The Impact of Quality Sexual Education on HIV/AIDS in Zambia: Evidence from a Natural Experience

By

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Funding: This project is supported by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) through CDC under the terms of the cooperative agreement U2GGH001226. The contents of this document do not necessarily reflect the views of the United States Government.

Declarations of interest: none

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Abstract

There is mixed evidence regarding the associations between education and HIV, partly related to how education is defined, in terms of quality and content and not just quantity. **This paper focuses on the manner in which quality sexual education is associated with HIV-related knowledge, stigma and risky sexual behaviour in Zambians.** The implementation of the Comprehensive Sexuality Education program (CSE) since 2014 from grades 5 to 12 provides a natural experiment for testing the hypothesis that quality of sexual education is positively associated with HIV knowledge, and negatively associated with risky sexual behaviours and stigma. Data are drawn from the recent and original 2016 Zambian Population-Based HIV Impact Assessment survey (ZAMPHIA), which sampled 24663 individuals aged 15-59 years old nationwide. Three-way fixed-effects double difference and triple difference approaches are used to test our hypothesis. We found that quality of sex education reduced the number of risky sexual behaviours among those who received the CSE curriculum by 0.28, while as expected it was associated with a higher probability to abstained from sex (0.15 points) and a greater number of correct HIV-related knowledge (0.42 points). No significant association was found between quality of sex education and HIV-related stigma. We also found no significant difference, overall, in the effect of the quality of sex education between the regions which received in-school teacher training at the beginning of the program and those where teachers were trained later. These results point to the importance of investing in high quality sexual education to combat the HIV-AIDS progression.

Key words: HIV/AIDS, quality of sex education, human capital, CSE program, PHIA survey, two-way fixed-effect Triple Difference, Zambia.

1. Introduction

The association between education and HIV prevalence has generally followed the lines of research on the association between education and fertility and child survival. Namely that education is associated with changes in how individuals process availability of information about gaining control of their health, whether through improved understanding of promotional materials, changes in their self-efficacy and sense of agency, or through more effective interactions with health care providers. Studies have found that educated individuals tend to adopt more protective behaviours such as condom use, testing for HIV (de Walque, 2009, 2007; Gummerson, 2013), and abstaining from sex (Alsan and Cutler, 2013) . Using an instrumental variable approach Agüero and Bharadwa (2014) found that secondary education reduces the number sexual partners in Zimbabwe and increases comprehensive knowledge about HIV, echoing the results of de Walque in five African countries (de Walque, 2009). According to Agüero and Bharadwa (2014) this effect could be explained by greater access to media by the more educated, while de Walque (2007) points out the greater responsiveness to HIV campaign by educated people. Additional evidence of a negative association between education and HIV incidence is reported by Bärnighausen et al (2007), Hargreaves et al. (2008) and Jukes et al (2008).

However, some studies have found an opposite pattern, namely a positive association between education and HIV prevalence in sub-Saharan Africa (SSA) (Fortson, 2008; UNAIDS, 1998). Some studies have found that more educated individuals are more likely than the non-educated to adopt some risky sexual behaviours such as having more sexual partners (Glick and Sahn, 2008; Gummerson, 2013; Lucas and Wilson, 2018), premarital sex (Fortson, 2008) or lower abstinence and higher level of infidelity (de Walque, 2009).

This paper aims to contribute to the literature by **examining the effect of the improvement of quality of sexual education on HIV-related knowledge, stigma and risky sexual behaviour.** Zambia is one of the first countries in the SSA region to have initiated a nation-wide scale-up of a Comprehensive Sexuality Education (CSE), which covers relationships, values, attitudes and skills, culture and human rights, human development, sexual behaviours and sexual and reproductive health (UNESCO, 2016). Since 2014, Zambia has scaled up the implementation of its (CSE) curriculum for grades 5 to 12 (UNFPA, 2015). This provides a natural experiment for testing the hypothesis that quality of sex education not quantity of education only is negatively causally related **to** risky behaviours and HIV-related stigma and ignorance.

The paper uses data from the Zambia Population-based HIV impact assessment (ZAMPHIA) of 2016, which is the first survey to measure the national HIV incidence in Zambia (Ministry of Health, Zambia, 2017). The ZAMPHIA survey produced HIV incidence and prevalence estimates for all persons by age, including children and adolescents, as well as collected detailed information about sexual behaviours, HIV knowledge, stigma, and HIV-prevention behaviours; therefore, it is suitable for assessing differences in risk behaviours, attitudes and knowledge by exposure to the CSE. The date of birth, the grade completed and the region of residence are used to determine whether or not an individual has been exposed to the quality sexual education and the intensity of that quality.

2. Context and CSE program

Located in southern Africa, Zambia is a land-locked country with a land area of 752,612 square kilometres divided into 10 administrative provinces (Central Statistical Office/Zambia et al., 2015). Its estimated population of 13.1 million in 2010 was very young with more than 50% under 15 years. Primary education is free and compulsory since 2002 (grade 1 to 7) (MESVTEE, 2015), although the net attendance ratio in primary education remained at 81% in 2014. The literacy rate was 83% among men and 68% among women aged 14-49 years. Zambia, therefore, has made great progress in terms of education since 2007.

Zambia also has had one of the highest HIV prevalence rates among adults (15-59 years), 13% in 2014 (DHS, 2014). Since 2002, the government of Zambia has designed several National HIV and AIDS Strategic Frameworks (NASF) to respond to the epidemic. The most recent strategic plan, the Revised National HIV and AIDS Strategic Framework (R-NASF) 2014 – 2016, was designed to provide "adequate space and opportunities for Communities, Civil Society, Private Sector, Development Partners (Bilateral and Multi-lateral Agencies) and Government institutions to actively participate in the implementation of evidence based HIV and AIDS programmes based on their mandates and comparative advantages" (Republic of Zambia, 2014, p. IV). These strategies include provision of HIV education through life skills courses, in which CSE features prominently. Since April 2014 a curriculum integrating CSE has been rolled out in all schools across Zambia (UNFPA, 2015).

