

Adolescents, sexual behavior and HIV-1 in rural Rakai district, Uganda

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Objectives: To describe the epidemiology of HIV-1 infection among adolescents aged 13–19 years, in rural Rakai district, Uganda.

Study design: Baseline survey and 2-year follow-up (1990–1992) of adolescents in a population-based, open rural cohort.

Methods: Annual enumeration and behavioral/serological survey of all consenting adolescents aged 13–19 years at recruitment, residing in 31 randomly selected community clusters.

Results: At baseline, of 909 adolescents present in study clusters, 824 (90.6%) provided interview data and serological samples. No adolescents aged 13–14 years were HIV-infected. Among those aged 15–19 years, 1.8% of men and 19.0% of women were HIV-positive. Among young women aged 15–19 years in marital/consensual union, 21.3% were HIV-positive; this rate did not differ significantly from the 29.1% prevalence in those reporting non-permanent relationships; prevalence was significantly lower in women reporting no current relationship (4.3%). After multivariate adjustment, female sex, age 17–19 years, residence in trading centers/trading villages and a history of sexually transmitted disease symptoms remained significantly associated with HIV infection. Seventy-nine per cent of adolescents provided a follow-up serological sample. No young men aged 13–14 years seroconverted during the study; in young women aged 13–14 years, HIV seroincidence was 0.6 per 100 person-years (PY) of observation. Among young men aged 15–19 years, there were 1.1 ± 0.6 seroconversions per 100 PY of observation prior to age 21 years; among women 15–19 years, the incidence rate was 3.9 ± 1.0 per 100 PY of observation prior to age 21 years. The mortality rate among HIV-positive adolescents aged 15–19 years, at 3.9 per 100 PY of observation, was 13-fold higher than that among the HIV-uninfected. By 1992, knowledge of sexual transmission was almost universal, the proportions reporting multiple partners had decreased and condom use had increased over baseline.

Conclusions: Adolescents, and young women in particular, are vulnerable to HIV infection. Despite reported behavioral changes, HIV incidence rates remain substantial, and there is a need for innovative HIV preventive measures.

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Introduction

Adolescence is the transition period, physically, biologically and socially, between childhood and adulthood. Individuals in this developmental stage are vulnerable to the dangers inherent in undertaking sexual activity, including the risk of HIV infection. Surveys from a number of African countries indicate early sexual initiation: in the late 1980s, between 22 and 64% of unmarried women aged 15–17 years residing in Kenya, Ghana, Botswana and Liberia reported being sexually experienced [1]. In Uganda, a 1988–1989 household survey conducted in urban and rural areas reported that 48.6% of men and 38.9% of women aged 15 years indicated they had experienced sexual debut, and by age 17 years, the rates had risen to 74% for both sexes [2]. The 1995 Uganda Demographic and Health survey found somewhat lower rates of sexual initiation in younger girls (30% of female adolescents reported having had sexual intercourse by age 15 years); however, 72% of young female respondents indicated they had experienced intercourse by age 18 years (whereas only 56% were married by this age), and median age of first intercourse was 16.5 years [3].

Adolescents in Uganda are at high risk of acquiring HIV-1 infection, as has been reflected in community-based serological surveys [4,5], and in national HIV/AIDS surveillance reports [6]. Thus, assessment of sexual activity, AIDS-related risk factors, and preventive behaviors among adolescents are of great importance as these individuals enter their reproductive years.

Rakai district, in south-western Uganda, is bordered by northern Tanzania and Lake Victoria. The district has a population of 380 000, residing in three geographic strata: main road trading centers which service local, domestic and international traffic; intermediate trading villages on secondary roads, which act as foci for local communications; and rural agrarian villages off main and secondary roads [4,7]. In 1989, we established the Rakai Project population-based longitudinal HIV cohort and have documented high HIV-1 prevalence and incidence rates in the district. In 1989, HIV prevalence rates were 38.5, 25.6 and 8.6% among individuals aged 13 years and over, in the trading centers, intermediate trading villages and rural agrarian villages, respectively ($P < 0.01$) [4,7]. Extrapolation of prevalence rates from the Rakai cohort to the population of the district indicates that 13% of Rakai adults, aged 13 years and above, were infected with HIV in 1989–1991 [4], consistent with the results of the 1987 Ugandan National Serosurvey [8]. Between 1989 and 1990, HIV incidence in the Rakai study population (age 13 years and above) was 2.1 ± 0.5 per 100 person-years (PY) of observation [9]. In this study, we present data on HIV infection and related risk behaviors in the general adolescent population of Rakai.

