Published in final edited form as:
AIDS. 2015 January 14; 29(2): 211–219. doi:10.1097/QAD.0000000000000533.

Trends in HIV acquisition, risk factors and prevention policies among youth in Uganda, 1999-2011

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Abstract

Objective: The objective of this study is to understand how trends in HIV acquisition among youth can be influenced by change in HIV risk factors, social factors and prevention and treatment programmes.

Design: Trends in HIV incidence (per 1000 person-years), by sex and age group, were estimated using data from youth (15–24 years: $n = 22\,164$) in the Rakai Community Cohort Study. Trends in HIV incidence were compared with trends in previously identified HIV risk factors, social factors and programmes.

Methods: Poisson and linear regression were used to test for statistical significance and decomposition was used to calculate attribution of risk factors to HIV incidence.

Results: Substantial declines between 1999 and 2011 occurred in sexual experience, multiple partners and sexual concurrency among adolescents and young adults. HIV acquisition declined substantially (86%, $P = 0.006$) among adolescent women (15–19 years) but not among men or young adult women. Changes in HIV incidence and risk behaviours coincided with increases in school enrolment, decline in adolescent marriage, availability of antiretroviral therapy (ART) and increases in male medical circumcision (MMC). Much of the decline in HIV incidence among adolescent women (71%) was attributable to reduced sexual experience;the decline in sexual experience was primarily attributable to increasing levels of school enrolment.

Conclusion: Dramatic decreases in HIV incidence occurred among adolescent women in Rakai. Changes in school enrolment and sexual experience were primarily responsible for declining HIV acquisition over time among adolescent women. Given limited improvement among young men and young adult women, the need for effective HIV prevention for young people remains critical.

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Conflicts of interest
The authors have no conflicts of interest to report.

Keywords

education; HIV incidence; HIV risk; sexual behaviour; youth

Introduction

Young people living in sub-Saharan Africa face considerable risk of HIV infection [1]. Factors associated with HIV infection in youth include early initiation of sexual intercourse, multiple sexual partners and sexual concurrency, failure to use barrier protection or receipt of male medical circumcision (MMC), sexually transmitted infections (STI), community HIV viral load and power dynamics within relationships including marriage to older partners [2–7].

Tracking of trends in risk factors, behaviours and HIV infection among adolescents and adults can provide insights into the effectiveness of prevention programmes [8,9]. Uganda was highly successful in containing HIV in the early years of the epidemic. HIV seroprevalence in antenatal clinics peaked at 30% around 1990, declined steadily in the 1990s and then plateaued during the early and mid-2000s. The source of this success has been hotly debated, though it is most likely a combination of high-level political commitment to a variety of prevention approaches, including community mobilization, and campaigns discouraging multiple partners (e.g. ‘Zero Grazing’) [2,10–13]. Behaviourally, reductions were seen in multiple sexual partners and sexual concurrency and increases in condom use with nonmain partners in the late 1980s and 1990s [2]. In addition, mortality from HIV infection undoubtedly played a major role in reduction of HIV prevalence [8]. More recently, HIV seroprevalence has increased among youth from 2.9% in 2005 to 3.7% in 2011; HIV risk factors also increased including premarital sex and nonuse of condoms [14], as well as increased use of antiretroviral treatment (ART). This increase in prevalence is an exception to declines seen among youth in other high prevalence countries of East and Southern Africa [15].

Explaining trends in HIV seroprevalence is difficult, given multiple potentially attributable factors that are often changing simultaneously at varied rates and directions [8,9]. Moreover, HIV prevalence reflects past and recent infections. HIV incidence, although harder to measure, is a better reflection of current HIV risk factors and prevention efforts.

This study examines trends between 1999 and 2011 in HIV incidence and associated risk behaviours among youth participating in a population-based cohort study in the Rakai District of Uganda. This third decade of the epidemic in Rakai saw the implementation of multiple treatment and prevention programmes, including prevention of maternal to child transmission in 2000, ART in 2004 and MMC in 2007 for adolescents (aged more than 12 years) and adult men [16]. In 1997, the Uganda government instituted a national policy of universal primary education (UPE) that abolished tuition fees and resulted in rising educational access for children and adolescents [17].

