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Explaining the Effect of Education on Health: A Field Study in Ghana

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Abstract

Higher education (or more years of formal schooling) is widely associated with better health, but the underlying causes of this association are unclear. In this study, we tested our schooling-decision-making model, which posits that formal education fosters intellectual ability, which in turn provides individuals with enduring competencies to support better health-related behaviors. Using data from a field study on formal education in 181 adults in rural Ghana, we examined health-protective behaviors related to HIV/AIDS infection, a critical health issue in Ghana. As expected, individuals with more education practiced more protective health behaviors. Our structural equation modeling analysis showed that cognitive abilities, numeracy, and decision-making abilities increased with exposure to schooling, and that these enhanced abilities (and not HIV/AIDS knowledge) mediated the effects of education on health-protective behavior. Research and policy implications for HIV prevention efforts in sub-Saharan Africa are discussed.

Keywords

education, health, cognitive abilities, decision making, numeracy

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Formal education has been called a "social vaccine," as greater school attendance is related to longer life expectancy, fewer offspring, and fewer negative health outcomes, even when controlling for socioeconomic status and other demographics (e.g., Baker, Collins, & Leon, 2009; de Walque, Nakiyingi-Miiro, Busingye, & Whitworth, 2005). These effects can be seen even after relatively little formal schooling. Just how school attendance produces such a wide range of effects is not well understood. One possibility is that education confers knowledge about general health and health risks. However, research suggests that knowledge alone is not sufficient to produce the range of effects associated with formal education. For example, approximately $750 million in U.S. federal money is spent each year on the Drug Abuse Resistance Education (D.A.R.E.) program to increase basic knowledge (defined as a superficial knowledge of the facts) about alcohol, smoking, and drugs. Although the program is intended to curtail risky behavior in adolescents, studies suggest that the program has no significant influence on drug-use behaviors (e.g., Birkeland, Murphy-Graham, & Weiss, 2005). Basic knowledge about health risks may therefore be a necessary but insufficient condition for making better health-related decisions (Baker et al., 2009).

Education Teaches One to Think

Another explanation for the beneficial health effects of formal schooling is that education may "teach one to think," imparting one with cognitive and decision-making abilities (CDAs) that are responsible for improving one's health (e.g., Lleras-Muney, 2005). Evidence suggests that formal education relates to increases in domain-general cognitive processes (i.e., working memory, inhibitory control, and attention-shifting processes), and general intelligence (Ceci, 1991; Nisbett, 2009). For example, schooling is associated with increases in IQ that are 3 to 4 times the IQ increases associated with maturation (Cliffordson & Gustafsson, 2008).

Neuroimaging studies suggest that numeracy education (improving numerical ability) may also exercise and enhance other cognitive abilities (Eslinger et al., 2009). Greater cognitive abilities and higher numeracy have both been linked to better decision making (Peters et al., 2006; Stanovich & West,

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2000), and some studies have related both (particularly numeracy) to better health behaviors and outcomes. Goldman and Smith (2002), for example, found that scores on the Wechsler Adult Intelligence Test explained the correlation between higher education and greater adherence by diabetic and HIV-positive patients to treatment recommendations. Furthermore, lower levels of numeracy are associated with health disparities, self-reported poor health, higher body mass index, poor health knowledge and disease self-management skills, and a tendency to choose lower-quality health options. These associations appear to be the result of less numerate individuals being less able to understand the cognitive and affective meaning of numeric information (Lipkus & Peters, 2009; Reyna, Nelson, Han, & Dieckmann, 2009).

The Schooling-Decision-Making Model

We hypothesized that cognitive, numeracy, and decision abilities are the primary factors that enable individuals to learn and extrapolate from basic knowledge, think counterfactually, forecast into the future, reason statistically, and acquire a deeper knowledge base. A wide knowledge base is an advantage in undertaking organized action. In addition, greater CDAs may directly influence protective health behaviors by providing other competencies needed to plan and take action.

On the basis of this reasoning, we developed the schooling-decision-making model (see Fig. 1). In this model, formal education increases numeracy, domain-general cognitive abilities (e.g., working memory and abstract reasoning ability), and other abilities necessary to make risky decisions. These attributes enable an individual to appreciate the consequences of risks and reason appropriately in novel situations. In this model, formal education also increases basic health knowledge. These associations may seem obvious, but surprisingly few studies on the effects of formal education have been carried out outside a laboratory setting and in countries other than relatively well-educated Western nations (Blair, Gamson, Thorne, & Baker, 2005). In the study presented in this article, we tested our model in Ghana, where the spread of HIV/AIDS is of considerable concern.