Methods

At the time of the surveys, the smallest political unit in Rakai District was the Level One Resistance Committee (RC1), each containing 100 households on average. In 1989, we established the Rakai Project cohort using two-stage stratified cluster sampling [4]. The cohort consisted of all residents of 840 households in 21 community clusters. In the first stage of sampling, clusters were chosen at random from the complete list of RC1s in the district. In second stage sampling, an index household was randomly selected in each of the RC1s, and all residents of this household and 39 contiguous ones were enrolled into the study (selected in concentric circles around the index household). Field supervisors oversaw the process and drew detailed maps of communities and clusters to ensure adherence to the sampling protocol. In 1990, the cohort was expanded with the addition of 10 more clusters (total number of clusters, 31) and by enlarging each cluster to 60 households, using identical methods of household selection as used in the original cohort. The total number of households in 1990 was 1860. Cluster sampling is the most feasible method for selecting a representative random sample in this rural environment, and is a standard technique in population-based health surveys in developing countries [10,11].

RC1s located in trading centers and secondary road trading villages were oversampled to ensure the representation of these potentially high prevalence communities [4]. Within the district as a whole, trading centers represent 5% of all Rakai communities and trading villages represent 4% of all such communities. Within the cohort study, we enrolled 11 clusters drawn from trading center RC1s and another 11 clusters selected from trading village RC1s (out of a total of 31 clusters), such that 35% of the study population was enrolled from each of these two strata.

At baseline and at subsequent yearly intervals, an enumeration team visited every study household and updated a list of all adults, adolescents and children resident in the household for at least 3 months of the previous year, whether present at the time of the enumeration or not (*de jure* population). The broad classification of residence was used to ensure inclusion of the majority of persons having substantial contact with the household. During the enumeration, basic demographic data (age, sex, place and household of residence) were obtained for all cohort subjects; reasons for absence were recorded for anyone not present in the household; and all births, deaths and in- and out-migrations which had occurred in the household in the previous year were noted.

Following the baseline and annual follow-up enumerations, trained interviewers/health workers visited every

consenting resident in the home to administer a questionnaire on sociodemographic characteristics, knowledge and behaviors, and to collect a venous blood sample for HIV testing. Individuals were informed that compliance was voluntary, that all data and results would be confidential, and that in keeping with Ugandan Ministry of Health policies, they would have access to their HIV results and counselling provided by trained project counsellors. Consent, confidentiality and all other survey/testing procedures were reviewed and approved by the AIDS Research Subcommittee of the Ugandan National Council for Science and Technology and by the Columbia University Institutional Review Board.

Among the information collected at interview were data on current and previous relationships, number of partners in the previous year and in the previous 5 years, pregnancy history, use of condoms, current and previous symptoms of sexually transmitted diseases (STD), and AIDS-related knowledge and attitudes. Venipuncture whole blood specimens were spun in the field and transported to the Uganda Virus Research Institute, a World Health Organization HIV Reference Laboratory in Entebbe, for storage at -20°C . Initial serum screening was carried out using a commercial enzyme-linked immunosorbent assay (ELISA; Recombigen HIV-1 EIA; Cambridge Biotech Corp., Worcester, Massachusetts, USA), and all samples found positive on ELISA were confirmed by Western blot (BioRad, Hercules, California, USA). The sensitivity and specificity of the enzyme immunoassays was 98 and 93%, respectively.

In 1990, we enumerated 8774 *de jure* residents in the study households, of whom 1237 (14.1%) were adolescents aged 13–19 years. Seventy-three per cent ($n = 909$) of the enumerated adolescents were present in the study clusters at the time of the 1990 enumeration/survey (*de facto* population). The rate of absenteeism among women (21.1%) was equivalent to that of the general population. Reasons for absence among women included schooling, work and visiting/residence with other relatives. As we have previously reported [4,7], the rate of absenteeism among young men, at 32.8%, was higher than that of the population as a whole, due primarily to mobility associated with work (including work-related seasonal migration to urban centers), schooling and, less commonly, military service. The majority of the absent men were resident in the trading centers and trading villages. We obtained interview data for 96.2% and a serological sample from 90.6% ($n = 824$) of the adolescents present at baseline. The overall rate of refusal among those present (9.4% for serological samples) was thus low: refusals were distributed throughout the age range and men made up two-thirds of refusers.

