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HIV SEROPREVALENCE IN A SAMPLE OF TANZANIAN INTRAVENOUS DRUG USERS

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Abstract

Injection drug use has recently emerged in sub-Saharan Africa. The purpose of this study was to assess the factors associated with increased risk of testing HIV-positive in a sample of injection drug users (IDUs) in Dar es Salaam, Tanzania. Participants were recruited by a trained outreach worker or were referred by IDUs who had completed the study. Blood specimens and self-reported socioeconomic and behavioral data were collected from 315 male and 219 female IDUs. Data were analyzed using univariate odds ratios and multivariate logistic regression modeling. Forty-two percent of the sample tested HIV-positive. Several socioeconomic, injection, and sexual factors were found to be associated with increased odds of testing HIV-positive. Multivariate analysis showed that having had sex more than 81 times in past 30 days, earning less than 100,000 shillings (US\$76) in the past month, residency in Dar es Salaam for less than 5 years, and injecting for 3 years were independently associated with the greatest risk of infection. The rate of HIV infection in this sample of IDUs was found to be very high, suggesting that injection drug use may be a factor in the continuing

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epidemic in sub-Saharan Africa. The factors associated with increased risk of HIV infection suggest further research is needed on the needle use and sexual networks of IDUs.

Two thirds of worldwide HIV infections have occurred in sub-Saharan Africa (Centers for Disease Control and Prevention, 2006; UNAIDS, 2006). The spread of HIV in sub-Saharan Africa has been explained by heterosexual sex whereas other factors, such as injection drug use, have been discounted. In 2004 it was estimated that there may be as few as 9,000 injection drug users (IDUs) in sub-Saharan Africa (Aceijas, Stimson, Hickman, & Rhodes, 2004); however, this estimate may be the result of a lack of surveillance data. A small number of studies have suggested that injection drug use in sub-Saharan Africa may be more common and that the number of drug users who are injecting may be rapidly increasing (Deveau, Levine, & Beckerleg, 2006; Dewing, Plüddemann, Myers, & Parry, 2006; Parry et al., 2002; Parry, Plüddemann, & Myers, 2003). These studies also suggest that at an increasing number of HIV infections in sub-Saharan Africa may be due to the needle sharing and sexual behaviors of IDUs.

Studies conducted in Tanzania have found that drug users in Dar es Salaam (McCurdy, Williams, Kilonzo, Ross, & Leshbari, 2005) and Zanzibar (Dahoma et al., 2006) inject drugs and engage in needle use and sexual behaviors that transmit HIV. Williams et al. (2007) interviewed 300 IDUs in Dar es Salaam and found that at least a fifth shared needles, three quarters used drugs before and during sex, and a third never used condoms. Findings also showed that approximately 80% of female IDUs in the study had traded sex for money. Additionally, McCurdy et al. (2006) found that 50% of used syringes collected from 73 IDUs residing in seven neighborhoods in Dar es Salaam were contaminated. Although these studies do not provide estimates of the numbers of IDUs in Dar es Salaam or the proportion who may be infected with HIV, they strongly indicate an ongoing HIV epidemic among drug users in Dar es Salaam related to injection drug use.

It is well established that injection drug use and related behaviors have played a significant role in the HIV epidemic outside sub-Saharan Africa (Friedman, Des Jarlais, Neaigus et al., 1989). Injection drug use is believed to have significantly contributed to emerging HIV epidemics, if not the driving force behind transmission, in eastern Europe (Rhodes & Simic, 2005), the Russian Federation (Burchell Calzavara, Oreskhovskiy, & Ladnaya, 2008), China (Qian, Schumacher, Chen, & Ruan, 2006), and Southeast Asia (Perngmark, Celentano, & Kawichai, 2003; Hammett et al., 2005; Hammett et al., 2006). The purpose of this study was to estimate HIV prevalence in a sample of sexually active IDUs in Dar es Salaam and to assess the factors associated with increased risk of testing HIV-positive. To our knowledge, this is the first study that has examined predictors of HIV infection in a sample of IDUs in a sub-Saharan African nation.

