

# Facts, Attitudes, and Health Reasoning About HIV and AIDS: Explaining the Education Effect on Condom Use Among Adults in Sub-Saharan Africa

David P. Baker · Juan Leon · John M. Collins

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**Abstract** In contrast to earlier in the HIV/AIDS pandemic, net of other demographic factors, formal education acts as a preventative factor in sub-Saharan Africa. Despite this trend, there has been almost no research on the causal mechanisms behind the widely reported education effect. Consistent with the education effect, structural equation modeling of the influence of education attainment on condom use with Demographic Health Survey data from nine sub-Saharan Africa nations collected between 2003 and 2005 finds that net of control variables, there is a robust, positive influence of education on condom use among sexually risky adults. Information-transfer and attitude change, the two most commonly assumed educational influences on the use of condoms, are tested, and although education attainment increases acquisition of basic facts and the inculcation of positive attitudes about HIV/AIDS, these factors have only weak influence on condom use. Given this, a new hypothesis about education's enhancement of health reasoning is developed from neuro-developmental and decision-making research. Modeling finds that education robustly influences health

reasoning ability and this factor mediates a significant proportion of the education effect on condom use. The results raise concern about the enormous effort by NGOs in the region to use mainly fact- and attitude-based educational programs to reduce future HIV infections. Future research on the causal mechanisms behind the association between education and HIV/AIDS prevention should focus how on schooling enhances the cognitive skills needed for health reasoning.

**Keywords** Africa · Education effect · Condom use · Multiple sexual partners · Causal mechanisms

## Introduction

A substantial literature on health consistently reports that attainment of formal education is negatively related with disease and premature mortality, as education often acts as a “social vaccine” lowering unhealthy risk-taking and leading to effective preventative [1–6]. As a recent analysis of 11 sub-Saharan African (hereafter SSA) nations and other studies find, the impact of formal education on the spread of HIV infection in SSA has shifted over time from being an unusual risk factor in a period marked by widespread misunderstanding and misinformation about the disease in the region until the mid-1990s when education became a social vaccine among younger cohorts [7–13]. While there is much conjecture over the cause behind the widely-reported association between education and health, along with frequent calls for gaining a clear scientific understanding of the education effect, there has been virtually no research aimed at identifying the causal mechanism [14–17]. With nationally representative Demographic Health Survey (hereafter DHS) data from nine SSA

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D. P. Baker (✉) · J. Leon  
Population Research Institute and Department of Education  
Policy, Pennsylvania State University, University Park, PA  
16801, USA  
e-mail: dpb4@psu.edu

J. Leon  
e-mail: jjl292@psu.edu

J. M. Collins  
USAID, Washington, USA

countries, initial analysis tests two of the most common assumptions about how education increases the use of latex condoms as a HIV preventative strategy among adults with multiple, non-spousal, sexual partners, a population at high-risk of contracting HIV.

Upon finding that these assumptions are only weakly supported, a new hypothesis emerging from neuro-developmental and decision-making research about the causal influence of education is tested in subsequent analysis. Implications of the results raise concern about the enormous effort by NGOs in SSA to use mainly fact- and attitude-based educational programs to reduce future HIV infections.

## Hypotheses

Since the mid-1990s, educational attainment has shifted to be a protective factor against HIV infection in SSA [7, 18]. Most of the protective shift has been attributed to changes in behaviors explicitly targeted in HIV prevention curricula: abstinence, being faithful to one sexual partner, and condom use for individuals with multiple sexual partners [19]. Similarly, in the data used here, net of economic status and other demographic characteristics, there is an association between education and the HIV prevention strategy of latex condom use among sexually risky adults in SSA. Specially, the number of years of formal education is positively associated with condom use among adults with non-spousal, multiple sexual partners. Attending school has a direct effect on health and prevention of disease; but what is it about education that leads to better health?

The first of the two most commonly assumed causal mechanisms is the “information-transfer” argument: Formal education increases an individual’s basic facts about the physical causes and prevention of disease, and this information translates directly into better decisions about risk and health [15, 20]. In the case of HIV and AIDS in SSA, it is widely assumed that basic facts about heterosexual transmission of the virus and about condoms taught in school and in out-of-school programs leads to engagement in preventative behavior [21–28]. This yields the first hypothesis (H1): Formal education will be associated with knowing basic facts about HIV transmission and condoms; and knowing these facts will lead to increased use of condoms.

