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Does increased general schooling protect against HIV infection? A study in four African cities

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Summary

BACKGROUND The association between educational attainment and risk of HIV infection varies between populations and over time. Earlier studies in sub-Saharan Africa have found that those with more education are at increased risk of HIV infection.

METHODS We investigated the associations between general schooling and both HIV and herpes simplex-2 (HSV-2) infection using data from the multicentre study on factors determining the differential spread of HIV in four African cities. Cross-sectional general population studies were conducted in 1997–1998 in Cotonou (Benin), Yaoundé (Cameroon), Kisumu (Kenya), and Ndola (Zambia), including about 2000 adults in each city.

RESULTS There was no association between schooling and HIV infection in men or women in Kisumu or Ndola. Women in Yaoundé and men in Cotonou, with more schooling, were less likely to be HIV positive. These associations persisted after adjusting for sociodemographic factors. Similar trends in men in Yaoundé and women in Cotonou were not statistically significant. Increased schooling was associated with significantly decreased risk of HSV-2 infection in women in Kisumu and Ndola and men in Cotonou. In all the cities those with more education tended to report less risky sexual behaviour.

CONCLUSIONS There was no evidence of an increased risk of HIV infection associated with education as seen in earlier studies. In each city there was some evidence of lower HIV or HSV-2 infection rates and less risky sexual behaviour associated with increased education levels. The most educated may be responding more readily to health education programmes. The challenge is to extend this to the rest of the population.

keywords HIV, schooling, education, risk factors, herpes simplex-2, sexual behaviour, Africa

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Introduction

Human immunodeficiency virus (HIV) control programmes aim to reduce transmission of the virus through behaviour change. Both behaviour and the ability to change behaviour are likely to be linked to education level. It is hoped that better educated individuals will be more likely to access relevant information on HIV prevention and more able to act on it to change behaviour. However the socioeconomic position, opportunities for travel, delayed first marriage and other factors that accompany education may increase behaviours leading to a higher risk of HIV infection. Conversely, low education and poverty in women may increase the exchange of sex for money, and pregnancy is an important cause of school drop-out. Schooling could therefore be associated with either an increase or a decrease in the risk of HIV infection depending on the balance of the different influences on behaviour (Gregson *et al.* 2001a).

In the early years of the HIV epidemic it was noted that HIV infection was more common in better educated people of higher socioeconomic status, but it was postulated that this pattern would change as HIV spread in the population (Over & Piot 1993). In recent years, improvement in sexual and/or reproductive health education specifically addressing HIV and sexually transmitted infections (STI) given in schools should also lead to safer sex behaviour among young people who have been to school.

Many studies have looked at education and risk behaviour but few have compared education with HIV status directly (Hargreaves & Glynn 2002). In Africa, after appropriate adjustment for age and other sociodemographic factors (and without additional adjustment for behavioural factors, as this may obscure any association), most studies in the general population have either shown no association between education and HIV-1 status, or an increase in HIV-1 risk with increasing education. Several large studies showed higher risks of HIV infection among those with more education than among those with less education: general population studies in Mwanza, Tanzania in 1991–1992 (Grosskurth *et al.* 1995; Quigley *et al.* 1997), Rakai, Uganda in 1990–1992 (Kirunga & Ntozi 1997; Smith *et al.* 1999), and Karonga District, Malawi in 1987–1989 (Glynn *et al.* 2001), and studies among women attending antenatal clinics in Fort Portal, Uganda in 1991–1994 (Kilian *et al.* 1999), and both rural and urban areas of Zambia in 1994 and 1998 (Fylkesnes *et al.* 1997, 2001). Two population-based studies in Africa showed the opposite trend after adjustment: among young women in a rural population in Zimbabwe in 1998–2000 (Gregson *et al.* 2001a), and for an association with HIV-2 in The Gambia (Wilkins *et al.* 1991). In Ethiopia higher levels of education were associated with lower HIV prevalence among sugar estate workers (Fontanet *et al.* 2000), but with higher HIV prevalence in male army recruits from rural areas (Abebe *et al.* 2003). Other studies have shown no statistically significant association between educational level and HIV status (Gregson *et al.* 2001b; Hargreaves & Glynn 2002).

In Uganda, Zambia and northern Malawi (Fylkesnes *et al.* 1997, 2001; Kelly *et al.* 1999; Kilian *et al.* 1999; Smith *et al.* 1999; Crampin *et al.* 2003), but not in Blantyre, Malawi (Taha *et al.* 1998) or Tanzania (Kwesigabo *et al.* 1998), there is some evidence from serial studies that the association may be changing over time, with a shift from a higher risk of HIV in those with more education to no association between education and HIV (Fylkesnes *et al.* 1997, 2001; Kilian *et al.* 1999; Crampin *et al.* 2003) or even to a protective effect of education in young age groups (Fylkesnes *et al.* 2001).

As part of the Multicentre Study on Factors Determining the Differential Spread of HIV in four African Cities, we collected data on education, HIV status and sociodemographic and behavioural factors in adults in the population, using identical methods in four cities: two with a relatively low HIV prevalence and two with a high prevalence. We have already shown that increased educational attainment was associated with increased condom use in non-spousal partnerships in these cities (Lagarde *et al.* 2001). Here we present the results of analyses on the association of education and HIV infection. We have also explored associations between education and Herpes simplex-2 (HSV-2) infection. HSV-2 infection is strongly associated with HIV infection (Weiss *et al.* 2001) but is present in a higher proportion of the population, giving us greater statistical power in the analyses, particularly in the lower HIV prevalence sites and younger age groups. It has been suggested as a biological marker of high-risk sexual behaviour (Obasi *et al.* 1999). Little is known about the association between education and HSV-2 in Africa (McFarland *et al.* 1999; Obasi *et al.* 1999).