METHODS

PROCEDURES

Data were collected between May 2005 and September 2006 in Dar es Salaam, Tanzania as part of a study of condom use in sexually active drug injectors. IDUs were recruited using a combination of targeted sampling (Carlson, Wang, Siegal, & Guo, 1994; Watters & Biernacki, 1989) and participant referral. Sampling was similar to snowball sampling with a number of zero order contacts.

A sampling plan was developed using information provided by key informants knowledgeable about illicit drug use in Dar es Salaam and the experience of one of the investigators who had worked with drug users in the city for many years. This information was used to select

neighborhoods in the city to target for recruiting IDUs. Neighborhood selection was confirmed by interviews with key informants and by direct observation of injection drug use by a trained outreach worker. Once the neighborhoods were identified, the outreach worker made contact with a number of IDUs and told them about the study. IDUs who expressed an interest were referred for screening. In addition to relying on the outreach worker, IDUs who had completed the study were asked to refer other injectors to be screened.

Persons referred to the study were asked to go to a data collection center, a rented duplex located near the city center, to complete a brief eligibility questionnaire. Participation was limited to persons who were 18 years or older, had injected an illicit drug in the past 48 hours, had had sex at least once in the past 30 days, and were willing to provide a blood specimen. Injection drug use was confirmed by the presence of observable needle track marks. Of 559 individuals screened, 537 met criteria. Of those ineligible, 15 had not had sex in the previous 30 days, six had not injected in the last 48 hours, and one was unwilling to provide a blood specimen.

After giving informed consent, a participant was immediately interviewed. After the interview, a blood specimen was collected by a trained nurse. The nurse also provided HIV pretest and posttest counseling. The specimens were labeled with a unique identification number, and all blood specimens were transported daily to a laboratory for testing. Participants who tested HIV-positive were referred to Muhimbili University Hospital for medical evaluation and possible treatment. Participants were paid 5,000 Tanzanian shillings (U.S.\$4) for their time and travel.

The study was reviewed and approved by university committees for the protection of human subjects in Tanzania and the United States and two national boards in Tanzania.

MEASURES

Data were collected in Swahili using a questionnaire based on instruments that have been used in the United States (Bowen, Williams, McCoy, & McCoy, 2001; Williams, Bowen, Timpson, & Keel, 2003; Williams, Timpson et al., 2003). Measures were translated into Swahili, and then back translated into English. Measures that produced unclear or inconsistent translations were adjusted by the investigators. Items identical or similar to those in the questionnaire have produced valid and reliable data from other samples of IDUs (Darke, 1998; Dowling-Guyer et al., 1994; Needle et al. 1995).

Socioeconomic characteristics were measured by asking respondents about their age, education, marital status, residential history, current living arrangements, current work situation, and source of income.

Frequency of non-injection drug use was assessed by first asking respondents if they had ever used alcohol, marijuana, or valium. If the response was "yes," they were then asked the number of times they had used the drug in the last 30 days. Because all participants were IDUs, injection drug use was measured by the number of times a respondent had injected in the past 30 days and which drug was injected most often.

To measure needle use risk respondents were asked how many times in the past 30 days they had injected with a needle that had been used by someone else and how many times they had given a used needle to another injector.

Sex risk was measured by asking the number of times respondents had had vaginal sex in the past 30 days, the number of partners with whom they had had sex, and how often they used condoms (never, sometimes, or always) with their partners. Trading sex for money was assessed by asking if a respondent had ever traded sex for money.

Blood samples were screened for HIV infection using the Capillus (Trinity Biotech, Bray, Ireland) and the Determine (Abbot Japan Co. Ltd, Tokyo, Japan) tests. Specimens producing contrary results were submitted to Elisa testing (Vironostica HIV UniForm II Ag/Lab, bioMérieux, Boxtel, the Netherlands). Repeatedly HIV positive specimens were confirmed using the Western Blot assay (INNO-LIA HIV I/II, Innogenetics, Gent, Belgium). Quality control was performed by the African Medical Research and Education Foundation reference laboratory in Dar es Salaam. There were no discrepant results.

