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University students and the risk of HIV and other sexually transmitted infections in Uganda: the Crane survey.

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Abstract: Adolescents and young adults are at high risk of human immunodeficiency virus (HIV) infection in sub-Saharan Africa. Previous reports have found that university students in Africa comprise a sexually active population, although the prevalence of HIV or sexually transmitted infections (STI) has not been measured. We conducted a cross-sectional survey of students from five large universities in Kampala, Uganda, using respondent-driven sampling. We asked students to complete behavioral questionnaires and provide biological samples to test for HIV, *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Treponema pallidum*, *Trichomonas vaginalis*, and bacterial vaginosis. We enrolled 649 students and obtained interpretable data from 640. Around 50% of the respondents were male, and the mean age was 22 years. An estimated 0.8% (95% CI 0.0–2.0) of male students had *Chlamydia* infection, approximately 4.3% (95% CI 2.0–7.0) had syphilis, 0.4% (95% CI 0.0–0.9) had HIV, and none had gonorrhea. An estimated 32.6% (95% CI 22.4–40.8) of women had bacterial vaginosis, 2.5% (95% CI 0.7–6.3) had *Chlamydia* infection, 1.7% (95% CI 0.5–3.6) had syphilis, 1.0% (95% CI 0.0–2.4) had gonorrhea, 0.9% (95% CI 0.0–4.2) had trichomoniasis, and 0.9% (95% CI 0.0–1.8) had HIV. We found no significant risk factors for HIV or other STI among males. We also found that not using a condom during the latest sexual intercourse was significantly associated with HIV infection, other STI, or bacterial vaginosis (OR 2.16; 95% 1.26–3.78) among females. We conclude that while university students are sexually active and there is substantial risk for syphilis, there is little evidence of substantially increased HIV risk among them.

Keywords: HIV; Uganda; students, university.

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Introduction

Adolescents and young adults in sub-Saharan Africa are at high risk of HIV infection. Models have suggested that 42% of prevalent HIV infections are among 15-to-24-year-old individuals (1). Moreover, most of these infections occur in women (2). In Uganda, the estimated prevalence of HIV among women aged 15–24 years was 4.8% in 2009 (2). In a nationwide population-based survey conducted from 2004 to 2005, 6.0% and 2.1% of Ugandan women and men aged 20 to 24 years were found to be infected with HIV, respectively (3). The same survey (3) estimated a 2.0% prevalence of syphilis among Kampala adults aged 15–49 years and a nationwide prevalence of 2.4% among adults aged 20–24 years.

University students in Africa are sexually active and at risk for HIV (4–10). For instance, a recent study in Nigeria found that while 85% of surveyed students believed they were at little to no risk of HIV infection, 77% were found to actually be at high risk based on behavioral risk assessments (8). Another survey of Kenyan university students found that 69% were sexually active and that 55% reported having first intercourse while attending university (4). None of these studies, however, quantified HIV prevalence.

To understand the epidemiology of HIV in Ugandan university students, we studied a sample of students from five universities in Kampala to ascertain the behavioral risk of HIV infection and the prevalence of infection.

Materials and methods

Study design

This study was part of a larger bio-behavioral study conducted in Uganda (The Crane Survey) to sample five distinct HIV at-risk populations using respondent-driven sampling. In addition to university students, the other four groups surveyed were men who have sex with men, female sex workers, male partners of female sex workers, and motorcycle taxi drivers. The Crane Survey was conducted jointly by the Makerere University School of Public Health, the Ugandan Ministry of Health (MoH), and the US Centers for Disease Control and Prevention (CDC). We conducted formative research prior to the survey to verify the instruments, language and study procedures, as well as to confirm that university students in Kampala were sufficiently networked to sustain referral chains. We collected survey data for university students between September 2008 and April 2009.

Setting

Kampala is the capital and largest city in Uganda, with approximately 1.4 million residents. It also has the greatest concentration of university students in the country; hence, we conducted the study in five of Kampala's largest universities, Kampala University, Kampala International University, Kyambogo University, Makerere University, and Makerere University Business School.