Methods

Full details of the methods have been described elsewhere (Buvé *et al.* 2001a). Two-stage cluster sampling was used to identify approximately 1000 men and 1000 women in each of Cotonou (Benin), Yaoundé (Cameroon), Kisumu (Kenya) and Ndola (Zambia) in 1997–1998. Within identified households, all individuals aged between 15–49 who had slept there the night before were eligible for inclusion. Repeat visits were made if those eligible were not present. If consent was given they were interviewed for the study. Questionnaires included questions on schooling

level, ethnic group, religion, marital status and detailed questions on sexual behaviour, including information on up to eight non-spousal partnerships in the previous 12 months (UNAIDS 1998). Separate consent was sought before taking blood, which was tested for HIV, HSV-2 and syphilis. Urine was tested for gonorrhoea and chlamydial infection. HIV testing was anonymous but linked. Participants wishing to know their HIV serostatus were referred for counselling and testing, free of charge.

Schooling level was recorded as none, primary incomplete, primary complete, secondary and higher. Due to small numbers with no schooling or higher education these categories have been combined with the nearest category. As the primary objective of this analysis was to examine any change over time, analyses were carried out for different age groups (15–24 and 25–49), as well as overall, and interactions with age examined. Odds ratios for the association of schooling and HIV infection, and schooling and HSV-2 infection were calculated and were adjusted for possible confounding by age, ethnic group and religion. Age was adjusted for using four groups (15–19, 20–24, 25–29, 30–49 years), when the whole age range was considered and by year of age when considering the smaller age groups.

In order to try to understand any associations found with schooling, we also examined the association between schooling and a number of behaviours which have previously been found to be, or are likely to be, associated with HIV risk: marriage; age at sexual debut <15; having more than three lifetime partners (for women) or more than five (for men); having more than one non-marital partner in the last 12 months (if unmarried) or any non-marital partners (if married). For those who had had any non-marital partnerships in the last 12 months we examined associations between education and having had any partnerships with the following characteristics: money was exchanged for sex; condoms were usually not used; sex occurred on the day that the partners first met; the partner was more than 5 years older than the respondent (for women) or no more than 5 years younger (for men); the age of the partner was not known. Associations with these factors were examined after adjusting for age, ethnic group and religion.

The associations between schooling and HIV, and schooling and HSV-2 were adjusted for these behavioural factors to see if any of the associations could be explained by the factors measured. If an association is found between schooling and HIV or HSV-2, but this association becomes less strong or disappears after adjusting for a behavioural factor, it would suggest that the effect of schooling is at least partly due to differences in this behaviour in those with different levels of schooling. For these adjustments, for variables that referred to details of relationships in the last 12 months (exchange of money, sex without condoms, sex on day of meeting, age of partner), individuals without any non-marital partners were classified as not having the risk behaviour, and individuals for whom details of some partnerships were missing were classified as having the risk behaviour.

Schooling could also influence the likelihood of getting treated for an STI. Men were asked what they had done if they had any pain or discharge or sores in the last 12 months. The detectable presence of treatable STIs when seen in the survey was explored as this also suggests a lack of appropriate treatment.

Ethical approval

Ethical approval was obtained from the national ethics committees in each of the countries where the study took place, as well as from the ethics committees of the Institute of Tropical Medicine, Antwerp, the London School of Hygiene and Tropical Medicine, and The Population Council.

Results

Between 75% and 96% of individuals eligible for the study were interviewed in the different cities, and between 62% and 89% were both interviewed and gave blood for HIV testing (Buvé *et al.* 2001a). The lowest participation rates were among men in Kisumu and Ndola. The main reason for not being included in the survey was not being found despite repeat visits: very few individuals refused to be interviewed. In Kisumu some men were interviewed in an extra round in which few HIV tests were taken. In all sites those with secondary education were the most likely not to have had HIV tests done, but there was little difference in reported sexual behaviour between those with and without HIV results.

The overall HIV prevalence was higher in Kisumu and Ndola than in Cotonou and Yaoundé, and was higher in women than in men (Table 1). Education levels were lowest in Cotonou, where nearly two thirds of the women and one third of the men had not completed primary education, and highest in Yaoundé, where these proportions were 14% and 8%.

There was no association between schooling and HIV infection in Kisumu or Ndola in either men or women, with or without adjusting for age, ethnic group and religion, overall or by age group. In Yaoundé, women with more schooling were less likely to be HIV positive. The association persisted after adjusting for age, ethnic group and religion, and was similar in those under 25 and over 25 years of age. In men in Yaoundé there was very little

Table 1 Association between schooling and HIV status in population surveys in four African towns

