HIV-1 Seroconversion and Risk Behaviors among Young Men in the US Army

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ABSTRACT

Objectives. This study sought to examine risk factors associated with human immunodeficiency virus type 1 (HIV-1) seroconversion among active-duty men in the US Army.

Methods. One hundred twenty-eight men with documented HIV-1 seroconversion between 1988 and 1991 were matched to control subjects on demographic variables. Risk factor information was collected for the seroconversion period.

Results. Forty-nine case subjects and no control subjects reported same-gender sex; this includes 34 case subjects who also reported sex with women. Seventy case and 118 control subjects reported no risk factors other than heterosexual intercourse. Among heterosexuals, excess risk was noted for men who had sex with women in risk categories defined by the Centers for Disease Control and Prevention (odds ratio = 10.0; 95% confidence interval = 1.3, 78.1). Significant trends of increasing risk for seroconversion were found with increasing numbers of female partners, nonsteady partners, and partners with whom sex occurred on the first day of acquaintance.

Conclusions. In this population, the major risk factor for HIV-1 seroconversion was same-gender sex. Among heterosexuals, sex with anonymous or casual partners increased this risk. Intervention programs should emphasize the risk of indiscriminate partner selection in addition to "safe sex" practices. (*Am J Public Health.* 1995;85:1500–1506)

Introduction

Several studies in the United States have identified behavioral and biological risk factors associated with prevalent human immunodeficiency virus type 1 (HIV-1) infection.[1–5] These studies, however, were unable to fully characterize recent trends in the HIV-1 epidemic because the duration of infection was unknown among participants. Risk factor studies based on individuals with documented seroconversion have tended to enroll participants from predetermined high-risk groups, such as intravenous drug users or homosexual men, with little racial, ethnic, or geographic diversity.[6–9] The purpose of this investigation was to identify and evaluate demographic and behavioral determinants associated with recent documented HIV-1 seroconversion among young men in the US Army, a racially, ethnically, and geographically heterogeneous population with relatively low incidence (approximately 0.27/1000 per year).[10,11] Our goal was to identify such factors so that interventions could be based on current risks for HIV-1 infection in the Army.

Methods

Study Population

The case group comprised all active-duty men with documented seroconversion to HIV-1 infection who were identified at 22 Army installations throughout the continental United States between July 1988 and December 1991. Soldiers with documented seroconversion—negative results on an HIV antibody test at least 2 months prior to positive results on such a test—were identified through the US Army HIV Data System, a surveillance database that records the HIV-1 testing histories of all active-duty soldiers in the Army. A roster of seroincident cases was sent every month to military installations where case subjects were assigned. Potential participants for the study were recruited by community health nurses working in the local Army HIV program.

At each installation where a case subject was identified, a control subject was randomly selected from a roster that contained all active-duty personnel testing negative for HIV antibodies. Eligibility for control status required that the soldier test negative no earlier than 3 months before the matched case subject. Control subjects were individually pair-

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matched to case subjects on age within 2 years, racial/ethnic group (White non-Hispanic; Black non-Hispanic; Hispanic; Asian; other); rank (junior enlisted; senior enlisted; warrant officer; commissioned officer), and length of military service within 5 years. Control subjects were also recruited by HIV program personnel. If the first potential participant declined, other individuals randomly selected from the roster of eligible control subjects were contacted.

Extensive procedures were used to maintain the anonymity and confidentiality of study subjects. The Army HIV program personnel, who were responsible not only for recruitment but also for assignment of code numbers for study subjects, did not have access to completed questionnaires. Nor did the civilian interviewers, who worked at local or state health departments, know the HIV antibody status of the respondents or any personal identifiers. Thus, there was no information in the interview itself that could link a questionnaire with a respondent. Participation in the study was voluntary, and informed consent was obtained from all respondents. The research protocol was approved by the institutional review boards at the Walter Reed Army Institute of Research as well as at each military installation where the study was conducted.