All new persons who migrated into the study households during follow-up were subsequently enrolled into this open cohort. Individuals who refused enrolment in 1990 but who subsequently consented to participate in 1991 were enrolled at that time. In addition, resident children were included in the adolescent group once they reached 13 years of age. In 1992, we enumerated 1470 adolescents (702 men and 768 women); 1116 (75.9%) were present in the communities at the time of the survey, and 86.6% of those present ($n = 967$) consented to the survey. The age and sex distribution of refusals was equivalent to that at baseline.

In this study, we report baseline information for those adolescents who provided both an interview and a serological sample upon entering the study in 1990. HIV incidence is reported for those seronegative adolescents enrolled in 1990 and 1991 (open cohort), on whom we have at least one follow-up serological sample collected up to and including age 20 years (a total of 820 individuals, or 78.8% of the 1040 seronegative adolescents on whom a baseline sample was collected in 1990 or 1991). Follow-up was higher for women than men (81.1 and 76.0%, respectively), higher in rural villages than in trading centers and trading villages, and higher for those HIV-uninfected (81.2%) than for those HIV-infected (70.8%), due to higher mortality and mobility rates in the latter group. The primary reason for loss to follow-up was out-migration from the community.

HIV incidence is also calculated for the closed cohort: of the 754 seronegative adolescents enrolled at baseline, 617 (81.9%) provided at least one follow-up sample by age 20 years.

In the intersurvey periods between 1990 and 1992, the Rakai Project provided community and individual health education, and access to condoms and to HIV serological results and counselling.

Statistical analysis

We estimated the prevalence of HIV infection associated with potential sociodemographic and behavioral risk factors for men and women. The unadjusted odds ratios (OR) and 95% confidence intervals (CI) were estimated from the number of infected and uninfected respondents within subcategories of variables. Tests of statistical significance used 95% CI of the OR, χ^2 and Fisher's exact test. Multiple logistic regression [12] was used to determine those factors independently associated with HIV risk after adjusting for potential confounders. A final logistic regression model was constructed from all variables found to be significant in bivariate analysis. The classification of the three residential strata (trading centers, 11 clusters; trading villages, 11 clusters; rural villages, nine clusters) developed in our previous analyses of the geographic distribution

of HIV in Rakai [4,7], is used in this study as a measure of community level exposure. The three strata were included in the logistic regression model in order to determine whether place of residence modified the effects of the individual sociodemographic and behavioral factors as determinants of HIV risk.

Results

Baseline data: younger adolescents aged 13–14 years

Thirty-one per cent ($n = 255$) of the adolescents on whom we collected interview data and serological samples at baseline in 1990 were aged 13–14 years; 117 were boys and 138 were girls. Fourteen per cent of the young men reported having been sexually active in the previous year, as did 8.7% of the young women. Only two adolescents in this age-group, both boys, reported ever using condoms. Two girls, and no boys, reported being married at baseline. A high proportion of adolescents aged 13–14 years had correct knowledge of

AIDS: 89.0% of boys and 96.2% of girls had heard of AIDS, and 63.8 and 81.8%, respectively, knew of sexual transmission (prompted response). None of the female respondents aged under 15 years reported a previous pregnancy. There were no HIV-positive individuals in this age-group at baseline.

Baseline data: older adolescents aged 15–19 years

Sociodemographic and behavioral characteristics

Except where indicated, all subsequent baseline results are reported for the 569 study subjects aged 15–19 years in 1990. Among the 222 men in this age-group, 119 (53.6%) were aged 17–19 years, whereas among the women, 215 out of 347 (62.0%) were aged 17–19 years. The distribution of principal sociodemographic and behavioral characteristics for adolescents aged 15–19 years, and the associated rates of HIV-1 infection, are shown in Table 1. Ninety-one per cent of men and 85.6% of women reported having received at least some primary education. Approximately one-half of the adolescents of both sexes worked in agriculture,

Table 1. Seroprevalence of HIV-1 and unadjusted odds ratio (OR) by sociodemographic risk factors and sex for adolescents aged 15–19 years in 1990 ($n = 569$). Includes sexually active and non-active respondents.