The CSE can be defined as an "age-appropriate, culturally relevant approach to teaching about sexuality and relationships by providing scientifically accurate, realistic, non-judgmental information" (UNESCO, 2009, p. 2). Even though many countries implemented such a programme at a local levels (Fonner et al., 2014) each of them has its own approach. In Zambia, the Life-Skills Education framework (2011) and Comprehensive Sexuality framework (2013) have been merged and included in the school curriculum at national level with the aim to reduce the impact of HIV on young people. The CSE is not a standalone subject, but is integrated into other subjects like social studies, civic education, biology, home economics. The CSE framework covered several topics, including relationship, values, attitudes and skills, culture and human rights, human development, sexual behaviours and sexual and reproductive health.

The targeted population is young people from grade 5 to 12, with the objective to improve their sexual and reproductive health (SRH) (UNFPA, 2015). In-service teacher training was provided in the provinces of Lusaka, Eastern and Copperbelt by CSE curriculum specialists in the first year, 2014 (phase 1), and then extended to Southern, Western and Central provinces (phase 2) and finally to Luapula , Muchinga, Northern and North-western provinces (phase 3) (UNESCO, 2016). By 2015, the CSE program had reached 100% of schools, with 77% of leaners from grade 5-12 and 38,251 teachers were trained to teach the CSE curriculum (UNESCO, 2016).

Figure1: CSE implementation grades and treated ages in 2014 and 2016

level	**Primary (compulsory)**							**Lower secondary**		**Upper Secondary**				
					Grades with CSE in 2014									
Grade	1	2	3	4	5	6	7	8	9	10	11	12		
					Age groups corresponding to CSE in 2014									
Age	7	8	9	10	11	12	13	14	15	16	17	18	19	20
					Age groups exposed to CSE in 2016									
Age	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Source: By the authors, based on data reported in UNESCO 2016.

3. Methodology

3.1. Data and sample

The data used for this study are from the Zambian Population-based HIV impact assessment (ZAMPHIA) survey. ZAMPHIA is a nationally representative survey that was conducted between March and August 2016 by the Government of Zambia through the Ministry of Health (MOH), with funding from the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), technical assistance of the U.S. Centers for Disease Control and Prevention (CDC) and implemented by ICAP at Columbia University. The objective of the survey was to provide national and subnational estimates of HIV prevalence and incidence, as well as indicators of HIV risk-behaviours, prevention, and treatment.

ZAMPHIA employed a two-stage stratified cluster sample design, with the selection of enumeration areas (EAs) at the first stage based on information from the 2010 Census of

Population and Housing of Zambia, followed by a random selection of households in each enumeration area. In total, 511 EAs and 13,441 households were selected, of which 10,957 households were successfully interviewed. The designated head of household provided consent for the household to participate in the survey, while individuals aged 15-59 years provided consent for the individual interview and for the biomarker component of the survey [2]. The biomarkers were collected at the household level, and tests included both rapid (Determine) and laboratory confirmation (Uni-Gold) of HIV status, hepatitis B and syphilis, with the return of results to participating individuals. ZAMPHIA measured HIV incidence in Zambia, identifying recent infections in the 6 previous months or 130 previous days, using a combination of the HIV-1 Limiting Antigen (LAg)-Avidity enzyme immunoassay (Sedia Biosciences Corporation) and viral load (Ministry of Health, Zambia, 2017). The protocol of the survey was reviewed and approved by the institutional review boards/ethics committees of the Tropical Diseases Research Centre Zambia, CDC and Columbia University.

Three main questionnaires were used: the household, the adult individual, and the adolescent questionnaires. In this study, only information from the two first questionnaires was used. Overall, 21,280 eligible individuals aged 15-59 years were interviewed; of which 19,115 consented for the biomarker module. Half of the adults were selected for the HIV/AIDS knowledge and attitude module, a total of 10,636 individuals.

3.2. Identification strategy

In order to estimate the effect of participation in the CSE curriculum on HIV-related knowledge, discriminatory attitudes and risky behaviours, we used double difference (DD) and triple difference (DDD) approaches.

Because only school age children at the time of the introduction of CSE were exposed to the intervention of improved quality of sexual education, the individual's year of birth or age was used to divide the sample into the Pre-CSE and Post-CSE groups, similar to the before/after treatment concept in impact evaluation studies. In Zambia, school starts at the age of 7, which means that a child reaches grade 5 at age 11 and grade 12 at age 18 (see figure 1). In 2014, at the time of the CSE introduction, this age range corresponds to the cohort born between 2003 and 1996. At the time of the survey, in 2016, two additional birth cohorts had been exposed (2004 and 2005). Hence, in 2016, persons aged 11- 20 years, could be considered as part of

[2] Parent's permission and participant's assent were requested for non-emancipated minor aged 15-17.

the Post-CSE cohort. However, because of the differences in assessment of HIV knowledge, stigma and risky behaviour for adolescents (aged 10-14) as compared to adults, the lower bound age for post-CSE cohort will be limited to 15 years. Additionally, in order to ensure the comparability between the pre- and post- CSE cohorts the upper bound age for our sample was fixed at 26 years. This allows us to create a *post-CSE* indicator taking the value 1 if the individual is from the cohort 1996-2001 (aged 15-20 in 2016) and 0 if (s)he is from the cohort 1995-1990 (aged 21-26 in 2016).

Given that CSE is a school based program implemented from grade 5, we are also able to identify the population that is likely to have been treated based on the grade completion. Hence, persons who reported completion of grade 5 or more will be considered as our treated group, while persons who had not completed grade 5 will serve as the control group. We thus created a variable *Grade 5* taking the value 1 if a person completed grade 5 or more education and 0 if not.

The interaction between the *post-CSE* and *Grade 5* variables allows identifying the effect of the CSE program on those who have actually been treated (post-CSE cohort with grade 5 or more).

