

Changing association between schooling levels and HIV-1 infection over 11 years in a rural population cohort in south-west Uganda

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Summary

BACKGROUND Previous studies have found that in Africa, a greater risk of HIV infection is often found in groups with higher educational attainment. However, some serial cross-sectional studies have found greater reductions in HIV prevalence among more educated groups, especially in cohorts of young adults. More recent studies have found some instances where higher schooling levels are associated with lower HIV prevalence.

METHODS We describe changes in the association between schooling levels, HIV prevalence and condom use in a rural population-based cohort between 1989/1990 and 1999/2000, in Masaka District, Uganda.

RESULTS In 1989–1990, higher educational attainment was associated with higher risk of HIV-1 infection, especially among males, but once odds ratios are adjusted for age, no significant relation between schooling and HIV infection remains. In 1999–2000, there is, for females aged 18–29 years, a significant relationship between higher educational attainment and lower HIV prevalence, even after adjustment for age, gender, marital status and wealth (P for trend 0.01). Tests for interaction, significant for males and both genders combined, show that more schooling has been shifting towards an association with less HIV infection between 1989–1990 and 1999–2000, especially for young individuals. Condom use increased during the study period and this increase has been concentrated among more educated individuals.

CONCLUSIONS These findings suggest that over a decade more educated young adults, especially females, have become more likely to respond to HIV/AIDS information and prevention campaigns by effectively reducing their sexual risk behaviour.

keywords Africa, epidemiology, HIV/AIDS, prevention of sexual transmission, risk-factors, seroprevalence

Introduction

A recent review (Hargreaves & Glynn 2002) of 27 studies containing appropriately analysed individual level data on the relationship between HIV prevalence and educational attainment in developing countries concluded that, in Africa, most studies have shown higher education levels to be associated with a greater risk of HIV infection. However, in several serial cross-sectional studies in Uganda (Kilian *et al.* 1999) and Zambia (Fylkesnes *et al.* 1997, 2001) greater decreases in HIV prevalence were observed for individuals with higher education levels, especially among younger age groups. And in more recent studies (Fylkesnes *et al.* 2001; Gregson *et al.* 2001; Glynn *et al.* 2004) instances of associations between more

general education and lower HIV infection were documented.

Schooling is generally considered as a factor increasing access to and understanding of health promotion campaigns (Kilian *et al.* 1999) and the fact that higher schooling levels were found to be associated with higher HIV prevalence has therefore been a cause of concern from a policy perspective. However, higher educational achievement is also associated with higher wealth and increased mobility, and therefore with behaviour that potentially increases exposure to HIV infection (UNAIDS 1998). Appreciation of the main risk factors for acquisition of HIV – early initiation of sexual activity, multiple sexual partners, and not using condoms – has occurred gradually, with the diffusion of AIDS specific health information.

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Variation over time in age-specific HIV prevalence according to level of education might therefore be informative about the way individuals reacted to that health information and how education is associated with the access and the processing of this information.

We describe the changes in the HIV prevalence/education gradient among a population-based cohort located in rural south-west Uganda followed between 1989/1990 and 1999/2000, in which HIV prevalence and incidence have been documented to be falling (Mbulaiteye *et al.* 2002a,b). We complement this analysis by describing the changes in condom use over time and across educational groups as a representative measure of sexual behaviour.