ANALYSES

Incomplete data from three participants were excluded. Data from 534 IDUs were available for analyses. Factors associated with greater odds of testing HIV-positive were estimated using chi-squared tests and univariate odds ratios. Factors measured at the interval or integer levels were recoded into discrete categories reflecting the distribution of the data on each factor. The comparison category for each factor was the one having the lowest HIV prevalence. Significance of odds ratios was assessed using 95% confidence intervals.

A multivariate model of the risk of testing HIV-positive was estimated by simultaneously entering all univariate factors producing significant odds ratios into a multivariate logistic regression model. Significance of the multivariate odds ratios was assessed using 95% confidence intervals. The amount of variance explained was estimated using Cox-Snell and Nagelkerke R^2 statistics. Analyses were conducted using SPSS 14.0.

RESULTS

SAMPLE

The sample was composed of 315 men and 219 women, who were relatively young (mean = 27.9 years, median = 27), single (75%), and had little formal education (mean = 6.7 years, median = 7). Most IDUs in the sample (61%) had lived in Dar es Salaam for 21 or more years and were currently living in their parents' homes (60%). Fewer than a fifth (17%) were living in their own home. A small number (4%) were living on the streets or in vacant buildings. Despite a high proportion of participants who had housing, a large number (25%) considered themselves to be homeless at the time of the interview.

Fewer than half (44%) had earned income by working at a full- or part-time job. Almost half of participants' income came from trading sex for money (33%) or some other type of illegal activity (16%). About half (46%) had a monthly income greater than 200,000 Tanzanian shillings (U.S.\$152). A quarter (27%) earned between 150,000 and 199,999 shillings, a fifth (17%) between 100,000 and 149,000, and a tenth (10%) less than 100,000 shillings (U.S.\$76).

All participants were injecting and were sexually active at the time of interview. A third had used alcohol (35%) but were not heavy drinkers (mean = 8.5 times, median = 4). Most (60%) smoked marijuana twice a day (mean = 74.0, median = 90). Use of valium (5%) was negligible. All participants injected heroin at the time of the interview. They did not report injecting any other drug. Most had recently begun to inject. More than half (56%) had started injecting in the past 3 years (mean years = 3.7, median = 3.0), and 18% had injected for the first time in the past 12 months. Most (60%) injected three times per day. About a third (31%) had injected with a needle used by someone else, and two fifths (41%) had given a used needle to another.

Frequency of sex in the last 30 days ranged from 1 to 300 times (mean = 36.1 times; median = 8). The number of sex partners ranged from 1 to 300 (mean = 26.5; median = 2), and half (51%) of the participants had had sex with two or more partners. Almost half of the participants (49%) did not use condoms during vaginal sex. The remainder used condoms sometimes (27%) or always (23%). Two fifths of participants (38%) had a lifetime history of trading sex for

money. Almost all women (90%) and six men had a history of trading. Only five participants said they were HIV-positive at the time of the interview.

UNIVARIATE ANALYSES

Slightly more than two fifths (42%) of IDUs tested HIV-positive. As shown in Table 1, several sociodemographic factors were found to be significantly associated with testing HIV positive. Gender, age, years living in Dar es Salaam, living arrangements, homelessness, income, and primary source of income were associated with greater odds of infection. Being female, between 26 and 30, living in the city three years or less, earning less than 100,000 schillings, and having a sex partner as the primary source of income were most strongly associated with testing HIV-positive.