The second most commonly assumed causal mechanism is the “attitude-change” argument: formal education imparts a more positive attitude about people living with HIV and AIDS (hereafter PLWHA), and such an attitude reduces stigma and creates openness to adopt preventative strategies among more educated individuals. The second hypothesis (H2) is: Formal education will be associated with holding a positive attitude about PLWHA; and holding this attitude will lead to increased use of condoms.

While these arguments are widely assumed to be true, to our knowledge they have never been directly tested in relation to HIV/AIDS in SSA even though they are central to assumptions about how education influences health [15, 29]. Importantly, the analysis below shows that although attending school is robustly associated with acquiring basic facts about sexual transmission and a positive attitude about PLWHA, these achievements are only weakly related to condom use, and a significant proportion of education’s association with this prevention strategy remains unexplained.

A plausible causal mechanism behind the education effect on health is that schooling enhances higher-order cognitive skills (such as reasoning, novel problem-solving, effortful thinking, and task planning) that in turn help individuals transform basic facts into deeper knowledge that enhances risk assessment and decision-making skills. Recent research on neuro-development and decision-making establish three interrelated findings that support this mechanism.

First, *neuro-development of high-order cognitive skills occurs at least through late adolescence and is highly responsive to environmental stimulation, such as that which routinely occurs in formal education*. Studies of child neurological and psychiatric disorders and normally developed children without any clinical disorders show that higher-order cognitive skills occurs through late adolescence and is a distinct set of cognitive capacities [30–34]. Furthermore, a set of developmental fMRI experiments finds that when school-aged children solve new mathematics problems similar to those commonly used in mathematics curricula, the brain areas associated with higher-order cognitive skills are activated (i.e. recruited activations in the superior parietal cortices most prominently, the dorsolateral prefrontal, occipital–temporal, and premotor/supplementary cortices, the basal ganglia, and insula) [35].

Second, *exposure to formal education is monotonically and linearly associated with enhanced higher-order cognitive skills*. A meta-analysis of over 50 studies using naturalistic observation, post-hoc statistical comparisons, and cohort-sequential analysis concludes that for every year of school attended, net of socio-economic factors, there is a monotonic increase in cognitive skills related to IQ [36]. Also quasi-experimental studies of unschooled and schooled adults in subsistence-level farming communities finds that small amounts of schooling as a child yields higher-order cognitive skills among adults net of social and economic status, and work conditions [37–41].

Third, *higher-order cognitive skills expressed as better numeracy are associated with better risk assessment and decision-making skills*. Numeracy is chiefly learned in formal education, and experiments on risk assessment and

the use of effective heuristics for decision making repeatedly find that such skills are positively associated with numeracy and higher-order cognitive skills [42, 43].

Taken together, these findings suggest a third hypothesis (H3): More years of formal education will be associated with better high-order reasoning skills; and these skills will enhance reasoning about HIV/AIDS transmission and prevention, which will lead to more condom use.

## Methods

Data from nine national Demographic and Health Surveys (DHS: Cameroon, Ghana, Guinea, Kenya, Lesotho, Malawi, Rwanda, Senegal, Tanzania) collected from 2003 to 2005 are analyzed. The analytical sample is made up of sexual-risky adults (age 15–59); defined as those adults reporting sexual active with multiple partners as a single or in addition to a spouse in the 12 months preceding the DHS survey ( $N = 19,800$ ). Sexually abstinent and faithful adults, including faithful polygamists, are excluded from the sample. Analysis sample sizes are Cameroon: 4,869; Ghana: 1,805; Guinea: 1,839; Kenya: 1,917; Lesotho: 3,043; Malawi: 1,413; Rwanda: 929; Senegal: 1,481; Tanzania: 2,504.

The variables in the estimated models include:

*Dependent Variable:* *Condom (latex) use* is measured by respondent's report on use during last intercourse; and, across the nine country sample, 35% of respondents with multiple non-spousal sexual partners report condom use at last intercourse. Condom use has been shown to be an effective protective behavior against HIV infection among populations in developing nations [44, 45]. The percentage of subjects reporting use of a condom during the last sexual intercourse in the analytic sample by country is: Cameroon: 41; Ghana: 33; Guinea: 30; Kenya: 32; Lesotho: 33; Malawi: 31; Rwanda: 24; Senegal: 47; Tanzania: 28.