The Difference in difference (DD) model corresponding is presented as follow:

$$Y_{ijkg} = \beta_0 + \beta_1 Grade5_g + \beta_2 PostCSE_j + \beta_3 Zone_k + \beta_4 PostCSE_j * Grade5_g + \beta_k X_{ijkg} + \varepsilon_{ijkg} \quad (1)$$

Where Y_{ijkg} is the outcome variables (HIV-related knowledge, discriminatory attitude and risky sexual behaviours) of individual *I*, from the cohort *j*, in the zone *k* and who completed a grade *g*. More details about the construction of outcome variables are given in section 3.3. *X* is a vector of control variables that are usually associated with HIV knowledge or risky behaviours. $PostCSE$ is a dummy variable for the post-CSE cohort. It captures aggregate factors that would cause changes in *Y* of the two cohorts even in the absence of introduction of CSE. The dummy variable $Grade5$ captures possible differences between individuals with grade 5 or plus and those with grade 4 or less prior to the introduction of CSE. β_3 is the effect of CSE treatment on the treated population, meaning the effect of grade5 and plus on post-CSE cohort, Although the CSE was implemented in the whole country in 2014, the provision of specific support for in-service teacher training was phased. We therefore have subdivided the treatment group into intensity zones, with zone 1 for individuals living in provinces which received in-service teacher trainings in 2014, (Lusaka, Eastern and Copperbelt) and zone 2 for those living in all other provinces, which received the in-service teacher training later on.

We then estimated DDD model simplistically presented as follow:

$$Y_{ijkg} = \beta_0 + \beta_1 Grade5_g + \beta_2 PostCSE_j + \beta_3 Zone_k + \beta_4 PostCSE_j * Grade5_g + \beta_5 PostCSE_j * Zone_k + \beta_6 Zone_k * Grade5_g + \beta_7 PostCSE_j * Grade5_g * Grade5_k + \beta_k X_{ijkg} + \varepsilon_{ijkg} \quad (2)$$

Zone allows controlling for the zone differences even in the absence of the program. The coefficients β_7 measures the difference in the effect of grade5 and plus on post-CSE cohort between the region which received better quality of CSE teachers and the others.

Our estimations control gender (Forston , 2008), religion, marital status, wealth index, ethnic background (de Walque, 2007, 2006; LUCAS and WILSON, 2018). Some estimates also control for age single dummies in order to account for the age specificities (more details are given below).

3.3. Outcome variables and models

The first outcome variable used in this work is HIV-related knowledge. The PHIA survey collected information on five HIV-related knowledge questions among adults 15-59 years: whether the risk of HIV transmission can be reduced by having sex with only one uninfected partner who has no other partners; whether a person can reduce the risk of getting HIV by using a condom every time they have sex; whether a healthy-looking person can have HIV; whether a person can get HIV from mosquito bites; and whether a person can get HIV by sharing food with someone who is infected. Based on this information we built an additive index to capture the number of accurate knowledge an individual has. The index ranged from

0 (for individuals who correctly responded to none of the questions or responded they do not know for all the questions) to 5 (for individuals who responded correctly to all 5 questions).

Because the HIV-related knowledge index is a count variable, in order to analyse this variable, the equations 1 and 2 will be fitted using a Poisson-type regression. A number of statistical tests, presented in annex 2a, were performed in order to determine the type of count model to be used (Winkelmann, 2008) and they pointed out the appropriateness of the Poisson regression.

The second outcome variable used in the analyses is HIV related discriminatory attitudes, based on the responses to the following questions: 1) Would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV? 2)Do you think that children living with HIV should be able to attend school with children who are HIV negative? The index of HIV discriminatory attitude was built ranging from 0 if yes to both questions to 2 if no to both questions.

The test performed in annex 2b showed that the most appropriate count model for this variable is a Negative Binomial model (NB). In the NB model, the conditional mean of the outcome given the value of predictors is the same as the one for the standard Poisson presented previously. However, the variance of the NB model is different from the one of the Poisson regression. In NB, variance account for the over-dispersion coefficient. If over-dispersion coefficient equal zero, the NB is identical to the Poisson model

Finally, this study used an index of risky sexual behaviour in the past 12 months as an outcome variable. Five sexual behaviours were used to build this additive index of number of risky sexual behaviours: 1) not all sexual partners in the last 12 months were spouse or living-in partners, 2) condom not used during sexual intercourse with non-marital sexual partner, 3) individual engaged in paid sexual intercourse (sold or bought) the last 12 months, 4) individual did not used condom during paid sexual intercourse and 5) person had more than two sexual partners in the last 12 months. The index of sexual risky behaviour ranges from 0, for those who did not have any of these behaviours, to 5, for individuals who cumulated all these risky sexual behaviours. Because abstinence can also be a strategy adopted by an individual to avoid HIV and STIs, especially among younger cohorts, those who did not have sex during the last 12 months are also considered as having 0 sexual risky behaviours.

Given that the zero observed can have two origins (those who will never engage in risky sexual intercourse and those who might have risky sexual intercourse) (Hu et al., 2011) and because of the statistical test (see annex 2c) the equations 1 and 2 for sexual risky behaviour will be fitted using a Zero-inflated Poisson regression (ZIP). The first step of the ZIP uses a logistic regression to estimate the probability that each individual with a zero value is in each two latent groups. Then, the Poisson regression is used for the part of the data that does not contain those who will never have risky sexual behaviours.

3.4. Robustness check

Our identification strategy can raise a number of issues. First, comparing the older and the younger cohorts can raise the question of their comparability. In fact the two cohorts can have different sexual behaviour and exposure. Although our coefficients of interest are estimated controlling for this cohort effect there could still remain unobserved differences. Moreover, a different cohort could have been exposed to other HIV age-specific campaigns. In order to limit this bias, a second set of estimations controls for single-year age dummies (De Neve et al., 2015; de Walque, 2007; LUCAS and WILSON, 2018). Controlling for single-year age dummies, which is similar to estimate a cohort fixed effect model, allows controlling for the unobserved elements which are constant within each cohort, hence it helps to account for unobserved elements that differentiate one cohort from another.

Second, people CSE curriculum was not identical at all grades. In order to account for this heterogeneity, we included a grade fixed-effect in our model. When we include age and region dummies we use a model similar to the two-way fixed effects Difference in Difference model (see Goodman-Bacon, 2018).

Third, different regions can have different infection patterns, because of the prevalence of HIV in the locality. As result of these differences in terms of prevalence, or for other reasons, people from these provinces could have had been exposed to different HIV related programs which may have affected their HIV related knowledge, stigma and risky behaviours. Failing to account for these regional differences could imply that the changes are due to the effect of CSE when actually they are attributable to other programs. To address this issue, we included province residence dummies for region fixed-effects estimations.