		Cotonou		Yaoundé		Kisumu		Ndola	
Age	Schooling	HIV+ % (*n*/*N*)	OR (95% CI)	HIV+ % (*n*/*N*)	OR (95% CI)	HIV+ % (*n*/*N*)	OR (95% CI)	HIV+ % (*n*/*N*)	OR (95% CI)
Women									
15–49	All	3.4 (35/1015)		7.8 (79/1017)		30.1 (269/893)		31.9 (290/910)	
15–49	<Primary	4.1 (26/629)	1	11.5 (16/139)	1	30.0 (115/384)	1	29.6 (95/321)	1
	Primary	2.3 (8/346)	0.52 (0.23–1.2)	7.6 (56/733)	**0.53 (0.27–1.0)**	30.0 (106/353)	0.89 (0.64–1.2)	33.1 (144/435)	1.2 (0.85–1.6)
	Sec/high	2.6 (1/38)	0.52 (0.07–4.0)	4.8 (7/145)	**0.30 (0.11–0.78)**	30.8 (48/156)	0.92 (0.60–1.4)	33.1 (51/154)	1.1 (0.69–1.6)
15–24	<Primary	4.3 (11/256)	1	15.0 (6/40)	1	31.6 (55/174)	1	25.3 (40/158)	1
	Primary	1.3 (2/158)	0.28 (0.06–1.3)	5.6 (21/375)	**0.31 (0.10–0.99)**	28.3 (52/184)	0.77 (0.48–1.2)	30.2 (67/222)	1.2 (0.76–2.0)
	Sec/high	0.0 (0/8)		5.0 (3/60)	**0.20 (0.04–1.0)**	31.9 (22/69)	0.84 (0.44–1.6)	29.9 (20/67)	0.95 (0.48–1.9)
25–49	<Primary	4.0 (15/373)	1	10.1 (10/99)	1	28.6 (60/210)	1	33.7 (55/163)	1
	Primary	3.2 (6/188)	0.68 (0.27–1.7)	9.8 (35/358)	**0.48 (0.21–1.1)**	32.0 (54/169)	0.96 (0.60–1.5)	36.2 (77/213)	1.0 (0.65–1.6)
	Sec/high	3.3 (1/30)		4.7 (4/85)	**0.22 (0.06–0.77)**	29.9 (26/87)	0.87 (0.49–1.5)	35.6 (31/87)	1.0 (0.60–1.8)
Men									
15–49	All	3.3 (31/928)		4.1 (37/896)		19.8 (123/622)		23.2 (145/624)	
15–49	<Primary	5.0 (15/299)	1	4.0 (3/75)	1	18.2 (29/159)	1	20.5 (24/117)	1
	Primary	2.9 (14/476)	**0.55 (0.26–1.2)**	4.6 (25/544)	1.3 (0.36–4.9)	21.4 (55/257)	1.1 (0.64–1.9)	22.3 (59/265)	0.94 (0.53–1.7)
	Sec/high	1.3 (2/152)	**0.17 (0.04–0.78)**	2.9 (8/276)	0.49 (0.12–2.1)	18.9 (39/206)	0.80 (0.45–1.4)	25.6 (62/242)	0.85 (0.48–1.5)
15–24	<Primary	2.1 (3/144)	1	0.0 (0/28)		5.8 (5/87)	1	6.3 (4/64)	1
	Primary	0.9 (2/227)	0.46 (0.07–2.8)	1.0 (3/298)		8.4 (11/131)	1.1 (0.34–3.4)	11.1 (13/117)	1.8 (0.54–6.3)
	Sec/high	0.0 (0/29)		0.0 (0/71)		10.0 (8/80)	0.94 (0.27–3.3)	7.8 (5/64)	0.92 (0.21–4.1)
25–49	<Primary	7.7 (12/155)	1	6.4 (3/47)	1	33.3 (24/72)	1	37.7 (20/53)	1
	Primary	4.8 (12/249)	**0.55 (0.24–1.3)**	8.9 (22/246)	1.3 (0.34–5.1)	34.9 (44/126)	1.1 (0.56–2.0)	31.1 (46/148)	0.77 (0.40–1.5)
	Sec/high	1.6 (2/123)	**0.18 (0.04–0.82)**	3.9 (8/205)	0.53 (0.12–2.4)	24.6 (31/126)	0.66 (0.34–1.3)	32.0 (57/178)	0.81 (0.42–1.5)

OR adjusted for age, ethnic group and religion.
OR shown in bold are significant at the 5% level.

power to test for an association due to the low prevalence of HIV infection and the small numbers with less than primary schooling, and the confidence intervals on the estimates are very wide. In Cotonou, men with more schooling were less likely to be HIV positive. Again this persisted after adjusting for confounding and was seen in both age groups (although there were only five HIV positive men under 25, so the association was not statistically significant in this group alone). Among women in Cotonou there were very few with higher levels of education. There was a trend towards lower risks of HIV infection with more schooling, but this was not statistically significant.

Associations with HSV-2 infection in women showed a different pattern from those with HIV infection (Table 2). Among women in Kisumu and Ndola the risk of HSV-2 infection decreased with increased schooling. In Ndola this was only seen in the younger women (although the interaction with age was not statistically significant). In Yaoundé there was a similar trend in younger women, but it did not reach statistical significance. In Cotonou there was little evidence of an association between education and HSV-2 status in women. Among men, HSV-2 seropositivity was less common among more educated men in Cotonou, and there were similar but non-significant trends among younger men in Yaoundé and Ndola, but not in Kisumu.

Marital status was dependent on education status, after adjusting for age (Tables 3–4), with more educated individuals being less likely to have been married (implying older age at marriage for the more educated). This was seen for men in Cotonou, Yaoundé and Kisumu, and for women in all four cities. Adjusting for marital status either had no effect on the odds ratios for the association of education with HIV and HSV-2 infection or increased them slightly, but did not explain the associations found.