TABLE 1—Characteristics and HIV-1 Risk Categories of 128 Seroincident Case Subjects and Pair-Matched Seronegative Control Subjects on 22 US Army Installations, 1988 through 1991

	Case Subjects (n = 128)[a]		Control Subjects (n = 128)[a]	
	No.	%	No.	%
Age, y[b]				
18–24	47	37	42	33
25–29	28	22	34	26
≥30	53	41	52	41
Race/ethnicity[b]				
White non-Hispanic	37	29	38	30
Black non-Hispanic	79	62	79	62
Hispanic	8	6	11	8
Other	4	3	0	0
Length of military service, y[b]				
<3	29	23	24	19
4–9	52	41	52	41
≥10	46	36	52	41
Length of exposure interval, mo[b]				
<18	43	34	43	34
18–24	32	25	32	25
≥25	53	41	53	41
Marital status				
Never married	40	31	22	17
Ever married	88	69	106	83
Education				
High school	50	39	54	42
Some college	61	48	58	45
2-year degree and higher	17	13	16	13
Smoking history				
Never	67	52	64	50
Ex-smoker	13	10	20	16
Current smoker	48	38	43	34
Alcohol use (drinks per month on average)				
Never	16	13	20	16
1–15	40	31	36	28
16–30	17	13	24	19
≥31	55	43	48	37
Risk category[c]				
Injection drug user	0		1	1
Sex only with men	15	13	0	
Sex with men and women	34	28	0	
Sex only with women	70	59	118	99

[a]Respondents with missing values were excluded.
[b]Matching variables.
[c]Eight respondents with unreliable interviews and one respondent who reported no sex during the interval were excluded, as were their matches.

Data Collection

Risk factor information was obtained with a structured 60-minute questionnaire, administered face-to-face by trained civilian interviewers in private rooms either on the military base or in a location agreed to by the respondent and interviewer. Each case subject was asked about risk factors that occurred during a defined period that began 6 months prior to his last negative HIV antibody test date and extended until his first positive test date (hereafter referred to as the seroconversion interval). Exposure information for control subjects was obtained for the same period. Information collected included sociodemographic characteristics; medical history, including a lifetime history of sexually transmitted diseases as well as a history of such diseases during the seroconversion interval; sexual history; drug use, including injection drug use; and other lifestyle factors. Respondents were asked several questions about the number of sex partners they had had during the interval—in particular, the number of partners with whom they had had sex on the first day they met the partner (including prostitutes) and the number of those who would be considered nonsteady (those with whom the respondent had had sex fewer than 10 times during the interval). The respondent was also asked to describe in detail each partner with whom he had had sex during the seroconversion interval. Information was sought on condom use, the frequency of various sexual activities, and bleeding during sex, as well as on whether money or drugs were provided for sex, whether the partner met risk categories defined by the Centers for Disease Control and Prevention (CDC), and whether the partner had multiple sex partners. If a respondent reported having had several sex partners who shared similar characteristics (such as prostitutes), he provided information on the group of individuals rather than on each individual separately.

TABLE 2—HIV-1 Seroconversion Associated with Sex Practices among Heterosexuals during the Seroconversion Interval, 22 US Army Installations, 1988 through 1991

	% Case Subjects[a] (n = 70)	% Control Subjects[a] (n = 70)	Odds Ratio	95% Confidence Interval
Type of partner				
Sex with partner in CDC-defined risk categories[b]				
No	85	99	1.0	
Yes	15	1	10.0	1.3, 78.1
Sex with prostitute				
No	78	91	1.0	
Yes	22	9	2.8	1.0, 7.8
Sex with partner who had had multiple sex partners				
No	57	72	1.0	
Yes	43	28	2.6	1.1, 6.2
Sexual behaviors				
No. female partners				
1	19	47	1.0	
2–3	27	26	4.0	1.3, 12.2
4–5	17	10	10.6	2.2, 51.1
≥6	37	17	16.3	3.9, 68.7
P for trend			<.001	
No. partners, including prostitutes, when sex occurred on first day of acquaintance				
None	40	71	1.0	
1–2	27	20	2.9	1.1, 7.4
≥3	33	9	28.3	3.5, 229.0
P for trend			<.001	
No. nonsteady partners[c]				
None	27	51	1.0	
1–2	26	31	2.7	1.0, 7.6
≥3	47	17	12.6	3.3, 47.7
P for trend			<.001	

Note. CDC = Centers for Disease Control and Prevention.
[a]Respondents with missing values were excluded.
[b]I.e., an HIV/AIDS partner, a partner with injection drug use, or an African partner.
[c]Sex fewer than 10 times with partner.