The estimated three-way fixed-effect model are presented in equation 3 for the DD and 4 for the DDD.

$$Y_{ijkg} = \gamma_j + \delta_k + \theta_g + \beta_4 PostCSE_j * Grade5_g + \beta_k X_{ijkg} + \varepsilon_{ijkg} \quad (3)$$

$$Y_{ijk} = \gamma_j + \delta_k + \beta_1 Grade5_i + \beta_2 postCSE_j * Grade5_i + \beta_k X_{ijk} + \varepsilon_{ijk} \quad (4)$$

$$Y_{ijkg} = \gamma_j + \delta_k + \theta_g + \beta_4 PostCSE_j * Grade5_g + \beta_5 PostCSE_j * Zone_k + \beta_6 Zone_k * Grade5_g + \beta_7 PostCSE_j * Grade5_g * Zone_k + \beta_k X_{ijkg} + \varepsilon_{ijkg} \quad (3)$$

$$Y_{ijk} = \gamma_j + \delta_k + \beta_1 Grade5_i + \beta_2 postCSE_j * zone_k + \beta_3 Grade5_i * zone_k + \beta_4 Grade5_i * postCSE_j + \beta_5 postCSE_j * Grade5_i * zone_k + \beta_k X_{ijk} + \varepsilon_{ijk} \quad (5)$$

Where γ_j is the cohort fixed effect, θ_g is the grade fixed effect and δ_k the province fixed effect. It is important to note that because the *grade5*, *cohort* and *zone* variables are collinear with the province and single-year age dummies, the estimation controlling for regional and age fixed-effects do not include these variables.

Third, in order to further test of identification strategy, we constructed a 'placebo' treated group. The placebo treated group (aged 21-26 in 2016) will be compared to another control group (aged 27-32 in 2016). In principle, both have not been exposed to the program, hence we should not observe any significant effect of the treatment (different effects of education grade 5 on outcomes). The non-significance of our variables of interest in placebo estimations would provide suggestive evidences that our DD, although imprecisely estimated, are not driven by inappropriate identification assumptions (Duflo, 2001).

Unless otherwise specified, all the results presented in this study are weighted and the variance is calculated using the Jack-knife replicate weights.

4. Results

4.1. Descriptive statistics

Table A1 in appendix presents a general description of the study population. Overall, 9409 individuals aged 15-26 were selected and responded to the individual interview, of which almost half participated to the HIV/AIDS knowledge and attitude module during PHIA (4752 individuals).

The Pre-CSE cohort had in general a higher number correct HIV-related knowledge, with a mean 4.12 HIV-related questions responded to correctly versus only 3.89 for the Post-CSE cohort. This latter cohort showed more discriminatory attitude and adopted, in mean, less risky sexual behaviour as compare to their pre-CSE peers as shown in table A1.

These differences in outcomes variables are examined in detail by grade completion and cohort in figure 2. The figure 2a shows that in general the number of correct HIV-related knowledge is lower among the younger cohorts as compared to older ones for both educated and less-educated groups. However, we notice that among the 1996 cohort, which is the first cohort to have been exposed to CSE program, for those with more than grade 5 education the number of correct HIV knowledge increased, while it continued to decrease for the less educated 1996 cohort. Overall, it seems that the exposure to CSE program at school reduced the knowledge gap between the young and the old generations for those with more than grade 5.

Figure 2b depicts that the younger a cohort is the more it tends to have higher number of discriminatory attitudes. In 1996 cohort however, there were a slight decrease of the number of discriminatory behaviours compare the previous 1995 cohorts and this decrease was even shaper among people with grade 5 or more who were exposed to the CSE program.

As far as risky sexual behaviours are concerned, we observed that among the 1990 -1995 cohort, the number of risky sexual behaviour was higher for the more educated as compared to the less educated. From the 1996 cohort forward, the numbers of risky sexual behaviour started decreasing among those with grade 5 or more. Even if from the 1997 cohort the number of the number of risky behaviours started lowering with age for the less educates as well, this latter have in general more risky sexual behaviours than their peers who have been exposed to CSE in grade 5 or more.

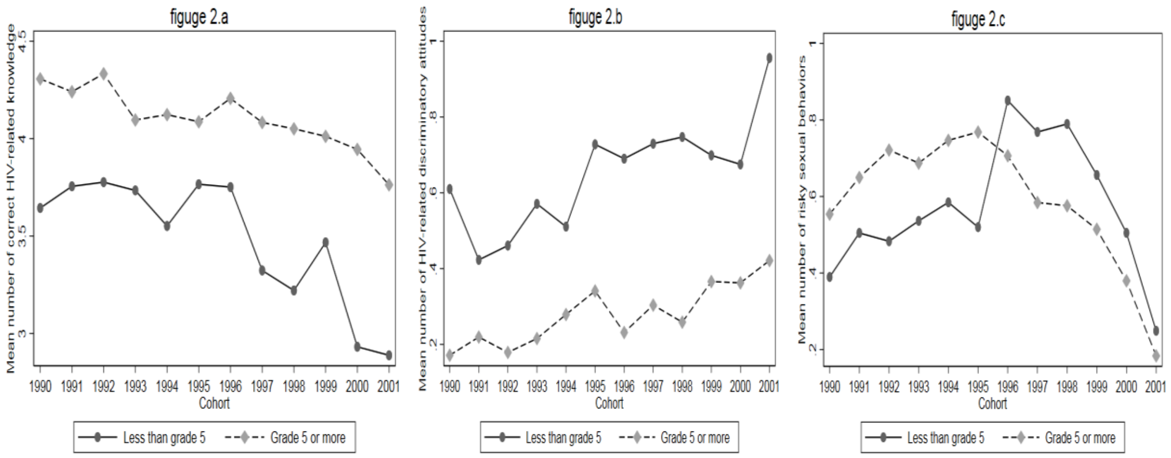


Table 1 summarise these results in terms of mean differences. The number of HIV-related correct knowledge is higher among those who are more educated as compared to those who did not complete grade 5, translating the positive association between correct knowledge of HIV and education. Similarly to what was observed above, the number of correct HIV-related knowledge is overall higher for the Pre-CSE this translates to the general positive association between HIV-related knowledge and age. However, when we look at the differences between cohorts for each level of education, we observe that these differences are lower in the group with grade 5 education or plus (-0.18) than for the cohort with less than grade 5 (-0.51). Quality of sex education seems to have reduced the gap between pre-CSE and post-CSE cohort. The younger cohort which received quality sexual education in grade 5 through CSE has number of correct HIV-related knowledge 0.34 point higher.

