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Risk Factors Associated with HIV Infection in Uganda

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Risk factor data were collected in 1,328 inpatients and outpatients in 1987 in 15 hospitals throughout Uganda; 42% were positive for HIV antibodies by ELISA. Seropositivity was associated with urban residence, sexually transmitted diseases (STD), number of sex partners, and sex for payment or with a person with an AIDS-like illness. Homosexuality and intravenous drug abuse, recognized risk factors in western countries, were not seen as risk factors. By multivariate analysis, urban residence and sex for payment were not independently associated with infection. Among females, number of sex partners, sex with a person with an AIDS-like illness, and numbers of episodes of STDs were significantly associated with seropositivity. In males, similar associations were seen, although number of reported sex partners was not independently associated with infection. These findings support the view that heterosexual contact is the predominant mode of transmission in Uganda and suggest that the main risk factors relate to high-risk heterosexual behavior.

Infection with the human immunodeficiency virus (HIV) has become a worldwide problem [1]. The risk factors for HIV infection initially identified in the United States and Europe, including passive anal intercourse in homosexuals and sharing of syringes and needles among intravenous drug abusers, play only a minor role in the transmission of HIV in Africa [2, 3]. Previous studies in Africa have shown most transmission to occur through heterosexual contact, although exact risk factors remain unclear [3–5]. The high prevalence of HIV infection in the general population in central Africa compared with lower rates in the general population in the USA and Europe suggests differences in the efficiency of heterosexual transmission between populations in Africa and in the USA and Europe [6, 7]. Two common hypotheses to explain high rates of HIV transmission in Africa are promiscuity and high prevalances of cofactors for infection [7–9]. Study of these factors is crucial in developing more directed interventions to reduce transmission of HIV in Africa.

As part of a study to evaluate the applicability of the World Health Organization (WHO) clinical AIDS case definition in Uganda [10], we collected epidemiologic data on the 1,328 participants. We evaluated these data in terms of risk factors associated with HIV infection.

Methods

Fifteen sentinel hospitals in Uganda that had reported cases of AIDS and were willing to participate were included in this study (Mulago, Rubaga, and Nsambya in Kampala; Kitovu and Villa Maria in Masaka; Entebbe Grade B in Entebbe; Lacor In Gulu; Nyenga in Jinja; Angal in Nebbi; Arua and Maracha in Arua; Matany in Moroto; St. Josephs and Kitgum in Kitgum; and Aber in Apac; figure 1). The study took place in June and July 1987. For each hospital, a 1-w period was chosen during which all inpatients (from all wards in the small general hospitals and from the medical ward in Mulago, the national referral and teaching hospital) including all new admissions were enrolled in the study. Patients were examined and administered a risk factor questionnaire by hospital physicians unaware of the pa-

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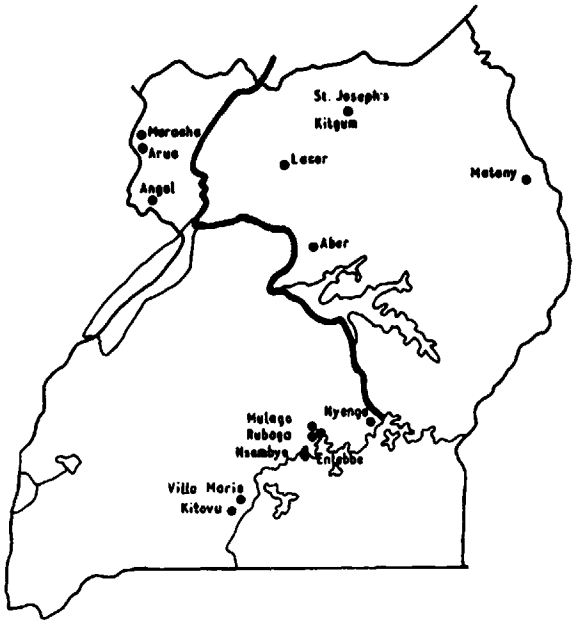