Sociodemographic characteristics*	Men		Women	
	HIV-positive/total (%)	OR (95% CI) [†]	HIV-positive/total (%)	OR (95% CI)
Sex	4/222 (1.8)		66/347 (19.0)	
Age (years)				
17–19	4/119 (3.4)	NE	57/215 (26.5)	4.9 (2.3–11.1)
15–16	0/103 (0)		9/132 (6.8)	1
Place of residence				
Trading center	2/41 (4.9)	5.9 (0.4–167.8)	32/101 (31.7)	6.5 (2.8–15.0)
Trading village	1/66 (1.5)	1.8 (0.1–65.4)	24/97 (24.7)	4.6 (2.0–10.9)
Agricultural village	1/115 (0.9)	1	10/149 (6.7)	1
Occupation				
Bar/vending/trucker	1/54 (1.8)	1	21/61 (34.3)	5.1 (1.3–23.7)
Agriculture	2/110 (1.8)	1	27/179 (15.1)	1.7 (0.5–7.6)
Student	1/32 (3.1)	1	3/32 (9.4)	1
Other/none	0/21 (0)	1.7 (0.1–25.8)	13/68 (19.1)	2.3 (0.5–11.0)
Education				
Secondary	1/31 (3.2)	1.9 (0.1–14.3)	21/67 (31.3)	7.0 (1.8–31.8)
Primary	3/166 (1.8)	1	40/225 (17.8)	3.3 (0.9–14.1)
None	0/19 (0)	–	3/49 (5.0)	1
Marital status				
Married/consensual	2/24 (8.3)	4.9 (0.5–52.4)	34/160 (21.3)	6.0 (1.9–20.7)
Non-permanent/friend/casual	2/110 (1.8)	1	25/86 (29.1)	9.1 (2.8–32.7)
No current relationship	0/86 (0)	–	4/93 (4.3)	1
Currently pregnant				
Yes			11/57 (19.3)	1
No			55/285 (19.3)	1
No. partners past year				
≥ 2	0/47 (0)	NE	16/44 (36.4)	5.1 (2.0–13.4)
1	3/61 (4.9)		37/183 (20.2)	2.3 (1.1–5.0)
0	0/109 (0)		11/109 (10.1)	1
Ever use condoms				
Yes	1/24 (4.2)	2.7 (0.1–37.8)	7/15 (46.7)	4.0 (1.2–12.6)
No	3/188 (1.6)	1	59/326 (18.1)	1
Ever had an STD symptom				
Yes	1/19 (5.3)	3.7 (0.1–48.0)	19/58 (32.8)	2.5 (1.3–4.9)
No	3/201 (1.5)	1	47/286 (16.4)	1

*Unknowns and no response not included. [†]Fisher's exact test: not significant for all male rates. CI, Confidence interval; OR, odds ratio; NE, not estimated due to empty cell.

Table 2. Distribution of adolescents aged 15–19 years by marital status and number of sexual partners reported in the past year, baseline data, 1990 (n = 551)*.

	Men (n = 217)		Women (n = 334)	
	Married/ Consensual	Unmarried	Married/ Consensual	Unmarried
Age 15–16 years (n)	5	94	26	98
No. partners [n (%)]				
0	0 (0)	66 (70.2)	0 (0)	76 (77.6)
1	2 (40.0)	14 (14.9)	18 (69.2)	16 (16.3)
≥ 2	3 (60.0)	14 (14.9)	8 (30.8)	6 (6.1)
Age 17–19 years (n)	18	100	132	78
No. partners [n (%)]				
0	1 (5.6)	42 (42.0)	1 (0.8)	33 (42.3)
1	10 (55.6)	35 (35.0)	118 (89.4)	31 (39.7)
≥ 2	7 (38.8)	23 (23.0)	13 (9.8)	14 (17.9)

*18 adolescents aged 15–19 years (3.5%) did not provide partner/marital status data. Two men were in polygamous marriage; both reported three or more partners.

whether on a cash or subsistence basis; 24.9% of the men and 17.9% of the women worked in bars, shops or lodges, or as truck drivers, occupations that have been associated with a high risk of HIV infection among adults in Rakai district [7].