A major challenge to exploring the causal impact of formal education in Western countries is that most adults in developed nations have significant educational attainment, and often to a similar high level. General access to schooling is a recent phenomenon in rural Ghana, however, where approximately half of all adults are either unschooled or underschooled. In this sample of Ghanaian adults, school attendance appears rarely, if ever, to be associated with real or perceived intelligence (see information on selection bias in the Results section). Ghanaian adults also have similar postschooling work experiences and economic status. This situation makes it easier to study our hypothesized model.

Method

Participants

Participants ($N = 181$) in eastern Ghana were from four small, agrarian villages with a high prevalence of HIV infection and little migration into or out of the villages. The participants were involved in everyday activities and had no apparent cognitive or psychiatric impairments. They participated in our study in exchange for a bucket, a bar of soap, and a roll of toilet paper. Most participants (48.9%) farmed for subsistence or minimal profit (another 36.6% reported farming as a secondary occupation), 21.1% traded goods, and 30% had other low-level jobs or were retired. Many participants reported not having piped water (90%), drainage (62%), electricity (38%), a toilet (43%), or a telephone (59%).

Participants had completed on average an elementary-school education (M = 6.6 years, SD = 4.8, range = 0–20 years), and the primary reason for each participant's school-attainment level was recorded. In addition, participants' age (M = 43.9 years, SD = 10.58, range = 30–75 years), marital status (72% married or cohabitating), and gender (62% female, 38% male) were recorded. Using the Wealth/Asset Index developed for similar populations (Sahn & Stifel, 2000), we calculated each participant's wealth on the basis of the number of assets or amenities in his or her household (e.g., stove, electricity, plumbing).

Measures

Materials were translated into Twi (the participants' native language) and back-translated into English to ensure the fidelity of the translation.

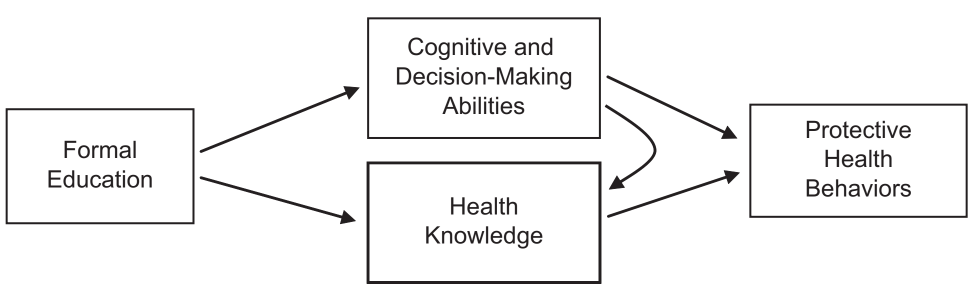

Fig. 1. Conceptual model of the effect of formal education on protective health behaviors and the mediation of this effect by increased cognitive and decision-making abilities.

Cognitive and decision-making abilities. We assessed participants' working memory via the backward-digit task (Wechsler, 1981; *M* = 2.37, *SD* = 0.93). The Delis-Kaplan Executive-Function System Tower test was used to measure participants' planning, strategy, working memory, and attention-shifting abilities (Delis, Kaplan, & Kramer, 2001; *M* = 10.82, *SD* = 4.1). Numeracy was assessed using the first 30 mathematical problems of the Woodcock-Johnson-III Calculation test (McGrew, Wood, & Mather, 2001; *M* = 15.09, *SD* = 4.81).

To assess a decision-making ability relevant to our dependent measure of protective behaviors, we developed the Stickman task, a culturally adapted ratio-bias task, as good performance on a standard ratio-bias task has been associated with numeracy (Peters et al., 2006). For the Stickman task, we presented participants with diagrams of hypothetical scenarios. A scenario was composed of two circles (each representing a different village); red stickmen (HIV-infected individuals) and black stickmen (individuals without HIV) were shown in each circle. Participants were told what the circles and stickmen represented and were asked in which village it would be most likely that the first person they met would be HIV positive. In each of four incongruent scenarios, the circle with a larger number of red stickmen corresponded to a lower probability of the first person met being HIV positive. For example, in one scenario, 4 out of 8 villagers from village A, and 3 out of 4 villagers from village B, were HIV positive. Ratios of infected to noninfected individuals in the other three scenarios (the village with the higher frequency and lower probability is listed first) were 5:10 (B) and 3:5 (A), 3:7 (B) and 2:4 (A), and 4:8 (A) and 2:3 (B).

