

Paper III

Associations between Sexual Behaviour Change in Young People and HIV Prevalence Decline in Zambia

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Abstract

Background: Evidence suggests that HIV prevalence amongst young Zambians has declined recently, especially in higher-education groups. We studied trends in key sexual behaviour indicators among 15-24 year-olds from 1995 to 2003, including the associations between sexual behaviour change and education.

Methods: The data stems from a series of three population-based surveys conducted in 1995 (n=1720), 1999 (n=1946) and 2003 (n=2637). Logistic regression and Extended Mantel Haenszel chi-square for linear trend were used to compare the three surveys.

Results: Men and lower-education groups reported more than one sexual partner in the previous year prior to the survey more frequently than did women and higher-education groups ($p < 0.01$), but these proportions declined regardless of sex and residence. Substantial delays in childbearing were observed, particularly among higher education and urban respondents. Condom use at last casual sexual intercourse increased from 1995 to 2003; the level was highest among urban and higher education groups. The number of women reporting frequent dry sex using traditional agents dropped during the period. Participants from the rural area and those with less education reported more sexual experience than urban and higher education participants in 2003. The reported number of sexual partners during the past year prior to the survey was a factor, which reduced the association between HIV and survey times among sexually active young urban men and women.

Conclusions: High risk behaviours clearly decreased, especially in higher-education and urban groups, and there is a likely association here with the decline in HIV prevalence in the study population. Fewer sexual partners and condom use were among the core factors involved for both sexes; and for women a further factor was delayed childbearing.

Introduction

A number of studies from sub-Saharan Africa have recently reported declines in HIV prevalence among young people which appear to be associated with sexual behaviour changes [1-6]. Several previous studies have examined the effect of behaviour changes on prevalence using mathematical models. The best method of obtaining indications of the effect of sexual behaviour change on HIV prevalence is, however, to study the inter-relation of changes in incidence and sexual behaviour within the same population; though if direct incidence measurement is not possible, prevalence among young people is commonly used as a proxy [7].

We have previously reported sharp HIV prevalence declines in selected urban and rural communities in Zambia from 1995 to 2003 based on three serial cross-sectional population-based surveys [8, 9]. In the age group 15-24 years we found that HIV prevalence declined by 44% in the 8-year period (from 5.7% to 3.2%; $p=0.143$) among rural males, by 62% (from 16.1% to 6.8%; $p<0.001$) among rural females, by 55% (6.9% to 3.2%; $p=0.005$) among urban males and by 51% (22.5% to 12.5%; $p<0.001$) in urban females.

At the start of the HIV epidemic in sub-Saharan Africa, higher-education groups were hit hardest [10-14], a fact attributed to more extensive travelling and higher number of sexual partners for this group [10, 11, 13]. More recent studies have, however, shown that the prevalence of HIV infection is decreasing among educated persons. In several countries the prevalence among young people with higher education is now lower than among the less educated, especially in urban areas [10, 12, 15, 16]. We have also reported particularly sharp prevalence declines among young people with higher education (≥ 10 years of schooling) in the period 1995 to 2003 of 62% for urban females, 71% among urban males, 84% among rural males and 90% among rural females – whereas the prevalence was more stable among less educated respondents over the same period. Thus, from being at higher risk of HIV infection in 1995, young people with higher education were at lower risk by 2003 compared to those with little education [8, 9].

In this study we investigated whether the observed decline in the HIV prevalence in selected communities in Zambia among young people was likely to be due to

behavioural changes. Furthermore, we examined how education was associated with changes in sexual behaviour.

Methods

The first population-based survey including data on HIV prevalence in Zambia was carried out in 1995 in Chelstone (urban), Lusaka, and the Kapiri Mposhi district. The methods of these surveys are described in detail elsewhere [8, 10, 17-19]. The study population was selected using a stratified random cluster sampling method. Ten urban clusters were selected in Chelstone and five in rural Kapiri Mposhi. The survey was repeated in 1999 and 2003 using the same procedures except that the number of rural clusters was doubled in order to detect small changes. All households in the sampled clusters were included, and all household members aged ≥ 15 years who were found at home, were asked to participate in a structured interview and to donate saliva for an anonymous HIV-test [10]. This was an open cohort. It was possible to link individuals participating in 2 or more of the surveys, but the long periods between surveys and the high mobility of the respondents caused problems in studying incidence (small numbers and a highly selected group); hence we used prevalence among young people as a proxy of incidence. The data was double entered in EpiInfo and validated.

Laboratory analysis

In the first survey all the saliva samples were tested using Gacelisa HIV 1&2 (Welcome Diagnostics). The Gacelisa saliva test was validated against serum tests on paired samples from 494 samples from antenatal clinic attendees, and the specificity and sensitivity of the saliva test was 100%. 450 randomly selected saliva samples from the survey were also tested with Bionor HIV-1&2 (BIONOR AS), and the two saliva tests showed 99.8% agreement [11, 17]. In the two follow-up surveys only Bionor HIV-1&2 (BIONOR AS) for saliva was used [10]. Those respondents who wanted to know their results also had a serum test, and this provided an extra opportunity for validation. In cases where saliva and serum results were discordant, the serum result was considered final. In all the survey rounds, 10% of negative and 10% of positive samples were re-tested by a different person.

Data analysis

The analyses were performed using STATA version 9 and were restricted to adults aged 15-24 years. Data from the three cross-sectional surveys was compared using logistic regression, adjusting for the cluster effect and age, and Extended Mantel Haenszel Chi Square for linear trend. Age adjustment was performed after considering age as a continuous factor. The median age at sexual debut was calculated using survival analysis and a log rank test for equality of survivor curves was used to compare the median ages in 1999 and 2003. (Questions about age at sexual debut, abstinence and current contraceptive use were not included in 1995, and hence we were only able to examine changes related to these variables between 1999 and 2003).

The total number of respondents was used as denominator when calculating the proportions for the following questions: 'ever had sex', 'sex by age 15', 'median age at debut', and 'ever given birth'. For condom use 'ever' and 'at last sexual intercourse prior to the survey', 'current contraceptive use', '≥2 partners last year prior to the survey', 'any casual partners last year prior to the survey', 'frequent dry sex with traditional agents', and 'self-reported experience of STI last year prior to the survey', the denominator was the number of sexually active respondents during the previous year prior to the survey. 'Condom use at last casual sexual intercourse' was calculated using the number of respondents who had at least one casual partner in the course of the last year prior to the survey as the denominator.

To allow comparisons with our previously published analysis of prevalence changes by educational attainment in young people, the analyses were repeated with the same educational groups (0-7, 8-9 and ≥10 years of schooling) [8, 9]. Analyses of the categories 'ever given birth' and 'any casual partner last year' were stratified by marital status. Logistic regression was performed both with survey time as exposure variable (stratified by educational level) and with education as exposure (stratified by survey time).

HIV prevalence declined significantly among young urban men and women and among rural women from 1995 to 2003 but not for rural men (AOR 0.51 [0.18-1.47]). To determine which behaviours contributed to the decline in HIV for urban men and women and rural women, we constructed a model based on the forward logistic regression of HIV risk by survey time, adjusted for age. We checked whether the following behaviour variables were confounders for the association between survey

times and HIV among men and women: 'number of sexual partners last year' (continuous variable), 'any casual partners last year', and condom use 'ever' and 'at last sexual intercourse'. In addition we tested whether 'condom use at last casual sexual intercourse' and 'STI last year' were confounders among males; and for females we also tested the variables 'ever given birth' and 'frequent dry sex using traditional agents' (though not, in the case of women, 'condom use at last casual sexual intercourse' since <10% reported a casual partner). Variables which resulted in both an increase in likelihood ratio chi square of $> |3.84|$ ($p < 0.05$) and AOR for HIV comparing 2003 and 1995 closer to 1, were considered to be confounders. The confounder that gave the largest change in AOR was added to the model (by adjusting for this variable), before the process was repeated to look for additional confounders. Step by step, the model was thus expanded until no additional confounding could be detected (Table 4).

Similarly, we tested how the association between survey time (2003 compared to 1995) and the odds of previous childbearing was affected when adjusting for 'condom use at last sexual intercourse', 'condom use ever', 'sexual activity last year', and 'current use of modern contraceptives' among urban young women. For rural women the proportion that had 'ever given birth' did not change significantly from 1995 to 2003 so these analyses were not performed for this group.

Ethical aspects

The protocol was approved by the National AIDS Research Committee for the two first surveys and by the University of Zambia Research Ethics Committee for the survey in 2003. All respondents were informed that the interview was anonymous and that the saliva-based HIV test would only be used for research purposes. Informed consent was required of all participants. Everyone was offered voluntary counselling and testing free of charge using blood specimens as was required by the national guidelines for HIV testing [19].