This study builds upon two earlier analyses from the Rakai Health Sciences Program. The first found increases in certain youth sexual risk behaviours from 1994 to 2003 (e.g.

increasing proportions of youth reporting multiple partnerships) and improvements in others (e.g. increased condom use with casual partners) but little change in HIV incidence or prevalence [8]. The second and more recent study identified risk factors for HIV acquisition among Rakai youth from 1999 to 2008; key factors included behavioural (multiple partners and concurrency) and biological factors (STI symptoms), and social transitions such as marital transitions and school enrolment [7]. This study builds upon our recent study and examines trends in HIV acquisition and compares these with trends in individual risk factors, schooling and HIV treatment and prevention policies.

Materials and methods

Using a prospective longitudinal study design of existing cohort data, we examined trends in HIV incidence, and in demographic, behavioural and biological factors associated with incident HIV infection in Rakai youth [7]. We examined individual behavioural factors such as sexual experience, multiple partners, concurrency and condom use and factors related to prevention programmes such as MMC and enrolment in school. We also examined change in HIV incidence before and after the availability of ART after 2004. Finally, we assessed attribution of change in HIV acquisition to changes in risk factors for the group in which we observed declines in incidence: adolescent women.

Study setting and sample

The Rakai Community Cohort Study (RCCS) is an open cohort of residents aged 15–49 years in the Rakai District of southwestern Uganda; it has been described elsewhere [18,19]. Communities are surveyed approximately annually. At each survey round, participants are consented, interviewed and asked to provide specimens for HIV and STI testing. For minors (<18 years), minor assent and parental/guardian consent for research participation is obtained. Questionnaires include questions on demographic, behavioural, reproductive and health characteristics. HIV status was determined by two separate ELISA tests and confirmed by HIV-1 western blot [20]. The RCCS achieves over 85% coverage among all residents. Among consenting participants, 99% respond to the full questionnaire and over 90% agree to specimen collection.

We used data from nine RCCS survey rounds (rounds 6–14) collected between March 1999 and June 2011. The full sample of youth included 22 164 participants residing in the 43 communities under continual surveillance. Of these, 18 244 were sexually experienced. At each round, 15-year-olds were newly recruited and youth aged more than 25 years were censored (excluded) from our analyses. Youth were eligible for analysis of HIV acquisition if they were HIV-negative and if they were tested at one of the next two study rounds. In and out migration was common; our analysis sample for HIV acquisition included 9989 youth followed over 18 256 survey intervals or an average of 1.8 study intervals and a range of one to nine intervals.

Institutional review board (IRB) approvals were obtained from Uganda Virus Research Institute’s Science and Ethics Committee, Uganda National Council for Science and Technology, and from IRBs at Columbia University and Johns Hopkins University.

Statistical analysis

Prevalence of HIV, defined as the proportion of HIV- positive cases among all youth, was calculated by RCCS survey round. Incidence rates were estimated per 1000 person-years over the interval between survey rounds. Information on demographic (age, school enrolment, marital status), behavioural (sexual experience, two or more partners in the last year, concurrent sexual partnerships, condom use in the last 12 months) and biological (circumcision) factors was gathered from the RCCS questionnaire. Most questions relevant to the present analyses were asked consistently across RCCS surveys rounds. The exceptions were sexual concurrency and condom use: the RCCS questionnaire assessed up to two partners until February 2001 and up to four partners after that time [7].

All trends were examined separately for women and men. For sexual behaviours other than sexual initiation, trends are reported among sexually experienced youth. Statistical significance of trends in HIV prevalence and risk/ protective factors was tested using logistic regression and proportional odds models. Significance of trends in incidence rates over study rounds was tested using Poisson regression with robust standard errors [21]. For tests of trend over the full youth age range (15–24 years old), we report P values adjusted by age group given the observed change in the age structure over time (see Table 1 for change in age structure).