Figure 1. Map of Uganda with location of 15 hospitals participating in study.

tient's HIV status. Risk factors included age, gender, number of wives in the household, and, within the 5 y before the study: travel within and outside Uganda; number of sex partners; numbers of episodes of gonorrhea, syphilis, and chancroid; sex with a non-Ugandan; payment given or received for sexual intercourse; homosexual relations; anal intercourse; blood transfusion; injections received in a marketplace or a health facility; traditional skin piercing for scarification or therapy; circumcision; and sex with a person with an AIDS-like illness.

During the same 1-w period in 6 of the 15 participating hospitals, all outpatients were enrolled in the study unless they presented for trauma, acute surgical disease, or acute illness lasting <1 mo. Outpatients with illnesses of long duration were included because, for the case definition part of the study, they were the group most likely to be clinically confused with AIDS cases.

To assess HIV-1 seropositivity, venous blood was obtained from all enrolled patients and serum was separated at the hospitals. In three hospitals (Nsambya, Rubaga, and Kitovu) samples were tested for antibody to HIV by commercially available competitive ELISA (Wellcozyme VK-50, Wellcome Diagnostics, Dartford, Kent, UK) following the manufacturer's instructions. Serum samples from the other hospitals were transferred on wet ice to the Uganda Virus Research Institute for testing using the same ELISA. All samples were stored at 4°C and tested within 10 d. Samples from Nsambya and Rubaga were retested and confirmed at the institute. A sample was considered positive if it was reactive on two separate assays. Western blot confirmation was done on a limited number of samples positive by competitive ELISA using commercially available strips (Bio-Rad, Hercules, Calif). A Western blot was considered positive if there was reactivity with core antigens p55, p24, p18, or p14 and with envelope antigens gp41, gp120, or gp160.

Statistical analysis included use of 2 × 2 contingency tables with Yates's corrected χ^2 and unpaired Student's *t* test or Mann-Whitney tests where appropriate. A *P* value ≤.05 was considered significant.

A logistic regression analysis was performed using HIV status by ELISA testing as the dependent variable with stepwise addition of variables that had been found by univariate analysis to be significantly associated with HIV status [11]. In addition, urban or rural residence and age group were included in the model. Because of the large number of distinct covariate patterns in the data, some categories were modified to allow the model to run. After similar associations had been shown for each sexually transmitted disease (STD) on univariate analysis, the numbers of episodes of chancroid, syphilis, and gonorrhea were combined as one variable. Occupation was categorized as businessman and clerk versus all other occupations. The model was subsequently run separately for male and female patients.

Results

Demographic data. A total of 1,328 patients were enrolled: 882 inpatients (66%) and 446 outpatients (34%). Of them, 721 (54%) were female and 607 (46%) male. Nationalities represented were: 1,284 (97%) Ugandan, 31 (2%) Rwandan, 4 Zairian, 2 Kenyan, 2 Sudanese, and 5 other. The distribution of religious denominations was similar to that in the general population in Uganda: 337 (25%) Protestant, 859 (65%) Catholic, 121 (9%) Islamic, 10 (1%) Animist, and 1 unknown. Ages ranged from 8 to 85 y with a mean of 31 y and a median of 28 y.

Laboratory results. All patients were tested by Wellcozyme ELISA: 562 (42%) were positive on at least two separate assays; 766 (58%) were negative.

Western blot examination was done on 348 of the samples positive by ELISA and confirmation was obtained for 323 (93%). Comparison of the 25 patients who were positive twice by ELISA but not confirmed by Western blot to the 323 who were confirmed did not show a difference between the proportion of patients who were symptomatic, who met the modified WHO definition, or who had a diagnosis of tuberculosis. Seropositivity was 37% (325/882) in inpatients versus 53% (237/446) in outpatients ($P < .0001$).