Concerning the HIV-related stigma, the older cohort have in general less discriminatory attitudes than the younger ones, and people with grade 5 or plus discriminate less than those with less education. The differences between cohorts are higher among the less educated group. The difference of differences shows that individuals from post-CSE cohort with grade 5 or plus have, in mean, 0.14 less numbers of discriminatory attitudes. They have also adopted in mean 0.28 less number HIV-related risky sexual behaviours the 12 previous months. These descriptive statistics necessitate, however, further analyses controlling for more characteristics.

4.2. Effect of quality sex education on HIV-related knowledge, discriminatory attitudes and risky sexual behaviours

Table 2 presents the marginal effects of the HIV-related knowledge regression. Model 1 presents the estimates of DD as expressed in equation 1. It shows, everything being equal, the number of correct HIV-related knowledge of an individual with grade 5 or more education, from the pre-CSE cohort 0.31 points higher as compared to those with less than grade 5 education from the same cohort. The interaction term shows that having grade 5 education or more for a person from the post-CSE cohort increases the number of correct HIV-related knowledge reported change by 0.45.

Compared to an individual from the pre-CSE with less than grade 5 educational level, the number of correct of HIV-related knowledge of an individual from the post-CSE cohort with the same level of education would be expected to decrease by 0.58. For individuals living in zone 1 of the program the number of correct HIV-related knowledge is 0.08 points lower as compared to the one of those living in zone 2 of the program.

Model 2 shows the results of the DD with age and region fixed effects as modelled in equation 4 to account for the fact each grade, age and region is specific. The effect of grade 5 on number of correct HIV-related knowledge increases by 0.43 when an individual is from the post-CSE cohort. Almost similar results are fond in the triple difference in difference models as modelled in equation 2 and 4. However, the interaction coefficient between post-CSE, grade 5 and zone of CSE program is not significant. It means that the effect of grade 5 on post-CSE cohort does not differ significantly in zone 1 and 2 of the CSE program.

The marginal effect results of the NB regression for number of HIV-related discriminatory attitudes are presented in table 3. Model 1 shows that, controlling for all socio-demographic characteristics, those with grade 5 or plus from the pre-CSE cohort reported in general 0.26 less number of HIV-related discriminatory attitude. On the contrary, those from the post-CSE with lower education have significantly 0.09 more number of discriminatory attitudes as compare to their peer from the pre-CSE cohort. Though the number of discriminatory attitudes of individual with grade 5 or more from the post-CSE cohort seems to be lower than those from pre-CSE with the same level of education, this difference is not significant. Quite similar results are found in model 2, 3 and 4.

Table 3 presents the results of the ZIP regression for risky sexual behaviours. For each model, the marginal effects of the logistic regression for the excess zero, meaning the zero due to the fact that the person did not have had sex the past 12 months, are first presented (logit column). Then, the marginal effects of the Poisson regression for number of risky sexual behaviour for those who has sex the past 12 months are presented (Poisson column). The logit column of model 1 shows that having completed grade 5 or more education for someone from the pre-CSE cohort reduces the probability of not having had sex by 0.11 point compare to a peer with less than grade 5 education. Nevertheless, for people from the post-CSE cohort, grade 5 or more education increase this probability of continence the 12 previous months by 0.11 point compare to those from the pre-CSE cohort. Similarly, the Poisson column shows that while grade 5 or more education increases the number or risky sexual behaviour in the pre-CSE cohort, having been exposed to CSE through grade 5 or more reduced the number of risky behaviour of post-CSE who had sexual intercourse the 12 past by 0.21. The DD with single grade, age and provinces dummies produced almost similar results. Grade 5 or more increase the probability of continence the 12 previous months by 0.12 points and reduces the number of risky sexual behaviour by 0.28 points among post-CSE compare to pre-CSE with the same educational level. The models 3 and 4 show almost the same results. No significant differences of the effect of grade 5 or more for post-CSE cohort have been found between the zone 1 and 2 of the CSE program.

The robustness check with the placebo post-CSE cohort presented in table A2 shows no significance of the interaction term coefficients for all the outcomes. Providing confidence that the results obtained are not just driven by the difference in the effect of grade 5 or plus education that can be found between younger and older cohorts.

5. Discussion

After 2 years of a scaled-up CSE program implementation in Zambia, an interesting way to assess the impact of quality sexual education in the long run on the HIV/AIDS pandemic is to look at its effect on some intermediary outcomes like HIV-related knowledge, discriminatory attitude and risky sexual behaviours. We found that the introduction of the quality sexual education from grade 5 significantly increased the number of correct HIV-related knowledge for the treated post-CSE group. When we control for grade, age and region specific characteristics, this effect is slightly lower but remains strongly significant. A similar result is obtained when using a triple difference. This result is similar to the one obtained during the focus group of the Monitoring and Evaluation of the CSE program (UNESCO, 2016). It was found that, in general, learners had strong knowledge about HIV. The effect of the CSE program on number of correct HIV-related knowledge is not significantly different for the treated population living in a zone exposed to an intense in-school teacher training as compared to those living in the other zone. This would mean that the timing of in-school teachers training does not matter. No significant effect is found with the placebo cohort providing more credit to our identification strategy.

The descriptive statistics seem to show that an individual from the post-CSE cohort, thus young enough to have been exposed to the program in school, with grade 5 or more education reported in the mean 0.14 less discriminatory attitudes toward HIV. However, this effect becomes non-significant when we control for the socio-demographic characteristics, grade, age and region fixed effects. The introduction of the quality of sexual education through CSE program from grade 5 upward has had no significant effect on the number of discriminatory attitudes reported by the post-CSE cohort treated by the program. We also found that, contrary to previous research (Tsai and Venkataramani, 2015), in general, those who are more educated reported less discriminatory attitudes compared to the less educated.