Substantially more women (47.2%) than men (10.8%) were married or in consensual union. Marriage refers to legal or religious union; consensual relationship includes cohabitation and informal marriage. Only 5.1% of the men aged 15–16 years were married or in consensual union, a rate which rose to 15.3% for men aged 17–19 years. Among women, 21.0% of those aged 15–16 years and 62.9% of those aged 17–19 years reported currently being in such a union. These rates of reported marriage and cohabitation are consistent with national data for rural regions of Uganda [3,13].

Partner data (interview and serological sample) were obtained from the male spouse of 95 married adolescent women. The mean and median ages of these 95 women were 17.5 and 18.0 years, respectively; the mean and median ages of the male partners were 25.5 and 23.0, respectively. Thus, on average, the female spouse was 8 years younger than her partner.

Fifty per cent of all men and 67.6% of all women aged 15–19 years reported having been sexually active in the previous year. Of these 108 currently sexually active men, 56.5% reported one partner in the previous year, 25.0% had two partners, 10.2% reported three partners, 4.6% had four partners, and 3.7% reported five or more partners in the previous year. Among the 227 currently sexually active women who provided partner data, 80.6% reported one, 11.9% reported two, 4.8% reported three, 1.3% reported four, and 1.3% reported five or more partners in the previous year.

Table 2 illustrates the numbers of partners reported in the previous year by sex, age-group and marital status. Virtually all of the adolescents (98.8%) who reported

being in marital or consensual union were sexually active in the previous year. Thirty per cent of unmarried young men aged 15–16 years reported at least one sexual partner in the previous year, compared with 22.4% of unmarried women in this age-group (Table 2). Among unmarried men and women aged 17–19 years, the proportion reporting at least one partner in the previous year was almost identical (58.0 and 57.7%, respectively). Forty-four per cent of the men aged 15–19 years who reported being sexually active in the past year (whether in marital or non-marital union) had more than one partner, and 18.3% of the sexually active women reported multiple partners in the previous year. Only two men reported being in a polygamous marital union; both of these men reported exactly three partners in the previous year. Overall, 76.0% of the 110 men and 76.7% of the 86 women in non-permanent relationship (casual relationship, having a boyfriend or girlfriend) reported at least one sexual partner in the previous year (data not shown).

A higher proportion of adolescents residing in trading centers and trading villages reported being sexually active in the previous year than those in the rural, agrarian villages. The proportions reporting multiple partners were also higher in the more urbanized centers. Thirty per cent of trading center men aged 15–19 years reported two or more partners in the previous year, compared with 18.2% of rural men; among women aged 15–19 years, the proportions reporting two or more partners in the trading centers and rural villages were 27.4 and 5.8%, respectively.

The proportions of adolescents who had ever had sex can be estimated from data on number of sexual partners in the past year and past 5 years, and in women, from additional data on pregnancy history. Of 222 men aged 15–19 years at baseline, 119 (53.6%) had evidence of sexual experience, and 254 out of 347 women aged 15–19 years (73.2%) similarly reported a sex partner in the last year or the past 5 years, or a previous pregnancy.

Use of condoms was reported by 11.3% of the adolescent men and 4.4% of the women. Nine per cent of men and 16.9% of the women aged 15–19 years reported previous or current potential symptoms of STD, including genital ulcer, discharge or symptoms of pelvic inflammatory disease.

HIV-1 prevalence and risk factors

Table 1 illustrates HIV prevalence by selected sociodemographic and behavioral characteristics (unadjusted OR). Overall, 1.8% of men aged 15–19 years were HIV-infected, compared with 19.0% of women (OR, 12.8; 95% CI, 4.4–41.9). Among women, the risk of HIV infection was significantly increased with older age, residence in trading centers or trading villages, occupation in the cash economy (primarily bar and shop work), higher level of education, higher number of partners reported in the previous year, use of condoms, and ever having had symptoms of an STD.

Among men, rates of HIV infection were higher with older age, residence in trading centers or trading villages, higher education, being married, use of condoms, and ever having had symptoms of an STD. However, the number of HIV-infected men was small and none of the associations attained statistical significance.

As also found in adults [4,7], HIV rates were substantially higher among adolescents resident in trading centers and trading villages, compared with rural communities. Extrapolation of adolescent HIV prevalence to the district as a whole (adjusted for sampling weights in the three community strata) yields a rate of 1.1% for men aged 15–19 years and 8.7% for women in this age-group.

