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Can AIDS education reduce HIV stigma? Evidence from Zimbabwe

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ABSTRACT

HIV stigma remains a barrier to HIV prevention, testing, and treatment in sub-Saharan Africa. This study uses Zimbabwe Demographic and Health Survey data to examine how education reduces HIV stigma, focusing on two key initiatives: the 1992 AIDS Action Program, which enhanced HIV awareness, and the 1980 education reform, which expanded schooling access. By addressing gaps in the literature on external HIV stigma, the study highlights education's long-term impact on attitudes toward people living with HIV. Our findings show that the 1980 reform is associated with a 1.19-year increase in educational attainment and a 42.6% rise in secondary school attendance for children aged 2–7 years in 1980 compared to those aged 16 and older. Furthermore, each additional year of schooling after the AIDS Action Program is associated with a 12.1% reduction in the likelihood of stigmatizing people with HIV and a 12.8% increase in HIV knowledge. Stigma reduction is more pronounced among rural residents (13.3%) and women (5.9%) but is insignificant for men and urban dwellers. These results underscore the role of schools in improving public health knowledge and reducing HIV stigma, offering valuable insights for future educational and health strategies.

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1. Introduction

The HIV/AIDS pandemic has persisted as a significant global public health challenge for over four decades, with Africa bearing a disproportionate burden of the disease (Pulerwitz & Bongaarts, 2014). In 2022, Africa accounted for over two-thirds of the global population living with HIV/AIDS, with Zimbabwe among the countries most severely impacted (United Nations Programme on HIV/AIDS (UNAIDS), 2023a). Despite substantial progress in combating the epidemic, stigma and discrimination against people living with HIV/AIDS (PLWHA) persist as significant barriers to prevention, testing, and treatment efforts (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2021; Ebrahimi et al., 2024; Ortblad et al., 2013; Pulerwitz & Bongaarts, 2014). Stigma, defined as "an attribute that significantly discredits" individuals with a disease, manifests in various ways, including avoidance behaviors, verbal abuse, gossip, and social exclusion (Bos & Onya, 2008; Florom-Smith & De Santis, 2012; Fortwengel et al., 2018; Lo Hog Tian et al., 2023; Meyer et al., 2023; Suantari, 2021). The persistence of stigma is driven by factors such as fear of transmission, sociocultural norms, religious beliefs, and educational background (Fortwengel et al., 2018; Meyer et al., 2023; Sambisa et al., 2010; Suantari, 2021; Treves-Kagan et al., 2017). In many African communities, HIV is often associated with promiscuity, which discourages individuals from seeking testing or disclosing their status, thereby exacerbating the spread of the disease (Adam et al., 2021; Derksen et al., 2022; Fortwengel et al., 2018).

Education is widely recognized as a powerful tool for reducing HIV-related stigma by promoting understanding and challenging misconception about the disease (Deribe et al., 2008; Kilewo et al., 2001; Mahajan et al., 2008; Sambisa et al., 2010; Yang et al., 2023). Educational interventions, particularly school-based programs, can shape societal attitudes by fostering knowledge and empathy toward PLWHA (Bobo & Licari, 1989; Cavaille & Marshall, 2019; Garcia, 2016; Herek & Capitanio, 1995; Hodson & Busseri, 2012; Prothro & Grigg, 1960; Roth & Sumarto, 2015). However, findings on the broader impact of educational

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policies are mixed. (Cody et al., 2021; Fortwengel et al., 2018; Fotso et al., 2020; Jacobi et al., 2020; Krishnaratne et al., 2020; Spence et al., 2022; Tsai & Venkataramani, 2015; Zhao et al., 2011). Despite significant research on HIV stigma, limited attention has been given to external stigma, which refers to negative attitudes and discriminatory behaviors directed at PLWHA. This gap is particularly relevant in Zimbabwe, where HIV prevalence remains high at around 11%, and nearly 68% of the population continues to hold stigmatizing attitudes toward PWHA (United Nations Programme on HIV/AIDS (UNAIDS), 2023b; Zimbabwe National Network of PLHIV (ZNNP+), 2022). Since 1992, the Zimbabwean government has implemented the AIDS Action Program in schools to raise awareness about HIV/AIDS. However, the program's impact on external HIV stigma has not been rigorously evaluated.

This study seeks to address this gap by investigating the long-term effects of Zimbabwe's AIDS Action Program on external stigma using Demographic and Health Surveys (DHS) data. The DHS data provide a valuable opportunity to analyze societal attitudes toward PLWHA over time. To estimate the effect of education on stigma, we use Zimbabwe's 1980 educational reform as an instrumental variable. This reform expanded access to schooling, allowing us to compare individuals exposed to both the educational reform and the HIV/AIDS education program with those who were not. This study contributes to the literature by quantitatively assessing the long-term impact of school-based HIV education program on external HIV stigma, providing insights into an underexplored area of public health. The findings have significant implications for policy, particularly in low-income, high-prevalence settings such as Zimbabwe. Understanding how educational programs influence societal attitudes can inform the design of more effective interventions aimed at reducing stigma and improving HIV-related health outcomes. This study not only contributes to academic literature but also has the potential to inform government efforts to improve HIV programs, ultimately enhancing health outcomes for PLWHA.