Methods

Survey methods

The study, which has been described in further detail elsewhere (Seeley *et al.* 1991; Nunn *et al.* 1994), surveys the general adult population living in a cluster of 15 homogeneous and contiguous villages in about 80 km² in Masaka District in south-west Uganda. The study area was increased to 25 villages in about 120 km² in 1999/2000. Old and newly surveyed villages are very comparable (Mbulaiteye *et al.* 2002a,b). Most inhabitants of the villages are subsistence farmers living in scattered homesteads and small trading centres. There are a dozen primary schools in the area and five secondary schools. Survey rounds started in November and ended in September (first round in 1989/1990 and 11th round in 1999/2000). Before each survey round, we conducted an annual community and household mobilization to explain the study aims and benefits of participation. We explained how to access HIV-1 test results, we answered questions and clarified any misconceptions in the community. Trained interviewers then collected socio-demographic census data (residence, migration and vital status of all registered residents) through household visits. Questions about schooling, including the highest grade attained, were included at rounds 1, 7, 8, 9 and 11. Information about condom use was collected at rounds 4, 7, 8, 10 and 11. After obtaining informed consent, trained survey staff administer standard risk factor questionnaires to individuals in private after which blood is drawn for HIV-1 serology. Questionnaires and serum samples are transported to Entebbe (about 100 miles away) for further processing.

Laboratory methods

Two independent enzyme immunoassays (EIA) are used to determine HIV-1 status (Wellcozyme HIV-1 recombinant

VK 56/57; Murex Biotech Ltd, Dartford, Kent, UK; and Recombigen HIV-1/2; Trinity Biotech plc, Galway, Ireland) following set algorithms. Samples discordant on EIA and all first time positive samples are tested by Western blot (Cambridge Biotech HIV-1 Western blot; Calypte Biomedical Corporation, Rockville, MD, USA) (Nunn *et al.* 1993).

Ethical issues

Survey staff encourage participants to request their HIV-1 test results from trained counsellors who operate within the study area (Seeley *et al.* 1991). In line with the Uganda national guidelines for HIV testing, results are only issued to respondents in person after pre- and post-test counselling (Uganda AIDS Commission policy statements). Residents have had access to free medical care from a purpose built study clinic since 1995. The HIV-1 status of participants is masked to local survey and clinical staff for reasons of confidentiality. The Uganda National Council for Science and Technology gave ethical approval for the study.

Statistical methods

Census, medical and laboratory data are double entered using Foxpro for Windows (Microsoft Corp., USA) and checked for consistency before statistical analysis is performed using Stata 8.0 (Stata Corporation, College Station, TX, USA).

HIV prevalence is computed using cross-sectional measures. The numerator is the number of adults with an HIV-1 seropositive status and the denominator is the total number of adult residents with a definite HIV-1 serostatus at that round.

The analysis is focused on rounds 1 (1989–1990) and 11 (1999–2000), the first and last ones where information about schooling levels is available. In order to follow the changes in the association between HIV infection and education between round 1 and 11, odds ratios (OR) for HIV infection by education categories were estimated by maximum likelihood. The analysis is stratified by gender. We performed an approximate chi-squared test of homogeneity of odds and a test for linear trend of the log odds against the numerical code used for the education categories. Both of these tests are based on the score statistic and its variance. Further, we present OR adjusted for gender, age, marital status and wealth, along with a score test for trend. Tests for interactions are used to report on the significance of differences across genders and across periods. For the test of the significance of differences by gender, if the interaction term between education and

being male is statistically greater than 1 (95% confidence interval does not include 1), it suggests that the effect of education on HIV infection is less protective for males than for females (and conversely if the interaction term is lower than 1). For the test of the significance of differences between round 1 and round 11, the data from both rounds were pooled. If the interaction term between education and round 11 is statistically lower than 1, it suggests that higher education levels have become associated with less HIV infection over time (and conversely if the interaction term is larger than 1).