Age at sexual debut among women was later in the more educated in all four cities. Among men, this trend was seen in Kisumu and Ndola, but in Cotonou and Yaoundé more educated men had earlier sexual debut. Higher numbers of partners were reported by the less educated women in Kisumu and men in Ndola, and the more educated men and women in Yaoundé and men in Kisumu. An association between schooling and reporting more than one non-marital partner (if not married) or any non-marital partners (if married) was found only among women in Yaoundé, where more educated women were less likely to have non-marital partners.

Among those with non-marital partners in the last 12 months, exchange of money for sex was less likely among the more educated women in all cities and also among the more educated men in Yaoundé. Sex without condoms in non-marital relationships was less common among the more educated. This was highly significant for women in all cities and for men in Cotonou and Kisumu. Sex on the day of meeting was less common among the more educated men and women in Yaoundé, but was reported by only a few women in all sites. Age difference between the partners was not strongly associated with schooling among women, although the proportion with partners more than 5 years older decreased slightly with education level in all sites. Men in Yaoundé and Kisumu with more education were more likely to have partners who were no more than 5 years younger than themselves. In Ndola, for both men and women, not knowing a partner's age was much more common among those with little schooling.

To see which behavioural factors explained the associations found between education and HIV or HSV-2 infection, the analyses were further adjusted by the behavioural factors. For women in Yaoundé, adjusting for total number of partners decreased the odds ratios (i.e. the association between schooling and HIV status became stronger) and adjusting for sex on the same day increased them (i.e. the association between schooling and HIV status became less strong). Adjusting for all the behavioural factors slightly weakened the effect of schooling on HIV status: OR 0.56 (95% CI, 0.27–1.2) for those with primary education and 0.37 (95% CI, 0.13–1.0) for those with secondary or higher education, compared to those with less than primary education. The effect of schooling was not changed by adjusting for HSV-2 status but was reduced after adjusting for treatable STIs (syphilis, gonorrhoea and chlamydia): ORs were 0.68 (0.33–1.4) and 0.45 (0.16–1.2), respectively. Adjusting the association of education and HIV infection among women in the other cities for the same factors had little influence on the results.

The associations between education and HSV-2 infection in young women in Kisumu and Ndola were also explored by adjusting for other factors. Adjusting for behavioural factors made little difference in either site. Adjusting for treatable STIs made no difference in Kisumu but attenuated the association in Ndola: OR 0.94 (95% CI, 0.56–1.6) for primary education and 0.65 (0.30–1.4) for secondary and higher education.

For men the only significant associations between education status and HIV and HSV-2 infection were found in Cotonou. Adjusting for the behavioural factors made no difference to the association between education status and HIV infection. Fully adjusted ORs for the association with HIV were 0.53 (95% CI, 0.24–1.1) for those with primary schooling and 0.17 (0.04–0.79) for those with secondary or higher schooling. Adjusting for the treatable STIs made no difference to the results. Adjusting for the same factors for men in the other cities also made no

Table 2 Association between schooling and HSV-2 status in population surveys in four African towns

		Cotonou		Yaoundé		Kisumu		Ndola	
Age	Schooling	HSV-2+ % (*n*/*N*)	OR (95% CI)	HSV-2+ % (*n*/*N*)	OR (95% CI)	HSV-2+ % (*n*/*N*)	OR (95% CI)	HSV-2+ % (*n*/*N*)	OR (95% CI)
Women									
15–49	All	29.5 (276/935)		50.9 (512/1006)		67.7 (558/824)		55.0 (487/885)	
15–49	<Primary	29.5 (171/580)	1	59.9 (82/137)	1	71.7 (258/360)	1	56.6 (175/309)	1
	Primary	28.2 (90/319)	1.1 (0.76–1.5)	49.5 (359/725)	0.95 (0.60–1.5)	66.1 (218/330)	**0.77 (0.53–1.1)**	54.9 (235/428)	**0.98 (0.71–1.4)**
	Sec/high	41.2 (14/34)	1.5 (0.72–3.2)	49.3 (71/144)	0.71 (0.41–1.2)	61.2 (82/134)	**0.52 (0.32–0.83)**	52.0 (77/148)	**0.66 (0.43–1.0)**
15–24	<Primary	14.6 (35/240)	1	33.3 (13/39)	1	53.6 (89/166)	1	45.7 (69/151)	
	Primary	9.5 (14/148)	0.87 (0.46–1.7)	26.6 (99/372)	0.80 (0.35–1.8)	52.7 (89/169)	**0.73 (0.45–1.2)**	39.6 (87/220)	**0.69 (0.44–1.1)**
	Sec/high	42.9 (3/7)		21.7 (13/60)	0.39 (0.14–1.1)	41.9 (26/62)	**0.35 (0.17–0.69)**	29.7 (19/64)	**0.31 (0.16–0.63)**
25–49	<Primary	40.0 (136/340)	1	70.4 (69/98)	1	87.1 (169/194)	1	67.1 (106/158)	1
	Primary	44.4 (76/171)	1.3 (0.91–2.0)	73.7 (260/353)	1.0 (0.57–1.8)	80.1 (129/161)	0.63 (0.35–1.2)	71.1 (148/208)	1.2 (0.78–1.9)
	Sec/high	40.7 (11/27)	1.3 (0.55–3.0)	69.1 (58/84)	0.87 (0.42–1.8)	77.8 (56/72)	0.56 (0.27–1.2)	69.1 (58/84)	1.1 (0.64–2.0)
Men									
15–49	All	11.3 (103/863)		26.6 (237/890)		34.7 (202/583)		35.6 (216/607)	
15–49	<Primary	13.6 (37/272)	1	31.1 (23/74)	1	32.4 (48/148)	1	27.9 (31/111)	1
	Primary	10.8 (48/443)	**0.76 (0.46–1.3)**	25.3 (137/541)	1.1 (0.59–2.1)	38.3 (92/240)	1.3 (0.80–2.2)	33.3 (87/261)	1.1 (0.60–1.9)
	Sec/high	12.2 (18/147)	**0.43 (0.23–0.83)**	28.0 (77/275)	0.66 (0.34–1.3)	31.8 (62/195)	0.77 (0.44–1.3)	41.7 (98/235)	1.0 (0.58–1.8)
15–24	<Primary	6.1 (8/131)	1	7.1 (2/28)	1	8.5 (7/82)	1	11.7 (7/60)	1
	Primary	2.3 (5/214)	0.35 (0.11–1.1)	4.7 (14/297)	0.59 (0.12–3.0)	15.9 (20/126)	1.8 (0.69–5.0)	9.6 (11/115)	0.69 (0.22–2.2)
	Sec/high	0.0 (0/29)		5.6 (4/71)	0.48 (0.07–3.2)	12.7 (10/79)	1.1 (0.36–3.5)	9.4 (6/64)	0.34 (0.09–1.3)
25–49	<Primary	20.6 (29/141)	1	45.7 (21/46)	1	62.1 (41/66)	1	47.1 (24/51)	1
	Primary	18.8 (43/229)	1.1 (0.60–1.9)	50.4 (123/244)	1.2 (0.61–2.5)	63.2 (72/114)	1.2 (0.64–2.4)	52.1 (76/146)	1.2 (0.63–2.3)
	Sec/high	15.3 (18/118)	0.63 (0.31–1.2)	35.8 (73/204)	0.69 (0.33–1.4)	44.8 (52/116)	0.63 (0.33–1.2)	53.8 (92/171)	1.2 (0.65–2.3)