The rate of HIV infection among women in marital or consensual union (21.3%) was not significantly different from that of women with a boyfriend (29.1%; OR, 1.5; 95% CI, 0.8–2.9), although women reporting no current relationship were at significantly lower risk of infection (4.3%; Table 1). Of the 95 women in permanent union (married or consensual) whose spouse also provided a serological sample, 15.8% were HIV-infected. The HIV prevalence among the male partners was 20.0%.

Among the 119 men with evidence of lifetime sexual exposure, HIV prevalence was 2.3%; among the 101 with no evidence of sexual experience, the rate was 1.0%. However, numbers were small (the latter rate is based on only one HIV-positive person). Among the 232 young women who reported being sexually active in the past year, 23.3% were HIV-infected. Of the 22 who reported no partner in the last year but had reported a partner or a pregnancy in the previous 5 years, four (18.8%) were HIV-positive. Among the 86 women reporting no partners or pregnancies now or in the past 5 years, six (6.9%) were HIV-positive.

Information on current or previous partners was unavailable for seven women, of whom two were HIV-positive.

On multivariate analysis, the adjusted risk of HIV infection was significantly increased for women relative to men (OR, 11.6; 95% CI, 3.8–35.0), age 17–19 years relative to age 15–16 years (OR, 4.6; 95% CI, 2.1–10.0), residence in trading centers (OR, 5.1; 95% CI, 2.2–11.9) or trading villages (OR, 3.9; 95% CI, 1.7–8.9), and a reported history of STD symptoms (OR, 2.7; 95% CI, 1.3–5.4). Educational and marital status, the number of reported partners, and use of condoms were no longer significantly associated with infection. In a multivariate model that excluded age, number of sexual partners remained statistically significant, indicative of the strong correlation between age and sexual exposure.

Fertility

At baseline, 16.4% of all women aged 15–19 years reported being currently pregnant. Among women in marital/consensual union, 28.1% were currently pregnant, compared with 12.8% of those who reported being in a non-permanent relationship, such as having a boyfriend. By age-group, 6.1% of women aged 15–16 years were pregnant and 5.1% had previously had a live-birth; among women aged 17–19 years, the rates of current pregnancy and previous live-birth were 22.3 and 40.0%, respectively. A higher proportion of women residing in the trading centers had previously had a live-birth than in the trading or rural villages.

HIV prevalence was not associated with current pregnancy status, and 19.3% of both the pregnant and the non-pregnant women were HIV-infected.

Knowledge of AIDS and condom use

In this adolescent population, knowledge of AIDS and sexual transmission was high. Ninety-eight per cent of all adolescents aged 15–19 years knew of AIDS. In the 15–16-year age-group, 92.5% of the women and 78.4% of the men knew of sexual transmission, a proportion which increased to over 94% for both sexes by age 17 years and over. However, at baseline, ever use of condoms was reported by only 11.3% of men aged 15–19 years, and 4.4% of women. Among those aged 15–16 years, 3.8% of men and 1.5% of women reported ever using condoms; in the 17–19-year age-group, the rates of reported use were higher at 17.6 and 5.6%, respectively.

Follow-up data, 1992: adolescents aged 13–14 and 15–19 years

AIDS-related knowledge and behavior

Between 1990 and 1992, rates of AIDS-related knowledge increased among adolescents in the Rakai study villages. By 1992, over 94% of both men and women

aged 13–19 years knew of sexual transmission, compared with baseline rates of 63.8% for men and 81.8% for women in this broad age-group. The proportion of men aged 15–19 years reporting multiple partners in the previous year declined slightly from 21.7% in 1990 to 17.5% in 1992 (not significant); in women, the rate decreased from 12.8 to 5.6% ($P < 0.001$). By 1992, 23.8% of men aged 15–19 years reported ever using condoms, compared with 11.3% at baseline ($P < 0.001$). Among women aged 15–19 years, the rate of ever using condoms in 1992 was 8.9%, a doubling from the baseline rate of 4.4% ($P < 0.05$). For both men and women, the increase in condom use occurred primarily among persons residing in trading centers.

HIV incidence 1990–1992

By 1992, at least one follow-up serological sample was collected up to and including age 20 years (but before age 21 years) for 820 of the 1040 HIV-negative adolescents aged 13–19 years enrolled at baseline in 1990 or 1991 (open cohort). Cumulative HIV incidence in this group between 1990 and 1992 was 2.1 ± 0.5 per 100 PY of observation. If only follow-up samples collected up to and including age 19 years are considered, the incidence rate was 1.9 ± 0.4 per 100 PY of observation.