Our results show that education reduces stigmatizing attitudes by 12.1%. We also find that this effect is stronger among women and rural residents. In exploring the main mechanism through which education affects HIV stigma, we provide evidence that increased HIV knowledge plays a significant role. These findings highlight the importance of addressing stigma through education, laying the groundwork for more targeted and effective public health strategies in Zimbabwe and beyond. While our results suggest that education contributes to stigma reduction, it is important to acknowledge that broader structural and cultural factors likely influenced the observed shifts in societal attitudes. Global HIV/AIDS campaigns, improvements in healthcare infrastructure, and changing cultural norms may have further amplified the impact of education.

The rest of this paper is organized as follows: Section 2 provides background information on the HIV situation, education system, and AIDS Action Program in Zimbabwe. Section 3 outlines the data sources and variable definitions. Section 4 discusses the empirical framework. Section 5 presents the main findings, and Section 6 concludes.

2. Background

2.1. AIDS action program in Zimbabwe

The first cases of HIV in Zimbabwe were discovered in the early 1980s, with the epidemic escalating rapidly. By 1990, one in every four adults was HIV positive (NAC, 2018). Mortality rates rose significantly (Lopman & Gregson, 2008; Stanecki et al., 2010). During this time, misinformation about HIV transmission and stigma were widespread. Over 78% of people believed that those infected should be quarantined. HIV was associated with homosexuality, witchcraft, and spiritual curses, fueling discrimination (Chingwaru & Vidmar, 2016; Mawadza, 2004; Zimbabwe National Network of PLHIV (ZNNP+), 2022). Recognizing the crisis, Zimbabwe's Ministry of Health partnered with the United Nations Children's Fund (UNICEF) in 1991 to address a lack of knowledge and stigma. After extensive consultations, AIDS prevention was prioritized, particularly targeting youth through schools. This decision leveraged Zimbabwe's strong educational infrastructure, with over 70% primary and 50% secondary school attendance at the time (Gudyanga et al., 2019; O'Donoghue, 2002).

In 1992, the AIDS Action Program was introduced in schools, becoming mandatory from Grade 4 (10-year-olds) through Form 6 (19-year-olds). While tertiary institutions were included, enforcement was easier in primary and secondary schools, where the program remains mandatory. The curriculum aimed to educate students about HIV/AIDS, dispel myths and promote values like gender equality, alongside life skills and sexuality education (Gudyanga et al., 2019; O'Donoghue, 2002). The program used participatory teaching methods, such as group discussions, role-plays, projects, and creative activities like poetry

and songs, fostering engagement. To preserve its interactive nature, the subject was not made examinable. English was the primary medium of instruction, with local languages used when necessary (Gudyanga et al., 2019; O'Donoghue, 2002).

2.2. Education system

During colonial rule (1890–1980), Zimbabwe's education system prioritized white children, offering them free and compulsory schooling, while black children faced barriers. Despite its racial bias, the system provided relatively equal opportunities for girls and boys. Following independence in 1980, the government embarked on educational reforms to increase access to education. Key changes included free primary education, removal of age restrictions, automatic grade progression, and large-scale school construction of schools. These reforms led to a 78.7% rise in the number of primary schools and a 620.9% increase in secondary schools by 1986. Primary school enrollment increased from 0.82 million in 1979 to 2.26 million by1986, with 97% of primary-school-age children in school. Secondary enrollment increased from 0.066 million in 1979 to 0.54 million, with primary-to-secondary transition rate increasing from 20% to 78% during the same period (Dorsey, 1989; Edwards & Tisdell, 1990; Nhundu, 1992). While these reforms benefited both primary and secondary education, their greatest impact was on secondary schooling, facilitated by the removal of age restrictions, automatic grade progression, and the massive construction of secondary schools (Dorsey, 1989).

Zimbabwe's education system consists of seven years of primary, four years of secondary, two years of advanced high school, and three to four years of tertiary, with an official school entry age of six. This implies that children aged 13 and below in 1980 had a higher chance of attending secondary school, though delayed enrollment meant some 14-and 15-year-olds partially benefitted. By 1994, 15–30% of children aged 14 and 15 were still in primary school (see Supplemental Figure 1). The 1980 reforms effectively created a natural experiment, where children aged 15 years or younger had more years of education and higher chances of attending secondary school due to the automatic grade progression policy, removal of age restrictions, easy access, and greater availability of schools.

3. Data

The data used in this study is drawn from the Zimbabwe DHS. We pooled the data from the last four waves of the DHS dataset (1999, 2006, 2011, and 2015). These are nationally representative surveys of reproductive-age men (15–54 years) and women (15–49 years). The sample was selected using stratified two-stage cluster sampling. Across the four waves, a total of 59,600 individuals were interviewed. Since our identification strategy relies on both the timing of the 1980 educational reform and the 1992 AIDS Action Program. Specifically, we focus on age cohorts that were young enough to have not entered secondary school by 1980 and who had also benefitted from HIV/AIDS-related curriculum (born in 1973 or after). We compare these individuals to those born before 1965who did not benefit from either policy. To ensure appropriate comparison, we restrict the sample to include individuals born between 1959 and 1964 (ages 16–21 in 1980) as the control group and those born between 1973 and 1978 (ages 2–7 years in 1980) as the treatment group. Additionally, the sample is limited to respondents who answered questions on HIV stigma, as this is the main outcome of interest. As a result, the final sample consists of 12,817 individuals, of whom 9,207 benefitted from both policies. Supplemental Table 1 gives detailed information on how we constructed the main sample for this study.