In these four scenarios, the proportion of correct responses given by study participants (i.e., correctly identifying in which village they were more likely to meet an HIV-positive individual) were 48.1%, 42.0%, 44.2%, and 48.1%, respectively. In such incongruent trials, participants should use objective probability (i.e., conclude that 75% is greater than 50%), but in fact, participants in our culturally modified task often choose on the basis of the number of red stickmen (i.e., 4 is greater than 3; mean number of correct responses = 1.82, *SD* = 1.46), in a manner similar to that of Western college students performing standard ratio-bias tests (Denes-Raj & Epstein, 1994).

HIV/AIDS knowledge. The HIV/AIDS knowledge test was adapted from the Demographic Health Surveys and Multiple Indicators Cluster Surveys collected worldwide by the Joint United Nations Programme on HIV/AIDS (UNAIDS, 2008) to monitor prevention efforts. Questions reflect HIV curricula currently used in interventions in the region (see Table 1 for items). We tested each participant's accurate knowledge of a specific topic by asking a question, and if he or she responded "yes," we asked the participant how to reduce the health risk targeted by that question. Accuracy per item was determined by assessing both responses. For example, when an unschooled, middle-aged villager was asked whether blood transfusions could infect him with HIV, his response, "Yes, but not if I wear a condom," would be coded as an incorrect response. Conversely, if a participant said one could get AIDS from holding hands (generally untrue), but then stated that the risk was reduced if neither person had an open wound, this item would be coded as a correct response. We assigned each

Table 1. Questions on the HIV/AIDS Knowledge Survey and Percentage of Correct Responses for Each Question

Question	Percentage of correct responses
1. Do condoms protect against disease?	97.1
2. Can AIDS be transmitted by having multiple sexual partners?	96.6
3. Can AIDS be transmitted by having unprotected sex?	95.6
4. Can AIDS be transmitted by holding hands with a person that has AIDS?	95.0
5. Can AIDS be transmitted by having sex with a prostitute?	93.3
6. Is it okay to reuse a condom if you wash it?	87.7
7. Can AIDS be transmitted by caring for a person that has AIDS?	86.6
8. Can AIDS be transmitted by sharing food with someone that has AIDS?	82.8
9. Do condoms contain HIV?	82.5
10. Can AIDS be transmitted by a blood transfusion?	77.8
11. Can AIDS be transmitted by drinking alcohol?	73.9
12. Can AIDS be transmitted by a mother to her child while breastfeeding?	68.9
13. Can AIDS be transmitted by buying food at the market?	65.6
14. Can AIDS be transmitted by a mosquito bite?	56.7
15. Can AIDS be transmitted by witchcraft or other supernatural means?	45.8
16. Can AIDS be transmitted by a mother to her child during birth?	38.9
17. Can AIDS be transmitted by kissing someone that has AIDS?	36.7
18. Can AIDS be transmitted by injecting illegal drugs?	27.9
19. Can AIDS be transmitted by other means?	17.7

Table 2. Questions on the HIV/AIDS Protective-Behavior Survey and Percentage of Participants Reporting Each Behavior

Protective behavior	Percentage of participants reporting behavior
1. Have you ever participated in an HIV/AIDS informational meeting/workshop/training?	64.6
2. Have you ever spoken with your spouse or partner about HIV/AIDS?	58.6
3. Have you ever talked about ways to prevent getting HIV/AIDS with your spouse/partner?	57.5
4. Have you ever used a condom during sex?	33.0
5. Have you ever been tested for HIV/AIDS?	19.9

participant a total knowledge score by summing the participant's number of correct responses (M = 13.18, SD = 2.55; α = .59).

Protective behaviors. In Ghana, 80% of HIV transmission occurs through heterosexual intercourse (Adih & Alexander, 1999). The risk-reducing behaviors included in our analysis were attending HIV informational meetings or classes, communicating about HIV and its prevention with a sexual partner, testing of one's own or one's partner's serostatus, and using condoms (see Table 2 for items; Horton & Das, 2008).[1] We assigned each participant a total protective-behavior score by summing the participant's number of reported risk-reducing behaviors (M = 2.33, SD = 1.60; α = .71).