No incident cases were observed in men aged 13–14 years at the beginning of each annual survey interval; the incidence rate among women in this age-group was 0.6 per 100 PY of observation. HIV incidence was 1.1 ± 0.6 per 100 PY of observation for men aged 15–19 years at enrollment and aged 20 years or less at follow-up, and 3.9 ± 1.0 for women in the same age-group ($P < 0.01$). (Truncating observation at age 19 years results in a rate of 0.9 ± 0.5 for men enrolled at ages 15–19 years, and 3.5 ± 0.9 for women.)

Although differentials were not statistically significant due in part to small numbers, in women the highest rates of seroconversion occurred in those residing in trading centers (6.4 per 100 PY of observation) and among those reporting one partner in the previous year (3.9 per 100 PY of observation); among men, those reporting two or more partners experienced the highest HIV incidence (2.7 per 100 PY of observation). HIV incidence did not change significantly between the first and second year of observation.

If data are examined only for those adolescents enrolled at baseline in 1990 (closed cohort), the HIV incidence up to and including age 20 years was 1.7 per 100 PY of observation. Among men, the rate was 0.7 per 100 PY of observation, and in women, 2.6 per 100 PY of observation.

Mortality

A total of eight HIV-positive adolescents aged 13–19 years at enrollment died prior to age 20 years (mortality rate of 3.9 per 100 PY of observation), compared with

four HIV-negative adolescents (mortality rate 0.3 per 100 PY of observation). The 13-fold differential in mortality between the HIV-infected and uninfected is consistent with data for the overall adult population in the Rakai cohort [14].

Discussion

In this study, we present population level data on adolescent HIV infection, sexual behaviors and risk factors. Study response and follow-up rates were high: 90.6% consented to enrolment at baseline and follow-up samples were obtained, by age 20 years, on 78.8% of those enrolled. In general, non-responders tended to reside in trading centers and be more mobile. The latter characteristics have been associated with higher rates of HIV infection [7], suggesting that our results represent a conservative estimate of HIV prevalence and incidence in this population.

A substantial proportion of adolescents in Rakai district report being sexually experienced, which in turn is associated with HIV infection and high pregnancy rates. Sexual activity among adolescents is also common in other parts of Uganda [2,3,13] and Africa [1,15,16]. Among American high school students, the median age of reported first sexual intercourse in 1990 was 16.1 years for men and 16.9 years for women [17] (the latter age being very similar to the median age of 16.5 years reported by Ugandan women [3]), and a substantial proportion of American teenagers who are sexually initiated report multiple lifetime partnerships [17,18].

Intravenous drug use is virtually unknown in Rakai and we previously found no significant association between injections from health workers or traditional healers and HIV status in this population [7]. HIV rates among young children aged 2–13 years have consistently been below 2% [14]. Taken together, these data strongly suggest that the HIV rates noted in young adolescent men and women are due to sexual exposure. In this study, sexual partner data were collected for the previous year and for the previous 5 years, and women were questioned regarding all previous pregnancies. The data thus encompass the great majority of sexual exposures in this young age-group. Some misreporting of sexual activity is likely (for example, 6.9% of women who reported no sexual contact or pregnancy in the past 5 years were HIV-infected and an unexpectedly high proportion of boys aged 13–14 years, 14%, reported a sexual partner in the last year). However, HIV rates were consistently higher among adolescents who indicated they had been sexually active and, in women, a greater number of sexual partners was associated with higher HIV prevalence (Table 1), suggesting that reported behaviors are reflective of risk status. The distribution of multiple partnerships reported by adoles-

cents is somewhat higher than that reported by all adults in the Rakai cohort [7], which further suggests that partner reporting by young adults does not substantially underestimate true exposure. Among adolescent men in our study, marital/consensual union status was associated with the highest rate of HIV infection on bivariate analysis, in part a function of the older age of married compared with unmarried men. Among women, permanent marriage/consensual union did not confer significant protection from HIV infection compared with having a boyfriend (21.3% prevalence compared with 29.1%). Women reporting either of these types of union were significantly more at risk of HIV than women reporting no current relationship. In spousal/consensual relationships, male partners were on average 8 years older than their adolescent wives and had a higher HIV prevalence than the female partner (20.1% compared with 15.1%, respectively, in these couples). In addition, a substantial proportion (40.5%) of young married men reported multiple partners, potentially further exposing the couple to HIV and STD. Thus, although the great majority (86.0%) of married adolescent women reported only one partner in the previous year, young monogamous women in permanent union remain at high risk of HIV infection through their partners.