*Independent Variables:* *Educational Attainment* is the numeric value of the last grade successfully completed by the respondent, with a mean of 7 years (s.d. 4), and the sample included 14% unschooled adults. *Basic Facts*, the variable to test H1, is a count of correct answers to seven prompted questions about HIV transmission by the respondent (e.g. "Can people reduce their chances of getting AIDS virus by using a condom every time they have sex?"), with a mean and of 1.7 (s.d. 1.09). *Attitudes*, the variable to test H2, is a latent variable constructed from three attitudinal questions that were asked in all 9 countries regarding attitudes about PLWHA (e.g. "If a female teacher has the AIDS virus, should she be allowed to continue teaching in school?") with a mean of 1.57 (s.d. 1.07). The DHS did not directly survey higher-order cognitive skills such as unique problem solving and working memory, but it did assess subjects' ability to synthesize and apply

information to reason about HIV transmission and other sexually transmitted infections (STIs), therefore H3 is tested with a latent variable measuring *Health Reasoning* comprised of self-generated responses about complex myths about HIV and sexual disease transmission in both males and females. Correct answers required reasoning with information to produce deeper knowledge about the disease, and the variable has a mean of 0.94 (s.d. 0.84).

*Control Variables:* Included is *Gender*, *Age*, *Marital status* (marriage and cohabitation or unmarried), *Residence* (urban or rural), *Index of economic resources*, and *Country*. Also included is the *Heckman self-selection probability* to control for potential selection bias resulting from restricting the sample size to individuals with multiple non-spousal sexual partners; which was calculated in two steps: (1) with data from all respondents to the DHS, a logistic regression estimates the probability of having multiple sexual partners as a function of demographic characteristics; and, (2) derived from the equation in step 1, the predicted probability of each subject being in the analysis sample (i.e. those with multiple sexual partners) is entered into estimation of models testing the hypotheses.

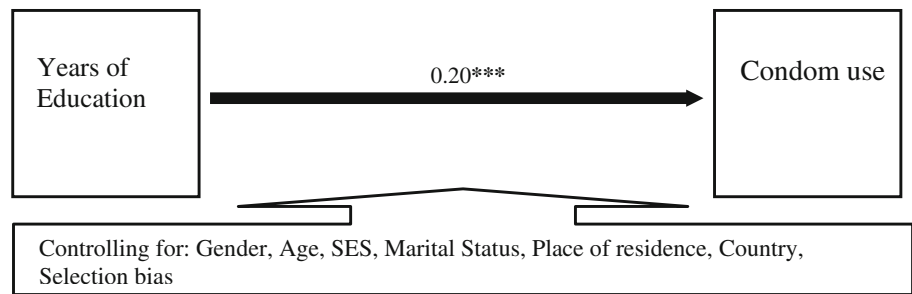
*Estimation:* To test the hypotheses, structural equation models (SEM) of measurement and structural components are estimated in stages, examining the influence of formal education on condom usage through the mediation of *Basic Facts*, *Attitudes*, and *Health Reasoning*. In the first stage, we examine the covariation among observed variables through a system of equations to estimate the direct and indirect influence of education on acquisition of facts, positive attitudes, and health reasoning. The second stage of the model then estimates these variables' influence on condom use for individuals with multiple non-spousal sexual partners [46–48]. This measurement model consists of relationships among observed variables for two latent constructs: *Attitudes* and *Health Reasoning*.