Injection and sexual behaviors found to be associated with testing HIV-positive are shown in Table 2. Among the factors examined, years injecting, frequency of injecting, trading sex for money, frequency of sex, number of sex partners, and condom use were also found to be associated with testing positive. Injecting for 3 years, injecting fewer than 90 times in the past month, having a history of trading sex for money, having had sex more than 80 times, having had 90 or more sex partners, and sometimes using a condom produced the highest odds of testing positive.

MULTIVARIATE MODEL

Four factors were found to be independently associated with testing HIV-positive. The strongest independent predictor of testing HIV-positive was having had sex 81 or more times ((odds ratio [OR] = 6.16, lower confidence interval [LCI] = 1.53, UCI = 24.77). An income of less than 100,000 schillings was the second strongest predictor (OR = 3.40, LCI = 1.52, UCI = 7.60), followed by residing in Dar es Salaam 5 or fewer years (OR = 2.99, LCI = 1.09, UCI = 8.18). Having injected for 3 years (OR = 2.40, LCI = 1.13, UCI = 5.10) was the weakest predictor. The model fit the data reasonably well, accounting for about a quarter (Cox-Snell $R^2 = .23$) to a third of the variance (Nagelkerke $R^2 = .31$) in the data.

DISCUSSION

The purpose of this study was to estimate HIV prevalence and to assess factors associated with increased risk of testing HIV-positive in a sample of sexually active IDUs in Dar es Salaam, Tanzania. Roughly 4 out of 10 participants tested HIV-positive. Almost all of the participants who tested positive were unaware that they were infected. The infection rate found in this sample of IDUs is almost six times the rate of infection in the adult population in Tanzania and four times that in the adult population in Dar es Salaam (Tanzania Commission for AIDS, National Bureau of Statistics, & ORC Macro, 2005). The rate of infection in the sample of IDUs is comparable to rates found in samples of IDUs in eastern Europe, the Russian Federation, China, Southeast Asian countries (Aceijas et al., 2003), and at least one sub-Saharan African nation (Deveau et al., 2006). Findings also indicate that IDUs are engaging in extremely high-risk behaviors, including injecting with used needles, having vaginal sex without condoms, and, especially female IDUs, trading sex for money. Although these findings cannot confirm a widespread HIV epidemic among IDUs in Dar es Salaam, the high rate of infection found in this sample suggests that, if injection drug use is rapidly increasing among drug users in the city, injection drug use may become a significant factor in the continuing HIV epidemic in Dar es Salaam and Tanzania.

Several socioeconomic, injection drug use, needle use, and sex risk were found to be associated with an increased risk of testing HIV-positive. The factors producing the highest odds of testing HIV-positive were clearly associated with being female, and indicate that risks of HIV infection

differ for male and female injectors. These findings also suggest that factors related to women's sexual networks may significantly determine their risks for infection. Of particular importance may be factors related to the sexual mixing of younger women and older men in sexual networks that include trading sex for money (Helleringer & Kohler, 2007; Lagarde et al., 2001). The finding that condom use is inversely associated with increased risk of infection is likely due to women using condoms with sex for money partners.

Other univariate factors that attained significance suggest that new initiates to injecting and recent migrants to Dar es Salaam are at increased risk of HIV infection. New initiates and recent migrants, because of financial or housing circumstances, may find themselves spending a great deal of time on the streets, exposing them to networks of high risk individuals (Montgomery, Hyde, De Rosa, et al., 2002). New initiates and recent migrants may also be unaware of safer needle use practices; lack the money to consistently buy new needles; be more reckless when they do inject; and, especially for women, find themselves in circumstances that encourages engaging in trading sex for money. The finding that less frequent injection was associated with increased risk of infection may be because of the composition of the needle use and sex networks of younger injectors and those who have recently begun to inject.

The multivariate model strongly supports conclusions that women, new initiates, and recent migrants are at greatest risk of HIV infection. Although the model was able to explain a fourth to a third of the variance, the large amount of unexplained variance suggests a complex risk dynamic that includes factors not in the model. The structures of injecting and sexual networks and their overlaps may play a large role in determining relative risk of infection. Further research on the interaction between individual and network level factors is needed.