In the group in which we observed a decline in HIV incidence (15–19-year-old women), we conducted a hierarchical decomposition analysis to assess to what extent the changes in sexual experience and schooling enrolment contributed to the decline in HIV incidence [22,23]. To do so, we first used a nonparametric Poisson regression to model the incidence rate among all adolescent women over time, and among sexual experienced adolescent woman alone; we then used a separate nonparametric logistic model to estimate change in sexual experience over time among adolescent women. On the basis of these models, we can evaluate the expected incidence rate over time assuming that the sexual experience rate remain unchanged, which in turn allows us to calculate the proportion of HIV incidence rate that was attributed to the change of sexual experience rate. This method is further explained in an online Appendix, http://links.lww.com/QAD/A613 to this article. A similar analysis was performed to investigate the contribution of currently being a student to the decline in sexual experience.

Results

Trends in HIV prevalence and incidence

HIV incidence rates were consistently higher among young women than young men (Table 1). Incidence rates fluctuated considerably over time in all groups; aggregation across survey rounds smoothed this fluctuation considerably. The rate of new infections in youth between survey rounds ranged from 10.3 to 16.2/1000 person- years in young women and5.5 to 10.4/1000person-years in young men. Among adolescent women, incidence decreased 86% from 16.9/1000 to 2.3/1000 person-years between 1999 and 2011 ($P = 0.006$). Incidence did not change significantly over time for adolescent men or young adult women or men (Table 1).

Consistent with the decline in HIV incidence, HIV prevalence declined among adolescent women and all young women. Prevalence among all young women declined from 9.1 to 6.1% between round 6 and round 14. After adjustment for age, we found no decline in HIV prevalence among young men ($P = 0.36$).

Trends in HIV risk factors

School enrolment increased dramatically in Rakai youth between 1999 and 2011 (Table 2). The increase in school enrolment was most marked in adolescents, from 26.0 to 58.9% among adolescent women and from 42.6 to 65.9% among adolescent men. Marriage rates also declined substantially among adolescent women (46.4–23.7%; $P < 0.0001$) and minimally among young adult women (82.7–81.7%). Marriage rates also declined among adolescent (4.7–0.9%) and young adult men (52.0– 37.3%; Table 3).

Sexual experience declined significantly between 1999 and 2011 (Table 2). Although significant declines occurred among both adolescents and young adults, the decline was most marked among adolescents; the percentage of adolescents who reported having initiated sexual intercourse declined from 75.9 to 50.4% among adolescent women ($P < 0.0001$) and from 63.0 to 41.4% among adolescent men ($P < 0.0001$). Rates of MMC rose slowly among men and among primary partners of women during the Rakai randomized clinical trial (rounds 8–11) and accelerated as MMC became a service offered throughout the Rakai communities.

Among sexually experienced youth, reporting of two or more partners in the past 12 months declined for adolescent women (10.6 to 6.2%, $P < 0.0001$) and adolescent men (39.3 to 19.5%, $P < 0.0001$). Declines in multiple partners were also found for young adult men and women. Reporting multiple sex partners from outside the community (data not shown) declined from 15.3 to 10.9% among men but did not change among women. Sexual concurrency at the time of survey declined among adolescent men (11.5–6.7%) and young adult men (20.4–13.6%). Compared with young men, young women less commonly reported sexual concurrency. Concurrency declined among adolescent women (2.2–1.4%, $P = 0.045$) but not among young adult women (1.8–1.6%).

Consistent condom use over the past 12 months with primary and other partners showed little change over time. For 15–19-year-old women and 20–24-year-old men, condom use with primary partner increased slightly. Condom use was particularly low among women aged 20–24 years with primary partners (only 6.5% in round 14). Substantial decreases in alcohol use from round 6 to 12 were found for adolescent and young adult men and women.

Incidence decline in adolescent women

A decline in HIV incidence was seen in adolescent women. Using decomposition, we found that 71% of the decline of HIV incidence could be attributed to the decline in sexual initiation and 29% was due to a lower incidence rate among sexually experienced adolescent women. The decline in sexual initiation was entirely attributable to the increase in student enrolment. The estimate was 125% and exceeds 100% because the large increase in school enrolment among adolescent women was greater than that needed to explain the decline in sexual initiation.