OR adjusted for age, ethnic group and religion.
OR shown in bold are significant at the 5% level.

Table 3 Association between schooling and behavioural risk factors in women

		Cotonou		Yaoundé		Kisumu		Ndola	
	Schooling	*n*/*N* (%)	OR (95% CI)	n/*N* (%)	OR (95% CI)	*n*/*N* (%)	OR (95% CI)	*n*/*N* (%)	OR (95% CI)
Ever married	<Primary	466/668 (69.8)	1	123/149 (82.6)	1	345/460 (75.0)	1	283/355 (79.7)	1
	Primary	193/371 (52.0)	**0.25 (0.16–0.38)**	396/788 (50.3)	**0.27 (0.15–0.50)**	288/394 (73.1)	**0.82 (0.55–1.2)**	323/463 (69.8)	**0.45 (0.28–0.70)**
	Sec/higher	26/42 (61.9)	**0.15 (0.06–0.34)**	74/168 (44.1)	**0.11 (0.05–0.22)**	144/203 (70.9)	**0.41 (0.24–0.69)**	106/175 (60.6)	**0.09 (0.05–0.16)**
Age at first sex <15	<Primary	46/673 (6.8)	1	30/148 (20.3)	1	183/454 (40.3)	1	93/358 (26.0)	1
	Primary	12/374 (3.2)	**0.45 (0.23–0.87)**	77/795 (9.7)	**0.42 (0.25–0.71)**	91/394 (23.1)	**0.47 (0.34–0.64)**	68/463 (14.7)	**0.51 (0.36–0.73)**
	Sec/higher	0/42 (0.0)		9/170 (5.3)	**0.23 (0.10–0.52)**	14/203 (6.9)	**0.12 (0.07–0.21)**	9/178 (5.1)	0.14 (0.07–0.29)
>3 partners	<Primary	96/671 (14.3)	1	49/148 (33.1)	1	105/459 (22.9)	1	53/362 (14.6)	1
	Primary	68/374 (18.2)	1.3 (0.94–1.9)	359/782 (45.9)	**1.8 (1.2–2.7)**	69/396 (17.4)	**0.73 (0.51–1.0)**	54/463 (11.7)	0.79 (0.52–1.2)
	Sec/higher	8/41 (19.5)	1.1 (0.47–2.4)	77/167 (46.1)	**1.3 (0.81–2.2)**	26/203 (12.8)	**0.46 (0.28–0.74)**	21/178 (11.8)	0.71 (0.41–1.2)
>1 partner in last	<Primary	18/671 (2.7)	1	26/151 (17.2)	1	23/460 (5.0)	1	9/363 (2.5)	1
12 months or	Primary	10/375 (2.7)	0.93 (0.42–2.1)	147/795 (18.5)	**0.81 (0.49–1.3)**	22/395 (5.6)	1.1 (0.58–2.0)	6/467 (1.3)	0.50 (0.17–1.4)
>0 if married	Sec/higher	1/42 (2.4)	1.0 (0.13–8.1)	24/170 (14.1)	**0.55 (0.29–1.0)**	12/204 (5.9)	1.4 (0.65–2.9)	1/178 (0.6)	0.23 (0.03–1.8)
Among those with at least one non-marital partner in last 12 months									
Exchange money	<Primary	11/98 (11.2)		11/46 (23.9)	1	42/92 (45.7)	1	23/41 (56.1)	1
for sex	Primary	0/78 (0.0)		45/363 (12.4)	0.49 (0.22–1.1)	30/74 (40.5)	**0.65 (0.33–1.3)**	24/59 (40.7)	**0.52 (0.23–1.2)**
	Sec/higher	0/10 (0.0)		11/86 (12.8)	0.50 (0.19–1.3)	10/37 (27.0)	**0.35 (0.14–0.87)**	10/36 (27.8)	**0.33 (0.12–0.88)**
Sex without	<Primary	87/92 (94.6)	1	40/41 (97.6)	1	75/87 (86.2)	1	36/40 (90.0)	1
condoms	Primary	64/74 (86.5)	**0.38 (0.12–1.2)**	295/347 (85.0)	**0.14 (0.02–1.1)**	59/73 (80.8)	**0.83 (0.34–2.0)**	45/58 (77.6)	**0.34 (0.096–1.2)**
	Sec/higher	6/10 (60.0)	**0.043 (0.007–0.28)**	60/83 (72.3)	**0.056 (0.007–0.44)**	20/33 (60.6)	**0.30 (0.11–0.82)**	20/35 (57.1)	**0.14 (0.037–0.56)**
Sex on same day as	<Primary	1/94 (1.1)		7/46 (15.2)	1	3/91 (3.3)	1	2/40 (5.0)	1
met partner	Primary	0/75 (0.0)		20/359 (5.6)	**0.41 (0.15–1.1)**	1/74 (1.4)	0.44 (0.044–4.4)	2/57 (3.5)	0.57 (0.070–4.6)
	Sec/higher	0/10 (0.0)		1/86 (1.2)	**0.064 (0.007–0.56)**	2/37 (5.4)	2.2 (0.31–15.1)	0/35 (0.0)	
Partner >5 years	<Primary	42/91 (46.2)	1	23/45 (51.1)	1	34/77 (44.2)	1	15/29 (51.7)	1
older	Primary	34/76 (44.7)	0.76 (0.40–1.5)	186/357 (52.1)	**0.70 (0.35–1.4)**	24/65 (36.9)	0.84 (0.40–1.7)	25/52 (48.1)	0.85 (0.33–2.2)
	Sec/higher	4/10 (40.0)	0.80 (0.20–3.2)	39/86 (45.4)	**0.46 (0.21–1.0)**	10/33 (30.3)	0.58 (0.22–1.5)	11/33 (33.3)	0.45 (0.15–1.3)
Don't know age	<Primary	7/98 (7.1)	1	2/47 (4.3)	1	15/92 (16.3)	1	12/41 (29.3)	1
of partner	Primary	3/79 (3.8)	0.55 (0.13–2.3)	7/364 (1.9)	0.74 (0.13–4.0)	9/74 (12.2)	0.79 (0.31–2.0)	7/59 (11.9)	**0.27 (0.092–0.82)**
	Sec/higher	0/10 (0.0)		0/86 (0.0)		4/37 (10.8)	0.58 (0.16–2.1)	3/36 (8.3)	**0.20 (0.048–0.83)**

OR adjusted for age, ethnic group and religion.
OR shown in bold are significant at the 5% level.