## Results

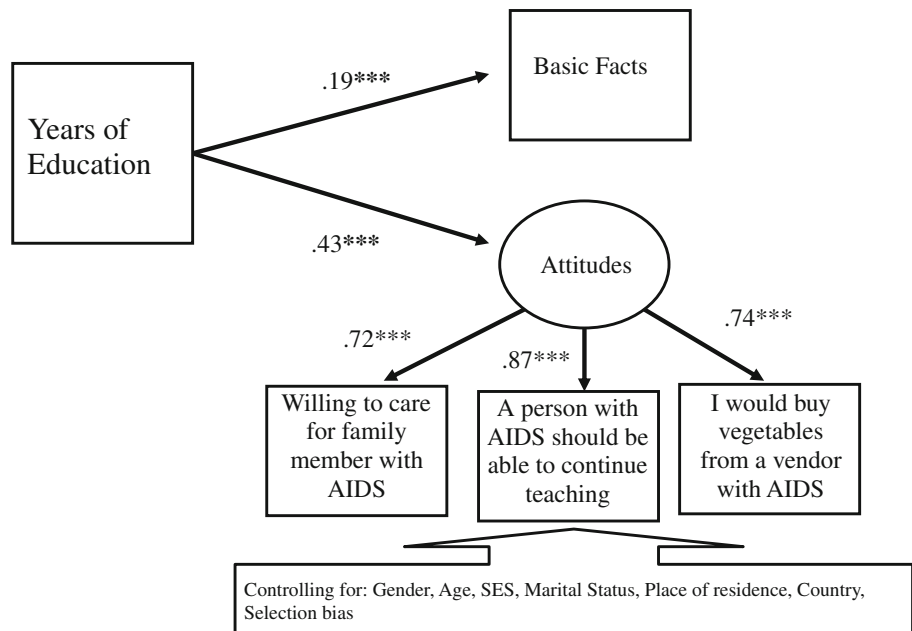
Figure 1 shows the estimate of the total association between formal education and condom use among sexually risky adults across all countries, before the inclusion of the hypothesized mediating factors are introduced. Net of background variables including economic resources, every additional year of education increases the likelihood of condom use at last sexual intercourse by 0.20. The preventative effect of formal education is considerable: Among sexually risky adults, compared with the uneducated, individuals with 12 years of education are almost twice as likely to use a condom.

To understand the mediating roles of information and attitudes, we expand the model to examine the first step in

**Fig. 1** SEM estimate of years of education's influence on condom use at last sexual intercourse among sub-Saharan African adults with non-spousal multiple sexual partners. Pseudo  $R^2$ : 0.23.  $***p < 0.001$ . Note: Coefficient in the figure is standardized



**Fig. 2** SEM estimate of years of education's influence on HIV basic facts and attitudes among sub-Saharan African adults with non-spousal multiple sexual partners. Model fit indicators: CFI: 0.91. TLI: 0.84. RMSEA: 0.037.  $***p < 0.001$ ,  $**p < 0.01$ ,  $*p < 0.05$ . Note: All the coefficients in the figure are standardized coefficients



the *information-transfer* (H1) and *attitude-change* (H2) hypotheses, Fig. 2 shows estimates of the influence of formal education on knowing basic facts about HIV transmission and possessing positive attitudes about PLWHA. In both cases as the hypotheses predicted, each additional year of formal education has a robust and significant influence on the acquisition of facts (0.19) and attitudes (0.43) net of the control variables.

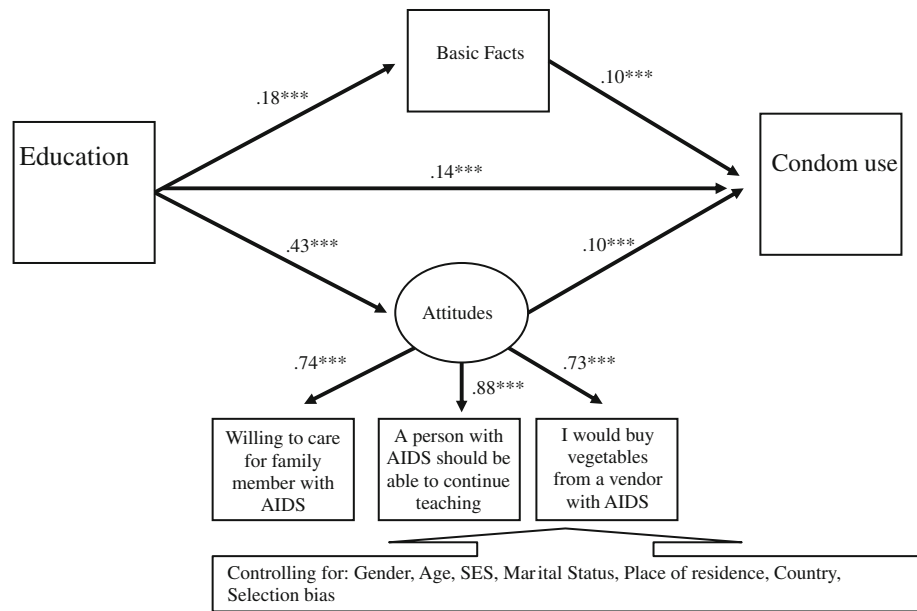
As shown in Fig. 3, estimating the full model of information and attitudes mediating the relationship between education and condom use reveals only weak effects of facts and attitudes, and undermines both commonly assumed causal mechanisms behind the education effect on health decisions (H1 and H2). Although education influences an individual's ability to retain basic facts about modes of HIV infection and inculcates a positive attitude, facts and attitude are not a sufficient explanation for the education effect on condom use. For sexually risky adults, facts and positive attitude increase condom use by 0.10, and thus the indirect effect of education via basic facts and attitude is respectively only 0.02 and 0.04 of the standard deviation in condom use for each additional year of