Discussion

During the third decade of the HIV epidemic in Rakai, remarkable changes occurred in HIV incidence, prevalence and risk behaviours among youth, particularly for young women. Between 1999 and 2011, HIV acquisition in Rakai declined substantially among adolescent women. Substantial declines also occurred in HIV risk behaviours among youth, including sexual experience, multiple partners and concurrency; the decline in sexual experience coincided with increased school enrolment and delays in entrance into marriage. These behavioural changes coincided with implementation of new national policies in promoting UPE and rising school enrolment among adolescent men and women. This pattern of findings over time in HIV incidence and HIV risk factors is consistent with our previous finding that current schooling is significantly associated with reduced HIV acquisition in young women [7].

Increases in school enrolment over time were concurrent with considerable declines in sexual experience among adolescent men and women. For adolescent women, much of this decline in HIV incidence was statistically attributable to reduced sexual experience and the decline in the sexual experience was entirely attributable to increasing levels of school enrolment. Among young men, rising school enrolment had no impact on HIV incidence but was concurrent with improvements in other HIV risk behaviours. Despite dramatic decreases in HIV incidence among adolescent women in Rakai, we found little progress among other groups, despite similar improvement in HIV risk behaviours in those groups. HIV acquisition remained high among young adult women. This pattern suggests that the protective effect of school enrolment has primarily delayed HIV acquisition.

The decline in HIV incidence among adolescent women also coincided with new availability of ART. Increased access to ART within a community can reduce viral load and therefore new HIV infections. However, if increased ART use was influencing HIV incidence, one would expect to see decreases in HIV incidence among other groups including young adults, which we did not.

MMC rose steadily beginning first among young adult men during the randomized controlled trial (RCT) [16] from 2003 to 2007 and rising among adolescent and young adult men after 2007. Although the protective effect of MMC is clear in randomized trials, we are not yet seeing a community-wide impact among young men, presumably because rates of circumcision are relatively low (<50%) as are rates of HIV acquisition. Although not examined here, HIV incidence among youth may be influenced by changes in the age of sexual partners. Other research underway with our group finds no change over time in the median age of sexual partners.

Increases in school enrolment among adolescents in Rakai coincided with the national policy of UPE started in 1997. UPE abolished tuition fees and resulted in rising educational access for children and adolescents [17]. In a previous study with Rakai youth, we found that school enrolment was protective against new HIV infection for sexually experienced young men and young women [7]. Early in the epidemic, education attainment – related to increased social power and an increased number of sexual partners – was often associated with increased HIV risk [24,25]. Our analysis is more in line with recent studies, which suggest that education is now more likely to be a protective factor [24,25].

Our qualitative research in Rakai suggests that youth are highly motivated to receive education [26]. Schools in Rakai promote hard work, motivation, respect for elders and HIV prevention. However, many youth are unable to meet their educational goals due to financial constraints, despite the implementation of UPE in Uganda [26]. Youth frequently report lack of funding, often precipitated by death of a parent, as the reason for terminating their education [26].

We found significant declines in reporting of multiple partners among youth and sexual concurrency among men. Our findings are not consistent with recent national trends in sexual partnerships. Although partner reduction was reported nationally in Uganda from the 1980s through the mid-2000s [2,9–11], reporting of multiple partners rose in the most recent (2011) Uganda AIDS Indicator Survey [14]. Declining reports of multiple partnerships and sexual concurrency within Rakai may be due to heightened HIV/AIDS messaging, which has been provided by the RHSP since 1994. Likewise, HIV education was provided to young men during the circumcision trial [16] and during rollout of circumcision as a community service.

Condom use showed little improvement over time, except for small increases in use with primary partners. Thus, it is doubtful that condom use contributed to changes in HIV acquisition.