The ZDHS includes seven questions to capture people's stigmatizing attitudes toward PLWHA (see Supplementary Appendix). These questions have been utilized in previous studies, such as Yu (2023) and Tsai and Venkataramani (2015), to measure external stigma. The questions are divided into three groups, namely, (1) *social rejection*; (2) *prejudiced attitudes*; and (3) *disclosure concerns*. We constructed a stigma score based on the number of questions where an individual displayed some level of stigma. We then used the score to construct an overall HIV stigma, a binary variable that takes a value of 1 if the person displayed some level of stigma toward people with HIV (HIV stigma score $\geq$ 1) and 0 if an individual showed no signs of HIV stigma (score = 0) by following past studies (Kalichman & Simbayi, 2003; Sambisa, 2008; Tsai & Venkataramani, 2015). Additionally, we created an HIV stigma index using the weighted z-scores of all HIV stigma-related questions. This standardized index has a mean of 0 and a standard deviation of 1 for the control group (see Kling et al., 2007). The ZDHS also includes five questions aimed at assessing respondents' understanding of HIV/AIDS (see Supplementary Appendix). Following the same definition as previous studies, we constructed a dummy variable, "comprehensive HIV knowledge",

which takes unity if all these five questions are answered correctly and zero otherwise (Agüero & Bharadwaj, 2014; Altindag et al., 2011).

4. Empirical framework

We assess the effect of education on HIV stigma-related outcomes, using years of schooling as a proxy for HIV education exposure, with a focus on Zimbabwe's 1980 educational reform and the HIV/AIDS curriculum introduced in the 1992 AIDS Action Program. The identification strategy leverages variation in educational attainment caused by the 1980 education reform, which increased access to education through reduced costs, large-scale school construction, and the removal of discriminatory policies, particularly for Black children and rural residents. Ageat the time of the reforms determined individuals' exposure: those aged 15 or younger in 1980 gained access to schooling at reduced costs, while older individuals did not As thepre-1992 school curriculum did not address HIV-related topics (O'Donoghue, 2002), we compare individuals who completed their primary education prior to both reforms (older than 15 in 1980) with those who were still in school in 1992 and were thus exposed to the HIV/AIDS curriculum (those aged 19 or younger in 1992). This framework provides a clear treatment and control group: the control group consists of individuals born before 1965 (who completed primary schooling before both reforms), while the treatment group includes those born after 1972 (who were still in school during the introduction of the HIV/AIDS curriculum). By comparing these two cohorts, we can evaluate whether exposure to the HIV/AIDS curriculum in schools reduced HIV stigma, specifically looking at external stigma (discriminatory attitudes toward PLWHA). Additionally, we account for the "dose effect" of the policy by examining the number of years of schooling in which individuals were exposed to the HIV/AIDS curriculum. This allows us to test whether increased exposure to HIV/AIDS education correlates with greater reductions in stigma.

To mitigate potential biases from unobservable factors such as family background, culture, and community characteristics, we employ a fuzzy regression discontinuity (FRD) design. This design is suitable given imperfect compliance with the policy, as not all eligible individuals fully adhered to it. Using this approach, we can estimate the effect of education on HIV stigma. Since FRD is equivalent to estimating two-stage least squares (2SLS), the first stage estimates are obtained from the following equation:.

$$E_i = \gamma_0 + \gamma_1 Z_i + \gamma_2 f_i + \gamma_3 Z_i \times f_i + X_i \gamma_4 + e_i \quad (1)$$

where f is the forcing variable, representing the difference between the birth year of individual i and 1965 and Z_i is an instrumental variable that equals 1 if the birth year is greater or equal to 1973. Equation (1) is estimated by ordinary least squares to obtain the predicted values of years of schooling. The second stage of the model is estimated as follows:

$$Y_i = \beta_0 + \beta_1 \hat{E}_i + \beta_2 f_i + \beta_3 Z_i \times f_i + X_i \beta_4 + \varepsilon_i \quad (2)$$

where Y_i is the outcome variable of interest (HIV stigma) for an individual i; E_i is years of schooling; X is a vector of individual and community-level characteristics as well as province and survey year fixed effects; ε_i is an error term; and β_2 and β_3 are the coefficients of the linear approximations above and below the cut off, respectively. We include controls that we expect to be correlated with health outcomes. For example, gender, ethnicity, religion, ethnicity, and area of residence can affect the probability of stigmatizing PLWHA. We use linear approximations in Equations (1) and (2). Hence, β_1 from Equation (2) is the local average treatment effect and can be interpreted as the impact of education on outcomes. Given that treatment status varies by year of birth and that factors such as school construction, availability of HIV/AIDS textbooks, and teacher quality likely differ across provinces, we cluster standard errors at both the year of birth and provincial levels to control for these variations. However, with only ten provinces in Zimbabwe, there are concerns about potential spatial correlation of standard errors within each province. To address the concern, we perform the wild bootstrap tests recommended by Cameron et al. (2008) in all the estimations.

The main identification assumptions are: (i) no manipulation of treatment status; (ii) smooth variation of covariates across the cutoff; (iii) outcome changes driven solely by years of schooling; and (iv) the instrumental variable is relevant. To address the potential for manipulation of treatment status we test for discontinuities in the birth year distribution following the methods of Imbens and Lemieux (2008) and Cattaneo et al. (2018). Results shown in Supplemental Figure 2 indicates no evidence of systematic birth timing manipulation. Additionally, formal tests shown in Supplemental Figure 3c on firm the continuity of the running variable at the cutoff, further supporting the validity of this assumption.

To ensure that no other policies confound the estimates, we test for the smoothness of covariates around the cutoff. Results in Supplemental Figure 4 show no jumps and discontinuities, supporting the validity of our identification strategy.

5. Estimation results

This section provides an overview of the key variables and presents a detailed analysis of the main results.