Risk factors. The mean age of female patients positive by ELISA was 27 y compared with 32 y in the infected male patients ($P < .0001$, Student's t test). The age distribution of infection is shown in figure 2. The female-to-male ratio was the same, 1.2:1, in HIV-positive and HIV-negative patients. There was no difference in positivity between religious or tribal groups once adjusted for area of residence; however, businessmen and clerks were more likely to be positive than were other occupations (78/116 [67%] and 60/114 [53%] vs. 424/1,098 [39%]; $P < .0001$, $P = .005$, respectively). Urban residents were more likely to be seropositive than were rural dwellers (254/538 [47%] vs. 308/790 [39%], $P = .004$). Single persons were not more likely than married persons to be infected; however, of the married patients, those in polygamous relationships were more likely to be infected than those in monogamous relationships (103/189 [54%] vs. 252/621 [41%], $P = .001$). The remaining results of the risk factor questionnaire are summarized in table 1. There was a significant association between HIV status and number of episodes of gonorrhea, chancroid and syphilis, and sexual relations with a person with an AIDS-like illness. HIV status was also associated with number of wives, number of sexual partners, and having given or received payment for sexual relations. Traveling extensively within Uganda was associated with seropositivity.

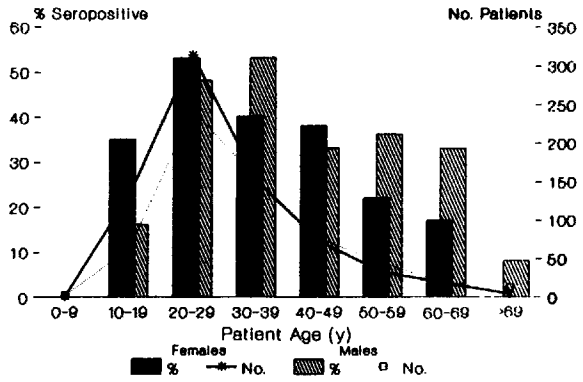

Figure 2. Age distribution of HIV infection. Bar graph, seropositivity by ELISA stratified by age and gender. Line graph, ages of the total cohort (1,328 patients) stratified by gender.

Among HIV-infected patients, 115 (21%) had none of the five major clinical criteria of HIV infection used in the provisional WHO Bangui clinical AIDS definition (fever for >1 mo, weight loss of >10% of body weight, diarrhea for >1 mo, cryptococcocis, or disseminated aggressive Kaposi's sarcoma) or of the minor symptoms (thrush, cough for >1 mo, aggressive or chronic herpes simplex, herpes zoster, generalized rash, or generalized lymphadenopathy) [12]. These patients were considered infected but asymptomatic. Risk factors for symptomatic and asymptomatic infected persons are also included in table 1.

Because of the difficulty of accurately diagnosing STDs in Uganda and the unreliability of self-reported diagnoses, all STDs for future analysis were collapsed into one variable. To evaluate risk factors in male and female patients separately, analysis stratified by sex was performed (table 2). Higher numbers of sex partners and episodes of STDs and having sex with a person with an AIDS-like illness appeared to be risk factors for both genders. Receiving payment for sexual relations and being in a polygamous relationship were associated with seropositivity only in female patients.

To evalute confounding between risk factors, we constructed a logistic regression model to study odds ratios for each risk factor (not shown). Urban or rural residence, number of wives, travel in Uganda, and giving or receiving payment for sexual relations did not significantly improve the model and therefore were not included. By use of this method, risk factors associated with HIV infection included sex with a person with an AIDS-like illness, being a businessperson or clerk, previous episodes of STDs, and higher numbers of sexual partners. Once adjusted for other factors, patients with traditional skin piercing had a lower risk of HIV infection.