Results

The primary goal of our study was to assess how education, mediated through CDAs and knowledge, related to protective behaviors. We conceptualized CDAs as indicators of a latent construct, and we found that CDA measures were positively correlated (rs = .29–.49, $p < .01$; see Table 3), as expected.

Structural equation modeling

We found that greater education was associated with taking more protective behaviors (r = .34, p = .001), which agrees with the findings of many other studies. However, the underlying mechanisms of this association are not known. A structural equation model[2] used to explore the simultaneous effects of education, CDAs, and knowledge about protective behaviors (see Fig. 2 for the model, Table 4 for the modeled correlations between the exogenous variables, and Table 3 for simple correlations between all variables in the model) did not initially provide a good fit to the data: comparative fit index (CFI) = .89; Tucker-Lewis index (TLI) = .86; root-mean-square error of approximation (RMSEA) = .07, 90% confidence interval (CI): (.04, .09); $\chi^2(49)$ = 89.55, p = .0004. Missing data for condom-related knowledge were

Table 3. Simple Correlations Between the Primary Variables and Demographic Controls (N = 181)

		Cognitive and decision abilities						Demographic controls			
Variable	Education	Working memory	Reasoning	Calculation	Decision making	Knowledge	Protective behaviors	Gender	Age	Marital status	Wealth
Education	1										
Cognitive and decision abilities											
Working memory	.49**	1									
Reasoning (Tower task)	.37**	.38**	1								
Calculation	.61**	.49**	.46**	1							
Decision making (Stickman task)	.38**	.37**	.29**	.37**	1						
Knowledge	.34**	.30**	.26**	.27**	.26**	1					
Protective behaviors	.34**	.27**	.21*	.38**	.29**	.22**	1				
Demographic controls											
Gender (0 = male; 1 = female)	–.44**	–.32**	–.27**	–.38**	–.41**	–.25**	–.39**	1			
Age	.07	–.01	–.06	.24**	.05	–.11	.08	–.07	1		
Marital status (0 = no partner; 1 = partner)	.11	.12	.16*	.13	.21**	.18*	.33**	–.33**	–.13	1	
Wealth[a]	.45**	.28**	.18*	.29**	.15*	.21**	.33**	–.08	–.04	.13	1

[a]Wealth is an average of factor-scored amenities and assets owned by the participant.
*$p < .05$. **$p < .01$.