Study subjects

We recruited participants using respondent-driven sampling (RDS). To be fully eligible, participants had to have been currently enrolled in one of the five universities, to have attended university for at least 1 year, to be from 19 to 25 years old, and to have already made their sexual debut. Participants who received a referral coupon from a non-university student or who were unable to complete interviews in English were deemed ineligible.

Sampling and study procedures

RDS is a modified chain-referral recruitment and analysis method that has been described in detail elsewhere (11) and has been used extensively for HIV surveys (12). From our formative research, we purposively selected eight seeds (initial recruits) by age, sex, and university. Each seed was given three coupons to give to three other university students whom they knew. Potential participants presented the coupons they had received to the single survey office in Old Kampala, near the city center. Eligible participants who consented to participate were asked to refer additional students whom they knew. Participants could refer persons of either sex from any of the five participating universities.

Survey staff screened each potential participant for eligibility, had them provide consent, and briefed them about specific interview terms, such as the definition of sexual intercourse, frequency of sex, partner types, and commercial sex. Following a short computer-based tutorial regarding audio-computer assisted self-interviewing (ACASI), participants underwent a standardized interview using Questionnaire Design Studio (QDS v2.5) software (NOVA, Bethesda, MD, USA). Following the interview, participants received pre-test counseling, after which they were asked to provide venous blood, urine, and other biological specimens using staff-collected vaginal and/or rectal swabs (for men and women). At the end of the first visit, study staff members provided coupons for peer recruitment and instructions on how to use them; the number of coupons issued per recruit varied between one and three over the course of the survey, depending on sampling efficiency and proximity to reaching the target sample size.

Participants returned to the survey office 2 weeks later for post-test counseling (HIV, syphilis, *Neisseria gonorrhea*, *Chlamydia trachomatis*, trichomoniasis, and bacterial vaginosis) and collection of secondary incentive for peer recruitment efforts. Survey staff provided oral treatment for non-viral sexually transmitted infections (STI) and bacterial vaginosis according to World Health Organization and/or Ugandan Ministry of Health guidelines; the staff also referred participants needing more advanced care for STI or HIV to health care providers with whom we had made arrangements prior to the start of the survey. At both visits to the survey office, we compensated recruits for their time and transport costs (US$3.00) and for recruitment efforts (US$1.00 per successfully recruited eligible participant) at the return visit. If ineligible, neither candidate recruits nor their recruiters (at their return visits) were informed as to the reason(s) for being ineligible.

Measurements

Our primary outcome measure was a combined variable, which included HIV infection or any other STI or reproductive tract infection, including *N. gonorrhoeae*, *C. trachomatis*, or syphilis in both men and women and, additionally, trichomoniasis or bacterial vaginosis in women. Potential predictor variables were selected based on prior research and included demographic characteristics; sexual orientation and experience; condom and lubricant use and sexual behavior in the 6 months preceding the interview; commercial sex and sex work; knowledge, opinions and attitudes concerning HIV/AIDS; history of HIV testing, sexual violence, abuse or blackmail; and reproductive tract symptoms and treatment.

Laboratory methods

We performed laboratory testing at Mulago Hospital, Kampala; a small number of tests were also performed at the CDC laboratory in Entebbe, Uganda, in order to meet deadlines for returning test results. Blood specimens were stored at 2–8°C at the survey office and transported twice daily to the laboratory. We tested sera for HIV antibody with a parallel testing algorithm using Vironostika® HIV Uniform II plus O2 (bioMeriéux, Marcy l'Etoile, France) and Murex® HIV Ag/Ab Combination (Abbott Laboratories, Abbott Park, IL, USA); we

resolved discordant results using HIV 1/2 STAT-PAK rapid test (Inverness Medical, Princeton, NY, USA). We also tested plasma for syphilis infection, using the anti-syphilis IgG ELISA (Biotec Laboratories, Suffolk, UK) for screening and the Rapid Plasma Reagin Syfacard-R Test (Murex Biotech, Dartford, UK) to identify current infection. We tested vaginal swabs, urine specimens, and rectal swabs for the presence of *N. gonorrhoeae* and *C. trachomatis* DNA (Cobas Amplicor or Amplicor PCR, Roche Diagnostics, Branchburg, NJ, USA) and vaginal swabs for *Trichomonas vaginalis* using the InPouch system (BioMed Diagnostics, White River, OR, USA).