Results

Interview information (including sex, age and residence) was available from 1720 adults aged 15-24 years in 1995, 1946 in 1999 and 2637 in 2003. Saliva-based HIV test results were obtained from 1547 respondents in 1995, 1722 in 1999 and 2228 in 2003. In the whole sample the most common reason for not being interviewed was absence because of school, admittance to hospital or temporary travel. Altogether 16% were absent in 1995, 28% in 1999 and 20% in 2003. In all the three surveys eligible men were approximately twice as likely to be absent as women, only 1-2% refused to be interviewed, and less than 10% refused to give saliva for testing [8, 10, 18]. The refusal rates were similar for men and women. There was no marked differential non-response by age throughout the period, but an increase in median age of rural men successfully interviewed from 26 in 1995 to 28 in 2003 was observed. The mean number of school years also increased somewhat for young urban male and female respondents (Table S1).

The proportion of young respondents admitting to having had a casual partner or having had more than one partner in the course of the last year prior to the survey ranged between 39-52% among men and 6-17% among women, in both the rural and urban areas over the study period (Table 1). Fewer married than single young respondents had casual partners, except among urban men (Table S2). In addition, young people with little education were more likely to have had more than one partner during the last year prior to the survey than those with more than 9 years of schooling, except among rural women (Figure 1). The proportion of respondents with more than one partner declined significantly for urban males and rural females (Table 1).

The proportions for 'condom use ever', 'condom use at last sexual intercourse', and 'condom use at last casual sexual intercourse', were highest among urban men, followed by urban women, and increased for all young adults. The most significant changes were found in the urban area, where 57% of young women reported using a condom at their last sexual intercourse in 2003, compared to 36% in 1995 (Table 1). For young rural men there was no increase. Young urban women used condoms more consistently with casual than with other partners, but for young urban men there was no difference. Individuals with higher education were more likely than the least educated to report condom use both at their last sexual intercourse prior to the survey

(Table 2) and their last casual sexual encounter. Condom use also increased more significantly among high-education groups, especially educated rural women, who had lagged behind in 1995 (22% condom use at last intercourse in 1995 compared to 70% in 2003; $p=0.009$). Among people with little education condom use at the last sexual intercourse was more common in the urban than the rural areas throughout the period (Table S3).

In 1995, the proportion that had 'ever given birth' was higher among single women with higher education than among the less educated single women; however, the figure declined for the first group and remained stable in the latter up to 2003, resulting in a reversed relationship. Among married urban women with higher education the proportion that had given birth also declined, but among less educated married women and married rural women with higher education there were no significant changes (Table 3). Throughout the period, previous childbearing was less common for young women in the urban than in the rural area. The declining proportion of women who had given birth among urban and higher education groups was also observed among HIV-negative women (Figure 2 and Table S4). Previous childbearing was associated with approximately double risk of acquiring HIV infection for single women. For married women the risk of HIV was non-significantly higher or equal for those who had ever given birth compared to those who had not (Table S5). 'Condom use at last sexual intercourse', 'condom use ever', 'no sexual activity during the last year', and 'current use of modern contraceptives', were all identified as confounding factors for the changes in the proportion of the respondents who had 'ever given birth' among young urban women (Table S6).

There was a marked reduction from 1995 to 2003 in the proportion of women who reported 'frequent dry sex using traditional agents', in both the urban and rural areas (Table 1). The practice was more common in the least educated groups throughout the period, but decreased for all educational levels (Tables S7 and S8). Use of modern contraceptives (condom, pill, injections, IUD) was more common among urban and among higher educated females. It increased from 1999 to 2003 for rural and urban females with higher education and urban females with the lowest educational attainment (from 19% to 35% among urban women with 0-7 years of schooling) (Tables S9 and S10). Interestingly, HIV prevalence among women currently using

modern contraceptives was more than twice as high as among those who did not use modern contraceptives in 1999 (AOR 2.49 [95% CI 1.47-4.21] for young urban females and AOR 2.57 [1.62-4.09] for young rural females) but in 2003 this association was not significant (AOR 0.92 [0.61-1.38] and AOR 0.77 [0.27-2.22], respectively). When we distinguished between condoms and the three other modern contraceptive methods, we found that condom use was a risk factor for HIV infection for urban women in 1999, and use of either IUD, contraceptive pills or injections was a risk factor for rural women in 1999, but neither of these associations were significant in 2003.

There was a significant drop from 1999 to 2003 in the proportion of rural respondents and high-education urban respondents who reported ever having had sex (Table 1 and Table S11). Median age at sexual debut increased among higher-education groups of rural men and urban women (Table S12). The proportion with sexual experience was lower among urban than among rural men and women, and lower for those with more than 9 years of schooling compared to the least educated (67% vs. 84% in the rural area in 2003; AOR 0.13: 0.07-0.26; other results not shown). Interestingly, comparisons of the proportions of reported early sexual debut between 1999 and 2003 showed significant differences among young men and women. In 1999, 28% of rural female and 42% of rural male 15-19 year-olds reported sex before age 15, but 4 years later, in 2003, 19% of rural female and 24% of rural male 19-23 year-olds reported the same (Figure S1). For older men and women the differences in reporting were not significant (Table S13). We also found that up to 8% of young people who claimed to be virgins were in fact HIV positive in 1999, and none of these reported having received a blood transfusion (Table S14). When pooling data from urban and rural men and women it was found that the risk of HIV infection for “virgins” was lower in 2003 than in 1999 (AOR 0.35 [0.16-0.76]).

The risk of acquiring HIV infection in 2003 compared to 1995 (AOR) was 0.55 [95%CI 0.31-0.96] for urban males, 0.35 [0.28-0.45] for urban females, and 0.27 [95%CI 0.11-0.68] for rural women. Using the survey time as exposure in modelling, we found that ‘number of sexual partners during the last year’, ‘any casual partners during the last year’, ‘condom use at last sexual intercourse’, ‘condom use at last casual sexual intercourse’ and ‘condom use ever’ were all confounders for the

association between HIV and survey time among sexually active young urban men. After adjustment for ‘condom use at last casual sexual intercourse’, there was no significant difference between the risk of HIV in 2003 compared to 1995. ‘Ever given birth’, ‘number of sexual partners last year’, ‘any casual partners last year’, ‘condom use at last sexual intercourse’, ‘condom use last casual sexual intercourse’, ‘condom use ever’ and ‘frequent dry sex using traditional agents’ were confounders for the association between HIV and survey time among sexually active young urban women. After adjusting the association between HIV and survey time for ‘any casual partners last year’ and ‘ever given birth’, the association between HIV and survey time was still significant, and no new confounders were found. Among rural women only ‘ever condom use’ was a confounder, and after adjusting for this variable, the association between HIV and survey time was still significant (Table 4).

We also carried out similar modelling for higher-education groups only. We still found that the strongest confounder was ‘condom use at last casual sexual intercourse’ for urban men and ‘condom use ever’ for rural women. However, for urban women with higher education all the same indicators as for all urban women were confounders, but ‘frequent dry sex’ was the strongest. For rural men adjusting for ‘any casual partners last year’ and ‘condom use at last sexual intercourse’ changed the AOR from 0.24 [0.13-0.42] to 0.70 [0.49-0.99] (Table S15).

Discussion

The findings showed a decline in high risk sexual behaviours and an increase in reported condom use among young adults aged 15-24 years. These changes were most prominent in the higher-education groups, and included fewer sexual partners and increased use of condoms at last sexual intercourse; and among women: delayed child-bearing and less use of traditional agents before sex. We have already reported a marked decline in HIV prevalence, especially among young people with higher education, in the same surveys [8, 9]. Our modelling of possible confounders of the association between survey time and HIV prevalence showed that differences in the above-mentioned indicators contributed to the decline in HIV prevalence from 1995 to 2003 among sexually active young people. Mortality in young infected individuals is likely to be relatively low [2]. We have previously reported that migration does not have a significant impact on our results[9]. Overall, these findings provide convincing evidence that the substantial drop in HIV prevalence in young people was associated with changes in sexual behaviour.