Education categories were defined as no education, some primary education (up to 6 years of schooling), primary education completed (7 years of schooling) and post-primary education (more than 7 years of schooling). Only a small fraction of individuals had some post-secondary education (47 or 1.55% at round 1 and 173 or 4.19% at round 11): they were, therefore, included in the larger post-primary education category. To account for changes in the distribution of education level over time and across age groups, ORs for an incremental year of education, i.e. the ORs of having HIV with ($n + 1$) years of schooling compared with n years of schooling, were also computed. Using the four education categories allowed us to verify the existence of non-linearities, while using the OR for an incremental year of education implicitly assumes that education has a linear effect. Adjustment for age was done using age-specific dummy variables. For marital status adjustment, data were stratified into three groups: single, currently married and previously married individuals (including divorced and widowed). For wealth adjustment, the measure used was the type of housing and the data were stratified into three categories: houses made of soft materials (mud or wattle walls with grass or reed roof), hard materials only (walls of bricks and iron sheet roof) or a combination of both (generally mud or wattle walls with iron sheet roof). The information about the type of housing was collected at round 1 and at round 12 (2000–2001). At round 11, we used the longitudinal feature of the data set and used as proxy for wealth the type of housing recorded at round 12. At each round, the analysis was performed for individuals aged 18 years and older, and then for two sub-populations: individuals aged 18–29 and individuals aged 30 and older. The purpose of the restriction to individuals aged at least 18 is to ensure that most participants have completed school and that therefore the levels of educational attainment used in the analysis are definitive and stable. This also ensures that the participants are not attending school where, in addition to general education, they could be exposed to specific prevention programs. The motivation behind the

cut-off between the two age groups is that, by isolating the group aged 18–29, we can focus, at round 11, on a group that started their sexual activity after HIV/AIDS education and information campaigns began in 1986, unlike the older group. Note that the individuals aged 18–29 at round 1 are different from the individuals aged 18–29 at round 11.

Results

The association between HIV prevalence and the four education categories at round 1 and round 11 is shown in Table 1. At round 1, the comparison of the prevalence for each schooling level and the unadjusted OR indicate that higher educational attainment is associated with a higher risk of HIV infection. The OR increases with education both for males (P for trend = 0.003) and females (P for trend = 0.003). For males, this association can be seen to be mainly because of the contribution of those aged over 29 (P for trend = 0.01). After adjusting OR for age, gender, marital status and wealth none of the tests for trend are significant for either gender or both age groups, and they are not significantly different from each other. It is mainly the adjustment for age that causes the association between higher schooling levels and higher risk of HIV infection to lose significance, since, when ORs are adjusted for wealth and marital status, but not for age, the association persists for males (P for trend = 0.001) and females (P for trend = 0.01).

At round 11 the unadjusted ORs indicate that higher schooling levels are associated with lower HIV prevalence for females aged 18–29 (P for trend = 0.0001), and for males (P for trend = 0.025). This is in sharp contrast to the positive HIV/education gradient observed at older ages (above age 29) for females (P for trend <0.0001).

When ORs are adjusted for age, gender, marital status and wealth, higher schooling levels are still significantly associated with lower HIV prevalence for young females (P for trend = 0.01) whereas the result for the older females is not robust to these adjustments (P for trend = 0.79). After adjustment, there is no clear or significant relationship between HIV and education among young males (P for trend = 0.26) or older males (P for trend = 0.47).

In Table 1, individuals are included in one of four educational categories, allowing for non-linear relationships between education levels and HIV infection. A test of homogeneity (equal odds) is performed for the unadjusted OR. The hypothesis that the odds of being HIV positive are equal for all education levels is rejected for both age-groups and genders at round 11 (1999–2000), while it is rejected only for both age-groups combined and for older males at round 1 (1989–1990).