Statistical methods

For sample size calculations, we assumed an HIV prevalence of 5.2% [approximately twice the observed HIV prevalence estimate from a 2004–2005 population-based survey of Ugandans in Kampala aged 15–19 years (3)], suggesting 95% confidence intervals (CI) of 3.2%–8.3% with an effective sample size of 300. Assuming a design effect of 2.0 due to the non-random sampling design we adjusted the target sample size to 600.

We tracked survey events (enrollments, recruiter-recruitee links, coupon numbers issued, unique codes, etc.) using in-house software developed specifically for the Crane Survey. We imported the ACASI interview data from QDS into Statistical Analysis Software-SAS v9.2 (SAS Institute, Cary, NC, USA) and checked them for inconsistencies and extreme values.

We present weighted data except for continuous data, and then conducted univariate analyses using RDSAT version 6.0.1. (www.respondentdrivensampling.org). We generated combined sampling weights in RDSAT and exported them to R. Finally, we conducted bivariate analyses in R 2.2.1 (www.r-project.org/).

Ethical considerations

The survey protocol was approved by the Uganda Virus Research Institute's institutional review board, the Uganda National Council of Science and Technology, and the US. CDC. We conducted the survey anonymously and collected no personal identifiers. We also obtained verbal informed consent from the participants. Using scanners and Griaule software (Griaule Biometrics, San Jose, CA, USA), the participants' fingerprints were imaged (but not stored) to generate unique alphanumeric codes in order to link recruits' return visits to their initial visits and laboratory results, to detect duplicate recruits (recruits attempting to enroll multiple times), and to detect recruits presenting coupons that had already been issued to other participants. Partners of respondents who were diagnosed with HIV, other STI, or bacterial vaginosis were not traced. HIV-infected participants were referred to care/treatment providers, and participants diagnosed with an STI or bacterial vaginosis were offered on-site treatment using MoH and WHO guidelines.

Results

We recruited 880 potential participants and found 703 (80%) who were initially eligible. Of these, 54 (6%) were later determined to be ineligible by virtue of never having had sex before. Of the remaining 649 students, two left the study early, and data for seven others were unusable, yielding a sample size of 640. Of the seven subjects whose data were unusable, six subjects' data were lost, and one subject was an initial recruit (seed) who did not recruit any additional participant. We recruited participants over 19 successive waves of referral (recruiter-recruit links following sampling initiation by seeds). Equilibrium (stable distribution of trait) for having HIV or another STI infection or bacterial vaginosis was reached after two waves. Each participant with an STI, HIV, or bacterial vaginosis referred on average 13 potential recruits over all waves of recruitment, while participants without an STI, HIV, or bacterial vaginosis referred an average of 17 potential recruits over all waves of recruitment. The median age of participants was 22 years [interquartile range (IQR), 22–24 years]; 360 (estimated population proportion: 50%) were male (Table 1). Among the participants, 94% were Ugandan nationals who were drawn from all of Uganda's major religions. Most (93%) did not live with a sex partner, 5% lived with a sex partner but were unmarried, and 1% was married.

Overall, 17.6% (95% CI 14.1%–21.2%) of students were found to have HIV, bacterial vaginosis, or other STI (Table 2); 0.6% (95% CI 0.1%–1.1%) were infected with HIV, and 2.9% (1.7%–4.5%) had syphilis. Among male students, 0.8% (95% CI 0.0%–2.0%) had urethral *Chlamydia* infection, 0.4% (95% CI 0.0%–0.9%) had HIV, and none had gonorrhea. An estimated 32.6% (95% CI 22.4%–40.8%) of women had bacterial vaginosis, 2.5% (95% CI 0.7%–6.3%) had *Chlamydia* infection, 1.7% (95% CI 0.5%–3.6%) had syphilis, 1.0% (95% CI 0.0%–2.4%) had gonorrhea (including one case of rectal gonorrhea), 0.9% (95% CI 0.0%–4.2%) had trichomoniasis, and 0.9% (95% CI 0.0%–1.8%) had HIV.