The study has a number of limitations. Care was taken in constructing the sample. However, as with all studies of hidden and illusive populations, generating a representative sample is impossible. Participation was restricted to sexually active IDUs, restricting an assessment of risk factors associated solely with needle use. Data were cross-sectional limiting the ability to impute causation. The behavioral measures may not have produced data indicative of long-term patterns, thereby also limiting an assessment of causation. The measure of sex was for vaginal sex and did not include anal and oral sex. Both these sexual behaviors, especially anal sex, may play some role in the sexual transmission of HIV among IDUs in Dar es Salaam, and the frequency of these behaviors requires additional study. The tests for HIV infection used in the study could not establish when infection occurred or whether the infection originated within or outside the IDU population. The latter limitation is important, as the study could not investigate whether infections were the result of interactions between IDUs or between IDUs and non-injecting heterosexuals. Finally, data used for this study do provide not estimates of IDUs' behaviors or HIV infection rates. Both may have changed because the data were collected.

Despite these limitations, the results are informative. To our knowledge this is the first study that has investigated factors associated with HIV infection in a sample of sub-Saharan African IDUs. The rate of infection was very high and indicative of an established epidemic among IDUs in Dar es Salaam, although the practice of injecting drugs may have been introduced fairly recently (Ross, McCurdy, Kilonzo, Williams, & Leshabari, 2008). The high rates of infection suggest that once HIV was introduced into networks of IDUs in Dar es Salaam, it may have spread very quickly among users (Des Jarlais & Semaan, 2008; Friedman et al., 1995). Given that few infected IDUs in the study were aware that they were infected, aggressive counseling and testing, distribution of bleach and condoms, and needle exchange programs should be implemented. Culturally appropriate and reasonably inexpensive drug treatment programs targeting IDUs are also needed.

The findings of this study also indicate that, if injection drug use in sub-Saharan Africa is rapidly increasing, the epidemiology of the HIV epidemic may be changing at a correspondingly rapid rate, at least in urban areas where there may be higher concentrations of injection drug users. In nations such as Tanzania, which have virtually no programs in place to prevent HIV infection in IDUs or to treat drug addiction, adjusting public policy to support and encourage the development of HIV prevention and treatment programs targeting IDUs will require the expenditure of substantial resources. However, failing to recognize or address what may be a changing epidemic may seriously threaten the progress that some sub-Saharan Africa nations, including Tanzania, have made in stabilizing or reducing HIV infection in their populations.

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TABLE 1

Socioeconomic Characteristics

	HIV-Positive/n(%)	Odds Ratio	95% Confidence Interval	<i>p</i>
Gender				< .001
Male	87/315(28%)	—		
Female	140/219(64%)	4.64	3.21, 6.73	
Age				.006
<20	27/54(50%)	2.40	1.07, 5.37	
21–25	57/151(38%)	1.46	.73, 2.89	
26–30	94/182(52%)	2.56	1.31, 5.00	
31–35	34/96(35%)	1.32	.63, 2.74	
> 36	15/51(29%)	—		
Years of school			.404	
0–3	19/46(41%)	1.32	.64–2.73	
4–6	60/133(45%)	1.54	.89–2.67	
7	116/263(44%)	1.48	.90–2.42	
≥ 8	17/60 (28%)	—		
Marital Status			.316	
Married	52/134(39%)	—		
Single	175/400(44%)	1.23	.82–1.83	
Years living in Dar es Salaam				.002
1–5	28/43(65%)	3.19	1.43, 7.12	
6–10	33/63(52%)	1.88	.93, 3.81	
11–15	19/36(53%)	1.91	.84, 4.36	
16–20	24/65(37%)	—		
> 21	123/327(38%)	1.03	.59, 1.79	
Living arrangements				< .001
Parents home	108/317(34%)	—		
Own home	41/92(45%)	1.56	0.97, 2.50	
Someone else's home	36/58(62%)	3.17	1.78, 5.65	
Short-term rental	30/45(67%)	3.87	2.00, 7.50	
Streets	12/22(55%)	2.32	0.97, 5.55	
Considers self homeless				.002
No	156/403(38%)	—		
Yes	71/131(54%)	1.90	1.27, 2.82	
Income (in schillings)				.002
< 100,000	35/54(65%)	3.16	1.71, 5.84	
100,000–149,000	36/90(40%)	1.14	.70, 1.87	
150,000–199,000	65/143(46%)	1.43	.94, 2.17	
> 200,000	91/247(37%)	—		
Primary source of income				< .001
Job	67/236(28%)	1.78	.38, 8.47	