Table 3 lists the odds ratios for risk factors in male and female patients. Women aged 20–29 y had the highest risk of infection; the peak risk for male patients was in the 30–39 y age group. Seropositivity in female patients was significantly associated with the numbers of episodes of STDs, number of sex partners, and sex with a person with an AIDS-like

Table 1. Risk factors for HIV infection in 1,328 patients during 1982–1987.

	HIV positive n = 559	HIV negative n = 745		HIV positive		
				Symptomatic n = 445	Asymptomatic n = 114	
Risk factor (range)	Mean no.		P*	Mean no.		P*†
Episodes of STDs‡						
Gonorrhea (0–12)	0.91	0.39	<.0001	0.92	0.86	NS
Chancroid (0–4)	0.047	0.016	.0024	0.049	0.035	NS
Syphilis (0–5)	0.21	0.08	<.0001	0.24	0.09	.01
Combined	1.17	0.48	<.0001	0.79	0.22	NS
Sex partners (0–1,000)	6.70	3.10	<.0001	7.42	3.85	.05
Wives (0–7)	0.87	0.76	.032	0.85	0.97	NS
	No. (%)		P§	No. (%)		P§†
Traditional skin piercing	102 (18)	170 (23)	.05	77 (17)	25 (22)	NS
Travel within Uganda	363 (65)	433 (58)	.015	289 (65)	74 (65)	NS
Had paid sex	103 (18)	98 (13)	.011	84 (19)	19 (17)	NS
Had sex with a person with an AIDS-like illness	34 (6)	7 (1)	<.0001	32 (7)	2 (2)	.05
Foreign travel	68 (12)	113 (15)	NS	54 (12)	14 (12)	NS
Had injections in the marketplace	239 (43)	279 (38)‖	NS	185 (42)	54 (47)	NS
Had injections in a health facility	458 (82)	626 (84)	NS	371 (83)	87 (76)	NS
Blood transfusions	51 (9)	61 (8)‖	NS	40 (9)	11 (10)	NS
Had sex with non-Ugandans	49 (9)	48 (6)	NS	43 (10)	6 (5)	NS
Had homosexual relations	3 (<1)	3 (<1)	NS	2 (<1)	1 (<1)	NS
Were circumcised in past 5 y	16 (3)	27 (4)	NS	12 (3)	4 (4)	NS
Had anal sex	10 (2)	8 (1)	NS	9 (2)	1 (1)	NS

NOTE. NS = not significant at the $P \leq .05$ level.
* Mann-Whitney U test.
† Probability that symptomatic and asymptomatic are the same.
‡ Self-reported sexually transmitted diseases combined for later analysis (see text).
§ Yates's corrected χ^2.
‖ Data available for 744 of 745 patients.

Table 2. Risk factors for HIV infection in 1,328 patients during 1982–1987 stratified by gender.

	Male patients			Female patients		
	HIV positive n = 252	HIV negative n = 342		HIV positive n = 307	HIV negative n = 403	
Risk factor	Mean no.		P*	Mean no.		P*
Episodes of STDs	1.62	0.79	.0001	0.79	0.22	.0001
Number of sex partners	6.40	4.70	.0001	6.93	1.76	.0001
	No. (%)		P†	No. (%)		P†
Travel within Uganda	185 (73)	230 (67)	NS	178 (58)	203 (50)	.053
Had paid sex	73 (29)	84 (25)	NS	30 (10)	14 (4)	.001
Had sex with a person with an AIDS-like illness	13 (5)	2 (1)	.0012	21 (7)	5 (1)	.0002
Married, polygamous‡	53 (29)	54 (26)	NS	50 (29)	32 (13)	.0001

NOTE. NS = not significant at the $P < .05$ level.
* Mann-Whitney U test.
† Yates's corrected χ^2.
‡ Vs. married, monogamous; men, n = 181 positive, 210 negative; women, n = 174 positive, 245 negative.

Table 3. Odds ratios of risk factors for HIV infection during past 5 years stratified by gender.