We explored risk factors for HIV or any other reproductive tract infection in our sampled population. As a result of female-specific STI and bacterial vaginosis, we stratified the bivariate analysis by gender (Tables 3A and B). In bivariate analysis, no risk factors for HIV or other STI were noted among the sampled males. Though not statistically significant, there was increased risk for HIV or other STI among men without a steady partner as compared with men with a steady partner (OR 1.57, 95% CI 0.54%–4.53%). Among sampled females, not using a condom during the latest sexual encounter was associated with a significant increased risk for HIV, other STI, or bacterial vaginosis (OR 2.16; 95% 1.26%–3.79%). Additionally, a borderline significant decreased risk was noted among women who used condoms two or more times

Table 1 Characteristics of study population, university students, Crane Survey, Kampala, Uganda, 2009.

Characteristic	n	Estimated population proportions, % (95% CI)
Sex		
Male	360	50.2 (41.8–57.2)
Female	280	49.8 (42.8–58.2)
Age		
18–20	55	8.7 (6.0–11.6)
21–25	585	91.3 (88.4–94.0)
Race		
Black/African	636	99.1 (98.6–100.0)
Asian	0	–
White/Caucasian	0	–
Other/Missing	4	0.9 (0.0–1.4)
Nationality		
Ugandan	609	93.7 (89.8–97.7)
Not Ugandan	31	6.1 (2.3–10.2)
If not Ugandan		
Kenyan	27	92.4 (77.8–100.0)
Tanzanian	2	7.6 (0.0–22.2)
Religion		
Catholic	189	31.6 (25.9–36.0)
Protestant	247	36.0 (31.7–41.4)
Born again	105	17.8 (13.6–21.9)
Moslem	75	11.4 (8.5–15.1)
Seventh day adventist	15	2.1 (1.0–3.7)
Hindu	3	0.6 (0.0–1.7)
Other/Missing	4	0.3 (0.0–1.0)
Live with a sexual partner		
Don't live with a partner	591	93.3 (90.7–95.8)
Live together, not married	39	5.3 (3.3–7.4)
Live together, married	7	1.1 (0.0–2.6)
Missing	2	0.3 (0.0–1.0)
Discipline at university		
Medicine	11	2.0 (0.6–3.8)
Law	23	4.2 (2.2–6.3)
Sciences	180	27.2 (21.6–32.5)
Arts	237	38.6 (32.3–45.4)
Business	136	19.8 (14.7–25.0)
Other/Missing	48	8.2 (5.3–12.3)
While attending school, where does subject stay		
Campus	61	8.3 (5.4–11.9)
Hostel	361	56.1 (50.1–61.2)
Family/friends	150	25.7 (21.3–30.6)
Other/Missing	67	10.0 (6.9–13.9)

compared with women who did not use condoms with steady male partners (OR 0.56, 95% CI 0.29%–1.05%). There was no significant relationship between having HIV or an STI or bacterial vaginosis and the following: the number of steady male partners, a history of casual partners in the last 6 months, the number of steady or casual female partners, or a history of forced sex (Tables 3A and B).

Discussion

We found low prevalence of HIV and varying levels of reproductive tract infections among sexually active university students living in Kampala. We also found that among women not using a condom during the latest sexual intercourse was associated with having HIV, other STI, or bacterial vaginosis.

Few other HIV-related studies have been conducted among Ugandan university students to date. A 2005 survey of Mbarara University of Science and Technology students in Uganda found that 63% of male students and 51% of female students had previously had intercourse (9). A much earlier study of Makerere University students in Kampala in 1989 found that 60% of men and 35% of women had had more than one sexual partner in the past year (10). Neither of these Ugandan studies, however, quantified HIV prevalence in this population. Another recent survey conducted at multiple universities across Uganda found an HIV prevalence of 1.2%, similar to our findings (13).

In contrast to HIV, the prevalence of syphilis in our target population appears to be consistent with that estimated for the general population in Kampala with a similar age band (3). The prevalence is also similar to that seen in a survey among attendees of a Kampala youth health clinic (14). The relatively high syphilis prevalence may serve as a reminder that risk behaviors among university students, such as having unprotected sex, occur. However, our estimated prevalence rates of *N. gonorrhoeae, C. trachomatis,* and *T. vaginalis* appeared lower than those found in other studies (14).