education in comparison to the remaining direct effect of education of 0.14 of the standard deviation. These two factors only partially mediate the effect of education on use of a condom, accounting for just one-fourth of a year of education's original influence.

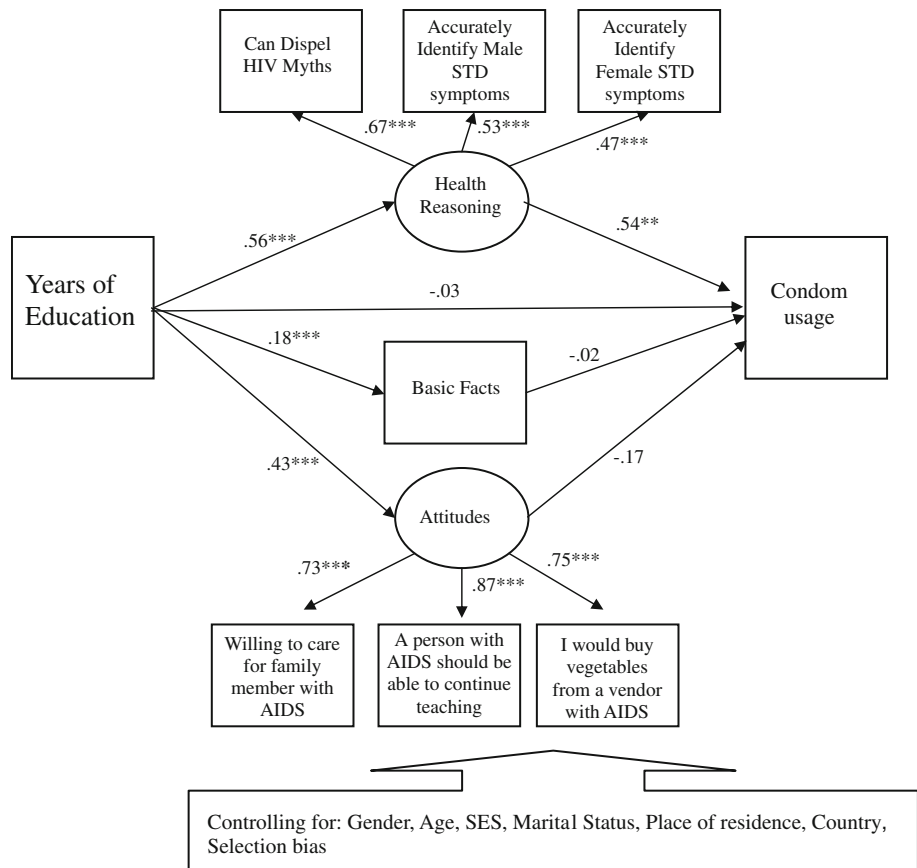
The limited influence of both the *information-transfer* and *attitude-change* mechanisms begs the question of what is responsible for the observed persistent effect of education on condom use for risky adults? As described above, the *education-enhanced cognition* hypothesis offers a plausible causal agent in the education effect. Figure 4 shows the addition of the *Health Reasoning* construct as a third potential mediating factor, and there are three notable findings in this model. First, like *Basic facts* and *Attitude*, formal education influences reasoning about HIV and other sexually transmitted infections, but the education effect on reasoning (0.56) is stronger than its effect on acquisition of basic facts (0.18) and positive attitude (0.43).