Although similar patterns of improvement in HIV risk behaviours were seen across sex and age groups, decline in HIV acquisition was only seen in adolescent women. As HIV incidence is low among adolescent men, the power to detect trends in incidence among adolescent men is limited. Among young adults (20–24-year-olds), increased school attendance and decreased sexual initiation are not likely to play a role in reducing HIV acquisition, as most education is completed and sexual experience is almost universal.

Given the decline in HIV incidence among adolescent women, HIV prevalence declined steadily among young women (aged 15–24 years). HIV prevalence can be influenced by HIV incidence, mortality from HIV, and in or out-migration of HIV-positive persons. Among young women in Rakai, the decline in HIV prevalence appears clearly related to declining incidence. Mortality from HIV among adults in Rakai has declined considerably, but ART use and HIV-related mortality are relatively low among youth. Unpublished data from Rakai suggest considerable in and out-migration among HIV-positive youth but no evidence of a net change over time [27]. Finally, HIV prevalence is consistently low among 15-year-olds in Rakai; this suggests little influence of perinatal transmission on HIV prevalence among adolescents.

Limitations and strengths

Although these data are representative of the Rakai District, they are not generalizable to all of Uganda or SSA. Behavioural data were self-reported and subject to social desirability bias. Although such data appear reliable with the Rakai cohort, the validity of self-reported sexual behaviours cannot be readily verified. We previously found very few cases of HIV incidence (three of 207 cases) among youth denying sexual experience [7].

Data on education were limited to school attendance; data on school performance were not available. Data on adolescent developmental transitions such as puberty were not available, although menarche has been a risk factor for leaving school among young women in countries within SSA such as Tanzania [28].

Implications

HIV prevention with youth remains a challenge. To understand trends in HIV prevalence and incidence, one must not only consider trends in demographic factors, behavioural risks for HIV, changes in HIV/AIDS treatment and prevention but also non-HIV policies such as UPE. These data suggest that an effort to increase access to education may be important to future HIV prevention efforts among youth in Uganda and in other areas of sub-Saharan Africa. Such efforts can be an important component of combination prevention and the goal of achieving a generation free of AIDS [29]. However, the absence of a reduction in HIV acquisition among young adult men and women suggests that multiple HIV prevention efforts with youth are needed to reach the goal of an AIDS-free generation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Funding for this study was provided by the National Institute of Child Health and Human Development.

J.S. conceptualized the study, designed the article idea and wrote the initial draft, and coordinated and contributed to each revision. Z.R.E. and S.M. contributed to the development of the initial article idea, participated in data review and preparation of the manuscript. Y.W. and X.S. conducted all data analyses, participated in data interpretation and wrote parts of the Methods section. A.S. contributed to the preparation of the article and reviewed drafts of the article. T.L., R.G., M.W., F.N. and D.S. oversaw the implementation of the project and collection of data and reviewed drafts of the article. All authors reviewed all draft versions and approved the final version.

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Table 1.

HIV incidence and prevalence in young women and men aged 15–24 years, Rakai District, Uganda, 1999–2011.