Our study has some limitations. First, our sample was drawn using RDS. This method, while widely used in HIV surveillance and for surveys of hidden and hard-to-reach populations (12), has been criticized recently for its performance in estimating prevalence in simulations of some populations whose prevalence was known and for providing misleadingly narrow CI values (15). Second, sexual behaviors were self-reported and could be either underreported or over-reported. However, we used ACASI to minimize response bias. Previous studies have suggested that computer-assisted interviewing leads to more reproducible responses (16). Finally, this study was powered assuming a 5.2% HIV prevalence, though the true HIV prevalence was later estimated to be less than 1%. As a result, the study had too few infected participants to examine the effects of many suspected predictors of HIV infection or other STI.

Nonetheless, our study is the first conducted in Africa to have biological outcomes in this population, and we believe that its results are generalizable to sexually active university students in Kampala. Our finding of

Table 2 HIV, other STI and bacterial vaginosis among university students, Crane Survey, Kampala, Uganda, 2009.

Agent	Overall		Men		Women	
	n/N	Estimated population proportion, % (95% CI)	n/N	Estimated population proportion, % (95% CI)	n/N	Estimated population proportion, % (95% CI)
HIV	6/637	0.6 (0.1–1.1)	2/358	0.4 (0.0–0.9)	4/279	0.9 (0.0–1.8)
Treponema pallidum	22/637	2.9 (1.7–4.5)	14/358	4.3 (2.0–7.0)	8/279	1.7 (0.5–3.6)
Chlamydia trachomatis	11/640	1.9 (0.7–3.4)	3/360	0.8 (0.0–2.0)	8/280	2.5 (0.7–6.3)
Neisseria gonorrhoeae	3/640	0.4 (0.0–1.0)	0/360	0	3/280	1.0 (0.0–2.4)
Trichomonas vaginalis	3/247	0.8 (0.0–4.1)	–	–	3/247	0.9 (0.0–4.2)
Bacterial vaginosis	78/248	32.8 (22.4–40.6)	–	–	78/248	32.6 (22.4–40.8)
Any STI	111/640	17.1 (13.7–20.7)	17/360	5.0 (2.6–7.9)	94/280	30.7 (24.5–38.1)
HIV or any STI	116/640	17.6 (14.1–21.2)	19/360	5.3 (2.9–8.2)	97/280	31.2 (25.1–38.5)

Note: counts may not add up correctly due to missing data.

low HIV prevalence suggests some unmeasured protective factor, such as high health literacy consistent with university students' higher educational attainment. This should be explored further, because resources might be better utilized in other Ugandan populations with higher disease burden where there are limited resources for HIV

Table 3A RDSAT adjusted estimations and 95% CI for selected characteristics by current infection status, male university students, Kampala, Uganda, 2009.

Selected characteristics	Neither HIV-nor STI (n=341)			Either HIV+ or STI (n=19)			Odds ratio[a]	95% CI
	n	%	95% CI	n	%	95% CI		
Socio-demographic characteristics								
Age								
18–20	16	4.7	2.2–7.9	3	9.1	0.0–23.8	Ref	–
21–25	325	95.3	92.1–97.8	16	90.9	76.2–100	0.52	0.13–4.22
General sexual history								
Steady partners								
Do you have a steady partner?								
Yes	216	62.0	55.5–69.7	8	46.1	19.2–75.8	Ref	–
No	117	38.0	30.3–44.5	9	53.9	24.2–80.8	1.57	0.54–4.53
How many steady male partners in the last 6 months?								
0 partners	290	86.2	81.4–90.3	19	–	–	Ref	–
1 partner	29	7.3	4.5–11.2	0	0.0	0.0–0.0	–	–
2–5 partners	17	5.1	2.2–8.1	0	0.0	0.0–0.0	–	–
≥6 partners	5	1.5	0.3–3.1	0	0.0	0.0–0.0	–	–
How many steady female partners in the last 6 months?								
0 partners	137	43.0	36.5–50.8	11	61.3	34.3–85.9	Ref	–
1 partner	119	34.0	27.5–40.2	2	10.5	0.0–27.5	–	–
2–5 partners	77	21.2	15.8–26.3	6	26.0	6.6–54.7	–	–
≥6 partners	8	1.8	0.4–3.4	0	0.0	0.0–0.0	–	–
Casual partners								
Do you have a casual partner?								
Yes	138	39.0	33.9–47.3	6	36.7	11.5–63.3	Ref	–
No	195	61.0	52.7–66.1	12	63.3	36.7–88.5	1.20	0.43–3.69
How many casual female partners in the last 6 months:								
0 partners	211	64.0	56.2–69.2	14	66.5	48.3–94.0	Ref	–
1 partner	57	17.0	13.6–23.9	2	8.2	0.0–20.0	0.17	0.01–7.22
2–5 partners	66	18.1	13.0–23.2	3	21.6	0.0–43.7	0.47	0.05–17.44
≥6 partners	7	0.9	0.2–1.8	0	0.0	0.0–0.0	–	–