Second, the inclusion of *Health Reasoning* in the model renders the earlier weak effects of basic facts and attitudes on condom use for risky adults statistically non-significant, or zero, and the indirect influence of years of education on

**Fig. 3** SEM estimate of years of education, HIV basic facts, and attitudes influence on condom use among sub-Saharan African adults with non-spousal multiple sexual partners. Model fit indicators: CFI: 0.91. TLI: 0.83. RMSEA: 0.03. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , † $p < 0.10$ . Note: All the coefficients in the figure are standardized coefficients



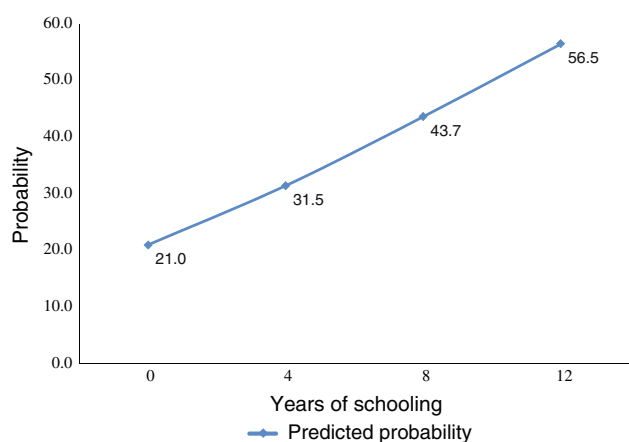
**Fig. 4** SEM estimate of years of education, HIV basic facts, attitudes, and health reasoning influence on condom use among sub-Saharan African adults with non-spousal multiple sexual partners. Model fit indicators: CFI: 0.97. TLI: 0.96. RMSEA: 0.03. \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , † $p < 0.10$ . Note: All the coefficients in the figure are standardized coefficients



condom use via reasoning is over one-fourth of a standard deviation (0.30) for every year of education. This robust effect size is shown in Fig. 5, which plots the predicted probabilities of condom use during last sexual intercourse for individuals with multiple non-spousal sexual partners. The causal path of formal education through *Health*

*Reasoning*, even after controlling for the respondents' *Basic Facts* and *Attitude*, significantly increases condom use during last sexual intercourse. An individual with 8 years of schooling doubles in their probability of condom use from 21% to almost 44% in comparison to an individual with no schooling, and the completion of senior





**Fig. 5** Predicted probability of condom use at last sex by years of education among sub-Saharan African adults with non-spousal multiple sexual partners based on structural equation modeling. The predicted probabilities of condom use for a person without education will be  $\text{Prob}(Y = 1) = F(BX)$  from the structural equation estimation in Fig. 4, where  $F$  is the cumulative normal distribution,  $B$  is the matrix of regression coefficients (including the constant), and  $X$  is a matrix of the sample means of the control variables

secondary school (12 years) increases the predicted probability of condom use to 56%.

Third, the addition of *Health Reasoning* to the model completely mediates the initial direct effect of education on condom use among sexually risky adults, as the direct effect of education drops to a statistically insignificant value.

### Limitations

Firstly, while the use of the DHS with its standard survey procedure and set of questions across national collections on similarly-defined nationally representative samples of adults in SSR adds significant validity to the results, as with all such omnibus data sets there is a need for caution in generalizing from limited measures. For example, the only available measure in the DHS of condom use—“condom use by respondent during last sexual intercourse”—is a restricted measure of proclivity compared to a measure of consistent condom use, and past research suggest that the former is not as related to HIV prevalence and engagement in protective behavior as the later [49]. Nevertheless, a number of other studies employing the last-intercourse measure found significant effects on reduction of HIV infection, and a significant positive association between condom-at-last-sex and consistent condom use [50–58]. So too, the measures about reasoning about HIV and STDs are proxies of cognitive skills and are not as direct as some reported in the literature on the links among education and cognition and health, but the ones used here do replicate the findings of more detailed and direct testing of cognitive skills [11].

Second, it should be noted that the DHS does not have indicators of social psychological outcomes from education such as self-efficacy and greater empowerment that in addition to facts and attitudes are often hypothesized as potential routes through which education could influence protective behavior, usually in the context of equality of social power in negotiations with a sexual partner. And although the path through health reasoning accounted for the entire education effect on condom use among sexually risky adults in SSA, future research should test other outcomes, particularly social psychological ones, relative to the cognitive argument advanced here. Similarly, it would be useful in future research to examine possible interactions between education and social-economic environments that might enhance or hinder the former’s effects on condom use.