Gender, risk factor	Odds ratio	95% Confidence interval	*P* value
Female			
Sex with person with AIDS-like illness	4.5	1.6, 12.4	.002
Number of STD episodes*			.002
≥1 vs. 0	1.8	1.2, 2.7	
Number of sex partners			.0009
1 vs. 0	2.8	1.3, 5.7	
2-5 vs. 0	2.7	1.3, 5.7	
≥6 vs. 0	7.2	2.6, 20.1	
Number of husbands			.0007
1 vs. none	0.55	0.4, 0.8	
Age			.028
20-29 y vs. 0-19 y	1.6	1.0, 2.6	
30-39 y vs. 0-19 y	1.2	0.7, 2.0	
40-49 y vs. 0-19 y	1.5	0.8, 2.8	
≥50 y vs. 0-19 y	0.6	0.3, 1.3	
Male			
Occupation†	2.3	1.5, 3.6	.0001
Traditional skin piercing	0.7	0.4, 1.1	.09
Sex with person with AIDS-like illness	7.0	1.5, 32.2	.003
Number of STD episodes			.0001
1-4 vs. 0	1.9	1.3, 2.7	
≥5 vs. 0	3.1	1.4, 6.8	
Age			
20-29 y vs. 0-19 y	3.1	1.5, 6.6	
30-39 y vs. 0-19 y	3.5	1.6, 7.6	
40-49 y vs. 0-19 y	1.8	0.8, 4.2	
≥50 y vs. 0-19 y	2.1	0.9, 5.0	

NOTE. Analysis was by logistic regression.
* Category modified because of small numbers in this group.
† Being a businessman or clerk vs. other occupations.

illness. Having a husband was associated with a significantly lower risk of seropositivity than was being single. Seropositivity in males was associated with being a businessman or clerk, having sex with a person with an AIDS-like illness, and number of STD episodes. Number of sex partners and number of wives was not associated with HIV infection in males when controlled for the other factors.

Discussion

The HIV infection rate of 42% seen in this hospital-related population is extremely high. However, patients presenting for hospital care in Uganda are likely not representative of ill persons in the general population. Thus the seropositivity rates seen in the in- and outpatients in this study cannot be generalized to other groups within Uganda. Other surveys in Uganda have shown HIV infection rates of 1.4%-4.8% in rural inhabitants in 1986, 15.8% in asymptomatic blood donors in Kampala in 1986, and 24.1% in Kampala antenatal clinic attendees in 1987 [13]. In this hospital population, the prevalence of asymptomatic infection (115/881 [13.1%]) was similar to that found in Kampala blood donors. Therefore, although the magnitude of HIV infection in the general population is unknown, AIDS is clearly a heavy burden to health service in Uganda.

A significantly higher proportion of outpatients than inpatients was infected with HIV, contrary to what one would expect. However, because all inpatients were included in the study whereas outpatients were selected by subjective criteria for inclusion into the study, the difference may be explainable by selection bias.

All interviews were conducted in the local language by the physicians caring for the patients. Despite this, the questions asked on behavior in this study are sensitive and we cannot exclude the possibility of over- or underreporting of risk behaviors by patients. However, if any differential in self-reported risk factors exists, we believe it would occur in the direction of underreporting risk factors, resulting in an underestimation of the strength of actual associations.

In most reported series, ELISA tests for HIV usually have a sensitivity and specificity of >95% compared to that of Western blot. In recent studies in Africa [14-16], however, the sensitivity and specificity has been lower. It is not clear whether this is because of false-positive ELISAs or false-negative Western blot tests. We used ELISA because it is more practical and economical for use in general hospital laboratories in Africa. Cases that were positive by ELISA but negative by Western blot were not epidemiologically different from the confirmed cases. Whether the discrepancies between tests represent cross-reactive serum or an unusual virus infection or antibody response remains to be determined. There are currently no facilities for HIV culture in Uganda to resolve this issue.