5.1. Descriptive statistics

Supplemental Table 2 presents the summary statistics of the characteristics of the control (born before 1965) and treated (born in 1973 or later) birth cohorts. On average, the treatment group has2.7 more years of education than the control group, and secondary attendance is 35% higher. The proportion of individuals displaying some level of stigma toward HIV patients is significantly lower in the treatment group compared to the control group. This relationship holds not only for the overall measure of stigma but also for all dimensions of stigmas, except for one question of the seven questions. Treatment cohorts are more likely to have correct knowledge about HIV than the control cohort.

Women constitute 59% of the sample, and close to 35% of the main sample resides in urban areas. Sixty percent of the population attended secondary school in their current province of residence. T-test results show no significant differences in these covariates between the control and treatment groups for most individual characteristics except for age.

5.2. Impact of the 1980 reform on education

Table 1 presents the results of estimating Equation (1), where years of schooling and the probability of attending secondary school are regressed on the instrumental variable, Z, a dummy variable that measures an individual's exposure to the 1980 education reform conditional on whether they benefitted from the HIV/AIDS-related curriculum. The result indicates that being exposed to the 1980 education reform increases individual's schooling by 1.19 years (Column 1) for those who were in school after the HIV/AIDS curriculum was introduced, compared to cohorts unexposed to the reform. Additionally, the birth cohorts exposed to the reforms experienced a 42.6% (14.3 percentage points from the baseline of 33.6%) increase in the probability of attending secondary school (Column 2) compared to older cohorts not exposed to the reforms. Figure 1 illustrates a clear discontinuity: children aged 7 or younger in 1980 achieved more years of schooling and were more likely to attend secondary school compared to those older than 15. These findings indicates that the education reform positively impacted the mean years of schooling and the chances of secondary school enrollment for the younger cohorts, particularly those aged 7 years and below when the free education policy was implemented.

Although the policy benefitted both boys and girls, its effects varied by gender. Panel B and C of Table 1 show the results on women and men, respectively, indicating that the education policy had a significant and substantial impact on females. Specifically, the

Table 1. First stage: Effect of the policy on educational attainment.

	Years of education (1)	Attended secondary (2)
Panel A.		
1[Birth_yr ≥ 1965]	1.186***	0.143***
	(0.249)	(0.036)
	{0.000}	{0.001}
Control mean	6.322	0.336
Observations	12817	12817
R-squared	0.327	0.2461
F-statistic	22.63	15.40
Panel B. Women		
1[Birth_yr ≥ 1965]	1.862***	0.226***
	(0.357)	(0.050)
	{0.000}	{0.001}
Control mean	5.308	0.215
Observations	7642	7642
R-squared	0.378	0.311
F-statistic	27.17	20.38
Panel C. Men		
1[Birth_yr ≥ 1965]	0.370	0.041
	(0.391)	(0.057)
	{0.414}	{0.503}
Control mean	8.073	0.497
Observations	5175	5175
R-squared	0.239	0.187
F-statistic	0.89	0.54
Panel D. Rural		
1[Birth_yr ≥ 1965]	1.509***	0.141***
	(0.265)	(0.051)
	{0.000}	{0.025}
Control mean	5.570	0.146
Observations	8130	8130
R-squared	0.258	0.170
F-statistic	32.52	7.60
Panel E. Urban		
1[Birth_yr ≥ 1965]	0.616	0.151**
	(0.383)	(0.058)
	{0.182}	{0.031}
Control mean	8.306	0.543
Observations	4687	4487
R-squared	0.233	0.204
F-statistic	2.58	6.71

Notes: Robust standard errors are in parentheses, clustered at the year of birth and provincial level. The wild cluster bootstrap p-values are reportedincurly brackets. The survey weights were used in all models. All estimates include all controls, provincial, and survey year fixed effects. All specifications include linear slopes on either side of the cutoff. *p < 0.1, **p < 0.05, ***p < 0.01.