Statistical Analyses

Odds ratios (ORs) and 95% confidence intervals (CIs) were obtained from conditional logistic regression techniques[12] using the computer software package EGRET.[13] Continuous variables were divided into ordinal intervals or categorized according to the distributions among control subjects. To assess the linear association between numbers of sexual partners and risk of HIV-1 seroconversion, the test for trend across categories was performed in logistic regression by treating the categorized variable as continuous in the model. Multivariate analyses were performed to assess the independent effects of risk factors that were significant in univariate analyses or were associated with elevated risks for seroconversion.

Serological Assays

The screening procedures and test performance of the Army HIV program have been described in detail elsewhere.[14–16] In brief, HIV-1 antibodies were detected by using a standard, commercially available enzyme-linked immunosorbent assay (ELISA). All reactive samples were retested in duplicate by ELISA. Serum samples that were repeatedly reactive on ELISA were confirmed by Western blot and recombinant enzyme immunoassay or radio immuno-precipitation.

Results

During the study period, 276 men with documented seroconversion were identified from the 22 military installations that participated in the study. Seventy-four of these men were not invited to participate in the study for administrative reasons: before they could be contacted, 18 soldiers transferred to a nonparticipating post, 10 left the service because their term of duty ended, and 22 retired or were medically discharged; an additional 24 soldiers were not contacted for other administrative reasons. Of the remaining 202 eligible case subjects, 62 declined to participate, leaving 140 case subjects (69%) to be interviewed. Age, race, and military rank were known for all eligible case subjects, and these factors differed little in their distribution between those subjects who participated and those who refused. A total of 142 control subjects was also interviewed. We were able to determine response rates for the matched control subjects at 10 of the 22 participating posts, representing 76% of individuals interviewed. The response rate among these individuals was approximately 75%. To perform matched analysis, we eliminated 12 case and 14 control subjects for whom a match could not be interviewed. This resulted in 128 matched pairs.

Sociodemographic characteristics and HIV risk categories of the study population are presented in Table 1. The median seroconversion interval was 23 months (range = 3 months to 61 months). Of the matching variables, approximately 60% of study subjects were under age 30, 71% were non-White, and 77% of case and 81% of control subjects had more than 3 years of military service. Compared with control subjects, case subjects were less likely to be married ($P < .01$). No difference was observed between the two groups with respect to years of education, smoking history, and alcohol use.

Because the interview contained sensitive questions regarding sexual activity and injection drug use, we asked the respondents at the end of the interview whether they answered the items honestly. For analyses based on self-report of sexual behavior and injection drug use, we eliminated six case and two control subjects (and their matches) who had answered no to these questions. We also deleted one control (and matched case)

subject whose sexual orientation could not be determined since he reported no sexual activity during the seroconversion interval. These exclusions left 119 matched pairs available for analysis.

One control subject and no case subjects reported injection drug use. Thirteen percent of case subjects reported having had sex only with men during the interval, and 28% reported having had sex with both men and women. In contrast, none of the control subjects reported same-gender sex ($P < .001$, Fisher's Exact Test). The remaining 59% of case subjects reported only heterosexual sex during the interval. Case subjects who reported only same-gender sex were more likely to be single and White than case and control subjects who reported only heterosexual sex during the interval. Because none of the control subjects reported having had sex with men, case-control comparisons to assess the risk of specific sexual practices were not feasible for homosexual and bisexual cases. All subsequent analyses were limited to the 70 case subjects (and their matched control subjects) who reported having had sex only with women during the interval.

Among men who reported having had sex only with women, there was an increased risk of HIV-1 seroconversion associated with a history of sex with women who had HIV/AIDS, who had used intravenous drugs, or who were from Africa or other countries where heterosexual transmission predominates (CDC-defined risk categories)[17] (Table 2). Significant elevated risks were also observed for men who had had sex with prostitutes when compared with men who did not. Similarly, men who had had sex with women who had multiple sex partners were also at higher risk of seroconversion when compared with men who did not engage in this practice.

