Is Education a Social Vaccine against HIV/AIDS in Sub-Saharan Africa?
The Effect of Schooling across Age Cohorts.

- Extended Abstract and Preliminary Results -

Abstract

Early in the HIV/AIDS pandemic in sub-Saharan Africa, epidemiological studies atypically identified formal education attainment as a risk factor: educated sub-Saharan Africans had a higher risk of contracting HIV than their less educated peers. Although some demographic research indicates that by the mid-1990s the education effect had reversed, there is still contradictory evidence as a recent major analysis reports that education still acts as a HIV/AIDS risk factor (Fortson 2008). This and related analyses fail to account for possible interaction between education and age cohort reflecting the effect of reaching sexual maturity at different points during the shifting political-informational environment over the course of the pandemic. A replication of Fortson's analysis with DHS data from five sub-Saharan national samples, but with a model incorporating interaction effects, finds that starting among the cohort who reached sexual maturity in the mid-1990s more schooling is associated with lower likelihood of HIV/AIDS infection.

Introduction

There is intensive scientific and policy interest in determining if education has either a positive or a negative effect on contracting AIDS/HIV in sub-Saharan Africa. Early in the pandemic in sub-Saharan Africa, epidemiological studies atypically identified formal education attainment as a risk factor: educated sub-Saharan Africans had a higher risk of contracting HIV than their less educated peers. But other research suggests that educational attainment played it usual disease preventative role as a social vaccine against AIDS/HIV infection in the region. With significant public health policy implications in the balance, this contradictory body of research is defined by two main questions. One, is education a *social vaccine* preventing AIDS/HIV infection as is the case with many other diseases, or for some reason unique to sub-Saharan Africa (hereafter SSA) does it play an atypical role of a risk factor? Two, net of economic and social resources associated with higher educational attainment, does exposure to more schooling directly influence health outcomes?

In light of past contradictory answers to the first question, we contend that over the course of the pandemic there was a shift in the effect of education from a risk factor to a social vaccine. And the reason for the shift was a change in the political-informational environment as to the recognition of the existence of disease and likely causes of viral transmission in SSA nations. Until the 1990s many SSA national governments public health agencies publicly denied the existence of AIDS in their countries, and in some cases propagated misinformation about viral transmission (Gow 2002; Grmek 1990). If this argument is correct, there should evidence of an interaction between the direction of the education effect and when during the pandemic individuals reached

sexual maturity. If our contention of an unusual historical change in the direction of effect is empirically supported, then significant light will be shed on the nature of the causal process behind the widely-reported education effect on general health.

A robust stream of research in South-Saharan Africa, based heavily on the Demographic Health Survey (DHS) data, provides support to the notion that education is currently having a negative, independent effect on AIDS/HIV. Although early research in SSA found that most educated people were most likely to be infected (Ainsworth and Semali 1998; Cogneau and Grimm 2006; Gregson et al. 2001; Smith et al. 1999.), recent analysis show that among younger cohorts this trend has shifted and education is playing its more expected role as a health preventive factor (Baker et al 2009; Kelly 2000; World Bank 2003). Also, these analyses suggest that education has a direct effect of its own, net of other social class indicators as occupation or income.

A recent analysis published in *Demography* has offered a different interpretation of the phenomena. Using DHS data for five Sub-Saharan African countries, Fortson (2008) finds that, controlling for age and other variables, education is positively related with HIV infection and HIV risk factors. She estimated quadratic least squares regressions and finds a nonlinear relation, with prevalence rates increasing with education up to the primary level, and then falling for those with higher levels of schooling (secondary or more). Theoretically, she understands the educational effect as a part of the influence of socioeconomic status on HIV/AIDS and suggests that education is related with certain risk factors for HIV, like having premarital sex.

In this paper we pursue a replication of Fortson's analysis and a new modeling strategy that takes into account the interaction effect between education and population cohort. We show that the effect of education varies by cohort, positive for older cohorts and null for younger cohorts. This finding provides support for the idea that the educational effect shifted historically, from acting as a risk factor in their earlier stages to becoming more of a social vaccine more recently. A proper understanding of the role of education should take into account the historic development of the epidemic in Africa, showing how public misinformation at early stages of the epidemic prevented educated people from using their higher cognitive and decision making skills and adopt safer sexual behavior.

An historical change in the relation between HIV/AIDS and education

The relationship between education and HIV/AIDS in SSA has intrigued demographers since early reports on the prevalence of the virus found that most educated individuals, especially men, were more likely to be infected than those with lower or no education (Ainsworth and Semali 1998; Cogneau and Grimm 2006; Gregson et al. 2001; Smith et al. 1999). This was an intriguing finding because it appeared to be an exception to the almost universal role of education as a *social vaccine* in health outcomes (Kelly 2000; World Bank 2003; Mirowski and Ross 2003). Also, the pattern was not found in other parts of the world; in the US, for example, education was never identified as a risk factor for AIDS infection (Grmek 1990).