It is reasonable to believe that asking a woman whether she has ever given birth will yield more reliable answers than asking her whether she has ever had sex, as child-bearing is associated with high respect in this society and is difficult to keep secret. The variable 'ever given birth' was associated with a doubling of the likelihood of HIV infection for single young women. This supports the interpretation that delaying the first pregnancy may be an effective preventive strategy [20-25]. The finding that the proportion of those postponing the first birth did not differ by HIV status indicates that decreased fertility among young women was more likely due to behaviour change than to the physiological effect of HIV infection. We found that delayed childbearing seemed to be due to a combination of abstinence, condom use and use of other contraceptives. It is possible that modern contraceptives were essentially used by women engaging in higher risk sexual behaviour in 1999 and that this therefore explains the association with HIV; for as contraceptives rapidly became more common, as well as strongly associated with higher education, this association disappeared [26].

Fewer women than men reported having had more than one partner during the last year prior to each of the three surveys. We also found that men with higher education

less often reported multiple partners in 2003 than in the previous surveys. Before the HIV epidemic in Africa, higher socio-economic and educational status was associated with a higher number of sexual partners [10, 11, 13]. The finding that higher educated young men and women already in the base-line survey less frequently reported more than one partner last year indicates that the process of change in sexual behaviour started earlier than the mid 1990s. This may be linked to the comprehensive HIV prevention campaigns, which were launched in the early 1990s. As people with higher education are usually more concerned with their health, it is likely that they changed their behaviour in response to health-promoting messages [10, 12, 27].

Consistent condom use has been shown to be effective in protection against HIV transmission, but it also seems that condom use must reach a certain level to significantly influence the HIV epidemic [28, 29]. Condom use at the last sexual intercourse is often employed as an indicator of frequency, but this has obvious limitations and may not give a representative picture of consistent condom use [30]. 'Condom use ever' is an indicator of acceptability. Both reported condom use 'at last sexual intercourse' and 'ever' increased, especially among urban respondents and people with higher education; these groups were already reporting higher use than rural and less educated respondents in 1995. This suggests that condom promotion has had limited success so far in reaching rural people and those with little education. The Sexual Behaviour Surveys of 2000, 2003 and 2005 also showed lower condom use in rural areas [31-33]. The resistance to condoms may arise from beliefs that they reduce sexual pleasure and male potency, or the belief that condoms are not effective in preventing HIV transmission [26, 32, 34]. Condom use has also been opposed by many religious communities. Individuals with casual partners during the last year were the only rural group that reported increased condom use; this trend was most evident among those few young women who admitted this behaviour. A higher frequency of condom use in casual relationships is also reported by other studies from sub-Saharan Africa [25]. Young women with casual partners are probably more conscious of the risk they are running as casual sex is considered especially inappropriate for them.

Frequent dry sex with traditional agents was associated with HIV infection among urban women. This practice has been believed to increase the susceptibility of women

to HIV by creating erosions in the mucous membrane. The evidence for increased susceptibility is, however, insubstantial, as most studies have, like ours, been cross-sectional, a design which prevents conclusions about causal relationships [35-37]. In any case, according to our results, this practice has become less common, with fewer women of all educational categories reporting it.

The differential HIV trends associated with the education-levels of young people indicate that important changes in sexual behaviour among educated people have taken place. In a society where people from different educational levels are part of the same social networks, distinct infection patterns reflect differences in risk exposure provided that the effects of differential mortality and migration are negligible. Thus we believe that most of the changes in reported behaviour observed between 1995 and 2003 are real. However, there are some signs of differential reporting bias in our study. We found that controlling for less risky sexual behaviour substantially reduced the association between HIV and survey time among urban men, but less so among women; this may suggest that self-reports from men on sexual behaviour are more reliable. Studies suggest that respondents, especially women, tend to underreport the number of lifetime sexual partners [38]. Therefore, analyses of associations with, and changes in, self-reported sexual behaviour should be interpreted with caution. This also means that changes in the number of partners during the last year reported by women should be interpreted with extra caution. The finding that higher educated rural women reported more partners in 2003 than in 1995, whereas all other groups reported less, could indicate less reporting bias in this group in 2003. We know that culturally inappropriate sexual behaviour is associated with stigmatisation, and social desirability may create reporting bias. Another variable that is known to be associated with social desirability – but also with recall bias – is early sexual experience. Recall bias can be expected to assume greater importance among older age groups. We found indications of underreporting of sexual experience among both males and females, in that some respondents claiming to be virgins were HIV positive whilst reporting no previous blood transfusions. There is convincing evidence that the dominant form of HIV transmission among adults in sub-Saharan Africa is through heterosexual intercourse [39-43], and other studies have also found HIV infection, STIs and current pregnancy among young people who denied having sex [25, 38, 42]. The decline in HIV prevalence among self-reported virgins could indicate less reporting bias in

2003. Except for individuals who strongly suspected that they were infected, it seems unlikely that respondents' actual HIV status itself affected the self-reporting in our study, since only 10% of respondents had ever been HIV tested. As the 1995 interview did not include questions on age at sexual debut, we can only compare changes between 1999 and 2003 on this variable, which makes the interpretations more vulnerable to error. We did not find a visible cohort effect as could be expected if there had been a real change in age at first sexual intercourse and the respondents were consistent as to which age they reported as that of their sexual debut from survey to survey. Instead, we found that among the youngest respondents, fewer admitted having had sex by the age of 15 years in 2003 than in 1999. Analyses of data from the Demographic and Health Surveys, Sexual Behaviour Surveys and from other countries show a similar pattern indicating underreporting [44-46]. It is probable that as HIV campaigns encouraging a delayed sexual debut and abstinence before marriage reach the population, people will report behaviour assumed to be more socially desirable. Other lifetime sexual behaviours like 'condom use ever' and 'ever given birth' are, however, less prone to recall and social desirability bias, and the reporting of both consistently increased (as might be expected given that the young age cohorts grew older between 1995 and 2003 [Figures S2 and S3]). Overall, it seems that bias in our study was mainly related to sexual debut and condom use at last sexual intercourse in 1999. The proportion that said they used a condom at their last sexual intercourse and at their last casual sexual intercourse increased over the 8 year period, but was much lower in 1999 than in 1995. While this is difficult to explain, such inconsistencies disturbing trend linearity may indicate random variation between the surveys, changes in the sample due to migration, changes due to higher absence in 1999, reporting bias, or data entry errors. As these inconsistencies seem to be limited to 1999 they are unlikely to be due to misunderstandings of the questions as they were formulated in the same way in all three surveys. However, for most indicators we observed linear trends or stability, which increases the likelihood that these reflect real behaviour patterns.

The identification of confounding variables for the association between HIV and survey time builds on the assumption that the behaviours reported in 1995 and 2003 reflected the overall level of respondents' risk behaviour. Because we only use rather crude information on behaviour, this model remains quite simplistic. It is not possible

to establish in cross sectional studies whether behaviour change occurred before getting the HIV infection in order for behaviour change to be associated with the HIV infection. Despite these important limitations we believe that since most young HIV infected individuals have been recently infected, the model provides clues to which behaviours actually contributed to the HIV decline. The analyses when not stratifying by education (Table 4) and when confining analysis to the higher-education groups identified the same confounders, except that ‘frequent dry sex’ proved to be the most important for urban women with higher education. Considering the insubstantiality of the evidence for a link between dry sex and HIV infection, we are more inclined to believe that ‘any casual partners’ and ‘ever given birth’ were the key factors, as suggested by Table 4.

The data in this study stems from only one urban and one rural community. Generalisation to Zambia as a whole naturally requires further study. However, HIV prevalence levels in these communities are demonstrably comparable to the national urban and rural estimates, and national surveillance data among antenatal attendees has shown prevalence declines in the age-group 15-24 years [10, 15, 18, 47]. Accordingly, this data might well contain important insights regarding overall national patterns of HIV-related behavioural responses.

We conclude that there is clear evidence of a shift to safer sexual behaviour among men and women in these communities, especially among young people with higher education. Moreover, these changes are likely to have contributed to the concomitant HIV-prevalence decline observed across the period. However, the results also pinpoint a need for much more effective preventive approaches targeting rural and less educated people in particular.

Conflicts of interest

None

Authors' contributions

IFS analysed and interpreted the data and drafted the manuscript. CM supervised and co-ordinated the 2003 data collection, and took active part in interpreting the results and revising the manuscript. SS planned and co-ordinated the 2003 data collection, and took active part in interpreting the results and revising the manuscript. KF made substantial contributions to the conception and design of the surveys, co-ordinated and supervised the data collection in 1995 and 1999, planned the data collection in 2003, and took active part in interpreting the results and revising the manuscript. All authors read and approved the final manuscript.

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Table 1: Trends in HIV and key sexual behaviours among young people aged 15-24, 1995-2003.