The risk of HIV-1 seroconversion was directly related to the number of female sex partners during the seroconversion interval (P for trend $< .001$) and increased significantly for each category of number of partners. For men who had had six or more sex partners during the interval compared with those who had had only one, the odds ratio was 16.3 (95% CI = 3.9, 68.7). Risk estimates also increased with the number of partners when sex occurred on the first day of acquaintance (P for trend $< .001$). Respondents who reported having had sex with three or more female partners on the first day of acquaintance were at much greater risk of HIV-1 seroconversion than respondents who never practiced this behavior (OR = 28.3; 95% CI = 3.5, 229.0). Excess risk was also associated with the number of nonsteady partners in the interval (P for trend $< .001$).

TABLE 3— HIV-1 Seroconversion Associated with Sexually Transmitted Diseases and Bleeding among Heterosexuals during the Seroconversion Interval, 22 US Army Installations, 1988 through 1991

	% Case Subjects[a] (n = 70)	% Control Subjects[a] (n = 70)	Odds Ratio	95% Confidence Interval
Sexually transmitted diseases during interval				
Any STD				
No	76	86	1.0	
Yes	24	14	2.0	0.8, 5.0
Gonorrhea				
No	86	96	1.0	
Yes	14	4	4.5	1.0, 20.8
Genital ulcer disease[b]				
No	96	97	1.0	
Yes	4	3	1.5	0.2, 9.0
Genital warts				
No	97	100		
Yes	3	0		
Other burning or discharge from penis				
No	96	91	1.0	
Yes	4	9	0.6	0.1, 2.5
Other sores in genital or anal area				
No	97	94	1.0	
Yes	3	6	0.5	0.1, 2.7
Bleeding during sex				
Menstrual bleeding during sex				
No	79	81	1.0	
Yes	21	19	1.1	0.5, 2.7
Nonmenstrual bleeding during sex				
No	80	81	1.0	
Yes	20	19	1.1	0.5, 2.6

[a]Respondents with missing values were excluded.
[b]Includes herpes and syphilis.

While 24% of case and 14% of control subjects reported having had a sexually transmitted disease during the seroconversion interval ($P > .05$), the frequency of specific sexually transmitted diseases was relatively rare (Table 3). Self-report of gonorrhea during the interval was the only risk factor that reached statistical significance. Fourteen percent of case and 13% of control subjects reported that their partner had a genital sore when they had vaginal intercourse (OR = 1.3; 95% CI = 0.4, 4.7) (data not presented). There was no association between seroconversion and menstrual or nonmenstrual bleeding during sex. Overall, the point estimates of risk associated with these factors were not elevated and not statistically significant.

No association was noted between HIV-1 seroconversion and the frequency with which vaginal, oral, or anal sex was practiced during the seroconversion interval. Compared with individuals who engaged in vaginal sex fewer than 100 times, the odds ratios for those who did so 100 to 200 times and 300 or more times during the interval were 0.5 (95% CI = 0.2, 1.2) and 0.7 (95% CI = 0.3, 1.9), respectively. Compared with individuals who had never engaged in cunnilingus, the odds ratios for those who did so 1 to 25 times and 25 or more times were 1.0 (95% CI = 0.4, 2.2) and 1.2 (95% CI = 0.5, 2.9), respectively. Similarly, compared with individuals who

TABLE 4—Multivariate Conditional Logistic Regression Models for HIV-1 Seroconversion, 22 US Army Installations, 1988 through 1991

Casual-Sex Variables	Adjusted Odds Ratio[a]	95% Confidence Interval
No. female sex partners		
1	1.0	
2–3	4.3	1.2, 15.6
4–5	8.8	1.6, 49.5
≥6	10.2	2.0, 53.1
Sex with prostitute or partner who had had multiple sex partners		
No	1.0	
Yes	2.6	1.0, 6.3
No. partners, including prostitutes, when sex occurred on first day of acquaintance		
None	1.0	
1–2	2.3	0.9, 6.0
≥3	25.1	2.4, 261.3
No. nonsteady partners[b]		
None	1.0	
1–2	2.2	0.8, 6.3
≥3	7.8	2.0, 30.8

[a]Adjusted for sex with partner in risk categories defined by the Centers for Disease Control and Prevention and self-report of gonorrhea during the interval; respondents with missing values were excluded.
[b]Sex fewer than 10 times with partner.

had never engaged in fellatio, the odds ratios for those who did so 1 to 25 times and 25 or more times were 1.4 (95% CI = 0.6, 3.3) and 2.3 (95% CI = 0.8, 6.3), respectively. Of note, the practice of anal sex was relatively infrequent in this population; 12 case and 9 control subjects had engaged in anal intercourse during the interval (OR = 1.4; 95% CI = 0.5, 3.8).