[a]Bivariate OR and CI calculated in R.2.2.

Note: Counts may not add up correctly due to missing values. Percent values refer to adjusted (population) estimates.

Table 3B RDSAT adjusted estimations and 95% CI for selected characteristics by current infection status, female university students, Kampala, Uganda, 2009.

Selected characteristics	Neither HIV to nor STI/BV (n=183)			Either HIV+ or STI/BV (n=97)			Odds ratio[a]	95% CI
	n	%	95% CI	n	%	95% CI		
Socio to demographic characteristics								
Age								
18–20	26	11.5	6.7–18.0	10	16.5	6.6–26.2	Ref	–
21–25	157	88.5	82.0–93.3	87	83.5	73.9–93.5	0.86	0.41–1.86
Steady partners								
Do you have a steady partner?								
Yes	145	78.3	70.8–85.3	74	79.5	68.4–88.1	Ref	–
No	36	21.7	14.7–29.2	21	20.5	11.9–31.6	1.03	0.54–1.91
How many steady male partners in the last 6 months?								
0 partners	40	25.0	14.8–36.4	24	23.5	16.3–31.2	Ref	–
1 partner	110	53.4	41.7–65.8	55	58.4	49.3–66.4	0.31	0.04–2.04
2–5 partners	33	18.1	11.8–261	16	18.1	8.4–28.3	0.33	0.04–2.34
≥6 partners	0	0.0	0.0–0.0	2	3.5	0.0–10.1	–	–
Out of the times you engaged in sex with a steady male partners, the number of times a condom was used (among females):								
0 times	44	29.9	21.4–40.1	31	43.2	29.1–57.1	Ref	–
1 time	16	10.8	4.7–15.5	8	8.0	2.0–14.1	0.51	0.16–1.43
≥2 times	74	59.4	49.9–69.5	31	48.8	35.0–64.5	0.56	0.29–1.05[a]
Casual partners								
Do you have a casual partner?								
Yes	43	26.3	18.2–35.2	21	19.5	11.3–32.8	Ref	–
No	135	73.7	64.8–81.8	74	80.5	67.2–88.8	1.37	0.75–2.58
Last sex act (with either casual or steady partner)								
Condom use during the last sex with a man?								
Yes	76	45.6	34.9–54.5	27	28.0	16.2–38.7	Ref	–
No	99	54.4	45.5–65.2	67	72.0	61.3–83.8	2.16	1.26–3.79[b]
Forced sex								
Ever forced to have sex?								
Yes	52	27.5	20.4–35.0	24	27.7	15.3–38.3	Ref	–
No	131	72.5	65.0–79.6	73	72.3	61.7–84.7	1.05	0.60–1.87

[a]Bivariate odds ratios and confidence intervals calculated in R.2.2; [b]$p<0.05$; [c]$p<0.01$; BV, bacterial vaginosis.
Note: Counts may not add up correctly due to missing values. Percent values refer to adjusted (population) estimates.

information, education, and prevention programming. The higher syphilis prevalence, however, suggests the existence of sufficient sexual risk behaviors that should raise concern regarding this issue.

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