Table 1 Educational levels and the risk of HIV infection at rounds 1 and 11

Age (years)	Schooling	Round 1			Round 11		
		HIV+ % (<i>n</i>)	OR (95% CI)*	OR (95% CI)†	HIV+ % (<i>n</i>)	OR (95% CI)*	OR (95% CI)†
<i>Females</i>							
18 and above	All	9.9 (1627)			7.6 (2271)		
18 and above	No education	7.8 (623)	1 (<i>P</i> = 0.003)‡	1 (<i>P</i> = 0.98)	4.2 (502)	1 (<i>P</i> = 0.132)	1 (<i>P</i> = 0.15)
	Some primary	9.7 (729)	1.26 (0.86–1.85)	0.70 (0.39–1.25)	9.1 (999)	2.29 (1.40–3.74)	0.84 (0.45–1.56)
	Primary completed	17.3 (144)	2.46 (1.45–4.16)	2.09 (0.82–5.35)	8.4 (369)	2.10 (1.18–3.72)	0.49 (0.23–1.05)
	Post-primary	12.9 (131)	1.74 (0.96–3.14)	0.93 (0.33–2.61)	7.5 (401)	1.85 (1.04–3.29)	0.38 (0.13–1.08)
			<i>P</i> = 0.004§			<i>P</i> = 0.007	
18–29	No education	21.0 (100)	1 (<i>P</i> = 0.94)	1 (<i>P</i> = 0.97)	15.9 (69)	1 (<i>P</i> = 0.0001)	1 (<i>P</i> = 0.01)
	Some primary	13.6 (337)	0.59 (0.33–1.05)	0.44 (0.19–1.01)	10.9 (394)	0.64 (0.31–1.32)	0.59 (0.24–1.46)
	Primary completed	18.8 (106)	0.87 (0.44–1.73)	1.73 (0.59–5.09)	6.8 (191)	0.38 (0.16–0.91)	0.40 (0.13–1.16)
	Post-primary	17.1 (70)	0.77 (0.35–1.71)	1.16 (0.37–3.64)	3.6 (250)	0.19 (0.07–0.50)	0.08 (0.01–0.88)
			<i>P</i> = 0.27			<i>P</i> = 0.0009	
30 and above	No education	5.3 (523)	1 (<i>P</i> = 0.12)	1 (<i>P</i> = 0.99)	2.3 (433)	1 (<i>P</i> < 0.0001)	1 (<i>P</i> = 0.79)
	Some primary	6.3 (392)	1.20 (0.69–2.10)	1.18 (0.49–2.81)	7.9 (605)	3.64 (1.8–7.32)	1.14 (0.47–2.76)
	Primary completed	13.1(38)	2.67 (0.96–7.42)	4.50 (0.58–34.8)	10.1 (178)	4.75 (2.12–10.6)	0.62 (0.20–1.91)
	Post-primary	8.2 (61)	1.57 (0.58–4.25)	0.49 (0.04–5.30)	13.9 (151)	6.83 (3.07–15.2)	0.83 (0.21–3.25)
			<i>P</i> = 0.23			<i>P</i> < 0.0001	
<i>Males</i>							
18 and above	All	10.0 (1388)			7.3 (1836)		
18 and above	No education	8.1 (204)	1 (<i>P</i> = 0.003)	1 (<i>P</i> = 0.40)	3.2 (216)	1 (<i>P</i> = 0.38)	1 (<i>P</i> = 0.22)
	Some primary	8.6 (745)	1.06 (0.64–1.75)	0.87 (0.41–1.82)	9.6 (857)	3.20 (1.45–7.05)	4.26 (1.19–15.2)
	Primary completed	14.5 (186)	1.92 (1.06–3.48)	2.23 (0.65–7.69)	6.1 (324)	1.96 (0.81–4.74)	2.81 (0.53–14.7)
	Post-primary	14.4 (173)	1.91 (1.04–3.50)	0.65 (0.19–2.12)	5.7 (439)	1.80 (0.76–4.24)	0.92 (0.19–4.39)
			<i>P</i> = 0.012			<i>P</i> = 0.002	
18–29	No education	8.5 (47)	1 (<i>P</i> = 0.32)	1 (<i>P</i> = 0.30)	2.4 (42)	1 (<i>P</i> = 0.025)	1 (<i>P</i> = 0.26)
	Some primary	11.5 (269)	1.40 (0.46–4.17)	1.37 (0.39–4.80)	7.5 (292)	3.34 (0.43–25.6)	1.27 (0.09–17.3)
	Primary completed	14.8 (108)	1.86 (0.58–5.97)	2.08 (0.40–10.7)	1.9 (153)	0.82 (0.08–8.14)	.
	Post-primary	13.2 (68)	1.63 (0.46–5.72)	0.36 (0.05–2.69)	2.4 (209)	1.00 (0.11–8.86)	0.87 (0.07–10.6)
			<i>P</i> = 0.68			<i>P</i> = 0.010	
30 and above	No education	8.0 (237)	1 (<i>P</i> = 0.011)	1 (<i>P</i> = 0.86)	3.4 (174)	1 (<i>P</i> = 0.32)	1 (<i>P</i> = 0.47)
	Some primary	6.9 (476)	0.85 (0.47–1.53)	0.63 (0.24–1.62)	10.8 (565)	3.38 (1.43–8.02)	6.41 (1.32–31.0)
	Primary completed	14.1 (78)	1.88 (0.84–4.17)	2.40 (0.38–15.1)	9.9 (171)	3.09 (1.17–8.11)	2.50 (0.49–12.7)
	Post-primary	15.2 (105)	2.06 (1.00–4.21)	0.90 (0.19–4.19)	8.7 (230)	2.66 (1.04–6.83)	0.95 (0.13–6.95)
			<i>P</i> = 0.015			<i>P</i> = 0.031	