The observed association between HIV status and risk factors of higher numbers of sex partners and episodes of STDs, as well as the female-to-male ratio of 1.2:1 seen in this study, support a predominantly heterosexual mode of transmission in

Uganda. Yet, the high seropositivity rates seen in this study do not seem associated with high rates of promiscuity. The mean number of sex partners seen in the seropositive patients in this population was less than that reported in other studies in Africa [9, 17]. This could result from underreporting of the numbers of sex partners or from different sexual practices in this population. Another possibility is that because of the high prevalence of infection in Uganda, high rates of promiscuity are no longer required for exposure to the virus and seroconversion.

STDs were strongly linked to HIV infection in this and other studies in multiple countries in Africa [5, 18–22]. The best-described of these is genital ulcerative disease, both nonspecific and due to syphilis and chancroid [18–20, 22]. Other studies have shown a relationship with chlamydia and genital herpes [21–23]. Because the patients' histories of STDs in this study were retrospective and self-reported and we were unable to separate the three types of STDs because of covariance to perform multivariate analysis, interpretation of the effect of each individual type of STD in this study is uncertain.

Not only did having one episode of an STD increase the risk of HIV infection, but the higher the number of STDs a patient had during the previous 5 y, the greater the risk of HIV infection (using total episodes of gonorrhea, syphilis, and chancroid and comparing HIV positivity; χ^2 linear trend, $P = 1 \times 10^{-9}$). The magnitude of the association between STDs and seropositivity suggests that STDs might be cofactors for infection rather than just markers of high-risk sexual encounters.

We observed in female patients an association between HIV infection and numbers of male sex partners independent of self-reported exposure to STDs, whereas in male patients HIV status was mainly associated with a history of STDs independent of number of female sex partners. A cofactor such as an STD may be more important for female-to-male transmission than for male-to-female transmission by vaginal sexual intercourse. Such an assumption would support previous studies that suggest a higher efficiency of heterosexual transmission from males to females than from females to males [2, 24].

Sexual relations for payment, a risk factor on univariate analysis and a known risk factor for AIDS in Africa [3, 18, 25], was not independently associated with risk of infection when controlled for STDs and sex with a person with symptomatic disease. This suggests that the higher risk associated with sexual relations for payment may be due to a higher prevalence of cofactors such as STDs in these persons.

Most cases of AIDS in Africa are thought to be sexually transmitted. However, continued concern exists as to the possibility of other means of transmission. Twenty-two of our seropositive patients (4%) denied having any sexual relations during the previous 5 y compared with 90 (12%; $P < .0001$) in those HIV-negative; 11 of the 22 (50%) were symptomatic and met the WHO criteria. Three had received a blood transfusion during the previous 5 y, which may explain their exposure to HIV. Of the 19 remaining patients, 3 (16%) had ritual skin piercing, 4 (21%) had received injections in the marketplace, and 11 (58%) had received injections in health facilities; however, none of these behaviors was more common in these patients than in the seronegative patients. Only one patient, a 65-y-old man, had had neither sexual relations in the past 5 y nor any other possible exposure route.

Cases of AIDS occur at a younger age in females than in males in Uganda [26], and other studies support our findings (unpublished data). This age difference has also been noted in Zaire [27], and other authors have mentioned the similarity between this pattern of transmission and that of other sexually transmitted diseases [3, 27]. This age distribution has important implications for targeting of health education.

The fact that there was no difference in seropositivity between different tribal and religious denominations suggests that there is no association between determinants for infection and tribe or religion. All tribal and religious groups in Uganda are at risk for the development of HIV disease.

Admitted homosexuality and admitted anal sex are rare in East Africa according to existing literature. Our results are in accordance with this.