	Rakai Community Cohort Study Survey Round, 1999–2011									
	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	***P* for trend (age-adjusted)**[a]
Sample of young women (15–24 years)										
Total *n*	3344	3397	3672	2657	2641	2631	2935	2757	2797	
% 15–19 years old[b]	44.6	41.6	41.6	40.3	38.6	41.9	44.5	49.3	51.3	
Total person-years	NA	1364	2109	1788	1901	1837	2161	2466	2145	
HIV incidence per 1000 person-years[c] (no.of new HIV-positive)										
All young women	NA	15.4 (21)	12.8 (27)	16.2 (29)	11.1 (21)	13.1 (24)	11.6 (25)	11.0 (27)	10.3 (22)	0.091 (0.102)
15–19 years old	NA	16.9 (8)	10.7 (7)	14.7 (8)	3.7 (2)	19.4 (10)	10.5 (6)	6.3 (5)	2.3 (2)	0.006
20–24 years old	NA	14.6 (13)	13.8 (20)	16.9 (21)	14.0 (19)	10.6 (14)	12.0 (19)	13.1 (22)	15.5 (20)	0.722
HIV prevalence, % (no. of HIV-positive)										
All young women	9.1 (247)	8.2 (234)	7.2 (225)	6.8 (151)	7.7 (180)	7.1 (177)	6.9 (198)	6.5 (179)	6.1(169)	<0.001 (<0.001)
15–19 years old	3.8 (46)	3.8 (46)	4.0 (53)	4.6 (41)	3.9 (36)	3.4 (36)	2.8 (36)	2.0 (27)	2.0 (28)	<0.001
20–24 years old	13.5 (201)	11.4 (188)	9.6 (172)	8.3 (110)	10.1 (144)	9.8 (141)	10.1 (162)	11.0 (152)	10.4(141)	0.06
Sample of young men (15–24 years)										
Total *n*	2173	2147	2465	1860	1638	1803	2153	2303	2439	
% 15–19 years old[b]	47.2	43.8	45.7	44.7	44.2	50.6	54.5	58.1	57.9	
Total person-years	NA	834	1408	1261	1247	1181	1710	2186	2261	
HIV incidence per 1000 person-years[c] (no. of new HIV-positive)										
All young men	NA	6.0 (5)	9.2 (13)	6.3 (8)	10.4 (13)	5.9 (7)	5.9 (10)	5.5 (12)	7.5 (17)	0.51 (0.75)
15–19 years old	NA	3.2 (1)	4.0 (2)	0.0 (0)	2.2 (1)	2.6 (1)	3.2 (2)	2.2 (2)	1.9 (2)	0.74
20–24 years old	NA	7.8 (4)	12.1 (11)	9.7 (8)	15.1 (12)	7.6 (6)	7.4 (8)	7.9 (10)	12.3 (15)	0.83
HIV prevalence, % (no. of HIV-positive)										
All young men	2.9 (49)	2.2 (37)	2.4 (50)	2.6 (38)	2.6 (37)	2.1 (35)	1.5 (31)	1.9 (44)	2.1 (50)	0.02 (0.36)
15–19 years old	0.7 (6)	0.4 (3)	0.2 (2)	0.2 (1)	0.5 (3)	0.4 (3)	0.7 (8)	0.5 (7)	0.8 (11)	0.22
20–24 years old	4.9 (43)	3.5 (34)	4.3 (48)	4.5 (37)	4.3 (34)	3.9 (32)	2.4 (23)	3.9 (37)	3.8 (39)	0.14

[a] *P* values estimated for incidence estimated using Poisson regression and for prevalence using linear regression.

[b] % of sample 1 5–19 years old among all youth aged 15–24 years.

[c] Among eligible participants: those entering RCCS as HIV-negative and followed up at next or subsequent study round.

Table 2.

Demographic characteristics and HIV risk factors in young women and men aged 15–24 years, Rakai District, Uganda, 1999–2011.