OR, odds ratio; CI, confidence interval.

* Unadjusted; † adjusted for marital status, wealth and age.

‡ The *P*-value between square brackets, next to the baseline value of 1 is for a score test for linear trend of the log odds, $P > \chi^2$.§ The *P*-value under the unadjusted odds ratio is for an approximate chi-squared test of homogeneity (equal odds), $P > \chi^2$.

After adjustment for wealth, age and marital status at round 11, females aged 18–29 with post-primary education are at significantly lower risk of HIV-1 infection (adjusted CI 0.01–0.88) than women with no education, the baseline group. Among males aged 18 and above, individuals with some primary education (but not completed) are at higher risk (adjusted CI 1.19–15.2) than individuals with no education. This effect is mainly because of males older than 29 (adjusted CI 1.32–31.0).

One important issue to address when comparing the association between HIV prevalence and education across

age groups and over time is that the distribution of educational attainment has been changing with the increase in the general level of education and the expansion of the supply of schools in the surveyed area. This can be inferred from the observations reported in Table 1 where, at both rounds 1 and 11, the fraction of individuals with no education is larger in the older age group and the fraction with at least some post-primary education is higher in the younger group. Also, at round 11, the fraction with no education was lower than at round 1 and the fraction with some post-primary education higher. In

Table 2 Years of education and the risk of HIV infection at rounds 1 and 11

Age (years)	Round 1			Round 11			Interaction rounds 1–11: both rounds, round 11 × education		
	Males, adjusted OR* (95% CI)	Females, adjusted OR* (95% CI)	All: interaction male × education, adjusted OR† (95% CI)	Males, adjusted OR‡ (95% CI)	Females, adjusted OR‡ (95% CI)	All: interaction male × education, adjusted OR§ (95% CI)	Males, adjusted OR* (95% CI)	Females, adjusted OR* (95% CI)	All, adjusted OR¶ (95% CI)
18 and above	1.016 (0.94–1.09)	1.013 (0.94–1.08)	1.068 (0.97–1.16)	0.951 (0.87–1.03)	0.937 (0.86–1.01)	1.072 (0.98–1.17)	0.917 (0.83–1.00)	0.967 (0.88–1.05)	0.944 (0.88–1.00)
18–29	1.007 (0.90–1.12)	1.019 (0.93–1.11)	1.037 (0.93–1.15)	0.910 (0.77–1.06)	0.863 (0.77–0.96)	0.984 (0.84–1.15)	0.812 (0.69–0.95)	0.940 (0.85–1.03)	0.902 (0.82–0.98)
30 and above	1.022 (0.92–1.13)	1.001 (0.89–1.12)	1.141 (0.97–1.33)	0.970 (0.87–1.07)	1.004 (0.90–1.11)	1.114 (1.00–1.23)	0.979 (0.87–1.10)	1.039 (0.88–1.22)	0.999 (0.90–1.09)

OR, odds ratio, CI, confidence interval. The Odds Ratio is an approximation to the odds ratio for one unit increase in schooling, i.e. one additional year of education.