Concerning the risky sexual behaviours, we found that having more than grade 5 education was associated with a higher number of risky sexual behaviour adopted for the pre-CSE cohort when controlling for cohort and region specific effects. A result similar to the one found in the literature by Glick and Sahn (2008) Gummerson (2013) and Lucas and Wilson (2018) concerning multipartners , or de Walque (2009) about lower abstinence and higher level of infidelity. But our results contradict the ones of De Walque (2007) about condom use, or Alsan and Cutler (2013) about abstinence, or Agüero and Bharadwa (2014) concerning the number sexual partners in Zimbabwe. The difference might come from the fact that these studies looked at the different sexual behaviours separately while this paper is looking at cumulative risky sexual behaviours adopted by individuals.

We also found that the introduction of quality sexual education in schools reduced the number of risky sexual behaviours adopted in the past 12 months and had increased the probability of abstaining from sex for the treated post-CSE group with more than grade 5. This result is robust to the control of single grade, age groups and province specific characteristic or exposure to age- or province-specific campaign. No significant difference of the effect of the treatment on treated group is found between the provinces which received intensive in-school teachers training at the beginning of the program and those which did not. Once again, the result using and an old cohort as placebo treated group showed non-significant results, providing more confidence to our identification strategy.

6. Conclusion

The aim of this study was to assess the effect of the quality of sexual education on HIV-related knowledge, discriminatory attitudes and risky sexual behaviours in Zambia. We used the data of the ZAMPHIA survey conducted in 2016. The introduction of quality sexual education from grade 5 to 12 in 2014 through the CSE program implementation provides us with a natural experience to assess the effect of a quality sexual education. We used three-way fixed-effects double and triple difference approaches and found a number of significant results.

We found first that, the improvement of the quality of sexual education through the CSE program has increased the number of correct HIV-related knowledge for the treated cohort by 0.43 points compared to the non-treated cohort. Second, no significant effect has been found for the number of discriminatory attitudes reported. Third, the implementation of quality sexual education in grade 5 and more has reduced the number of risky sexual behaviours by 0.28 points for the treated group compared to the non-treated cohort and has increased the probability of abstaining from sex by 0.15. Finally, in general, no significant difference of treatment effect has been found for the treated group living in the zone which received better quality teaching through intensive in-school teachers' training at the beginning of the program and the treated group in other zones.

This study has, however, some limitations. First, because we are not using an experimental design the identification strategy could be imperfect, notably in terms of the comparability of our treated and non-treated groups. However, we reduced significantly this backward by controlling for observables and non-observables specific to each age and region through age and region fixed-effect analysed. Second, it would have been interesting to assess the change in HIV incidence since the introduction of CSE. Although, PHIA survey allows identifying HIV infections that occurred 130 days before the survey, we could not make powerful analyses of incidence because of the limited counts of new HIV infections in our age group (18 cases). Having new infections for the whole period covered by CSE would probably allow to have better estimates of the effect of the CSE program on the HIV pandemic progression.

Nevertheless, this study contributes to the literature in many ways. First, it addresses the question of the quality of sexual education instead of the quantity of education as previous studies did. Doing so, it takes advantage of the introduction of a better quality sexual education in 2014 for a natural experience. Second, the study analyses the effect of the quality sex education on both HIV-related knowledge, discriminatory attitudes and risky sexual behaviours using additive indexes for each HIV-related variables. Finally, the study produced results which have important policy implications.

Positive results of the introduction of the quality sexual education from grade 5 have been found on HIV-related knowledge and risky sexual behaviour. The investment in scaled-up quality of sexual education could be an efficient way to reduce the progression of HIV-AIDS and other sexually transmitted infections. Zambia is one of the first countries to implement such a nation-wide program to improve the quality of sexual education in a school setting (UNESCO, 2016). This program should be replicated in other countries in the SSA region. We also found no significant difference in the effect of the program between the regions which received in-school teacher training at the beginning of the program and those which did not. Hence, in the presence of limited resources to run a nation-wide in-school teacher training, developing a good curriculum and appropriate books and material, as it was the case for the CSE program, should produce some positive outcomes. Finally, no significant effect has been found on the number of discriminatory attitudes. The curriculum should find a way to strengthen these aspects.

Tables

Table 1: Outcome variables by grade completion and cohort

	More than grade 5		Less than Grade 5		Difference of differences
	Percent	**SE**	**Percent**	**SE**	
HIV-related knowledge					
Post-CSE cohort	4.01	0.03	3.18	0.09	
Pre-CSE cohort	4.19	0.02	3.70	0.06	
Difference	-0.18		-0.51		0.34
p-value	0.000		0.000		
HIV -related discriminatory attitude					
Post-CSE cohort	0.32	0.01	0.77	0.05	
Pre-CSE cohort	0.24	0.01	0.55	0.05	
Difference	0.08		0.22		-0.14
p-value	0.000		0.001		
HIV-related risky sexual behaviour					
Post-CSE cohort	0.50	0.02	0.58	0.05	
Pre-CSE cohort	0.69	0.02	0.50	0.04	
Difference	-0.20		0.08		-0.28
p-value	0.000		0.259		
Observations	**8068**		**1333**		

Note: All the figures are weighted using PHIA appropriate weights. P-value are P values from the t-test of means difference. The observations for HIV-related knowledge and attitudes are 4068 and 684 for more than grade 5 and less than grade 5 groups respectively.

Table 2: Marginal effects of the Poisson regression of HIV-related knowledge in Zambia.

	Model 1	Model 2	Model 3	Model 4
	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)
Grade 5 or more	0.31***	0.32***	0.34***	0.36***
	(0.07)	(0.07)	(0.08)	(0.08)
Post-CSE	-0.58***		-0.56***	
	(0.13)		(0.16)	
Grade5*Post-CSE	0.45***	0.42***	0.43***	0.39**
	(0.13)	(0.13)	(0.16)	(0.16)
Zone 1	-0.08**		-0.02	
	(0.04)		(0.14)	
Grade5 *Zone 1			-0.07	-0.11
			(0.15)	(0.15)
Post-CSE *Zone 1			-0.04	-0.07
			(0.26)	(0.26)
Grade7*Post-CSE *Zone 1			0.06	0.07
			(0.28)	(0.28)
Age fixed-effects?	No	Yes	No	Yes
Province fixed-effects?	No	Yes	No	Yes
Observations	4658	4658	4658	4658

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Coef: marginal effects, SE: Standard error. All the estimations are weighted using PHIA knowledge weights. Additional control variables are ethnic group, religion, gender, wealth index and marital status. The knowledge and attitude estimations are based on a subsample randomly selected from individuals eligible for the individual survey.