Any use of condoms during the seroconversion interval was reported by more case subjects (71%) than control subjects (58%) ($P > .05$). Nonsignificant increased risks of seroconversion were noted with the frequency of condom use. Compared with respondents who reported never using a condom, the odds ratio was 1.7 (95% CI = 0.8, 3.5) for respondents who reportedly used one less than 100% of the time and 2.6 (95% CI = 0.5, 15.2) for those (four case subjects and five control subjects) who reportedly used one 100% of the time.

To assess independent risk factors for seroconversion, a series of multivariate models was created. These included the variables of partners at CDC-defined risk and self-report history of gonorrhea in the interval as well as one of the following casual-sex variables: number of female partners, number of prostitutes or partners who had had multiple sex partners, number of female partners with whom sex occurred on the first day of acquaintance, and number of nonsteady female sex partners in the interval. These variables were elevated or statistically significant in univariate analyses. Because the casual sex variables were highly correlated or were parallel measures of the same underlying sex behaviors, they were not introduced into the model simultaneously but rather were assessed individually. As observed in the univariate analysis, all casual sex variables were significantly associated with HIV-1 seroconversion (Table 4). The odds ratios for partners in CDC-defined risk categories in these trivariate models ranged from 5.9 (95% CI = 0.5, 73.8) (adjusted for number of partners) to 14.8 (95% CI = 0.5, 426.8) (adjusted for sex on first day of acquaintance); those for self-report of gonorrhea during the interval ranged from 3.1 (95% CI = 0.6, 16.9) (adjusted for number of nonsteady partners) to 5.4 (95% CI = 1.1, 28.0) (adjusted for sex with a prostitute or partner who had had multiple sex partners). Other factors, such as smoking, alcohol, and condom use, were also evaluated in multivariate analyses, but none of these factors showed independent risks or conferred any substantial confounding on the associations noted above.

Discussion

This matched case–control study examined risk factors for HIV-1 seroconversion among men on active duty in the US Army. Our results showed that 41% of the case subjects and none of the control subjects reported same-gender sex during the seroconversion interval. Injection drug use was extremely rare in this population, reported by only one control subject during the interval. This finding was not unexpected as the Army conducts random screening for illicit drug use and has aggressive drug abuse prevention programs.

A major advantage of this study, in addition to our ability to define the time interval in which seroconversion occurred, was the detailed information collected on each sex partnership in the seroconversion interval. Large, independent excess risks of HIV-1 seroconversion were found for respondents who reported sex with anonymous or casual partners. In contrast, the type of sexual activity and the number of times specific sex acts occurred were not risk factors. These findings demonstrate that the selection of a sex partner was a strong determinant of risk in this population and that the risk of seroconversion increased with opportunities for contact with an HIV-infected sex partner or a partner with high or unknown risk of HIV-1 infection. The observation that it is riskier to have more partners with few sexual contacts than few partners with many sexual contacts is supported by several mathematical models that predict the probability of HIV-1 heterosexual infection.[18–20]

Several studies of prevalent and incident HIV-1 infection have reported an association between sexually transmitted diseases, particularly genital ulcer diseases such as herpes and syphilis, and HIV-1 in men who reported having sex only with women.[4,5,21,22] In the univariate analysis, we observed an increased risk among respondents who reported gonorrhea during the seroconversion interval, as have other studies.[5,9] The adjusted estimate of risk, however, was not statistically significant in a multivariate analysis. The prevalence of genital ulcer disease was very low in this population. Moreover, no association was found between seroconversion and self-report that the partner had a genital sore. These data on sexually transmitted diseases should be interpreted with caution because they were

based on self-report and so the low prevalence may have been the result of underreporting. In observational studies with larger sample sizes, it has been difficult to determine whether sexually transmitted diseases were specific cofactors for transmission or acted as markers reflecting sexual contact with HIV-infected partners.[23] We also did not find an elevated risk of HIV-1 seroconversion for men who reported having sex with women where either menstrual or nonmenstrual bleeding occurred during sex, although a positive relationship with nonmenstrual bleeding has been reported previously in a partner study[24] as well as in a study based on prevalent disease in an Army population.[25]