* Adjusted for age, wealth and marital status; † odds ratio for the interaction between years of education and male, adjusted for years of education, age, wealth and marital status; ‡ adjusted for age, wealth and marital status and village in old or new sample; § odds ratio for the interaction between years of education and male, adjusted for years of education, age, wealth and marital status and village in old or new sample; ¶ adjusted for age, wealth, gender and marital status.

general, males have a higher educational attainment than females, but this difference tends to disappear as documented by the age-group 18–29 at round 11.

Table 2 shows the relationship between years of schooling and risk of HIV infection at rounds 1 and 11. This allows for a change in the distribution of education over time, by calculating the impact of one additional year of schooling (OR of HIV infection for an incremental year of schooling) rather than going from one education category to another, as in Table 1. At round 1, for both genders and for both age groups and for all individuals older than 17 taken together, none of the OR, adjusted for gender, marital status, wealth and age are statistically different from 1. At round 11, the adjusted OR of HIV infection for one additional year of education is significantly lower than 1 (OR 0.863, CI 0.77–0.96) for females aged 18–29. At round 11, we present OR adjusted for age, marital status and wealth but also for whether or not the individual belongs to one of the new villages added to the sample at round 11, in order to control for any potential effect specific to the new villages.

Table 2 also reports interaction tests for the statistical significance of differences across genders. The interaction terms are not significantly different than 1 at round 1, suggesting no statistical difference in the effect of education by gender. At round 11, the interaction term between education and males is significantly higher than 1 for individuals older than 29, suggesting a stronger protective effect of education for females.

The last three columns of Table 2 report the results of interaction tests for the statistical significance of differences between round 1 and round 11, for males and females separately and for both genders together. For males and for both genders together, the interaction terms between education and round 11 are significantly lower than 1, indicating that higher education levels have become associated with less HIV infection over time for individuals aged 18 and above and for individuals aged 18–29 years.

Despite the fact that the information about condom use is not available at each round, there has been a clear upward trend in condom use in the surveyed population over time. The proportion of sexually experienced individuals older than 17 who report ever having used a condom was 6.99% at round 4 (1992/1993), 19.48% at round 7 (1995/1996), 21.61% at round 8 (1996/1997), 23.57% at round 10 (1998/1999) and 25.66% at round 11 (1999/2000). Ever use of condoms among sexually experienced individuals is taken as a representative measure of protective sexual behaviour. Figures 1a,b analyse the diffusion of condom use across different educational groups in the population, separately for males and females. The results are reported for the three rounds

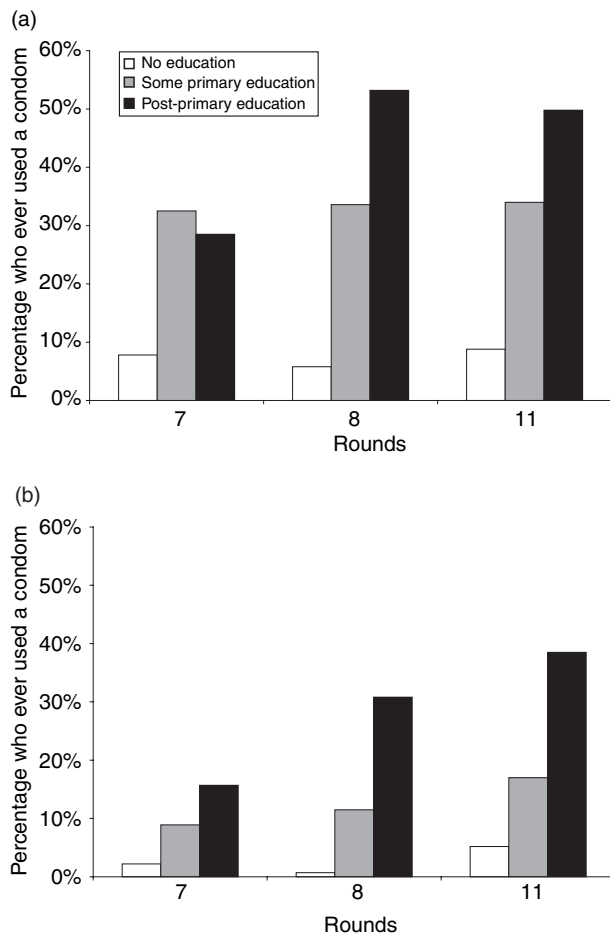
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Figure 1 (a) Percentage of sexually experienced males older than 17 who ever used a condom, by education category at several rounds of the General Population Cohort, MRC, Rural Uganda. (b) Percentage of sexually experienced females older than 17 who ever used a condom, by education category at several rounds of the General Population Cohort, MRC, Rural Uganda.