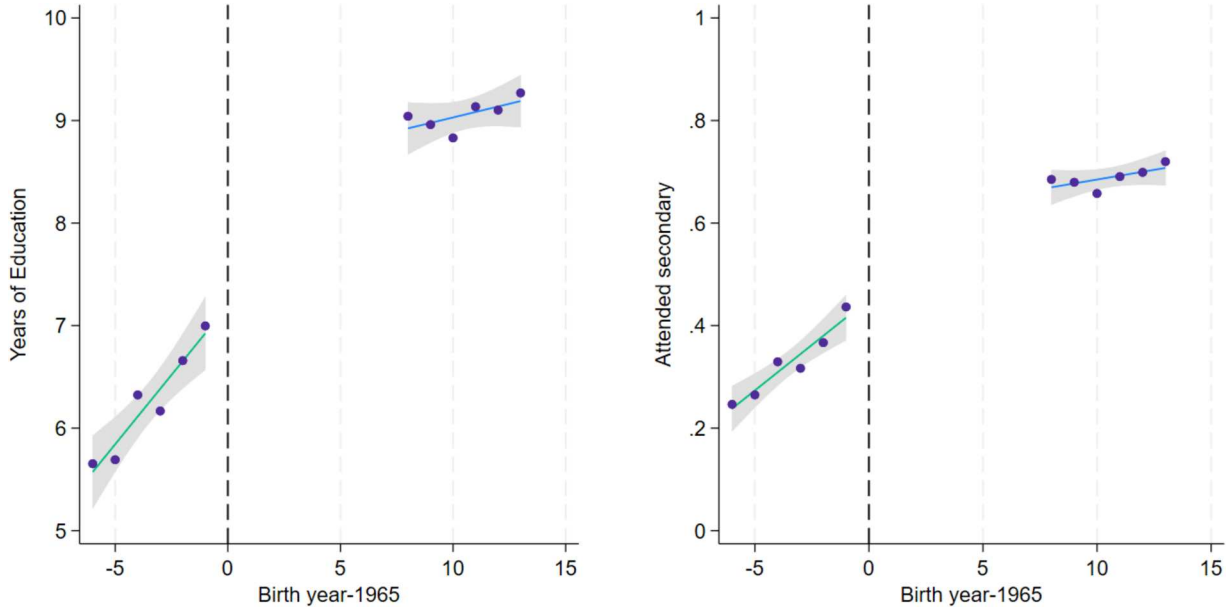

Figure 1. Effect of the policy on educational attainment.

Source: 1999, 2006, 2011, and 2015 DHS surveys. Note: The birth cohorts are normalized at the pivotal cohort so that the value of a given birth cohort is positive for post-reform cohorts and negative for pre-reform cohorts.

reform increased the years of schooling for girls aged 7 or younger in 1980 by 1.86, while its impact on boys, although positive, was not statistically significant. The gender differences are further illustrated graphically in Supplemental Figures 5 and 6, which highlight a historical bias where parents prioritized boys' education prior to the reform.

Moreover, the education policy had a differential impact on area of residence, likely due to differences in school accessibility and resources such as textbooks and infrastructure. Panel D and E of Table 1 explore these disparities, revealing that the education reform significantly increased years of schooling for rural residents by an average of 1.51 years. In contrast, the effect on urban residents, while positive, was not statistically significant.

5.3. Impact of education on attitudes toward PLWHA

Table 2 presents the estimated effect of education on HIV stigma. Overall, the results in Panel A show that an additional year of schooling with an HIV/AIDS-related curriculum is associated with a 12.1% (8.6 percentage points reduction from the baseline of 71%) decrease in the likelihood of holding negative attitudes toward people living with HIV. Figure 2 reinforces these findings, highlighting a clear discontinuity: individuals who were 7 years old or younger in 1980 were significantly less likely to exhibit discriminatory attitudes toward PLWHA compared to those who were older than 15 at the time. This suggests that education, particularly when it includes HIV/AIDS-specific content, plays a significant role in reshaping social attitudes toward PLWHA. The reduction in stigma is not only evident in absolute terms but also holds when using a standardized measure, as an additional year of education reduces the HIV stigma index by 0.18 standard deviations. These results suggest that education has the potential to combat HIV stigma, likely by increasing awareness, correcting misconceptions, and fostering empathy through targeted curricula. This finding is consistent with previous research, such as that of Jacobi et al. (2020) and Fotso et al. (2020), who observed a reduction in HIV stigma levels following the implementation of an AIDS education program in Cameroon and Zambia. The convergence of findings across different contexts highlights the critical role of education in changing deeply ingrained social attitudes, particularly in regions where stigma around HIV/AIDS remains high.

Our analysis of the 1980 education reform, which had a stronger effect on girls and rural residents, indicates differential impacts across demographic groups. Panels B – E of Table 2 reveal that the additional year of schooling following the AIDS Action Program is associated with a 13.3%(4.3 percentage points reduction from a baseline of 72.6%) reduction in the likelihood of stigmatizing PLWHA among rural residents (9.8% from a baseline of 73.5%) and a 5.9% reduction among women. In contrast, the association

Table 2. The impactof education on HIV-related outcomes.

	HIV Stigma (overall) (1)	HIV Stigma Index (overall) (2)
Panel A.		
Years of education	−0.086***	−0.184***
	(0.021)	(0.050)
	{0.001}	{0.004}
Control mean	0.713	0
R-squared	0.121	0.130
Observations	12817	12817
Panel B. Women		
Years of education	−0.043**	−0.097**
	(0.015)	(0.039)
	{0.014}	{0.040}
Control mean	0.789	0
R-squared	0.216	0.095
Observations	7642	7642
Panel C. Men		
Years of education	−0.286	−0.666
	(0.287)	(0.639)
	{0.134}	{0.151}
Control mean	0.668	0
R-squared	0.063	0.156
Observations	5175	5157
Panel D. Rural		
Years of education	−0.098***	−0.201***
	(0.025)	(0.061)
	{0.001}	{0.003}
Control mean	0.744	0
R-squared	0.156	0.136
Observations	8130	8130
Panel E. Urban		
Years of education	−0.029	−0.134
	(0.055)	(0.114)
	{0.491}	{0.146}
Control mean	0.654	0
R-squared	0.260	0.020
Observations	4687	4687

Notes: Robust standard errors are in parentheses, clustered at the year of birth and provincial level. The wild cluster bootstrap *p*-values are reportedincurly brackets. The survey weights were used in all models. All estimates include all controls, provincial, and survey year fixed effects. All specifications include linear slopes on either side of the cutoff. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

for urban residents and men is statistically insignificant. This differential effect could be explained by the varying levels of access to information and educational resources across these groups. Rural residents and women, who may have faced more limited access to health information prior to the reform, appear to have benefited the most from the curriculum's focus on HIV/AIDS. For these groups, education may serve as a crucial means of breaking entrenched stereotypes and misconceptions, which might already be less prevalent in urban or male populations.