Indicator	Year	Rural													
		M							F						
		%	N	Crude OR	95% CI	AOR	95% CI	P	%	N	Crude OR	95% CI	AOR	95% CI	P
HIV infection	1995	5.7	176	Ref.		Ref.		0.143	16.1	236	Ref.		Ref.		<0.001
	1999	7.5	268	1.42	0.66-3.05	1.45	0.66-3.17		10.3	380	0.59	0.38-0.92	0.60	0.37-0.96	
	2003	3.2	309	0.56	0.26-1.20	0.56	0.25-1.26		6.8	456	0.38	0.19-0.78	0.35	0.17-0.76	
Ever sex	1999	88	290	Ref.		Ref.			86	424	Ref.		Ref.		-
	2003	77	328	0.37	0.24-0.58	0.32	0.18-0.56		80	486	0.65	0.41-1.03	0.53	0.32-0.89	
Casual partner last year	1995	46	142	Ref.		Ref.		0.852	13	184	Ref.		Ref.		0.023
	1999	52	206	1.27	0.68-2.37	1.25	0.65-2.40		12	340	0.99	0.55-1.77	0.90	0.48-1.69	
	2003	48	191	1.07	0.70-1.64	1.08	0.69-1.69		7	340	0.53	0.31-0.90	0.52	0.29-0.93	
>=2 sexual partners last 12 months	1995	50	147	Ref.		Ref.		0.491	10	189	Ref.		Ref.		
	1999	51	206	1.03	0.74-1.43	1.02	0.72-1.42		10	340	1.03	0.54-1.95	0.95	0.49-1.85	0.056
	2003	47	194	0.87	0.55-1.37	0.87	0.55-1.38		6	340	0.56	0.34-0.92	0.56	0.33-0.96	
Ever used condom	1995	54	147	Ref.		Ref.		0.891	26	189	Ref.		Ref.		
	1999	60	207	1.25	0.73-2.14	1.32	0.74-2.36		36	338	1.57	0.82-3.02	1.59	0.85-3.00	0.098
	2003	56	199	1.06	0.66-1.69	1.05	0.66-1.65		34	348	1.48	0.97-2.27	1.48	0.97-2.26	
Used condom at last sexual intercourse	1995	38	136	Ref.		Ref.		0.681	13	159	Ref.		Ref.		
	1999	26	181	0.58	0.23-1.46	0.56	0.22-1.44		19	268	1.63	0.45-5.99	1.58	0.43-5.84	0.108
	2003	35	133	0.91	0.48-1.73	0.93	0.49-1.77		19	248	1.67	0.86-3.24	1.69	0.87-3.29	
Used condom at last casual sexual intercourse	1995	27	62	Ref.		Ref.		0.571	9	23	Ref.		Ref.		
	1999	14	110	0.42	0.18-0.998	0.43	0.18-1.05		3	40	0.27	0.04-1.91	0.26	0.04-1.83	0.004
	2003	29	89	1.09	0.35-3.36	1.09	0.35-3.42		39	23	6.75	2.15-21.2	6.31	1.50-26.48	
Modern contraceptive use	1999	-	-	-	-	-	-		16	395	Ref.		Ref.		-
	2003	-	-	-	-	-	-		17	400	1.04	0.65-1.66	0.97	0.61-1.54	
Ever given birth	1995	-	-	-	-	-	-		54	257	Ref.		Ref.		0.114
	1999	-	-	-	-	-	-		61	411	1.32	0.69-2.53	1.61	0.74-3.51	
	2003	-	-	-	-	-	-		61	467	1.32	0.87-1.99	1.35	0.78-2.33	
Most often traditional agents before sex	1995	-	-	-	-	-	-		36	188	Ref.		Ref.		
	1999	-	-	-	-	-	-		20	381	0.44	0.24-0.81	0.48	0.25-0.90	<0.001
	2003	-	-	-	-	-	-		16	364	0.34	0.16-0.71	0.33	0.15-0.72	

Indicator	Year	Urban															
		M								F							
		%	N	Crude OR	95% CI	AOR	95% CI	P	%	N	Crude OR	95% CI	AOR	95% CI	P		
HIV infection	1995	6.9	434	Ref.		Ref.		0.005	22.5	702	Ref.		Ref.		<0.001		
	1999	7.4	432	1.07	0.67-1.72	1.01	0.61-1.66		18.3	641	0.77	0.59-0.99	0.72	0.55-0.93			
	2003	3.2	623	0.45	0.28-0.70	0.40	0.25-0.66		12.5	840	0.49	0.36-0.66	0.43	0.33-0.57			
Ever sex	1999	65	496	Ref.		Ref.		-	65	723	Ref.		Ref.		-		
	2003	60	695	0.81	0.61-1.07	0.70	0.52-0.96		55	958	0.65	0.50-0.83	0.54	0.42-0.68			
Casual partner last year	1995	46	254	Ref.		Ref.		0.436	12	433	Ref.		Ref.		0.841		
	1999	46	207	0.99	0.70-1.20	0.98	0.69-1.40		17	336	1.56	0.94-2.59	1.59	0.96-2.62			
	2003	43	244	0.87	0.63-1.20	0.86	0.63-1.17		11	363	0.93	0.66-1.30	1.00	0.73-1.37			
>=2 sexual partners last 12 months	1995	51	269	Ref.		Ref.		0.003	13	432	Ref.		Ref.		0.117		
	1999	44	207	0.73	0.54-1.00	0.68	0.48-0.99		10	338	0.76	0.47-1.23	0.77	0.48-1.22			
	2003	39	243	0.59	0.48-0.72	0.54	0.42-0.70		10	359	0.71	0.42-1.19	0.80	0.50-1.26			
Ever used condom	1995	70	273	Ref.		Ref.		<0.001	59	445	Ref.		Ref.		<0.001		
	1999	84	207	2.22	1.53-3.24	1.82	1.23-2.68		75	338	2.09	1.27-3.43	2.08	1.27-3.40			
	2003	84	263	2.24	1.63-3.06	1.68	1.13-2.49		81	387	3.48	2.00-4.28	2.76	1.89-4.04			
Used condom at last sexual intercourse	1995	53	247	Ref.		Ref.		<0.002	36	412	Ref.		Ref.		<0.001		
	1999	26	255	0.31	0.21-0.48	0.31	0.21-0.48		25	425	0.60	0.44-0.81	0.58	0.42-0.79			
	2003	67	249	1.80	1.04-3.11	1.59	0.97-2.60		57	347	2.34	1.45-3.79	2.43	1.51-3.93			
Used condom at last casual sexual intercourse	1995	50	108	Ref.		Ref.		0.023	46	50	Ref.		Ref.		<0.001		
	1999	65	94	1.85	1.07-3.19	1.69	1.05-2.74		53	57	1.30	0.62-2.76	1.29	0.60-2.78			
	2003	65	104	1.89	1.10-3.23	1.68	1.00-2.82		83	40	5.53	2.89-10.6	5.80	2.88-11.69			
Modern contraceptive use	1999	-	-	Ref.		Ref.			27	616	Ref.		Ref.		-		
	2003	-	-	-	-	-	-		37	494	1.64	1.13-2.37	1.30	0.94-1.81			
Ever given birth	1995	-	-	Ref.		Ref.		-	39	772	Ref.		Ref.		<0.001		
	1999	-	-	-	-	-	-		27	713	0.57	0.44-0.75	0.43	0.31-0.61			
	2003	-	-	-	-	-	-		26	834	0.54	0.35-0.83	0.33	0.20-0.55			
Most often traditional agents before sex	1995	-	-	Ref.		Ref.		-	20	429	Ref.		Ref.		<0.001		
	1999	-	-	-	-	-	-		2	590	0.09	0.03-0.24	0.10	0.04-0.29			
	2003	-	-	-	-	-	-		5	427	0.23	0.09-0.55	0.21	0.09-0.49			

Table 2: Proportions reporting condom use at last sexual intercourse by educational attainment among adults aged 15-24, 1995-2003

Year	School years	1995						1999						2003					
		%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI
Males	0-7	31	142	Ref.		Ref.		25	164	Ref.		Ref.		28	109	Ref.		Ref.	
	8-9	50	118	2.23	1.22-4.08	2.38	1.20-4.70	27	101	1.09	0.66-1.82	1.13	0.66-1.94	50	72	2.52	1.46-4.34	2.60	1.45-4.67
	10+	63	122	3.81	2.25-6.46	3.65	2.06-6.47	26	166	1.05	0.63-1.76	1.02	0.59-1.75	73	201	6.68	3.41-13.1	7.20	3.56-14.5
Females	0-7	21	261	Ref.		Ref.		21	349	Ref.		Ref.		20	262	Ref.		Ref.	
	8-9	32	173	1.79	1.09-2.96	1.79	1.08-2.97	18	146	0.86	0.52-1.42	0.87	0.52-1.44	45	112	3.26	2.15-4.93	3.84	2.46-5.99
	10+	41	133	2.56	1.13-5.79	2.54	1.13-5.70	29	197	1.54	1.08-2.19	1.57	1.09-2.25	64	219	7.30	4.26-12.5	9.19	5.52-15.3