Table 4 Association between schooling and behavioural risk factors in men

		Cotonou		Yaoundé		Kisumu		Ndola	
	Schooling	*n*/*N* (%)	OR (95% CI)	*n*/*N* (%)	OR (95% CI)	*n*/*N* (%)	OR (95% CI)	*n*/*N* (%)	OR (95% CI)
Ever married	<Primary	155/331 (46.8)	1	40/82 (48.8)	1	100/202 (49.5)	1	56/132 (42.4)	1
	Primary	185/513 (36.1)	**0.46 (0.29–0.72)**	201/586 (34.3)	**1.0 (0.51–2.1)**	182/333 (54.7)	**0.64 (0.33–1.2)**	160/302 (53.0)	0.86 (0.44–1.7)
	Sec/higher	100/175 (57.1)	**0.32 (0.18–0.58)**	126/310 (40.7)	**0.48 (0.23–1.0)**	180/291 (61.9)	**0.31 (0.16–0.62)**	183/283 (64.7)	0.65 (0.32–1.3)
Age at first sex <15	<Primary	24/331 (7.3)	1	6/82 (7.3)	1	68/201 (33.8)	1	25/127 (19.7)	1
	Primary	50/512 (9.8)	1.3 (0.76–2.1)	98/586 (16.7)	**2.6 (1.0–6.8)**	87/332 (26.2)	0.74 (0.50–1.1)	61/297 (20.5)	1.1 (0.67–1.9)
	Sec/higher	19/175 (10.9)	1.9 (0.97–3.6)	54/311 (17.4)	**3.5 (1.3–9.4)**	62/291 (21.3)	0.69 (0.45–1.1)	31/279 (11.1)	**0.52 (0.29–0.96)**
>5 partners	<Primary	122/329 (37.1)	1	41/79 (51.9)	1	66/199 (33.2)	1	48/132 (36.4)	1
	Primary	166/511 (32.5)	0.86 (0.62–1.2)	354/573 (61.8)	**2.9 (1.6–5.4)**	151/329 (45.9)	**1.6 (1.0–2.4)**	125/295 (42.4)	1.1 (0.70–1.8)
	Sec/higher	81/175 (46.3)	0.81 (0.54–1.2)	219/296 (74.0)	**2.2 (1.2–4.1)**	129/289 (44.6)	**1.1 (0.71–1.7)**	95/271 (35.1)	**0.54 (0.34–0.88)**
>1 partner in last 12 months or >0 if married	<Primary	77/332 (23.2)	1	31/82 (37.8)	1	50/201 (24.9)	1	27/133 (20.3)	1
	Primary	128/510 (25.1)	1.2 (0.85–1.7)	305/585 (52.1)	1.6 (0.98–2.8)	94/333 (28.2)	1.2 (0.80–1.8)	69/301 (22.9)	1.2 (0.73–2.0)
	Sec/higher	44/175 (25.1)	0.97 (0.62–1.5)	172/308 (55.8)	1.4 (0.81–2.4)	78/292 (26.7)	1.1 (0.74–1.8)	47/284 (16.6)	0.74 (0.43–1.3)
Among those with at least one non-marital partner in last 12 months									
Exchange money for sex	<Primary	24/139 (17.3)	1	18/41 (43.9)	1	18/88 (20.5)	1	21/50 (42.0)	1
	Primary	34/230 (14.8)	0.81 (0.45–1.5)	86/382 (22.5)	**0.46 (0.22–0.95)**	30/149 (20.1)	0.96 (0.49–1.9)	44/101 (43.6)	1.0 (0.52–2.1)
	Sec/higher	9/75 (12.0)	0.55 (0.23–1.3)	42/218 (19.3)	**0.30 (0.14–0.65)**	24/129 (18.6)	0.80 (0.39–1.7)	32/72 (44.4)	1.0 (0.48–2.2)
Sex without condoms	<Primary	95/107 (88.8)	1	22/30 (73.3)	1	65/72 (90.3)	1	36/42 (85.7)	1
	Primary	149/193 (77.2)	**0.46 (0.23–0.94)**	274/339 (80.8)	1.4 (0.58–3.4)	96/122 (78.7)	**0.36 (0.14–0.89)**	72/87 (82.8)	0.83 (0.29–2.4)
	Sec/higher	49/67 (73.1)	**0.36 (0.15–0.85)**	135/199 (67.8)	0.62 (0.25–1.5)	82/113 (72.6)	**0.30 (0.12–0.75)**	44/68 (64.7)	0.37 (0.13–1.1)
Sex on same day as met partner	<Primary	15/137 (11.0)	1	18/41 (43.9)	1	5/85 (5.9)	1	8/49 (16.3)	1
	Primary	17/223 (7.6)	0.62 (0.29–1.3)	95/383 (24.8)	**0.53 (0.26–1.1)**	21/146 (14.4)	2.3 (0.83–6.5)	24/96 (25.0)	2.0 (0.77–4.9)