	Rakai Community Cohort Study Survey Round, 1999–2011									*P* for trend (age-adjusted)	Model for test
	6	7	8	9	10	11	12	13	14		
Women (15–24 years)											
Enrolled in school											
15–1 9 years old	26.0%	29. 9%	30.9%	35.6%	36.9%	46.8%	50.7%	57.1%	58.9%	<0.001	Logistic regression
20–24 years old	1.4%	1.0%	0.9%	1.9%	2.1%	4.1%	4.5%	3.9%	3.9%	<0.001	Logistic regression
Ever married											
15–1 9 years old	46.3%	45.0%	42.6%	40.2%	39.3%	29.5%	26.9%	23.2%	23.6%	<0.000	Logistic regression
20–24 years old	82.7%	82.1%	81.1%	82.9%	83.5%	77.9%	79.0%	82.5%	81.7%	0.011	Logistic regression
Risk factors among all women											
Ever had sex											
15–1 9 years old	75.9%	75.2%	78.4%	73.6%	73.5%	64.4%	63.0%	55.1%	50.3%	<0.001	Logistic regression
20–24 years old	99.1%	99.1%	98.9%	98.9%	99.0%	98.2%	98.2%	98.0%	97.8%	<0.001	Logistic regression
Primary partner has received male medical circumcision											
15–19 years old	NA	NA	NA	27.1%	28.0%	33.1%	38.9%	44.6%	55.5%	<0.001	Logistic regression
20–24 years old	NA	NA	NA	25.5%	28.0%	32.9%	38.9%	47.2%	51.6%	<0.001	Logistic regression
Risk factors among sexually experienced women											
Number of sex partners, last 12 months											
15–1 9 years old										<0.001	Proportional odds model
0	7.4%	7.0%	6.2%	6.5%	9.7%	9.7%	12.1%	13.2%	12.2%		
1	82.0%	83.3%	82.1%	83.1%	80.7%	81.4%	78.8%	77.1%	81.6%		
More than 2	10.6%	9.7%	11.8%	10.4%	9.6%	8.9%	9.1%	9.7%	6.2%		
20–24 years old										<0.001	Proportional odds model
0	3.5%	3.7%	3.8%	2.8%	3.2%	4.6%	3.6%	3.4%	4.4%		
1	90.5%	89.1%	89.5%	92.2%	91.8%	89.9%	90.2%	91.4%	90.7%		
More than 2	6.0%	7.2%	6.7%	5.0%	5.0%	5.5%	6.3%	5.2%	5.0%		
Concurrent sexual partners at the date of interview											
15–1 9 years old	2.2%	1.5%	2.8%	2.4%	2.1%	1.8%	1.8%	0.9%	1.4%	0.048	Logistic regression
20–24 years old	1.8%	1.8%	1.8%	1.6%	2.1%	2.3%	2.3%	1.8%	1.6%	0.723	Logistic regression

	Rakai Community Cohort Study Survey Round, 1999–2011										
	6	7	8	9	10	11	12	13	14	*P* for trend (age-adjusted)	Model for test
Always used condoms, primary partner in last 12 months											
15–1 9 years old	15.7%	19.1%	21.6%	21.0%	21.3%	24.8%	29.7%	29.2%	22.9%	<0.001	Logistic regression
20–24 years old	7.4%	7.6%	8.5%	5.3%	5.8%	8.3%	8.0%	6.1%	6.5%	0.396	Logistic regression
Always used condom with 2–4 partners, last 12 months											
15–1 9 years old	40.0%	25.2%	42.6%	34.9%	41.7%	38.1%	36.0%	41.1%	42.2%	0.183	Logistic regression
20–24 years old	27.0%	33.8%	35.5%	37.2%	31.3%	33.7%	36.0%	29.6%	37.3%	0.250	Logistic regression
Alcohol use in last 30 days											
15–1 9 years old	28.7%	27.0%	27.2%	14.6%	13.6%	13.0%	9.2%	NA	NA	<0.001	Logistic regression
20–24 years old	35.1%	33.6%	31.9%	22.7%	21.3%	24.6%	21.7%	NA	NA	<0.001	Logistic regression
Men (15–24 years)											
Enrolled in school											
15–19 years-old	42.6%	43.5%	47.4%	53.4%	53.7%	60.1%	59.0%	61.8%	65.9%	<0.001	Logistic regression
20–24 years-old	6.0%	7.2%	7.0%	9.1%	8.6%	12.6%	11.2%	12.6%	11.9%	<0.001	Logistic regression
Ever married											
15–1 9 years-old	4.7%	4.2%	3.3%	2.1%	2.1%	2.5%	1.8%	1.3%	0.9%	<0.001	Logistic regression
20–24 years-old	52.0%	49.0%	49.5%	48.3%	43.4%	39.7%	40.6%	40.4%	37.3%	<0.001	Logistic regression
Risk factors among all men											
Ever had sex											
15–19 years-old	63.0%	63.0%	65.7%	60.4%	59.0%	54.7%	53.8%	44.5%	41.4%	<0.001	Logistic regression
20–24 years-old	95.6%	94.6%	96.1%	95.8%	96.4%	95.4%	94.1%	92.0%	90.9%	<0.001	Logistic regression
Male Medical Circumcision											
15–19 years-old	NA	NA	16.8%	20.8%	20.4%	21.2%	21.8%	28.4%	35.7%	<0.001	Logistic regression
20–24 years-old	NA	NA	15.4%	1 7.2%	18.3%	24.2%	30.0%	38.1%	42.3%	<0.001	Logistic regression
Risk factors among sexually experienced men											
Number of sex partners—last 12 months											
15–19 years-old										<0.001	Proportional odds model
0	18.4%	18.2%	17.6%	18.5%	22.2%	25.7%	22.2%	31.8%	31.2%		
1	42.3%	40.9%	43.2%	46.6%	45.7%	47.0%	49.5%	46.7%	49.3%		
More than 2	39.3%	40.9%	39.2%	34.9%	32.1%	27.5%	28.3%	21.5%	1 9.5%		
20–24 years-old										<0.001	Proportional odds model