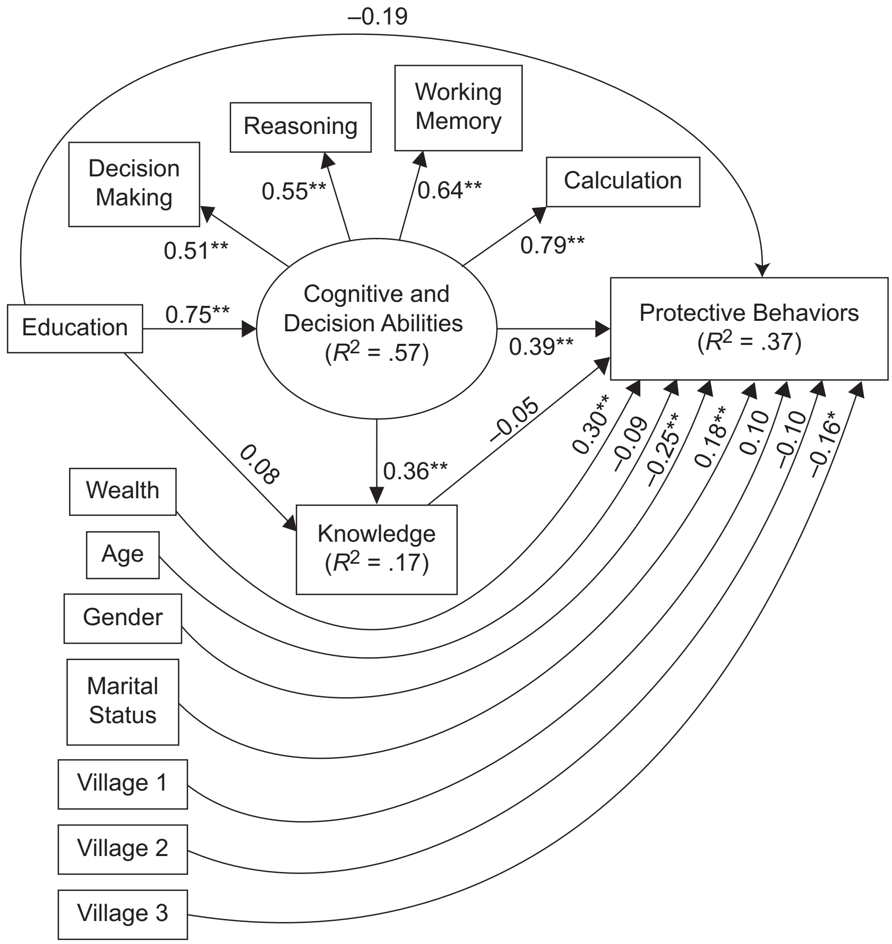

Fig. 2. Initial structural equation model of the effects of education on health-protective behaviors. The R^2 values represent the proportion of variance explained by the indicated variables. Numerical values linked with a pathway represent standardized path coefficients (*p < .05, **p < .01). The four villages studied were entered into the model as three orthogonal dummy codes: Villages 1 through 3.

approximated with full-information, maximum likelihood estimates (Little & Rubin, 2002). We removed nonsignificant pathways from demographic controls to protective behaviors, as well as nonsignificant intercorrelations among endogenous variables. The resulting final model (see Fig. 3) provided a good fit to the observed data: CFI = .97; TLI = .96; RMSEA = .04, 90% CI: (.00, .08); $\chi^2(29) = 39.44$, p = .09. Removing the remaining nonsignificant pathways would have improved model fit further, but we retained these pathways given the conceptual model in Figure 1.

We found that greater education was related to increased CDAs (β = 0.75, p < .0001, p_{rep} = .99), and that higher CDAs were associated with greater knowledge (β = 0.36, p = .02, p_{rep} = .93) and engagement in more health-protective behaviors

Table 4. Modeled Correlations Among Exogenous Variables for the Initial Structural Equation Model Shown in Figure 2

Variable	Education	Wealth	Age	Gender	Marital status	Village 1	Village 2	Village 3
Education	1							
Wealth	.45**	1						
Age	.07	−.03	1					
Gender	−.44**	-.06	−.07	1				
Marital status	.11	.13+	−.13+	−.33**	1			
Village 1	−.19*	−.35**	−.22**	−.09	.06	1		
Village 2	−.01	−.13+	−.07	−.22**	.04	—	1	
Village 3	−.10	.18**	−.01	.03	.07	—	—	1

+p < .10. *p < .05. **p < .01.