Table 3: Changes in the proportion of women aged 15-24 reporting who had ever given birth by educational attainment, 1995-2003

Residence	Marital status	Year	0-7						8-9						10+					
			%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI
Rural	Single	1995	17	72	Ref.		Ref.		20	35	Ref.		Ref.		29	7	Ref.		Ref.	
		1999	17	94	1.03	0.43-2.44	1.38	0.72-2.66	26	31	1.39	0.88-2.19	1.87	1.36-2.58	19	14	1	0.48-2.07	1.11	0.59-2.09
		2003	18	94	1.10	0.44-2.77	1.47	0.66-3.29	24	49	1.30	0.57-2.95	2.53	0.99-6.44	14	36	0.40	0.17-0.93	0.33	0.19-0.58
	Married	1995	82	99	Ref.		Ref.		95	19	Ref.		Ref.		80	10	Ref.		Ref.	
		1999	79	214	0.83	0.26-2.66	1.02	0.26-3.94	86	29	0.35	0.04-2.78	0.19	0.01-2.72	75	4	0.75	0.03-20.3	16.3	0.25-1056
		2003	86	229	1.42	0.68-2.94	1.40	0.71-2.77	89	28	0.46	0.08-2.72	0.17	0.02-1.25	89	9	2	0.12-32.5	3.97	0.29-54.9
Urban	Single	1995	14	197	Ref.		Ref.		27	187	Ref.		Ref.		22	176	Ref.		Ref.	
		1999	11	141	0.74	0.35-1.55	0.52	0.23-1.17	20	161	0.68	0.39-1.19	0.40	0.19-0.86	12	284	0.51	0.32-0.82	0.57	0.31-1.03
		2003	14	117	0.92	0.38-2.22	0.55	0.21-1.49	18	125	0.59	0.32-1.08	0.33	0.13-0.85	11	432	0.44	0.28-0.69	0.47	0.29-0.78
	Married	1995	87	71	Ref.		Ref.		86	56	Ref.		Ref.		86	44	Ref.		Ref.	
		1999	89	37	1.20	0.41-3.53	1.12	0.42-3.00	80	35	0.67	0.24-1.88	0.43	0.11-1.68	74	31	0.45	0.17-1.20	0.41	0.15-1.10
		2003	79	39	0.56	0.07-4.33	0.52	0.07-3.96	83	36	0.83	0.28-2.47	0.55	0.11-2.63	75	61	0.48	0.24-0.98	0.35	0.17-0.69

Table 4: Age-adjusted odds ratio (AOR) of risk of HIV by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for urban men and urban and rural women aged 15-24

Urban men			
One by one behaviour indicator included			
Behaviour indicator	Chi-square change	AOR	95% CI
Number of sex partners last 12 months**	-15.0	0.72	0.36-1.42
Casual partner last year	-20.59	0.66	0.27-1.64
Condom use at last sexual intercourse	-18.77	0.70	0.38-1.27
Ever used condom	-19.06	0.68	0.40-1.16
Used condom at last casual sexual intercourse	-21.07	1.12	0.71-1.77
STI last year*	21.98	0.55	0.32-0.94

Notes: **Before adding the behaviour variables the Chi square was 22.19 and AOR 0.55 (0.31-0.96) in 2003 compared to 1995.** If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents during the last year prior to the survey. *The Chi square change was significant, but the AOR was unchanged. **The chief confounder in this step.

Urban women											
One by one behaviour indicator included				Two behaviour variables included				Three behaviour variables included			
Behaviour indicator	Chi-square change	AOR	95% CI	Behaviour indicator	Chi-square change	AOR	95% CI	Behaviour indicator	Chi-square change	AOR	95% CI
Ever given birth	-4.51	0.49	0.37-0.63	Casual partner and ever given birth**	-8.34	0.59	0.42-0.83	-	-	-	-
Number of sex partners last 12 months	-26.97	0.52	0.38-0.70	Casual partner and number of sex partners	-1.38	0.53	0.38-0.73	Casual partner, ever given birth and number of sexual partners	1.62	0.58	0.41-0.82
Casual partner last year**	-27.25	0.54	0.39-0.75	-	-	-	-	-	-	-	-
Condom use at last sexual intercourse	6.57	0.45	0.32-0.63	Casual partner and condom use at last sexual intercourse	13.53	0.46	0.34-0.63	Casual partner, ever given birth and condom use at last sexual intercourse*	16.44	0.52	0.37-0.72
Ever used condom	-18.06	0.50	0.37-0.68	Casual partner and ever used condom	2.37	0.51	0.37-0.69	Casual partner, ever given birth and ever used condom*	5.32	0.56	0.41-0.77
Frequent dry sex	-30.29	0.49	0.37-0.64	Casual partner and frequent dry sex	-8.85	0.54	0.38-0.77	Casual partner, ever given birth and frequent dry sex#	-5.83	0.59	0.42-0.83

Notes: **Before adding the behaviour variables the Chi square was 53.88 and AOR 0.35 (0.28-0.45) in 2003 compared to 1995.** If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents during the last year prior to the survey.

*The Chi square change was significant, but the AOR was further from 1, which meant that adjusting for 'condom use at last sexual intercourse' or 'ever condom use' in addition to 'any casual partners last year' increased the strength of the association between HIV and survey time, rather than reducing it. # The Chi square change was significant, but the AOR was unchanged. **The chief confounder in this step.

Rural women			
One by one behaviour indicator included			
Behaviour Indicator	Chi-square change	AOR	95% CI
Ever given birth	0.15	0.28	0.11-0.72
Number of sex partners last 12 months	-1.7	0.31	0.13-0.75
Casual partner last year	-0.62	0.30	0.12-0.72
Condom use at last sexual intercourse	-3.45	0.28	0.09-0.81
Ever used condom**	-4.81	0.32	0.13-0.75
Frequent dry sex	-1.9	0.26	0.11-0.63

Notes: **Before adding the behaviour variables the Chi square was 9.53 and AOR 0.27 (0.11-0.68) in 2003 compared to 1995.** If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents during the last year prior to the survey. **The chief confounder in this step.

Table S1: Characteristics of respondents

	Age 15-24												
	1995				2003				1999				
	Rural		Urban		Rural		Urban		Rural		Urban		
Sex distribution (%)	M	43.2	197	40.5	290	44.9	432	37.9	479	40.8	1230	42.1	1675
	F	56.8	259	59.5	426	55.1	530	62.1	1264	59.2	1230	57.9	1675
Mean age in years (95% CI)	M	19.9 (19.5-20.2)	197	19.6 (19.3-20.0)	290	19.7 (19.4-20.0)	432	18.9 (18.7-19.2)	479	19.3 (19.1-19.6)	1230	19.5 (19.3-19.7)	1675
	F	19.3 (18.9-19.6)	259	19.2 (18.9-19.4)	426	19.4 (19.2-19.7)	530	19.1 (18.9-19.3)	785	19.4 (19.2-19.6)	1230	19.5 (19.3-19.6)	1675
Median age in years (IQR)	M	20 (18-22)	197	20 (17-22)	290	20 (17.5-22)	432	19 (17-21)	479	19 (17-22)	1230	19 (17-22)	1675
	F	19 (17-22)	259	19 (17-22)	426	20 (17-22)	530	19 (17-22)	785	19 (17-22)	1230	19 (17-22)	1675
Mean number of school years (95% CI)	M	7.0 (6.6-7.5)	195	6.4 (6.0-6.7)	290	7.1 (6.7-7.5)	326	9.2 (9.0-9.4)	477	10.1 (9.9-10.3)	1230	10.6 (10.4-10.8)	1675
	F	6.3 (5.9-6.6)	256	5.4 (5.2-5.7)	425	5.7 (5.4-6.0)	485	8.4 (8.2-8.6)	778	9.2 (9.0-9.4)	1230	9.9 (9.8-10.1)	1675
Median number of school years (IQR)	M	7 (6-9)	195	7 (4-8)	290	7 (5-9)	326	9 (7-11)	477	10 (9-12)	1230	11 (9-12)	1675
	F	7 (5-8)	256	6 (4-7)	425	6 (4-8)	485	9 (7-10)	778	9 (7-12)	1230	11 (8-12)	1675