Although several papers reported this unusual role of education as a risk factor for HIV/AIDS in SSA, the understanding of the possible mechanisms involved in this finding was weak. As the pandemic developed and the response from national governments and international organizations improved, new trends have appeared and researchers have been able to build a more complete historical picture. The basic finding has been the shift from an early risk factor role of schooling to a more recent preventive role among younger cohorts.

The key of the process is that a number of historical circumstances fostered weak public information and misunderstanding about the disease and its transmission mechanisms in the region, precluding educated individuals to adopt a safer behavior in the early stages. Although nowadays the virus is considered to have originated in the Great Lakes in the SSA during the 1970s, news in the early 1980s about an unknown disease first appeared in the United States affecting homosexual males and drug users. In the early 1980s, some cases were identified in Europe, especially in France, suggesting a path of infection with origin in Africa. However, for the international scientific community the connection was still unclear, and and African governments that at first received the notice of the disease –and the stigmas associated with it– rejected it as a foreign threat that was irrelevant to its their own populations. In SSA the typical transmission mechanisms observed in the US and Europe were not in place, and the unnoticed spread of the disease exploded through heterosexual males, female prostitutes, and mother-to-child transmission when almost no information was available. The weak response by many African governments, denying the existence of the disease or not developing adequate public policies to prevent it worsened the epidemic (Grmek 1990). Without accurate information about AIDS, educated heterosexual men in SSA were more likely to be infected because they were more likely, on average, to engage with multiple sexual partners than non-educated men due to their average higher social status and wealth (Carael 1995).

Differences in the institutional context and governmental response played a role in the actual pace of expansion of the pandemic in different SSA countries. The case of Kenya is paradigmatic for the tardiness of the governmental response, which came when the HIV pandemic was already a national disaster. On the other hand, stronger and stable governance institutions allowed a better response to the disease and thus lower prevalence rates in Ghana. The other 3 countries in our sample (Ghana, Cameroon, Burkina Faso and Tanzania) had also a relatively early governmental response. However, the effectiveness of the governmental action was generally weak, in part due to weak top-level support to policy initiatives.

Data and Methods

To examine the relationship between schooling and HIV and AIDS in SSA we used 5 DHS surveys that were administered between 2003 and 2004 that had HIV testing data available. The DHS surveys, funded by the United States Agency for International Development (USAID), have been administered by Macro International since 1984 and are available by request from www.measuredhs.com.

The surveys are nationally representative household samples ranging between 5,000 and 6,000 households using representative probability sampling techniques. The survey respondents are selected using a two-stage stratified random sampling technique. All women between the age of 15 and 49 and males between the ages of 15-59 of the selected household are eligible to be included in the surveys.

The cross-sectional surveys include questions that assess respondent's fertility, family planning, maternal and child health, child survival, malaria, and nutrition in addition to an HIV and AIDS component. The DHS surveys are typically conducted every five years. Surveys began collecting HIV and AIDS knowledge, attitudes, and behavioral data in the early 1990s and began conducting HIV biomarker testing and data after 2000 in addition to the three distinct questionnaires: household, women, and men.

For the analysis on HIV infection, we use 5 surveys conducted between 2003 and 2004 in SSA that included HIV datasets. Table 1 indicates the countries used in the HIV analysis, the year the survey was conducted, sample size and the HIV infection rate in the country during the year of the survey, and educational level of the population. The 5 countries represent a wide range of countries that represent significant variation in geographic and HIV prevalence in SSA.

Table 1: Main characteristics of the countries included in the analysis

	Year	Sample	HIV rate (%)	Education (%)		
				No education	Primary	Secondary or more
Burkina Faso	2003	7,530	2	73	15	12
Cameroon	2004	10,199	5	17	38	45
Ghana	2003	9,564	2	23	18	59
Kenya	2003	6,190	7	9	58	33
Tanzania	2003	10,743	7	17	74	9

Source: Demographic Health Surveys

As shown in Table 1, educational attainment ranges widely between countries, but all have significant variation within each country. These samples maximize the schooling effect and thus allow more thorough analysis of pathways between schooling and HIV infection.

We examine the relationship between schooling and HIV infection using Ordinary Least Squares (OLS) [1] regression analysis with fixed effects by communities[2]. The variables used in the analyses come from the three DHS questionnaires for the household, women, and men as well as the biomarker data. For this study, we first estimate Fortson's (2008) model , in order to ensure that we get the same results; then, we estimate an alternative model that controls by differences across communities (clusters), and interaction effects

[1] It was also estimated the models using logistic regression models and the results are the same. However, it is included in the body of the text the OLS results since they are easy to interpret.
[2] It is used as proxy for community the cluster that each subject belongs in the sample.

between age of cohort and schooling.

Variables

Dependent variable: HIV infection is the result of the dry blood spot test given to a sub-sample of the DHS sample. The variable is a dichotomous variable reported as either HIV positive (equal 1) or HIV negative (equal 0).