Table 3: Marginal effects of NB regression of HIV-related discriminatory attitudes in Zambia.

	(1) Model 1 Coef/(SE)	(2) Model 2 Coef/(SE)	(3) Model 3 Coef/(SE)	(4) Model 4 Coef/(SE)
Grade 5 or more	-0.26***	-0.26***	-0.20***	-0.20***
	(0.05)	(0.05)	(0.06)	(0.06)
Post-CSE	0.09**		0.10**	
	(0.04)		(0.04)	
Grade5*Post-CSE	-0.03	-0.02	-0.03	-0.02
	(0.04)	(0.04)	(0.05)	(0.05)
Zone 1	0.03		0.12*	
	(0.03)		(0.07)	
Grade5 *Zone 1			-0.10	-0.10
			(0.06)	(0.06)
Post-CSE *Zone 1			-0.01	0.01
			(0.07)	(0.07)
Grade7*Post-CSE *Zone 1			0.01	-0.02
			(0.09)	(0.08)
Age fixed-effects?	No	Yes	No	Yes
Province fixed-effects?	No	Yes	No	Yes
Observations	**4618**	**4618**	**4618**	**4618**

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Coef: marginal effects, SE: Standard error. All the estimations are weighted using PHIA knowledge weights. Additional control variables are ethnic group, religion, gender, wealth index and marital status. The knowledge and attitude estimations are based on a subsample randomly selected from individuals eligible for the individual survey.

Table 4: Marginal effects of the ZIP regression of risky sexual behaviours in Zambia.

	Model 1		Model 2		Model 3		Model 4	
	Logit	Poisson	Logit	Poisson	Logit	Poisson	Logit	Poisson
	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)
Grade 5 or more	-0.11***	0.14***	-0.12***	0.15***	-0.13***	0.14***	-0.13***	0.15***
	(0.03)	(0.05)	(0.03)	(0.04)	(0.03)	(0.05)	(0.03)	(0.05)
Post-CSE	0.18***	-0.24***			0.13***	-0.23**		
	(0.04)	(0.07)			(0.05)	(0.09)		
Grade5*Post-CSE	0.11***	-0.21***	0.15***	-0.28***	0.14***	-0.17**	0.17***	-0.25***
	(0.04)	(0.07)	(0.04)	(0.07)	(0.05)	(0.09)	(0.05)	(0.08)
Zone 1	-0.00	-0.05			-0.10	-0.01		
	(0.02)	(0.03)			(0.06)	(0.10)		
Grade5 *Zone 1					0.08	0.01	0.05	-0.01
					(0.06)	(0.11)	(0.06)	(0.10)
Post-CSE *Zone 1					0.13*	-0.05	0.15**	-0.07
					(0.07)	(0.13)	(0.06)	(0.12)
Grade7*Post-CSE *Zone 1					-0.10	-0.06	-0.09	-0.07
					(0.08)	(0.11)	(0.07)	(0.11)
Age fixed-effects?	NO		Yes		No		Yes	
Province fixed-effects?	No		Yes		No		Yes	
Observations	**8948**		**8948**		**8948**		**8948**	

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Coef: marginal effects, SE: Standard error. All the estimations are weighted using PHIA individual weights. Additional control variables are ethnic group, religion, gender, wealth index and marital status.

Annex 1: Complementary tables

Table A1: General description of the sample

	Pre-CSE		Post-CSE			Overall	
	Percent	SE	Percent	SE	P-values	Percent	SE
HIV-related knowledge[a]	4.12	0.02	3.89	0.03	0.000	3.99	0.02
HIV-related discriminatory attitude[a]	0.28	0.01	0.38	0.02	0.000	0.34	0.01
HIV-related risky sexual behaviour	0.67	0.02	0.51	0.02	0.000	0.58	0.01
Sex							
Female	52.22	0.46	49.64	0.29	0.000	50.80	0.15
Male	47.78	0.46	50.36	0.29		49.20	0.15
Age	23.39	0.02	17.48	0.02	0	20.12	0.02
Wealth index	0.24	0.04	0.18	0.03	0.029	0.20	0.03
marital status							
Never married	45.89	1.05	88.61	0.51	0.000	69.39	0.64
Married or living together	48.09	1.04	10.22	0.48		27.26	0.62
Divorced/separated/Widowed	6.02	0.37	1.17	0.16		3.35	0.20
CSE program zones							
Zone 2	49.05	1.38	54.31	1.35	0.000	51.96	1.22
Zone 1	50.95	1.38	45.69	1.35		48.04	1.22
Ethic group							
Bemba	31.24	0.99	31.03	1.06	0.585	31.12	0.89
Tonga	14.45	0.73	14.27	0.78		14.35	0.61
Kaonde	2.83	0.34	2.81	0.37		2.82	0.31
Lozi	7.01	0.61	6.83	0.60		6.91	0.50
Lunda	2.96	0.33	3.40	0.38		3.20	0.31
Luvale	2.83	0.28	2.80	0.26		2.81	0.20
Mambwe	3.36	0.31	2.45	0.26		2.85	0.24
Ngoni	4.85	0.38	4.78	0.50		4.81	0.38
Nyanja	7.77	0.68	8.47	0.61		8.16	0.55
Tumbuka	4.66	0.40	4.59	0.50		4.62	0.41
Other	18.05	0.79	18.58	0.94		18.34	0.75
Religion							
Catholic	19.70	0.93	19.32	0.94	0.017	19.49	0.82
Protestant	68.18	1.01	70.37	1.01		69.39	0.88
Muslim	0.34	0.10	0.38	0.10		0.36	0.08
Other	10.97	0.69	8.83	0.58		9.78	0.54
None	0.81	0.17	1.10	0.20		0.97	0.15
Observations	**4,253**		**5,156**			**9,409**	

Note: Noted: All the figures are weighted using PHIA appropriated weights. [a] The corresponding observations are 4752, 2127 and 2625 overall for pre-CSE and post-CSE cohorts respectively.

Table A2: 'Placebo' estimations using 2 untreated cohorts.