Table 3 presents further insights into how education is associated with specific aspects of HIV stigma. An additional year of schooling is associated with a 10percentage points (a 20.2% reduction) decrease in the probability of expressing negative attitudes toward HIV-infected vegetable vendors or shopkeepers. This effect addresses stigma in everyday, public interactions, suggesting that education challenges fears or prejudices against those perceived to pose a direct risk(such as vendors or shopkeepers with HIV). Additionally, education appears to moderately reduce internalized and perceived shame associated with HIV. Specifically, an additional year of schooling is associated with a 6.9 percentage points reduction in the belief that people living with HIV should feel ashamed and a 5.4 percentage points decrease in the belief that an individual's HIV status should be kept secret. These results suggest that education not only influence public attitudes but also begins to address more deeply ingrained societal norms about secrecy and shame surrounding HIV. By providing accurate information about the nature of HIV transmission and emphasizing human rights, education likely helps reduce the fear and social judgment that contribute to these stigmatizing beliefs.

Despite these findings, establishing definitive causality remains challenging. The observed reductions in stigma during the study period likely reflect a confluence of factors beyond educational attainment. While the AIDS Action Program and the 1980 education reform were undoubtedly influential, their impact is likely augmented by concurrent global and local campaigns, shifting cultural norms, and broader structural changes. For example, evolving societal attitudes shaped by media coverage and advocacy efforts may have amplified the role of education. Although the longitudinal DHS data capture trends over time, attributing stigma reduction solely to these policies risks oversimplifying a complex interplay of influences. Nevertheless, these findings underscore the transformative potential of integrating HIV/AIDS-related curricula into education systems. While education alone may not eradicate stigma, it serves as a powerful mechanism for reducing barriers faced by people living with HIV/AIDS, particularly in underserved communities. By fostering inclusive and empathetic attitudes, education can complement broader strategies to combat stigma and improve public health outcomes.

5.4. Channels linking education to HIV stigma

In this subsection, we explore a key mechanism through which education may reduce HIV stigma: by increasing knowledge about HIV/AIDS, which in turn lowers misconceptions and prejudice. Our analysis shows that the introduction of AIDS education program in schools significantly enhanced individuals' understanding of HIV/AIDS, which likely contributed to the reduction in stigma. Table 4 shows that an additional year of schooling following the AIDS

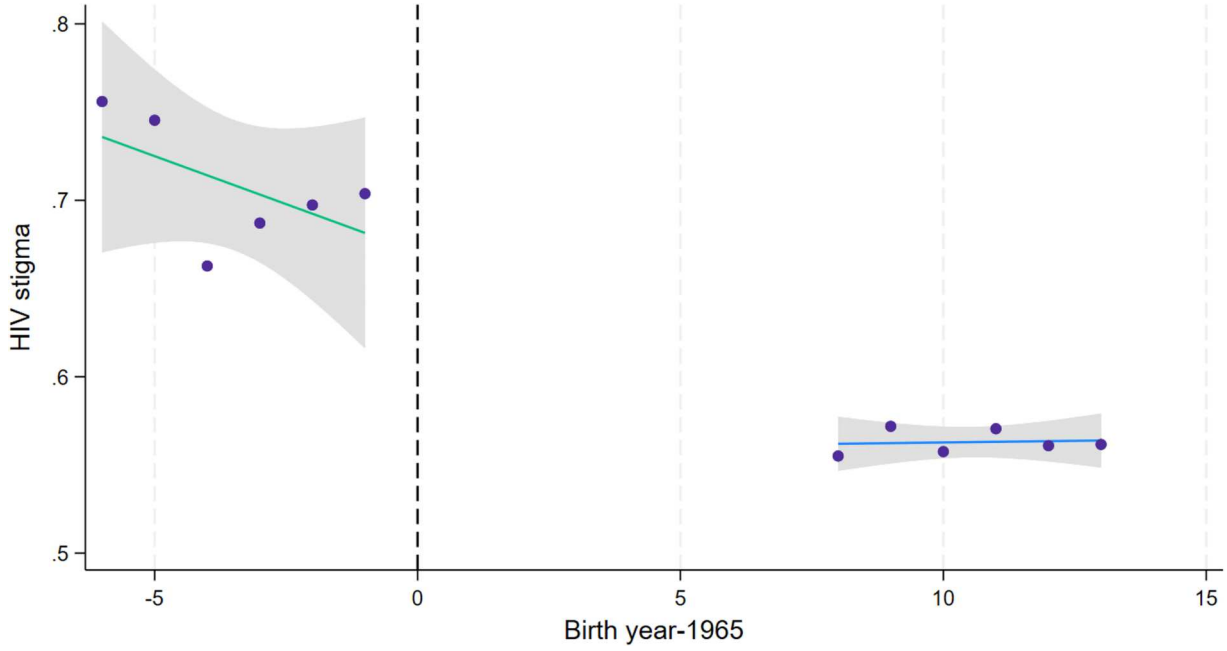

Figure 2. Effect of education on HIV stigma.
Source: 1999, 2006, 2011, and 2015 DHS surveys.

curriculum increased the probability of having comprehensive knowledge of HIV by 12.8%, equivalent to a 3.8 percentage points increase from the baseline of 29.8%. Moreover, this additional year of schooling improved the knowledge of HIV index by 0.17 standard deviation units. These results strongly suggest that education plays a key role in disseminating accurate information about HIV, challenging the myths, and addressing fears that often underlie stigma. Figure 3 provides further evidence by graphically illustrating the impact of the policy intervention. The graph shows a clear and substantial increase in HIV knowledge after the introduction of the AIDS curriculum. Individuals who benefitted from this policy exhibited significantly higher levels of HIV knowledge compared to those who did not, reinforcing the idea that education interventions can lead to tangible improvements in awareness.