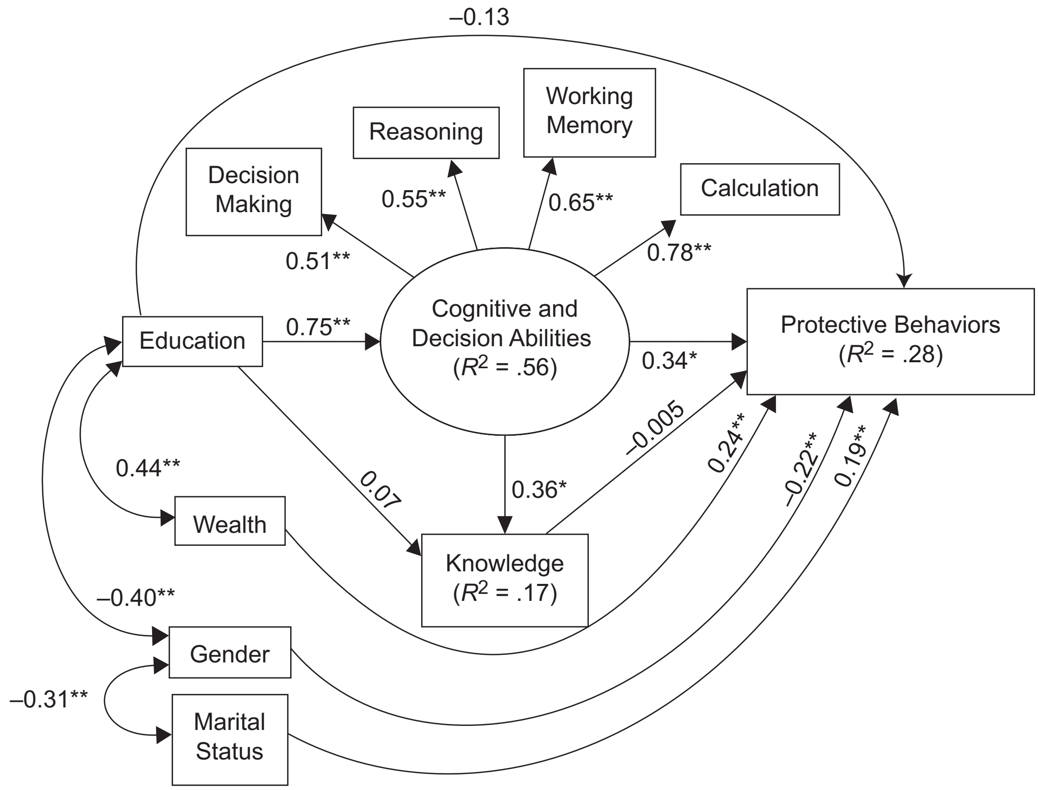

Fig. 3. Final structural equation model of the effects of education on health-protective behaviors. The R^2 values represent the proportion of variance explained by the indicated variables. Numerical values linked with a pathway represent standardized path coefficients (* p < .05, ** p < .01).

(β = 0.34, p = .02, p_{rep} = .93). After accounting for the mediating effect of CDAs, we found that education was not directly related to knowledge (β = 0.07, p = .59) or protective behaviors (β = –0.13, p = .30). We also found that engagement in more protective behaviors was linked to greater wealth (β = 0.24, p = .001), being male (β = −0.22, p = .004), and being married (β = 0.19, p = .005). Although studies show that education is associated with increased engagement in protective health behaviors (e.g., Martikainen, Blomgren, & Valkonen, 2007), our findings are consistent with CDAs (very likely to have been acquired through schooling) driving engagement in health-protective behaviors.

We also tested several alternative models. In the first alternative model, we reversed the direction of pathways between protective behaviors and CDAs, knowledge, and education, but each reversal resulted in a poor-fitting model. A reversed pathway between education and knowledge did not influence fit, and the pathway remained nonsignificant. In the second alternative model, reversing the pathway between education and CDAs resulted in a similar fit (we defend our final model's hypothesized pathway directions in the next section of this article). In our third alternative model, we added an interaction term between CDAs and knowledge, because it is possible that individuals with high CDAs and broad knowledge are also the most likely to engage in health-protective behaviors. The effect of this interaction, however, was not significant (p = .83).

Selection bias and endogeneity

Although the design of our study is an improvement over the design of previous studies about the effects of education in highly educated populations, the participants in our study were not randomly exposed to schooling, and reversing the direction of the pathway between education and CDAs resulted in a model similar to that in which the direction was not reversed. Thus, it is not clear from our data whether more education leads to greater CDAs, or whether individuals with greater CDAs attain more years of education. Other factors (e.g., sample-selection bias and endogeneity—correlated, unobserved factors relegated to the error term) predict this reversed pathway or a third variable causing both greater education and higher CDAs. We analyzed four such possible factors in our participant sample.

First, one selection-effect explanation may be that parents perceive higher cognitive aptitude in some children and provide them with schooling. In our sample, however, the reasons individuals gave for their school attendance were limited to noncognitive factors, such as access to schooling, financial circumstances related to school fees, gender preference, or death of a parent or sibling. When we coded each reason and entered the codes into the model, we observed no change in coefficient, either in sign or in relative size.[3]

A second possible factor is that participants with greater academic aptitude may attain higher schooling and greater CDAs

(Seltzer, Choi, & Thum, 2003). However, unless one assumes that schooling has no cognitive impact on students with other aptitude levels (an incorrect assumption among children in developed nations; Nisbett, 2009), the hypothesized pathway direction between schooling and CDAs is the most likely direction. We also hypothesized that schooling enhances CDAs (and not that schooling is the sole cause of CDAs), as genetic, familial, and other environmental factors can also influence CDAs (Rindermann & Ceci, 2009). As a limited control for academic aptitude, we constructed a variable of the number of years participants took to reach their final educational level, assuming that participants with lower aptitude would take longer to complete their education. Adding this variable to our model did not substantially change model coefficients.