	Rakai Community Cohort Study Survey Round, 1999–2011									*P* for trend (age-adjusted)	Model for test
	6	7	8	9	10	11	12	13	14		
0	7.9%	8.2%	7.2%	7.5%	8.40%	10.2%	9.5%	9.9%	12.7%		
1	47.6%	47.1%	42.3%	47.8%	48.0%	46.2%	43.3%	51.2%	54.0%		
More than 2	44.4%	44.7%	50.5%	44.7%	43.6%	43.5%	47.3%	38.9%	33.3%		
Concurrent sexual partners at date of interview											
15–19 years-old	11.5%	13.0%	11.2%	15.1%	8.2%	8.8%	10.1%	6.7%	6.7%	<0.001	Logistic regression
20–24 years-old	20.4%	1 8.7%	21.2%	20.7%	19.6%	20.6%	21.5%	16. 7%	13.6%	<0.001	Logistic regression
Always used condoms w/ primary partner—last 12 months											
15–19 years-old	37.2%	40.1%	43.9%	47.8%	44.5%	37.1%	41.0%	39.3%	38.1%	1.000	Logistic regression
20–24 years-old	23.7%	29.5%	28.0%	29.4%	32.2%	32.2%	28. 6%	28.5%	30.1%	0.007	Logistic regression
Always used condom w/ 2–4 partner—last 12 months											
15–19 years-old	31.5%	37.9%	39.5%	37.9%	46.7%	40.2%	33.5%	35.9%	39.5%	0.013	Logistic regression
20–24 years-old	39.1%	37.7%	38.0%	42.5%	43.3%	37.0%	36.3%	36.4%	33.7%	0.412	Logistic regression
Alcohol use in last 30 days											
15–19 years-old	37.5%	37.8%	33.2%	22.1%	17.1%	13.8%	13.3%	NA	NA	<0.001	Logistic regression
20–24 years-old	56.9%	57.4%	53.8%	42.2%	37.5%	37.2%	33.7%	NA	NA	<0.001	Logistic regression

Statistical testing used to assess change over time, p values adjust for single year of age. Denominators for certain analyses limited to sexually experienced youth as noted above.

Table 3.

Multivariate models of associations with incident HIV infection among sexually experienced youth, Rakai District, Uganda, 1999–2011.

	Women				Men			
		95% CI				95% CI		
	IRR	**Low**	**High**	***p***	**IRR**	**Low**	**High**	***p***
Interview date in year[a]	0.98	0.94	1.02	0.395	1.02	0.91	1.14	0.715
Enrolled in school								
No	1							
Yes	0.25	0.12	0.53	0.000				
Ever married								
No	1				1			
Yes	0.72	0.51	1.01	0.060	2.24	1.24	4.05	0.008
Number of sex partners, last 12 months								
0	1				1.00			
1	1.97	0.96	4.04	0.064	2.64	0.53	13.07	0.234
More than 2	6.01	2.83	12.77	0.000	5.83	1.19	28.53	0.03
Alcohol use in last 30 days								
No					1			
Yes					2.62	1.47	4.68	0.001

Poisson regression used to generate incidence rate ratios (IRR) and 95% confidence intervals (CI).

[a]Time is not significant in female teenagers as well controlling for student, married and number of sex partners.