Table S2: Changes in the proportions reporting having any casual partner during the last year prior to the survey by marital status, adults aged 15-24, 1995-2003

Residence	Year	%	N	Single			Married				
				Crude OR	95% CI	95% CI	Crude OR	95% CI	AOR		
Rural	Males	1995	50	106	Ref.	34	35	Ref.	Ref.	0.64-2.30	
		1999	60	139	1.48	0.64-3.42	39	61	1.24	0.63-2.43	1.21
		2003	55	126	1.21	0.66-2.23	35	62	1.05	0.47-2.39	1.09
	Females	1995	25	51	Ref.	0.77-2.56	6	126	Ref.	Ref.	0.49-2.45
		1999	32	74	1.40	0.66-2.22	4	245	0.69	0.32-1.52	0.63
		2003	14	66	0.46	0.25-0.87	5	262	0.71	0.30-1.69	0.73
Urban	Males	1995	46	240	Ref.	0.66-1.37	50	14	Ref.	Ref.	0.30-1.80
		1999	45	195	0.95	0.63-1.36	64	11	1.75	0.41-7.47	1.72
		2003	42	229	0.87	0.63-1.16	38	13	0.62	0.13-3.05	0.63
	Females	1995	17	235	Ref.	0.93-2.48	4	169	Ref.	Ref.	0.13-3.01
		1999	24	218	1.52	0.90-2.49	3	104	0.81	0.14-4.59	0.78
		2003	15	221	0.86	0.54-1.36	2	130	0.64	0.37-1.12	0.58

Table S3: Changes in the proportions reporting condom use at last sexual intercourse by educational attainment among adults aged 15-24, 1995-2003

Residence	School years	Year	0-7			8-9			10+			
			%	N	Crude OR	95% CI	AOR	95% CI	Crude OR	95% CI	AOR	95% CI
Rural	Males	1995	23	83	Ref.		Ref.		Ref.		Ref.	
		1999	28	134	1.28	0.72-2.31	1.18	0.65-2.13	0.21	0.06-0.80	0.13	0.06-0.32
		2003	18	74	0.72	0.34-1.52	0.72	0.34-1.55	0.77	0.21-3.07	0.99	0.50-1.90
	Females	1995	9	116	Ref.		Ref.		Ref.		Ref.	
		1999	20	223	2.35	0.89-6.21	2.28	0.85-6.06	0.70	0.15-3.21	0.58	0.02-14.1
		2003	13	189	1.39	0.59-3.28	1.41	0.60-3.29	1.28	0.49-3.31	8.17	3.25-20.5
Urban	Males	1995	42	59	Ref.		Ref.		Ref.		Ref.	
		1999	13	30	0.21	0.07-0.59	0.21	0.08-0.57	0.45	0.20-1.02	0.22	0.12-0.37
		2003	51	35	1.44	0.45-4.60	1.40	0.48-4.08	1.08	0.64-1.81	1.71	0.95-3.08
	Females	1995	30	145	Ref.		Ref.		Ref.		Ref.	
		1999	23	126	0.69	0.38-1.25	0.63	0.33-1.19	0.45	0.24-0.85	0.58	0.36-0.93
		2003	38	73	1.43	0.64-3.18	1.58	0.74-3.37	2.25	1.48-3.43	2.44	1.31-4.54

Table S4: Changes in the proportions of HIV-negative women aged 15-24 who had ever given birth by educational attainment, 1995-2003

Residence	School years	Year	0-7			8-9			10+					
			%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI
Rural	Females	1995	53	148	Ref.	0.47-	Ref.	0.43-	70	10	Ref.	0.04-	Ref.	0.17-
		1999	60	275	1.37	0.58- 3.24	1.67	0.67- 4.13	33	12	0.21	1.06	0.67	0.17-
		2003	67	299	1.81	1.02- 3.21	1.89	1.10- 3.25	23	40	0.12	0.06- 0.24	0.17	0.09- 0.34
Urban	Females	1995	31	211	Ref.	0.35-	Ref.	0.17-	28	142	Ref.	0.30-	Ref.	0.28-
		1999	32	139	1.04	0.56- 1.92	0.73	0.41- 1.28	16	235	0.48	0.75	0.53	0.28-
		2003	26	118	0.80	0.33- 1.93	0.50	0.19- 1.30	19	397	0.61	0.38- 0.99	0.56	0.33- 0.96

Table S5: HIV prevalence by whether 'ever given birth', stratified by marital status. Women aged 15-24.

Year	Residence	% No Yes	Rural			Urban			Single			Married			Rural			Urban								
			N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	
1995	No	8.0	87	Ref.	1.24	0.91-	Ref.	1.74-	Ref.	2.19	1.43-	22.2	18	Ref.	0.89	0.34-	Ref.	0.60	0.22-	23.8	21	Ref.	0.62-	Ref.	1.64	0.34-
	Yes	20.0	20	2.86	1.24	0.37- 4.19	3.10	1.74- 5.52	29.4	102	3.10	20.2	99	0.89	2.32	1.63	0.62-	8.20	0.60	0.22-	41.3	138	2.25	0.62-	1.64	0.34-
1999	No	5.0	100	Ref.	1.07	0.17-	Ref.	1.59-	Ref.	1.68	1.05-	4.3	47	Ref.	3.05	0.68-	Ref.	2.02	0.48-	23.5	17	Ref.	0.25-	Ref.	0.60	0.18-
	Yes	13.0	23	2.85	1.07	0.17- 6.66	2.47	1.59- 3.84	28.0	75	2.47	11.9	176	3.05	13.6	8.55	13.6	2.02	0.48-	26.9	78	1.20	0.25-	0.60	0.18-	
2003	No	0.7	139	Ref.	17.2	3.53-	Ref.	1.13-	9.4	524	Ref.	3.1	32	Ref.	2.80	0.68-	Ref.	2.23	0.54-	24.0	25	Ref.	0.38-	Ref.	0.90	0.37-
	Yes	17.6	34	29.6	17.2	1.62- 183	2.12	1.13- 3.97	18.0	78	2.12	8.3	217	2.80	11.6	9.21	11.6	2.23	0.54-	22.6	93	0.92	0.38-	0.90	0.37-	

Table S6: Age-adjusted odds ratio (AOR) of having given birth comparing 2003 and 1995 (2003 and 1999 for modern contraceptives) and adjusting for 'current use of modern contraceptives', 'used condom at last sexual intercourse' and abstinence among rural and urban women aged 15-24

a) Urban women		One by one behaviour indicator included			
Beh. Indicator	Chi square	Chi-square change	AOR	95% CI	
Comparing 2003 and 1995	109.69	18.86	0.46	0.27-0.76	
Condom use at last sexual intercourse	126.72	35.89	0.54	0.30-0.96	
Ever used condom	36.19	-54.64	0.51	0.32-0.84	
Sexually active last year					
Comparing 2003 and 1999	112.12	21.29	1.02	0.72-1.44	
Modern contraceptive use					
Notes: Before adding behaviour variables Chi square was 90.83 and AOR for having given birth 0.33 (0.20-0.55) in 2003 compared to 1995 and 0.77 (0.53-1.11) in 2003 compared to 1999. If chi square >3.84, the added variable is a confounding variable. The denominator is the total number of women.					
b) Rural women		One by one behaviour indicator included			
Beh. Indicator	Chi square	Chi-square change	AOR	95% CI	
Comparing 2003 and 1995	40.51	-60.0	1.81	1.10-2.97	
Condom use at last sexual intercourse*	74.83	-25.68	2.14	1.30-3.51	
Ever used condom*	50.52	-49.99	1.71	0.99-2.94	
Sexually active last year*					
Comparing 2003 and 1999	105.87	5.36	0.98	0.53-1.79	
Modern contraceptive use					

Notes: Before adding behaviour variables Chi square was 100.51 and AOR for having given birth 1.35 (0.78-2.33) in 2003 compared to 1995 and 0.84 (0.44-1.60) in 2003 compared to 1999. If chi square >3.84, the added variable is a confounding variable. The denominator is the total number of women. *The Chi square change is significant, but the AOR is further from 1, which means that adjusting for 'condom use at last sexual intercourse', 'ever condom use' or sexual activity last year increases the strength of the association between 'ever given birth' and survey time, rather than reducing it.