(7, 8 and 11) where both information about schooling levels and condom use had been collected. At the three rounds there is a strong association between higher schooling levels and greater likelihood of having ever used a condom (P for trend <0.0001 at each of the three rounds for both genders). The comparison between Figure 1a and b indicates that, while the level of condom use is higher among males, the gradient between higher educational achievement and greater condom use is steeper for females than for males (at round 7, chi-square for trend of odds is 19.88 for males and 41.53 for females; at round 8, 69.10 for males and 82.13 for females and at round 11, 103.01 for males and 164.18 for females).

Discussion

This study is one of the few to report a statistically significant association between greater educational attainment and less HIV infection on the African continent. Other documented instances are among sugar estate workers in Ethiopia (Fontanet *et al.* 2000), among males and females aged 15–24 years in urban areas in Zambia (Fylkesnes *et al.* 2001) and in Gambia (Wilkins *et al.* 1991). In addition, Glynn *et al.* (2004), in their comparative study of four African cities, report associations between more education, less risky sexual behaviour and less HIV infection for women in Yaoundé (Cameroon) and for men in Cotonou (Benin), but not in Kisumu (Kenya) or Ndola (Zambia).

Our study complements and extends the previous studies by showing changes in the association with education over time. Indeed, the present study allows us to follow the evolution of the HIV/education gradient in a population over more than a decade. We describe the change from the absence of a significant association between HIV infection and education early in the history of the epidemic (1989–1990) to the appearance of an association between higher schooling levels and lower HIV prevalence among young women at the end of the decade (1999–2000). We also show, through interaction tests, that the nature of the association between schooling and HIV-1 infection is statistically different – shifting towards a negative relationship – over this study period for males and for both genders combined. We complete this analysis by showing that condom use increased during the study period and that this increase has been concentrated among more educated individuals.

We cannot completely exclude the possibility of bias in our results, due for example to shifts in the population structure or residual confounding if wealth or marital status are subject to misclassification. However, in Table 2 we accounted for the changes of the educational distribution in the population. We have also taken into account the addition of ten new survey villages at round 11.

Many studies conducted early in the history of the epidemic in Malawi (Glynn *et al.* 2001), Tanzania (Grosskurth *et al.* 1995; Quigley *et al.* 1997; Senkoro *et al.* 2001), Uganda (Kirunga & Ntozi 1997; Konde-Lule *et al.* 1997; Smith *et al.* 1999) and Zambia (Fylkesnes *et al.* 1997) have found that higher schooling levels were associated with higher risk of HIV infection, both in rural and urban settings. The analysis performed in this study at the initial round (1989–1990), if unadjusted, yields the same conclusion, in particular for individuals older than 29. However, when the OR are

adjusted for age, gender, marital status and wealth, the observed association between education and HIV infection disappears. In the surveyed area, the positive correlation between HIV infection and schooling is mainly because of an age profile effect, since both HIV infection and higher educational attainment are commonest between ages 20 and 40 years. We have noted this effect in previous studies (Nunn *et al.* 1994). Many earlier studies also found no statistically significant association between education and HIV infection (see Hargreaves & Glynn 2002 for a complete review).