	HIV Knowledge	Discriminatory attitude	Risky sex	
			Logit	Poisson
	Coef/(SE)	Coef/(SE)	Coef/(SE)	Coef/(SE)
Grade 5 or more	0.31***	-0.22***	-0.03	0.01
	(0.08)	(0.05)	(0.02)	(0.05)
Grade5*Post-CSE	-0.01	0.04	-0.03	0.04
	(0.10)	(0.04)	(0.03)	(0.07)
Age fixed-effects?	Yes	Yes	Yes	
Province fixed-effects?	Yes	Yes	Yes	
Observations	**3765**	**3755**	**7238**	

Note: Significance levels: * p < 0.1, ** p < 0.05, *** p < 0.01. Coef: marginal effects, SE: Standard error. All the estimations are weighted using PHIA appropriated weights. Additional control variables are ethnic group, religion, gender, wealth index and marital status.

Annex 2: Model identification for count variables

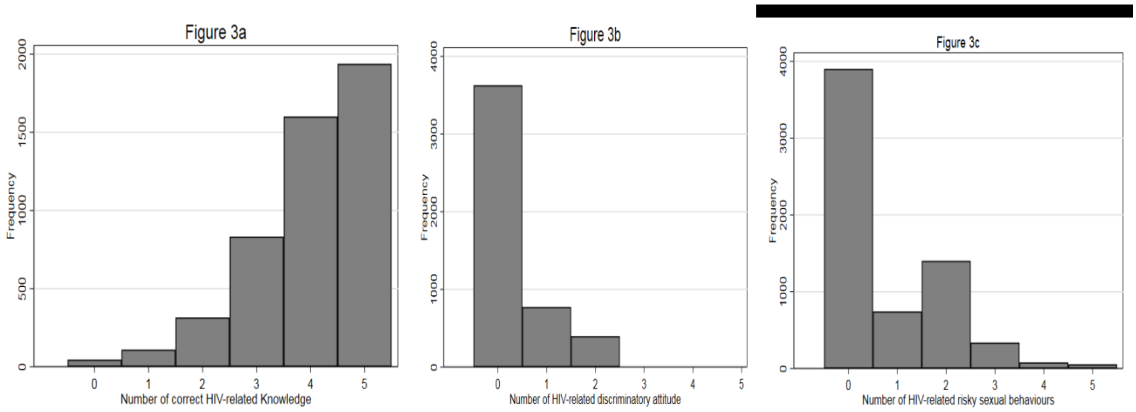
In presence of count outcome variables (non-negative integer) linear regression can produce biased results, for the outcome is not normally distributed (Coxe et al., 2009; Hu et al., 2011). We have performed a set of statistical tests for each count variable in order to identify the model which is appropriated for the data. The tests are performed on unweighted data.

Annex 2a: Identification of the count model for the HIV-related knowledge index

The figure 3a shows that the HIV-related knowledge variable does not present an important number of zeros, thus a count model accounting for excess of zero might not be necessary. In addition, the descriptive statistics presented in table A1 indicate that the variance in not greater than the mean, hence we do not have an overdispersion for this variable. These descriptive figures are confirmed by the goodness-of-fit test of the model. The p-value of the deviance statistic and the Pearson statistic reported in table A3 show that the Poisson regression is appropriate for our data. In addition, the p-value of the likelihood ratio test shows that the overdispersion parameter alpha is not significantly different from zero, thus the Poisson distribution is confirmed. A Poisson regression will thus be used for the HIV-related knowledge index.

Annex 2b: Identification of the count model for the HIV-related discriminatory index

The figure 3b for the HIV-related discriminatory attitude index shows high occurrence of zeros, indicating we might need to account for that distribution in the analyses of the outcome. The variance of this variable is lower than the mean as shown in table A1, pointing the absence of overdispertion. The P-value of the Pearson statistic of the goodness-of-fit test reported in the second column of table A3 suggests that the Poisson regression is not appropriated for our data, even if the deviance statistic is suggesting the contrary. In general, the excess of zero can be accommodated by the Negative binomial (NB) model (Winkelmann, 2008). The likelihood ratio test of overdispersion computed after the NB model and presented in table A3 shows that the parameter of overdispersion is significantly different from zero, hence, the NB model is better that Poisson. Another way to account for the large proportion of zero in data is to use a Zero-Inflated-Poisson regression (ZIP) However, with our data, the ZIP model were not able to converge. In addition, because theoretically our discriminatory attitude index does not include different types of zeros, we are not going to use the ZIP for this index. The Models Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) presented in the third and fourth column of table A4 show that BIC and AIC are lower for the NB, thus we are going to use a NB for the discriminatory attitude index.



Annex 2c: Identification of the count model for the HIV-related risky sexual behaviour index

Similarly to what is observed for the discriminatory index, the graph 3c shows that there is a large proportion of zero for the risky sexual behaviour index, and the variance is not higher than the mean presented in table A1, indicating no overdispersion. The Pearson and deviance statistic of the goodness-of-fit test indicate that the Poisson model does not fit well the data. The Likelihood ratio test of over-dispersion confirms this result. However the AIC and BIC information criteria indicate the superiority of the ZIP over NB. Moreover the ZIP model is justified theoretically by the fact that we have 2 types of zeros: first, those who did not have sexual intercourse in the last 12 months, "structural zero", and second those who had sexual intercourse but did not adopt any of the sexual risky behaviour considered "sampling zero" (Coxe et al., 2009; Hu et al., 2011).

Table A3: P-values of the tests for the identification of the model identification for HIV-related count variables.

Test	Knowledge index	Discriminatory index	risky sexual behaviour index
Goodness-of-fit test deviance statistic	1.000	1.000	0.000
Goodness-of-fit test Pearson statistic	1.000	0.000	0.000
Likelihood ratio test	1.000	0.000	0.000

Table A4: Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) of count models for each HIV-related count variables

Model	**Knowledge index**		**Discriminatory index**		**Risky sexual behaviour index**	
	AIC	BIC	AIC	BIC	AIC	BIC
Poisson	16881.9	17166.35	6700.995	6985.08	17429.28	17742.58
NB	16881.9	17166.35	6682.73	6973.27	16674.53	16994.95
ZIP	NA	NA	NA	NA	15127.12	15753.72

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