Table S7: Changes in the proportion of all women aged 15-24 who frequently use traditional agents before sex to make the vagina drier, by educational attainment, 1995-2003

Residence	School years	Year	0-7			8-9			10+			
			%	N	Crude OR	95% CI	AOR	95% CI	Crude OR	95% CI	AOR	95% CI
Rural	Females	1995	41	133	Ref.		Ref.		13	15	Ref.	
		1999	21	312	0.39	0.26-0.60	0.42	0.27-0.63	0.48	0.12-1.85	0.50	0.03-9.89
		2003	19	291	0.33	0.18-0.62	0.32	0.17-0.60	0.11	0.01-0.87	0.26	0.02-3.40
Urban	Females	1995	22	163	Ref.		Ref.		17	128	Ref.	
		1999	4	160	0.14	0.03-0.59	0.15	0.03-0.66	0.17	0.05-0.55	0.02	0.003-0.11
		2003	13	96	0.50	0.17-1.48	0.47	0.17-1.27	0.23	0.08-0.69	0.10	0.03-0.30

Table S8: Proportions of all women aged 15-24 who frequently use traditional agents before sex to make the vagina drier, by educational attainment, 1995-2003

Residence	Year	School years	1995			1999			2003			
			%	N	Crude OR	95% CI	AOR	95% CI	Crude OR	95% CI	AOR	95% CI
Rural	Females	0-7	41	133	Ref.		Ref.		19	291	Ref.	
		8-9	28	39	0.57	0.27-1.21	0.57	0.26-1.22	0.60	0.17-2.41	0.20	0.02-1.63
		10+	13	15	0.23	0.04-1.32	0.21	0.03-1.34	0.29	0.08-1.05	0.18	0.08-0.40
Urban	Females	0-7	22	163	Ref.		Ref.		13	96	Ref.	
		8-9	20	134	0.89	0.55-1.45	0.85	0.50-1.46	0.86	0.37-1.99	0.49	0.28-0.87
		10+	17	128	0.73	0.35-1.54	0.57	0.27-1.18	0.07	0.01-0.69	0.15	0.06-0.39

Table S9: Changes in the proportions of females aged 15-24 reporting current use of modern contraceptives by educational attainment, 1995-2003

Residence	School years	Year	0-7					8-9					10+							
			%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI
Rural	Females	1999	15	324	Ref.		Ref.		Ref.		Ref.		Ref.		20	15	Ref.		Ref.	
		2003	13	309	0.88	0.55-1.39	0.82	0.53-1.26	0.82	0.53-1.26	0.65	0.36-1.20	0.66	0.34-1.27	50	34	4.00	2.15-7.43	3.13	1.51-6.49
Urban	Females	1999	19	167	Ref.		Ref.		Ref.		Ref.		Ref.		31	280	Ref.		Ref.	
		2003	35	110	2.23	0.92-5.40	1.86	0.84-4.14	1.86	0.84-4.14	1.24	0.78-1.97	0.90	0.58-1.38	40	280	1.53	1.10-2.12	1.26	0.95-1.69

Table S10: Changes in the proportions reporting current use of modern contraceptives by educational attainment among females aged 15-24, 1995-2003

Year	Residence	School years	1999					2003							
			%	N	Crude OR	95% CI	AOR	95% CI	%	N	Crude OR	95% CI	AOR	95% CI	
Rural	0-7	15	324	Ref.		Ref.		Ref.		13	309	Ref.		Ref.	
	8-9	27	56	2.16	1.51-3.07	2.09	1.38-3.17	1.61	0.90-2.86	19	57	1.68	0.97-2.92	1.68	0.97-2.92
	10+	20	15	1.47	0.78-2.78	1.62	0.84-3.15	6.72	4.52-10.0	50	34	6.73	4.96-9.14	6.73	4.96-9.14
Urban	0-7	19	167	Ref.		Ref.		Ref.		35	110	Ref.		Ref.	
	8-9	28	169	1.63	1.21-2.18	1.55	1.01-2.38	0.91	0.42-1.97	32	102	0.81	0.37-1.75	0.81	0.37-1.75
	10+	31	280	1.87	1.20-2.92	1.55	0.98-2.45	1.28	0.62-2.63	40	280	1.05	0.58-1.89	1.05	0.58-1.89

Table S11: Changes in the proportions reporting ever having sex by educational attainment among adults aged 15-24, 1995-2003

Residence	School years	0-7						8-9						10+						
		Year	%	N	Crude OR	95% CI	AOR	95% CI	N	%	Crude OR	95% CI	AOR	95% CI	N	%	Crude OR	95% CI	AOR	95% CI
Rural	Males	1999	90	202	Ref.	Ref.	Ref.	88	59	Ref.	Ref.	Ref.	Ref.	97	29	Ref.	Ref.	Ref.	Ref.	Ref.
		2003	79	196	0.43	0.20-0.89	0.42	0.18-0.96	78	58	0.47	0.25-0.87	0.25	0.07-0.86	72	72	0.09	0.01-1.05	0.08	0.01-0.75
Urban	Females	1999	87	342	Ref.	0.47-1.34	Ref.	81	64	Ref.	Ref.	Ref.	Ref.	78	18	Ref.	Ref.	Ref.	Ref.	Ref.
		2003	84	356	0.79	1.34	0.65	0.35-1.22	69	81	0.52	0.40-0.67	0.58	0.38-0.88	67	48	0.57	0.28-1.15	0.33	0.09-1.18
Urban	Males	1999	60	68	Ref.	0.97-2.74	Ref.	57	141	Ref.	Ref.	Ref.	Ref.	70	287	Ref.	Ref.	Ref.	Ref.	Ref.
		2003	71	73	1.63	2.74	0.96	0.42-2.23	50	143	0.73	0.33-1.64	0.60	0.30-1.18	62	477	0.69	0.53-0.89	0.74	0.52-1.06
Urban	Females	1999	66	193	Ref.	0.46-1.22	Ref.	65	206	Ref.	Ref.	Ref.	Ref.	65	324	Ref.	Ref.	Ref.	Ref.	Ref.
		2003	59	193	0.75	1.22	0.70	0.44-1.09	55	198	0.66	0.34-1.26	0.70	0.31-1.58	54	564	0.61	0.47-0.80	0.51	0.38-0.69

Table S12: Changes in the median reported age at sexual debut by educational attainment among adults aged 15-24, 1995-2003

Residence	School years	0-7				8-9				10+				
		Year	Median	IQR	N	p-value	Median	IQR	N	p-value	Median	IQR	N	p-value
Rural	Males	1999	16	15-16	201	0.07	15	14-16	59	0.013	16	15-17	29	< 0.001
		2003	16	15-16	195		17	16-18	58		18	17-20	72	
Urban	Females	1999	15	15-16	342	0.50	17	16-18	64	0.73	17	16-19	17	0.26
		2003	16	15-16	354		17	16-18	81		19	17-20	47	
Urban	Males	1999	17	17-18	68	0.45	18	17-19	141	0.58	18	17-18	285	0.15
		2003	18	16-19	73		17	17-18	143		18	18-19	473	
Urban	Females	1999	18	17-18	192	0.73	18	18-19	206	0.77	19	19-20	323	0.005
		2003	17	17-18	192		18	18-19	198		20	20-20	554	

Table S15: Age-adjusted odds ratio (AOR) of risk of HIV infection by survey time comparing 2003 and 1995, adjusting for sexual behaviour variables, for urban and rural men and women aged 15-24 with higher education (≥10 years of schooling)

a) Urban men aged 15-24 with 10+ years of school						b) Urban women aged 15-24 with 10+ years of school									
One by one behaviour indicator included						Two behaviour variables included									
Behaviour indicator	Chi-square	Chi-square change	AOR	95% CI		Beh. indicator	Chi-square	Chi-square change	AOR	95% CI	Beh. indicator	Chi-square	Chi-square change	AOR	95% CI
Number of sex partners last 12 months	8.94	-17.06	0.52	0.29-0.94		Frequent dry sex and ever given birth	13.64	-1.78	0.51	0.31-0.84	Frequent dry sex and number of partners and ever given birth	4.95	-1.78	0.54	0.31-0.93
Casual partner last year	7.49	-18.51	0.53	0.26-1.08		Frequent dry sex and number of partners**	6.73	-8.69	0.50	0.29-0.86	-	-	-	-	-
Condom use at last sex	3.48	-22.52	0.45	0.23-0.88		Frequent dry sex and casual partner last year	13.44	-1.98	0.48	0.27-0.83	Frequent dry sex and number of partners and casual partner	10.56	3.83	0.49	0.28-0.85
Ever used condom	14.69	-11.31	0.49	0.28-0.85		Frequent dry sex and condom use at last sex	9.31	-6.11	0.46	0.31-0.70	Frequent dry sex and number of partners and condom use at last sex	5.06	-1.67	0.49	0.33-0.73
Condom use with last casual partner**	3.48	-22.52	0.63	0.23-1.72		Frequent dry sex and ever condom use	6.82	-8.6	0.48	0.26-0.89	Frequent dry sex and number of partners and ever condom use	5.58	-1.15	0.49	0.27-0.92
STI last year	28.01	2.01	0.42	0.29-0.59											
Notes: Before adding the behaviour variables the Chi square was 26.00 and AOR 0.41 (0.28-0.56) in 2003 compared to 1995. If the chi square changed > 3.84 , the added variable was a confounding variable. The denominator was the number of sexually active respondents last year. **The chief confounder in this step.															