The fact, observed at the end of the study period, that higher education levels are associated with a lower risk of HIV infection, is only significant for the group of women aged 18–29. In this age group, the evolution of the HIV prevalence is less likely to be greatly affected by HIV/AIDS related mortality, given that the median time between seroconversion and death is around 10 years (Morgan & Whitworth 2001; Morgan *et al.* 2002).

Crucially, this is also an age group in which individuals will have started their sexual life after the beginning of HIV/AIDS information campaigns. The first case of AIDS was diagnosed in Uganda in 1982 and in 1986 the first prevention efforts at a national level were launched. The arrival of our Programme in the survey area in 1989 may have further increased AIDS awareness in the population.

Most individuals born before 1971 will have started their sexual life before the national prevention campaigns began, assuming that age at first sex is 16–18 years (Kamali *et al.* 2000). By contrast, individuals born after 1971 had already had access to information about the epidemic when they initiated their sexual activities. The age group 18–29 in 1999/2000 (round 11) is therefore composed of individuals who started their sexual activity after the information campaigns began. In contrast, the same age group in 1989/1990 (round 1) and the older age group started their sexual life before information about HIV and AIDS became available. Even though later in life, they would be exposed to the information and prevention campaigns, they may have already developed sexual behaviours that put them at risk of HIV infection.

It is among the individuals who have been exposed to the information and prevention messages from the beginning of their sexual life that the differences between round 1 and round 11 in the association between education and HIV infection are statistically significant. This result suggests that, once the information about the HIV/AIDS epidemic and its prevention methods is diffused, more educated young individuals are able to adapt more quickly and more substantially change their behaviour.

However, at round 11, it is only among young females that higher educational achievement is significantly associated with a lower HIV prevalence. The reason for this difference in the role of education across genders is interesting and should be further studied. One potential explanation is that education promotes self-efficacy and will particularly help women who typically play a subservient role in sexual negotiation.

The most plausible connection between increased education and a lower prevalence of HIV infection is through changes in sexual risk behaviour. This is consistent with our finding that there has been an increase of condom use during the survey period and that this increase has been concentrated among the more educated groups of the population. Even though the reported level of condom use is higher among males, the fact that the positive gradient between education and condom use is steeper for females is consistent with the finding that it is only among females that higher schooling levels are significantly associated with lower HIV prevalence. The findings of this paper are consistent with the hypothesis that education helps individuals in accessing and processing health related information (Kilian *et al.* 1999) even in a rural population of subsistence farmers. In this regard, it is important to notice that our results are robust when we adjust for wealth (using the type of housing as a proxy), which indicates that education has an effect independent of income. Our previous studies (Mbulaiteye *et al.* 2002a,b; Whitworth *et al.* 2002) have established the existence of a significant decline in adult HIV incidence, showing that the observed decline in HIV prevalence was not merely the consequence of the mortality of the people previously infected. The present study, by suggesting that more educated people have benefited most from the HIV information campaigns, further reinforces the conclusion that behavioural changes have driven the decline in HIV prevalence in the survey area. Indeed, it is among more educated young adults, the group that one would expect to be the most responsive to health information, that behavioural responses, as indicated by larger declines in HIV prevalence, have been largest.

This conclusion, from a policy perspective, is encouraging as it demonstrates that information campaigns have been effective. Further, the main result of the present study, the fact that higher educational attainment is associated with lower HIV prevalence for young women (ages 18–29), suggests that the role of the educational sector in fighting the HIV/AIDS epidemic should not be overlooked. In the long run, a more educated population is more responsive to health promotion campaigns. This conclusion is of crucial importance, as many African countries are now experiencing a large generalization of

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the epidemic that puts a heavy drain on the education system.

Finally, the fact that less educated individuals have benefited less from the prevention efforts might indicate that alternative approaches should be developed to better reach them.

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