In Table 4, we present the disaggregated HIV-knowledge outcomes, which offer more specific insights into how education influences knowledge about different aspects of HIV. For example, an additional year of schooling increased the probability of knowing that a healthy-looking person can have HIV by 3.3 percentage points. Similarly, knowledge that mosquitoes cannot transmit HIV increased by 5.3 percentage points and understanding that sharing food with an HIV-infected person does not spread the virus rose by 5.5 percentage points. These findings highlight education's role in addressing and correcting common misconceptions, which are key drivers of stigma. As individuals gain a clearer understanding

Table 3. The impact of education on HIV/AIDS stigma indicators.

	Social Rejection			Prejudiced Attitudes			Disclosure Concerns
	Female HIV$^+$ teacher should not teach (1)	Male HIV$^+$ teacher should not teach (2)	Not willing to buy from HIV$^+$ vendor (3)	Not willing to take care of a HIV$^+$ relative (4)	PLWHA should be blamed (5)	PLWHA should be ashamed (6)	HIV status should be kept a secret (7)
Years of education	−0.046	−0.019	−0.100***	−0.008	0.022	−0.069*	−0.054*
	(0.036)	(0.037)	(0.031)	(0.025)	(0.040)	(0.037)	(0.032)
	{0.179}	{0.600}	{0.001}	{0.763}	{0.579}	{0.036}	{0.104}
Control mean	0.334	0.272	0.414	0.141	0.271	0.351	0.463
R-squared	0.158	0.113	0.270	0.048	0.074	0.147	0.67
Observations	7377	7369	9891	10256	4018	6531	10250

Notes: Robust standard errors are in parentheses, clustered at the year of birth and provincial level. The wild cluster bootstrap *p*-values are reportedincurly brackets. The survey weights were used in all models. All estimates include all controls, provincial, and survey year fixed effects. All specifications include linear slopes on either side of the cutoff. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Table 4. The impact of education on HIV knowledge (mechanisms)

	Comprehensive HIV knowledge (1)	Comprehensive HIV knowledge index (2)	A healthy-looking person can be HIV+ (3)	Having one uninfected faithful partner can reduce HIV (4)	Mosquito can transfer HIV (5)	Can get HIV by sharing food (6)	Condom reduces HIV (7)
Years of education	0.038**	0.167***	0.033**	0.023	0.052**	0.055*	0.018
	(0.018)	(0.050)	(0.014)	(0.020)	(0.025)	(0.030)	(0.024)
	{0.020}	{0.001}	{0.071}	{0.257}	{0.036}	{0.212}	{0.443}
Control mean	0.298	0	0.869	0.802	0.861	0.799	0.712
R-squared	0.266	0.100	0.136	0.129	0.129	0.090	0.110
Observations	12780	12780	12763	10594	12775	9883	10302

Notes: Robust standard errors are in parentheses, clustered at the year of birth and provincial level. The wild cluster bootstrap *p*-values are reportedincurly brackets. The survey weights were used in all models. All estimates include all controls, provincial, and survey year fixed effects. All specifications include linear slopes on either side of the cutoff. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

that HIV is not spread through casual contact, such as sharing food or mosquito bites, they are less likely to avoid or stigmatize individuals living with HIV in everyday social situations. However, our results also show that education had no statistically significant impact on more nuanced aspects of HIV knowledge, such as understanding that condoms are not 100% effective and that having one sexual partner reduces the risk of infection. This finding suggest that while education dispels certain myths, it may be less effective in promoting more complex or behaviorally oriented information. These topics require deeper engagement or cultural shifts that go beyond basic awareness.

Overall, the findings provide strong evidence that increased HIV knowledge facilitated by education is a key channel for reducing stigma. However, the interplay between education, policy interventions, and broader societal factors warrants further investigation. While education alone cannot fully explain the observed reductions in stigma, its role in equipping individuals with accurate information and fostering empathy is undeniable. Consistent with findings from Agüero and Bharadwaj (2014), our results highlight the importance of educational interventions in improving HIV knowledge. As individuals become more informed, they are better equipped to recognize the realities of HIV transmission and the social and medical advancements that have been made, fostering more compassionate and less discriminatory attitudes toward people living with HIV/AIDS. Nonetheless, understanding the broader context, including societal and cultural dynamics, is crucial for developing effective and multifaceted strategies to reduce stigma and improve public health outcomes.