The ubiquity of injections both in health facilities and in the marketplace is evident. Our study did not show an increased risk of HIV infection in persons thus exposed. It cannot be excluded, however, that the infections seen in the 16 persons described above without a history of sexual relations in the past 5 y and without a history of transfusion or ritual scarification might have occurred by this route. However, since persons can be infected asymptomatically for years, the question of injection-associated HIV

transmission may be adequately answered only by identifying a seronegative population and following them prospectively.

Transfusion probably plays a small role in primary transmission of HIV in Uganda because of the infrequency of transfusions in this country. However, HIV screening of donor blood does have a high priority in those health facilities where blood transfusions are given, because of the high seroprevalence of HIV infection.

Urban residence, a known risk factor for HIV infection in Africa, was not significantly associated with infection once controlled for other risk factors. This suggests that the increased numbers of sexual encounters and sexually transmitted diseases coincident with urban lifestyle accounts for the higher frequency of infection in urban residents in Uganda. Persons who travel extensively within Uganda and those whose occupations provide access to money and goods, such as businessmen and clerks, are probably exposed to similar lifestyles.

Early studies of risk factors in Africa suggested that blood-soiled instruments used in circumcision and ritual scarification might be implicated as a method of HIV transmission [28]. This study posed questions about these exposures during the previous 5 y to evaluate this hypothesis; no association with recent circumcision was found. The presence of a foreskin has been suggested as a predisposing factor for acquisition of HIV [29]. In Kenya, noncircumcision has been noted to be associated with higher rates of HIV infection independent of STDs [30, 31]. As we have no information on the numbers of males ever circumcised in this cohort, confirmation of this important finding will have to await further studies.

Skin piercing was less common among seropositive persons, suggesting that traditional skin piercing is not a major means of HIV transmission in Uganda. Skin piercing is more common among rural than among urban residents (189/767 [25%] vs. 83/537 [16%], $P = .0001$) and in certain ethnic groups. The fact that skin piercing seems to be associated with a lower risk of HIV infection even after controlling for rural residence may suggest it is a marker for traditional lifestyles, which may be associated with low risk for AIDS transmission compared with urbanized lifestyles [32].

It is interesting that infected but asymptomatic patients have a risk factor profile somewhere between that of uninfected and symptomatic persons. One could postulate that the symptomatic persons were infected earlier and, therefore, had a longer time to accumulate exposures as a result of high-risk activities. However, although it is impossible to disprove this hypothesis, the younger age of the symptomatic patients (29.0 vs. 30.9 y for asymptomatic patients) perhaps makes this less plausible. Another possible explanation is that the intensity of exposure to some risk factors such as multiple STDs affects the likelihood not only of becoming infected but also perhaps of developing disease. This exposure to multiple infections has been postulated to be a cofactor for infection and to be one of the main factors accelerating conversion from an asymptomatic infection to overt AIDS in Africa and in the homosexual population of the United States [6].

We demonstrated that most common risk factors for HIV infection in Uganda relate to high-risk heterosexual behavior such as contracting sexually transmitted diseases, having sex with persons with symptomatic HIV infections, and promiscuity. However, the differences in the magnitude of the exposures to these risk factors, e.g., ~2 times the number of sexual partners and 1.5 times the number of sexual encounters for payment, seen in seropositive compared with seronegative patients seem small compared to the high seroprevalence in this population. We therefore postulate that cofactors to infection such as STDs dramatically amplify the efficiency of HIV transmission. Homosexuality and intravenous drug abuse do not seem to be risk factors in this population. Further studies to identify other risk factors and cofactors are underway and the data obtained will be used to plan the most important areas for risk reduction interventions. For example, if STDs can be definitively shown to be a cofactor increasing efficiency of transmission in Uganda, vigorous control of STDs may contribute significantly to reduced transmission. Proving that interventions against identified cofactors will reduce transmission of HIV becomes the next great hurdle in the battle against this epidemic. Meanwhile, an intensive education campaign to inform people of the already-identified heterosexual high-risk behaviors within the population in Uganda is being vigorously pursued.

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