The higher HIV prevalence noted in adolescent women compared with adolescent men is most pronounced under the age of 20 years, but persists up to age 30 years in the general population of Rakai [7], as has been noted elsewhere in rural Uganda [5]. Sexual contact of young women with older men, employment of women in bars where they are exposed to commercial sexual activity [7], and the potentially greater biological susceptibility of young women to STD and HIV [19], contribute to the phenomenon of earlier female infection.

Symptoms of STD were previously identified as factors associated with HIV infection among adults in this community [7], and this finding persisted among adolescents. Despite potential under-reporting, a substantial proportion of men and women (8.6 and 16.9%, respectively) reported current or previous symptoms (primarily genital ulcer and discharge). This finding emphasizes the need for programmes aimed at controlling STD, because of their potential role in facilitating HIV transmission and because of their direct, deleterious effects on health and pregnancy outcomes.

The high rates of HIV infection among adolescents in trading centers and trading villages compared with rural areas reflect the higher reported rates of sexual activity, exposure through greater mobility and occupations such as bar work, and the risk conferred by an elevated background HIV seroprevalence as we previously reported for adults in general [7].

High HIV seroconversion rates were noted in this adolescent population. In women enrolled at age 15–19 years and followed up to and including age 20 years, the rate of seroconversion was 3.9 ± 1.0 per 100 PY of observation, which is significantly higher than the rate of 1.1 ± 0.6 observed in men. Although we did not observe any significant difference in incidence rate between the first and second year of observation, the data suggest that HIV seroconversion may have declined compared with rates experienced some years prior to 1990: for example, the HIV prevalence of 26.5% noted at baseline among women aged 17–19 years is unlikely to be reached at current female rates of seroconversion. Although both behavioral change and the dynamics of viral spread may contribute to a potential attenuation of HIV seroincidence among adolescents [20,21], the limited period of observation available in this study constrains our ability to document and explore any such trends.

In the 2-year period reported in this study, knowledge of HIV and its transmission increased among adolescents, and declines were noted in the proportions of male and female adolescents reporting multiple partnerships. The latter decline was noted particularly in women, where the proportion reporting two or more partners in the previous year fell significantly from 12.8% in 1990 to 5.6% in 1992. However, it should be noted that women remain at higher risk of HIV seroconversion despite such reported reductions and, indeed, the highest rate of seroconversion was noted among women reporting only one partner (marital or other) in the previous year. The latter finding could be due to misreporting of partner information, but also to the risk faced by young women in monogamous union who have substantial sexual contact with a partner/husband who is himself infected. As noted earlier, permanent male partners tend to be both older and to have higher HIV rates than their adolescent female partners.

The proportion of adolescents reporting ever using condoms increased between 1990 and 1992, but overall rates remained low. As is also seen in other African surveys [15,16], reported condom use among young women was substantially lower than among men in the same age-group. The discrepancy between men and women ever using condoms is due in part to male condom use with casual or potential high-risk partners (such as bar workers) rather than with regular partners or those perceived to be at low risk of infection [22]. Lower reported use of condoms in women compared with men has also been reported in the United States [17]. In univariate analysis, reported use of condoms was associated with higher HIV seroprevalence. However, this association did not persist on multivariate analysis which controlled for place of residence and behavioral risk factors: the data again suggest that indi-

viduals who are otherwise at higher risk of HIV acquisition tend to recognize that risk and use condoms.

In conclusion, data from this population-based study indicate that the adolescent population as a whole, and young women in particular, represent a group which is vulnerable to HIV infection. Given the apparent lack of protection conferred by marriage/permanent union *per se*, the data suggest that a broad spectrum of HIV preventive activities is needed for adolescents who are either within or outside a partnership. The Rakai Project is continuing AIDS education, outreach activities to promote and provide condoms and serological counselling, and has embarked on an intensive, community-based trial of STD control to assess the potential effects of this intervention on reducing HIV transmission/acquisition in all age-groups.

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