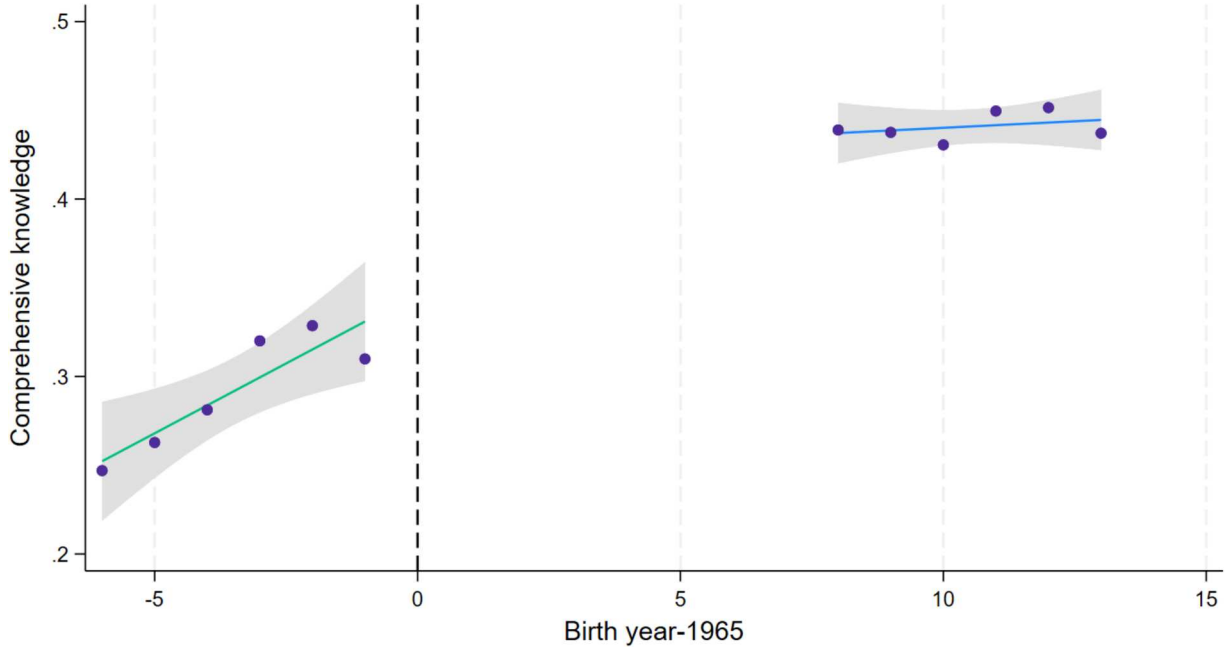

Figure 3. Effect of education on HIV knowledge.
Source: 1999, 2006, 2011, and 2015 DHS surveys.

5.5. Robustness checks

Given the range of outcomes considered in this study, there is a risk of multiple inferences problems. To address this, we applied the Romano – Wolf correction method, which controls for the family-wise error rate (FWER), potentially mitigating type 1 error when dealing with a family of hypotheses (Akresh et al., 2023; Clarke & Tapia-Schythe, 2021; Jones et al., 2019). Accordingly, we performed multiple hypothesis testing on all the main outcomes (HIV stigma index and dummy, HIV stigma indicators, and HIV knowledge index and dummy). The joint test confirmed the same significance level for all the outcomes as those obtained in the main results (see Supplemental Table 3).

Next, we tested whether the results are robust to different clustering. In our main analysis, we clustered standard errors at the year of birth and province level. We present the results of the main outcome variables with standard errors clustered at cluster level, without clustering, and with clustering only at the year of birth level. As shown in Supplemental Table 4, the standard errors remain consistent with those of the main results. Additionally, we considered potential variations in the survey data collection. Since some of the stigma-related questions were not included in the 1999 and 2015 surveys, we reanalyzed the data using only the 2006 and 2011 surveys, where the questions were consistent across both years. The results, presented in Supplemental Table 5, remain statistically significant and exhibit similar magnitudes to those in the main analysis.

6. Conclusion and policy recommendation

This study demonstrates that the 1980 education reform is associated with an increase in the number of schooling years for individuals aged 2–7 years in 1980, compared to those older than 15 years who did not benefit from the policy. The increase is particularly pronounced among females and rural residents, highlighting disparities in educational access. Additionally, for those aged 2 to7 who participated in the AIDS Action Program, an extra year of education is correlated with a reduced likelihood of holding negative attitudes toward PLWHA. This relationship likely reflects the role of education in enhancing HIV knowledge, which can help reduce stigma. However, these findings should be interpreted with caution, as other potential factors, such as media exposure, global awareness programs, health campaigns, and broader social changes, may also have contributed to the observed trends. In light of these findings, it is important for the government to reinforce its commitment to HIV/AIDS education and explore innovative ways to enhance the curriculum. Doing so will not only support the ongoing fight against HIV/AIDS but will also highlight the significant potential of schools to influence knowledge and combat stigma surrounding HIV/AIDS, herpes, and mental health issues across Africa. To strengthen efforts in combating HIV/AIDS stigma, it is essential to continually expand and enhance educational programs to ensure they remain relevant and impactful. Additionally, integrating comprehensive health education that addresses other stigmatized conditions, such as herpes and mental health issues, will further enhance the effectiveness of these interventions. Engaging communities in awareness programs will amplify the impact of school-based education and reach the broader population.

Moreover, ongoing research is essential to monitor the effectiveness of educational interventions and facilitate data-driven adjustments for continuous improvement. The significant influence of culture, teaching methods, and students' comprehension levels must also be considered when shaping beliefs and attitudes toward HIV/AIDS. Future studies should explore how these factors, along with the dynamics between students and educators, affect educational outcomes. Furthermore, research should investigate the interplay between education and external influences, such as media, international campaigns, and societal changes, to gain a more comprehensive understanding of stigma reduction. Educational interventions should be culturally sensitive and tailored to the specific needs of communities in order to effectively reduce stigma. Announced understanding will enhance the effectiveness of educational programs and contribute to comprehensive strategies for combating HIV stigma.

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Authors' Contributions

All authors contributed to the conception and design of the study. Data analysis and material preparation were performed by Getrude Njokwe. The first draft of the manuscript was written by Getrude Njokwe, and Yoko Kijima commented on and corrected previous versions. The final manuscript was read and approved by all authors.

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Availability of data and material

Publicly available data was used in this study and can be accessed at: https://dhsprogram.com/data/available-datasets.cfm

Code availability

STATA code is available upon request.

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