Independent variables: The independent variables of interest for all analyses are years of schooling, that is the numerical value of the last grade successfully completed by the participant, and socioeconomic status as measured by a wealth index.

Control variables: All models have controlled for gender (female), marital status (married or co-habitate), age of cohort (15 to 24, 24 to 34, 34 and over), the respondent's place of residence (urban), and dummy variables by region to control for differences across them.

Statistical model

For this study, we estimated three models for each country. The first two models are the same than Forston (2008) where quadratic terms for education and wealth are introduced in order to account for the non-linear relationship between HIV prevalence and these variables. The third model made a twist to the models stated by Forston in the sense of including in the same equation wealth and education, and adding interaction variables between schooling and age cohort. We proceed to give some details about the equation of these models.

$Y_j = \alpha_o + \alpha_1 E_j + \alpha_2 E^2_j + \alpha_3 D_j + \alpha_4 R_j + \varepsilon_j$ - Model 1 -

$Y_j = \alpha_o + \alpha_1 W_j + \alpha_2 W^2_j + \alpha_3 D_j + \alpha_4 R_j + \varepsilon_j$ - Model 2 -

Where:

Y_j	: HIV prevalence
$\alpha_o, \alpha_1, \alpha_2, \alpha_3$, and α_4	: regression coefficients
E_j	: years of schooling
E^2_j	: years of schooling (squared)
W_j	: wealth index
W^2_j	: wealth index (squared)
D_j	: demographic variables (e.g.: gender, age's cohort)
R_j	: dummies variables by region
ε_j	: random term

$Y_j = \alpha_o + \alpha_1 E_j + \alpha_2 W_j + \alpha_4 E^* A_j + \alpha_5 D_j + \alpha_6 C_j + \varepsilon_j$ - Model 3 -

Y_j	: HIV prevalence
$\alpha_o, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ and α_6	: regression coefficients
E_j	: years of schooling

W_j : wealth index
A_j : age's cohorts
D_j : demographic variables (e.g.: gender, age's cohort)
C_j : dummies variables by cluster (proxy for community)
ε_j : random term

Lastly, for the third model, we developed multicollinearity tests (Variance Inflation Factor test and Collin test) to ensure that we did not have biased estimations for our relationships since we use in the same model schooling and wealth index that are variables highly correlated[3].

Preliminary findings

The nature of the relationship between education and the likelihood of infection is contrasted across three cohort-education variables, the results of each reflecting the interaction between schooling and age cohort. Even though educational expansion has led to an increase in the youngest cohort's mean number of years of educational attainment, there is still considerable variation in educational attainment within all age-cohorts, including in each cohort sizable proportions of unschooled individuals.

Table 2 summarizes the findings from a multivariate analysis of the relationship between formal education and likelihood of infection among adults in each of the 5 SSA countries net of gender, marital status, and socioeconomic status. The same equation is estimated for each country by a linear regression with fixed effects by communities and the variance-covariance matrix is also adjusted by the nested characteristic of the sample. As shown in table 2, among the youngest cohort in all the countries there is evidence of education acting as a social vaccine: having some schooling reduces the risk of HIV/AIDS infection. In contrast, the education role among the middle age-cohort is null in all the cases.

[3] The pearson correlation between schooling and wealth index was for Burkina Faso: .63 ($p<.00$), Cameroon: .60 ($p<.00$), Ghana:.47 ($p<.00$), Kenya: .44 ($p<.00$), and Tanzania: .43 ($p<.00$).

Table 2. Interaction effects of Education and Age's cohort on HIV prevalence

	Ghana	Cameroon	Kenya	Burkina Faso	Tanzania
Education	0.000	0.001	0.000	0.000	0.004 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Wealth index	-0.007 *	-0.001	-0.001	0.005	-0.009 *
	(0.003)	(0.004)	(0.009)	(0.003)	(0.004)
Younger cohort (15 - 24)	-0.020 **	-0.013	-0.044 **	-0.016 **	-0.026 *
	(0.007)	(0.010)	(0.015)	(0.005)	(0.011)
Middle cohort (25 - 34)	-0.003	0.013	0.007	0.002	0.005
	(0.006)	(0.011)	(0.016)	(0.005)	(0.012)
Ed*Younger cohort	-0.002 *	-0.005 **	-0.003	-0.003 *	-0.006 **
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Ed*Older cohort	0.000	0.000	0.000	0.000	-0.003
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
Constant	0.031 ***	0.054 ***	0.086 ***	0.031 ***	0.065 ***
	(0.005)	(0.009)	(0.013)	(0.005)	(0.009)
F-statistic/Chi-square	10.080	22.260	14.730	6.640	21.480
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

1/The reference group for Younger and Middle cohort was Older cohort (35 years old or more)
2/The control variables included in the model were: gender, marital status, and dummy variables per community.

In sum, what is clear by contrasting the cohort-education effects is that instead of concluding that education continues to be a risk factor or at most a null effect (both unusual effects), there is evidence that education is starting to play its more historical role in health as a preventative factor against HIV.

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