEMALES*												
20-24	729234	0.967	705382	615260	**-90122**	**-14.65**	288584	0.972	280438	234360	**-46078**	**-19.66**
25-29	638724	0.962	614451	556160	**-58291**	**-10.48**	211010	0.968	204189	169620	**-34569**	**-20.38**
30-34	481840	0.955	459986	438260	**-21726**	**-4.96**	97060	0.962	93350	81480	**-11870**	**-14.57**
35-39	410623	0.944	387736	377040	**-10696**	**-2.84**	44273	0.953	42208	40460	**-1748**	**-4.32**
40-44	347610	0.928	322692	326080	3388	1.04	18386	0.941	17300	18400	1100	5.98
45-49	286986	0.902	258983	230840	**-28143**	**-12.19**	7279	0.921	6705	7260	555	7.65
50-54	238535	0.859	204806	211560	6754	3.19	3761	0.889	3342	4140	798	19.27
55-59	180818	0.787	142218	156700	14482	9.24	1885	0.833	1571	1920	349	18.19
60-64	167020	0.677	113082	136680	23598	17.27	951	0.745	708	2340	1632	69.74
65-69	117858	0.285		81620			284	0.581		1300		

* The survivorship ratio for females with secondary or more education is estimated using the level used for males with secondary or more education.

For men with secondary education, the impact of AIDS-induced deaths is heavy between the ages of 25 and 39. It should be noted that the deficit due to AIDS increased as the age increased to 40. This could be because older young-adults might have more resources to afford extramarital relationships and travel more than the younger young-adults.

A comparison of deaths due to AIDS by gender and education shows important distinctions. First, among the young adults, more losses were observed for women. Among those with low education, men between ages 20 and 34 and women between ages 20 and 39 were affected by AIDS. At each age group more women died due to AIDS. This is consistent with previous findings (Glynn et al. 2001; Pictet et al. 1998; Anarfi 1995). The second important distinction is that AIDS affects men up to age 35, but for women, the effect of AIDS is substantial to age 40. Among people with secondary education, the impact of AIDS on women started as early as 20, while men were affected between the ages of 25 and 39. Previous studies have indicated that women are affected at younger ages than men, which is consistent with our findings.

Conclusion

In sub-Saharan Africa, research on the impact of HIV/AIDS on adult mortality has focused on examining trends and differentials primarily using data from sentinel sites. This paper analyzes data from the 1989 and 1999 population censuses of Kenya to assess adult mortality due to AIDS, taking into account age, sex and education variables. Intercensal survival cohort analysis in conjunction with Coale and Demeny model life tables are used to analyze the data. The paper provides consistent results with previous findings from sentinel sites and hence, corroborates with existing knowledge on the impact of AIDS on adult mortality. During the first period of the epidemic, there is a real association between education and deaths due to AIDS. This phenomenon seems counter-intuitive as education is believed to improve access to HIV prevention knowledge and skills. However, given that hardly any HIV information was available to the public during the early period of the epidemic, the association between education and HIV infection needs explanation outside of the knowledge/skill acquisition, because during this period, education was a proxy for social status, putting people at a higher risk of HIV infection and hence death.

The effect of AIDS on adult mortality in 1989 decreased as age increased to 39, and rose among those aged 45-49. The impact is insignificant for those aged 40-44 in 1989. Previous studies have shown that the effect of AIDS is significant among young adults. For instance, Pictet et al. (1998) show that the proportion of AIDS deaths was almost four times greater among young adults (aged 15-44) than for any other age group. The insignificant impact of AIDS on cohorts aged 40-44 and the observed rise in mortality due to AIDS for people aged 45-49 need further investigation. With the exception of men aged 20-24, the pattern of a declining effect of AIDS up to age 39, and a rise in the group aged 45-49 is true regardless of sex and education level. Men aged 20-24 in 1989 do not seem to be affected by the epidemic. One plausible reason could be that men in this age group in 1989 could have improved their educational status from primary to secondary during the intercensal period. Such transition could have offset intercensal loss due to death. The inverse relationship between age and deaths due to AIDS up to age 39 and a rise in the cohort aged 45 to 49 in 1989 is true for both sexes and education levels.

Regardless of educational status, generally for young adults (up to age 39), deaths due to AIDS are higher for women. This is consistent with results from previous studies. Both behavioral and biological factors are suspected to conspire to increase the risk of HIV infection among young adult women (Glynn et al. 2001; Carael and Holmes 2001). Men and women with higher education are more affected by deaths due to AIDS. This finding concurs with results reported by previous studies in the early days of the epidemic, when education put people at a higher risk of HIV infection (Fylkesnes et al. 1997; Hargreaves and Glynn 2002) by improving their social status.

This evidence shows that censuses can still be useful in examining the relationship between education and HIV/AIDS deaths, especially in the early period of the epidemic. Similar research should be carried out to assess if consistent results can be replicated elsewhere. Further research, using census data, is also needed to develop a methodology to estimate adult mortality due to AIDS in the second decade of the epidemic, when education began to enhance knowledge and skills about HIV transmission and means of prevention, leading to a shift in behavior to avert HIV infection.

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