Third, the DHS data allow one to go only so far in understanding the psychological process behind the model. At what point does more effective reasoning become a habit that turns the use of protective behavior into a habit? How exactly does improved health reasoning influence practice? The results here bring these kinds of questions to the fore, and answers require future detailed research on the links in the model tested here.

### Conclusion

As a whole, these results strongly indicate that *education-enhanced cognition* is a plausible causal mechanism through which formal education enhances prevention strategies among sexually risky adults in SSA. The results of the second model indicate that the two commonly hypothesized mechanisms—*information-transfer* and *attitude-change*—linking formal education to sexual behavior in the HIV and AIDS pandemic are not sufficient explanations of the causal impact of education. Although education does increase acquisition of facts and positive attitude, these only weakly influence preventive condom use among sexually risky adults in SSA, and neither accounts for most of the observed co-variation between education and condom use. An adult’s ability to reason about HIV infection also increases with exposure to formal education as a child, but unlike facts and positive attitude, reasoning ability increases the likelihood of condom use, accounting for nearly all of the co-variation between education and condom use net of the adult’s demographic characteristics and economic resources. These results have important implications for both scientific research and HIV and AIDS prevention policy.

Future research on parsing out the causal mechanism of education should move towards the argument of *education-enhanced cognition*, and could effectively address what it

is about education that enhances cognition and enables individuals well into adulthood to translate information into protective health decisions. The findings presented here support a growing research literature that finds enhanced cognitive and problem-solving skills through formal education [35–37, 59, 60]. Certainly minimum amounts of accurate information are necessary for effective reasoning and decision-making about health, but information alone is not sufficient to enable an individual to effectively use provided information across the myriad of social, environmental, and cultural risk factors related to HIV infection in SSA. The ability to effectively reason about disease and health plays a crucial role in education's "social vaccine" against HIV infection [7, 61, 62].

The results also suggest why there was a shift in SSA from formal education acting as a risk factor earlier in the pandemic to acting as a social vaccine since the mid-1990s [7]. As misinformation was replaced with more accurate facts, such as HIV was indeed a real disease and heterosexual acts could cause infection in both males and females, the greater reasoning capacity on average among more schooled individuals likely enabled them to take the facts and form a more accurate assessment of their risks and an understanding of the need for protective behaviors [11]. Just as early in the pandemic, more educated individuals may continue to have greater opportunity for sexual liaisons, but now armed with accurate information their more effective reasoning skills makes them more likely to practice safer sex.

The second implication of this study is a need to critically assess the effectiveness of the substantial investments by bi- and multi-lateral agencies, NGOs, and governments in the region whose prevention programs chiefly target the acquisition of accurate facts and a positive attitude [29, 63]. The recent observations that formal education prevents new infections among younger adults in SSA are most likely due to the reasoning ability that education strengthens, rather than the heavy focus of NGO-based prevention programs on fact acquisition and attitude change [18, 29, 64–68].

Increasing facts and positive attitude about the modes of HIV transmission without a corresponding ability to apply these facts to complex social, cultural, and economic realities is an inadequate strategy to combat the spread of HIV. Without a more concerted effort to expand access to and quality of basic schooling and adult educational programming in SSA, the reasoning gap will continue to grow as the world's largest population of unschooled and low-schooled people continue to be at greater risk of HIV infection. Current interventions may be successful in increasing the unschooled and low-schooled ability to retain facts about modes of transmission, but are not adequately providing the reasoning

skills to apply these facts to effective behavioral strategies.

One-third of the world's out-of-school children and the world's largest unschooled adult population reside in SSA [69]. The results here support the recommendation that governments and NGOs in the region should focus on the cognitive benefits of including formal education as an integral part in the prevention of HIV and AIDS in the region. The results also show that education is so crucial for population health that beyond facilitating general access to schooling, SSA governments must embrace the primary goal of reducing barriers to regular school attendance, such as reducing school-related fees and biases towards schooling for females, as well as committing appropriate resources to raise the educational quality of mass public schooling.

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