	HIV-Positive/n(%)	Odds Ratio	95% Confidence Interval	<i>p</i>
Spouse/sex partner	17/23(74%)	12.75	2.12, 76.57	
Family/friends	2/11(18%)	—		
Trading sex for money	116/178(65%)	8.42	1.76, 40.18	
Illegal activity	25/86(29%)	1.84	.37, 9.15	

TABLE 2

Drug Use and Sexual Behaviors

	HIV-POSITIVE/n(%)	Odds Ratio	95% Confidence Interval	<i>p</i>
Times used alcohol, last 30 days				.206
0	149/345(43%)	1.39	.87–2.21	
1–4	35/99(35%)	—		
≥5	43/90(48%)	1.67	.93–3.00	
Times used marijuana, last 30 days			.913	
0	93/216(43%)	1.09	.71–1.65	
1–89	62/151(41%)	—		
≥90	72/167(43%)	1.09	.70–1.70	
Times used valium, last 30 days				.736
0	216/510(42%)			
≥1	11/24(46%)	1.01	.90–1.05	
Years injecting				.012
1	43/96(45%)	2.31	1.21, 4.43	
2	45/106(42%)	2.10	1.11, 3.98	
3	52/97(54%)	3.29	1.72, 6.29	
4	36/92(39%)	1.83	.95, 3.54	
5–6	20/77(26%)	—		
> 7	31/66(47%)	2.52	1.25, 5.10	
Times injected, last 30 days				.037
< 89	42/84(50%)	1.98	1.13, 3.46	
90–119	141/319(44%)	1.57	1.02, 2.40	
> 120	44/131(34%)	—		
Times used used needles				.691
0–2	176/403(44%)	1.43	.71–2.89	
3–5	17/45(38%)	1.12	.45–2.77	
6–10	13/37(35%)	—		
> 10	21/49(43%)	1.39	.57–3.34	
Times gave used needles to others			.307	
0	139/315(44%)	1.31	.89–1.94	
1–5	59/157(38%)	—		
> 5	29/62(47%)	1.46	.80–2.65	
Ever traded sex for money				< .001
No	96/331(29%)	—		
Yes	131/203(64%)	4.45	3.07, 6.47	
Times had sex, last 30 days				< .001
1–2	31/111(28%)	—		
3–4	34/97(35%)	1.39	.77, 2.51	
5–10	33/103(32%)	1.22	1.72, 6.29	
11–80	52/116(45%)	2.10	1.21, 3.65	

	HIV-POSITIVE/n(%)	Odds Ratio	95% Confidence Interval	<i>p</i>
> 81	77/107(72%)	6.62	3.67, 11.97	
Number of sex partners, last 30 days			< .001	
1	85/261(33%)	1.01	.56, 1.83	
2	20/62(32%)	—		
3–20	20/53(38%)	1.27	.59, 2.74	
21–60	26/49(53%)	2.37	1.10, 5.15	
61–89	40/58(69%)	4.67	2.16, 10.08	
> 90	36/51(71%)	5.04	2.26, 11.26	
Times used condom, last 30 days		< .001		
Never	80/264 (30%)			
Sometimes	81/146 (56%)	2.87	1.89, 4.36	
Always	66/124 (53%)	2.62	1.69, 4.06	