Third, a possible source of endogeneity may be the effect of an individual's family (prior to that individual's schooling) on CDAs and education. However, given that parental education is a primary cause of preschool cognitive enhancement (Schaub, 2010), and most participants' parents were unschooled (schooling in rural Ghana was rare at the time), it is likely that only limited and invariant parental influences existed in our participant sample.

A fourth factor may be that more educated individuals show greater postschooling effects on CDAs. For example, job content can influence cognitive functioning, but parallel evidence demonstrates that the impact of schooling on adult cognition is 2 to 3 times the impact of job type on adult cognition (Inkeles, 1996). Furthermore, the cognitive demands of the different jobs our participants held varied little, and controlling statistically for job type did not alter any coefficients. Finally, the estimates for the model in Figure 3 control for demographic variables: When 4 participants with some postsecondary education and moderately complex jobs were excluded from the analysis, the results did not change. Overall, our data were more consistent with our final hypothesized model than with a model with the reverse pattern of causality.

Discussion

Although the association between education and health is well documented, little is known about the mechanisms underlying this association. Our results suggest that formal schooling influences protective health behaviors and knowledge through the increased development of CDAs in school. With more developed CDAs, individuals may be better equipped to extrapolate from health knowledge to new situations, think counterfactually about their actions, and reason statistically in everyday life. Although it is possible that individuals with higher CDAs may simply attend school for a longer period of time than individuals with lower CDAs, our analyses suggest that this reversed pathway is unlikely. It is also possible that better health and more schooling are the result of general societal developments affecting both variables. However, this is also unlikely, as our results show that CDAs mediate the relation between formal education and protective health behaviors (after controlling for demographic variables).

The results of our study suggest that knowledge of specific HIV/AIDS facts may not increase protective behaviors, but it is possible that our study did not include important aspects of HIV/AIDS knowledge related to health-protective behaviors. Our measure of HIV/AIDS knowledge, however, was based on validated scales and consisted of numerous items probing both superficial facts and risk-reduction knowledge. The absence of a direct relation between knowledge and protective behaviors could also be the result of the specific protective behaviors queried. For instance, we assume that the knowledge that HIV can be contracted through unprotected sex with prostitutes will lead to avoidance of sex with prostitutes. However, the questions in our study asked only about more general behaviors known to reduce heterosexual HIV transmission, and did not specifically ask about sex with prostitutes. In addition, we did find a simple correlation between knowledge and protective behaviors ($r = .22$, $p < .01$), but this effect disappeared when we controlled for CDAs in the model.

Our findings suggest that education may have a broader effect on cognitive abilities and knowledge than other studies suggest, with an ensuing significant impact on risk perceptions, decision making, and, ultimately, health behaviors. Although we focused in this study only on behaviors related to HIV/AIDS, our schooling-decision-making model could potentially also be used to study longevity, and the quality of other health and economic decisions. Our findings also support two related policy recommendations on HIV prevention in regions of the world with sizable underschooled and unschooled populations.

First, approximately $8.9 billion has been spent on HIV prevention in Ghana and the surrounding region since 2000, in an attempt to stem the spread of AIDS by disseminating facts about the disease (Oomman, Bernstein, & Rosenzweig, 2007). However, the effectiveness of these education programs has never been assessed systematically. Our findings suggest that they should be, as these efforts, however well intentioned, may be insufficient without significant improvements in interventions to assist at-risk adults to reason correctly with the facts they have been taught (Baker et al., 2009). Second, we hope the results of our study will stimulate examination of the costs and benefits of spreading basic education worldwide. It is not clear whether training in specific cognitive, numeracy, or decision abilities is particularly effective. Given that sub-Saharan Africa is home to both the largest unschooled population in the world and the largest HIV-infected population in the world, understanding the efficacy of various HIV-prevention programs in this region and how best to stem the HIV pandemic is vital.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Notes

1. Studies sometimes include abstinence and the absence of multiple sexual partners as protective behaviors (UNAIDS, 2008). However, our participants were all sexually active; only 5 participants reported recent multiple partners. These behaviors were excluded from analyses.
2. Data were analyzed using MPlus_3.13 computer software (Muthén & Muthén, 1998−2010).
3. Unreported analyses are available from the second author.

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