We found that intermittent condom use was not protective. As has been noted in other investigations,[7,8] individuals who "ever used" condoms or used condoms intermittently were at greater risk of seroconversion than those who used them all the time. There are several possible explanations for our finding. Case subjects may have overreported the frequency of condom use. In addition, control subjects who reported multiple partners were more likely to use condoms some of the time than were individuals who reported only one partner, suggesting that condom use may be a marker of individuals who engage in high-risk practices. Consistent and correct use of condoms has been shown to be protective,[26,27] but we were unable to fully evaluate this practice because so few of our case and control subjects (four and five, respectively) reported having used condoms 100% of the time.

Some possible limitations of this study should be considered before conclusions are drawn. Methodological research studies have raised questions about the accuracy of data based on self-reported sexual behavior and drug use,[28] and particularly about the accuracy of information collected in military populations where sanctions against such behaviors exist.[29] Although a previous investigation reported that it is feasible to elicit reliable sexual and illicit drug use histories from both HIV-infected and uninfected active-duty Army personnel when the study is designed to protect anonymity,[25] some respondents in this study were probably reluctant to report high-risk behaviors. We eliminated from analyses records of respondents who admitted that their interviews were unreliable. Undoubtedly, however, there was some misclassification of the sex of partners and of the types and frequencies of certain practices. In addition, recall bias is of concern as both case and control subjects were aware of their HIV status at the time of the interview. Finally, the relatively small sample size limited our ability to analyze several factors in greater detail or to estimate risks with greater precision.

In conclusion, this matched case–control study found that the major risk factor for HIV-1 seroconversion among active-duty male soldiers of mixed race/ethnicity was same-gender sex. Among respondents who reported having had sex only with women, an elevated risk was noted for those who had had sex with partners in CDC-defined risk categories. In addition, men who had had sex with anonymous or casual partners were much more likely to seroconvert than were men who had not engaged in casual sex. These results indicate that key determinants of HIV-1 seroconversion among heterosexuals are factors that predict the likelihood that the sexual partner is infected. Educational messages to prevent HIV-1 infection typically emphasize the type of sexual acts and the consistent and correct use of condoms. The prevention message directed at young adult heterosexual men should also stress the importance of careful partner selection and the risk of casual sex. □

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NIH Conference on Physical Activity and Cardiovascular Health to Be Held December 18 through 20, 1995

Physical activity and cardiovascular health is the subject of an upcoming consensus development conference sponsored by the National Heart, Lung, and Blood Institute and the National Institutes of Health (NIH) Office of Medical Applications of Research. The conference is scheduled for December 18 through 20, 1995, in the Natcher Conference Center in Bethesda, Md, and is open to the public.

The purpose of the conference is to reach agreement on physical activity and cardiovascular health. Key questions to be addressed are (1) What is the health burden of a sedentary lifestyle? (2) What type, what intensity, and what quantity of physical activity is important to prevent cardiovascular disease (CVD)? (3) What are the benefits and risks of different types of physical activity for people with CVD? (4) What are the successful approaches to adopting and maintaining a physically active lifestyle? (5) What are the important questions for future research?

The conference will bring together specialists in cardiovascular disease and other relevant fields. On the first 2 days, experts will present current scientific thinking about the diagnosis, management, and prevention of cardiovascular disease, and concerned voluntary organizations will be invited to make statements. On the third day, after considering the scientific evidence, the consensus panel will present its draft report and invite comments from the audience. Russell V. Luepker, MD, Professor of Epidemiology and Medicine, School of Public Health, University of Minnesota, will chair the panel.

To register for the Consensus Development Conference on Physical Activity and Cardiovascular Health or to obtain further details, contact Debra DeBose, Technical Resources International, Inc., 3202 Tower Oaks Blvd, Rockville, MD 20852; tel (301) 770-0610; fax (301) 468-2245.