	Sec/higher	6/74 (8.1)	0.59 (0.21–1.7)	56/218 (25.7)	**0.44 (0.21–0.94)**	9/126 (7.1)	1.1 (0.33–3.5)	10/72 (13.9)	1.0 (0.35–3.0)
Partner older or ≤5 years younger	<Primary	102/140 (72.9)	1	23/41 (56.1)	1	60/83 (72.3)	1	22/31 (71.0)	1
	Primary	164/226 (72.6)	1.1 (0.65–2.0)	284/372 (76.3)	**2.3 (0.95–5.4)**	109/135 (80.7)	**2.7 (1.1–7.0)**	66/86 (76.7)	1.3 (4.4–3.9)
	Sec/higher	34/74 (46.0)	0.54 (0.27–1.1)	157/219 (71.7)	**4.0 (1.6–9.8)**	88/123 (71.5)	**2.5 (0.99–6.4)**	36/59 (61.0)	0.66 (0.21–2.0)
Don't know age of partner	<Primary	1/141 (0.7)	1	0/41 (0.0)		5/88 (5.7)	1	22/53 (41.5)	1
	Primary	5/231 (2.2)	2.9 (0.33–25.7)	18/390 (4.6)		14/149 (9.4)	1.8 (0.62–5.6)	19/105 (18.1)	**0.31 (0.14–0.65)**
	Sec/higher	3/77 (3.9)	5.0 (0.48–51.9)	2/221 (0.9)		7/130 (5.4)	0.75 (0.22–2.6)	16/75 (21.3)	**0.40 (0.18–0.91)**

OR adjusted for age, ethnic group and religion.
OR shown in bold are significant at the 5% level.

difference. In Cotonou, men with less than primary schooling were more likely to have had symptomatic STIs within the last 12 months for which they did not seek treatment from a pharmacy, clinic or health worker. Adjusting for this did not influence the association between education and HIV infection but reduced that between education and HSV-2 infection (OR 0.86; 95% CI, 0.52–1.4 for primary education and 0.57; 0.30–1.1 for secondary and higher education).

A further analysis explored to what extent the protective effect of education found in the younger age group could be explained by individuals still being in school. Current schooling was not recorded directly but individuals could list their current occupation as 'student'. Those listed as students had varying levels of education, including (occasionally) no schooling, implying that some of these individuals may have been in training or apprentice positions rather than school or college students. In young adults protective effects of education were found in women in Yaoundé (for HIV), and in women in Ndola and Kisumu (for HSV-2). In all three groups of women, those who were current students had lower HIV and HSV-2 levels, and this association persisted after adjusting for age, schooling level, religion and ethnic group. In Yaoundé adjusting for being a student, or excluding students, reduced the association between schooling and HIV status. However, almost all of those with secondary or higher education, and half of those with primary education were listed as students. In Kisumu and Ndola, adjusting for or excluding current students had only a slight influence on the results. In both cities only 20% were listed as students, and in Kisumu this was only slightly higher in those with higher levels of education.