Notes: **Before adding the behaviour variables the Chi square was 41.17 and AOR 0.27 (0.17-0.43) in 2003 compared to 1995.** If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year.

c)

Rural men aged 15-24 with 10+ years of school

Beh. indicator	One by one behaviour indicator included		Two behaviour variables included		AOR	95% CI
	Chi-square	Chi-square change	Chi-square	Chi-square change		
Number of sex partners last 12 months	20.74	-172.99	29854.28	-39370	0.29	0.20-0.42
Casual partner last year**	69224.28	69030.55	-	-	0.70	0.49-0.99
Condom use at last sex	8022.54	7828.81	-	-	0.53	0.35-0.81
Ever used condom	1704.62	1510.89	165481.25	96256.97	0.60	0.49-0.75
Condom use with last casual partner	-	-	-	-	0.60	0.49-0.75
STI last year	193.73	0	69224.28	0	0.60	0.49-0.75

Notes: Before adding the behaviour variables the Chi square was 193.73 and AOR 0.24 (0.13-0.42) in 2003 compared to 1995. . If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year. *The Chi square change was significant, but the AOR was further from 1, which meant that adjusting for 'condom use at last sexual intercourse' or 'number of sexual partners last year' in addition to 'any casual partners last year' increased the strength of the association between HIV and survey time, rather than reducing it.

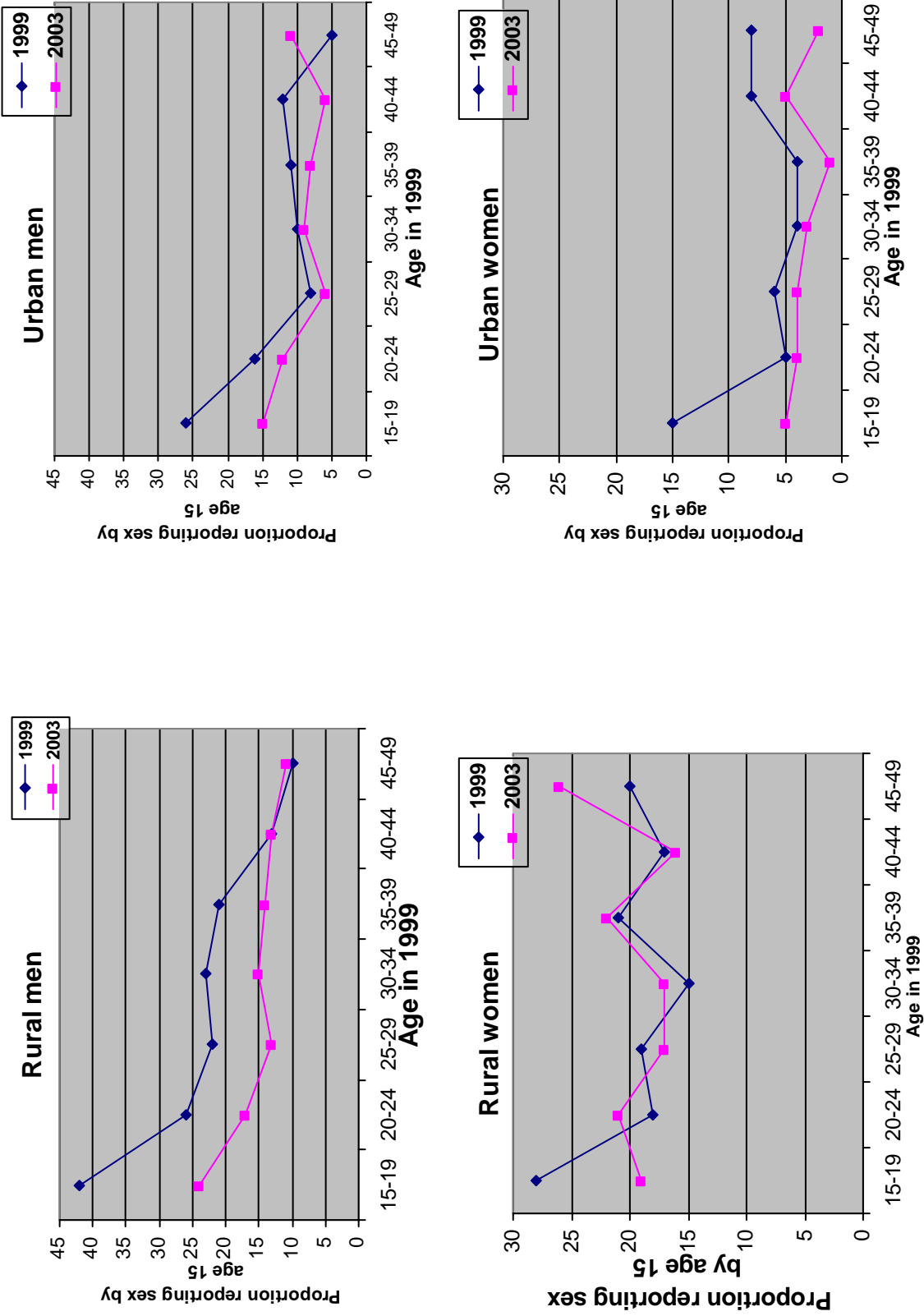
d)

Rural women aged 15-24 with 10+ years of school

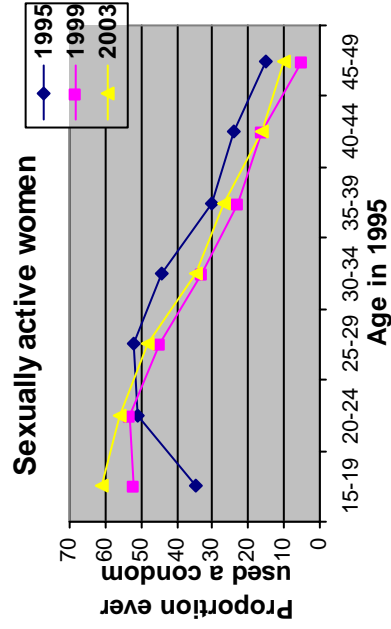
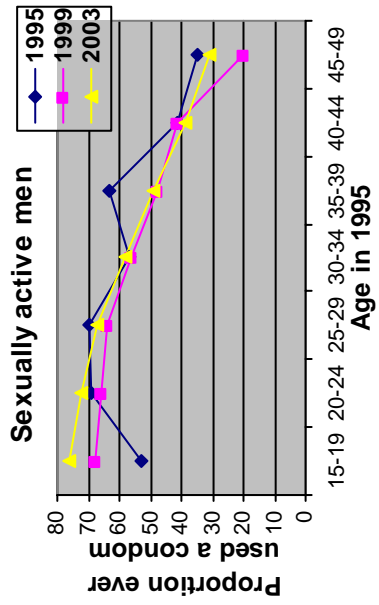
Beh. indicator	One by one behaviour indicator included		AOR	95% CI
	Chi-square	Chi-square change		
Ever given birth	55.12	-18.87	0.20	0.02-1.64
Number of sex partners last 12 months	23.90	-50.09	0.22	0.04-1.16
Casual partner last year	28.01	-45.98	0.21	0.06-0.78
Condom use at last sex	-	-	0.76	0.45-1.29
Ever used condom**	198.82	124.83	0.27	0.14-0.52
Frequent dry sex	41.94	-32.05	0.27	0.14-0.52

Notes: Before adding the behaviour variables the Chi square was 73.99 and AOR 0.18 (0.04-0.85) in 2003 compared to 1995. If the chi square changed > |3.84|, the added variable was a confounding variable. The denominator was the number of sexually active respondents last year.

Supplementary figure 1: Percentages reporting having had sex by the age of 15 in 1999 and in 2003 based on the age groups of the respondents in 1999



Supplementary figure 2: Proportions who reported ever having used a condom in 1995, 1999 and 2003 based on the age groups of the respondents in 1995. The denominator is the number of sexually active respondents



Supplementary figure 3: Proportion of women reporting 'ever given birth' in 1995, 1999 and 2003 based on the age groups in 1995