Discussion

In all four cities, for both men and women and in different age groups, after adjusting for age, ethnic group and religion, there was either no association between schooling and HIV or HSV-2 infection, or those with more schooling had lower risks of these infections. A protective effect of schooling in women was found in Yaoundé for HIV infection and in Kisumu and Ndola among younger women for HSV-2 infection. For men significant protective effects were only seen in Cotonou, and were present for both HIV and HSV-2 infections.

There are several possible explanations for the differences between the sites. Besides differences in level of education (Table 1), there were differences in the proportion of young adults still recorded as students: this was higher in Cotonou and Yaoundé than in Kisumu and Ndola (not shown). We have previously shown that in these four cities condom use within non-spousal partnerships was higher in the more educated and was more common in non-regular, short-term partnerships (Lagarde *et al.* 2001). In cities with less generalized epidemics, where HIV transmission from core groups is particularly important, this pattern of condom use would have a greater impact on the association between HIV and education, than in cities with a high HIV prevalence in the general population. Finally, we have assessed only the level of education and both the content of education received, and the expectations and behaviours associated with higher education and social status are likely to vary between settings.

No significant interactions with age were found, so there was no clear evidence of any changes in the association with education over time. However, all these cities have long-standing HIV epidemics and therefore the results in the older age groups will be influenced by the deaths of those infected at young age. This may obscure any associations between education and HIV in these groups. The interpretation of schooling level is different in the younger age groups in which many are still in school. In Table 1 it is apparent that the proportion of 15–24 year olds with secondary or higher education is smaller than the proportion of 25–49 year olds who have reached this level in all cities. This may be due both to the young not having reached their final level of education and to missing young people who are away from home due to education. These factors make comparison of time trends by comparing age groups difficult.

The associations found did not seem to be explained by the measured behavioural factors. Schooling level was associated with many of these factors, but adjustment for the behavioural factors did not remove the associations between schooling and HIV or HSV-2 infection seen. Many of the behavioural factors refer only to reported practices in the last year, whereas HIV and HSV-2 status reflect the result of many years of possible exposure. Behaviours may well have changed recently. In general, those with more schooling reported lower risk behaviour and this pattern was more consistent for behaviours during the last year than for reports of lifetime behaviour such as number of partners. In Yaoundé the association between schooling and HIV infection was reduced after adjusting for treatable STIs but not for HSV-2 infection. This is compatible with schooling influencing the likelihood of treatment for STIs, rather than the presence of STIs simply being a measure of risk behaviour. However, lack of treatment for STIs, although associated with schooling, did not seem to explain the association between schooling and HIV infection in Cotonou. Being currently at school may explain some of the protective effect of schooling seen in

young women in Yaoundé, but almost all those with secondary or higher education were still at school so it was not possible to distinguish whether it was the level or being in school that was important. In Kisumu and Ndola, being in school did not appear to be an important explanation of the associations found in young women.

The inability to account for the association between schooling and HIV or HSV-2 infection using the measured behavioural factors suggests that either they are inaccurately or too crudely measured, or that there are other factors not included. One such factor is the HIV prevalence among partners of men and women of different socio-economic status. For instance men with lower schooling may visit sex workers who are of lower socio-economic status, have more clients in a day and are more likely to be HIV infected, thus increasing their exposure to HIV. Several studies from Africa have documented higher rates of HIV infection in lower socio-economic status sex workers (Kreiss *et al.* 1986; Rodier *et al.* 1993). This may explain the association between lower schooling and HIV infection in men in Cotonou, even after adjusting for individual behaviour.

It is possible that education may influence reported behaviour rather than actual behaviour (social desirability bias). As with other studies, there are difficulties in obtaining accurate sexual behaviour data (Buvé *et al.* 2001b), and this may have contributed to our inability to explain associations of HIV and HSV-2 infection with schooling using the measured behavioural factors. However, several of these reported behaviours were associated with HIV and HSV-2 infection in these populations (Auvert *et al.* 2001; Weiss *et al.* 2001), suggesting that they do reflect actual behaviour to some extent.

Among women, higher schooling was associated with reduced HSV-2 infection in Kisumu and Ndola, but there was no evidence of an association with HIV infection. HSV-2 is much more easily transmitted than HIV infection so it might be expected that seropositivity to HSV-2 should be more determined by behavioural factors, in particular age at first sexual intercourse, and hence higher schooling.

There was no sign of the increased risk of HIV infection with more education seen in several earlier studies, and in each city lower HIV or HSV-2 infection rates in the more educated were seen in either men or women. This study assessed education level and not the effect of any specific school education on HIV/STI. Although there was some evidence that higher levels of education were associated with less risky sexual behaviour there is further to go: risky sexual behaviour and STIs were common at all educational levels. The most educated are likely to be the first to respond to health education messages and the evidence here suggests that some are doing so. The challenge is to extend this to the rest of the population. This means improving general education levels, as well as targeting health messages more effectively at those with poor education and empowering them to act on them.

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