Estimated HIV Incidence Among High-Risk Heterosexuals in New York City, 2007

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Abstract: Estimates of HIV incidence rates among high-risk heterosexuals (HRH) in the United States have been limited to heterosexual subgroups like prison inmates and commercial sex workers. In this analysis, we estimate incidence with detuned assay testing among a group of HRH defined through a multidimensional sampling strategy and recruited through respondent-driven sampling. Incidence was 3.31% per year (95% confidence interval = 1.43 to 6.47) overall and 2.59% per year (95% confidence interval = 0.84 to 6.06) among participants with no lifetime history of drug injection or male-to-male sex. This study design is suggested as an efficient method for recruiting HRH for cohort studies and behavioral interventions.

Key Words: HIV, heterosexual, high risk, incidence, prevalence

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INTRODUCTION

Heterosexual contact has exceeded injection drug use as the second most common HIV transmission risk in the United States, accounting for 28% of cases as of 2006.[1] Incidence studies extrapolating from diagnoses suggest that nearly 17,000 heterosexual infections occur each year.[2] Although these extrapolation methods can provide incidence rate estimates by gender and race, rates for transmission risk categories are unavailable because corresponding population sizes are unknown. This would first require a population definition, and one ongoing debate is how to define high-risk heterosexuals (HRH) as a group distinct from the larger heterosexual population. The Centers for Disease Control and Prevention (CDC) surveillance standard (used by extrapolation studies) categorizes an infection as heterosexual only if there is a known risk (eg, HIV infection, drug injection, or male-to-male sex) in a heterosexual partner.[3] On the other hand, most cohort studies of heterosexual HIV incidence in the United States have been limited to groups, such as prison inmates or commercial sex workers, defined principally by specific individual-level behavioral risks.[4]

Recent behavioral research suggests that heterosexual HIV is driven by a complex mix of individual, partner, community, and structural risk factors.[5,6] Estimates of HIV incidence among heterosexuals whose risk is defined with a systematic, multidimensional approach are needed to design empirical studies and behavioral interventions. In this study, we estimate HIV incidence in a cross-sectional study of HRH defined with such an approach, using detuned assay testing and incidence rate calculations based on the Serologic Testing Algorithm for Determining Recent HIV Seroconversion (STARHS), found to be an accurate and efficient method for determining incidence among men who have sex with men (MSM) and injection drug users (IDU).[7,8]

METHODS

Sampling and Recruitment

Data were collected as part of the National HIV Behavioral Surveillance (NHBS) study, a cross-sectional study of HIV prevalence and risk among MSM, IDU, and HRH.[9] This analysis is based on NHBS data collected among HRH in New York City (NYC) from 2006 to 2007. The NHBS methods for defining HRH have been explained in detail elsewhere.[10] Briefly, we used local HIV surveillance and census data to identify neighborhoods where heterosexual HIV infection and poverty were clustered. For each NYC zip code, we calculated rates of new adult heterosexual HIV diagnoses (2001–2006) and household poverty (2000). On a composite standardized index of these 2 components, the quintile of zip codes with the highest index values were chosen as "high-risk areas" (HRAs) for sampling: a main study eligibility criterion was residing in or having a social connection to an HRA.

A social connection was defined as being recruited into the study by a previous participant who resided in an HRA. Respondent-driven sampling (RDS) was used for this peer recruitment.[11] Study ethnographers selected a small group of recruits (n = 8), called seeds, through community-based outreach: our objective was to recruit 2–3 seeds, diverse in terms of race, age, and gender, from each of three main HRA geographic clusters (Harlem, South Bronx, and Central Brooklyn). Seeds participated in the study and were then asked to recruit up to 3 peers; this next wave was given the same recruitment opportunity and so on until we reached our

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target sample size. Recruiters were instructed to recruit peers similar to themselves but were not provided explicit criteria. Participants residing outside an HRA were not allowed to recruit others to maintain the social connection to HRAs.

To be eligible, participants also had to report heterosexual vaginal or anal intercourse in the past year, be aged 18–50 years, reside in New York City, and comprehend English or Spanish. Informed consent was obtained from all eligible participants, who were compensated for participating in the study ($30) and peer recruitment ($10 for each eligible recruit). All study procedures were approved by the Institutional Review Boards of the participating organizations.

Measures

A trained interviewer administered the structured NHBS survey in a private setting. For this analysis, we report on participants' gender, race/ethnicity, age, sociodemographics, and past-year sexual risk factors and substance use, and lifetime history of drug injection and male-to-male sex. To determine HIV infection, blood collected through venipuncture was tested on HIV1/2 enzyme-linked immunosorbent assay (EIA) and HIV1 western blot platforms (Bio-Rad Laboratories, Hercules, CA). HIV-infected specimens were then tested on the less-sensitive (LS) EIA (bioMerieux, Durham, NC). EIA-positive/LS-EIA–negative specimens were defined as recent HIV infections, with estimated seroconversion within the previous 170 days [95% confidence interval (CI) of 162 to 183 days].[12]

Statistical Analysis

All analyses were limited to nonseed recruits who completed an HIV test as part of the study. In accordance with the Janssen method,[13] annualized HIV incidence was calculated based on the results of the standard and detuned assay testing. The incidence rate was as follows:

$$I = \left(\frac{HIV_{pos(rec)}}{HIV_{pos(rec)} + HIV_{neg}}\right)\left(\frac{365.25}{170}\right)$$

where I is the annualized incidence rate, $HIV_{pos(rec)}$ is the number of recent infections determined through the LS-EIA, and HIV_{neg} is the number of HIV-negative cases. The standard error for recent infections assumed a Poisson distribution and 95% CIs were calculated.

For demographics and risks, we conducted a weighted analysis using the RDS Analysis Tool 5.6 (Cornell University, Ithaca, NY), which adjusts for recruitment biases common in peer-referral sampling, including the tendency for groups with large networks and in-group recruitment (homophily) to be overrepresented.[11] HIV prevalence and incidence rates were analyzed overall by demographic strata and after removing participants with a lifetime IDU or MSM history. For the main HIV prevalence estimates and incidence rate calculations, data were not weighted because of the need for absolute sample sizes in the incidence formula (unavailable in RDS). However, we conducted a sensitivity analysis to estimate the impact of RDS weighting on prevalence and incidence outcomes by applying the RDS weight for HIV prevalence to both outcomes. All data were analyzed in SAS 9.2 (SAS Institutes, Cary, NC).

RESULTS

Of the 1015 nonseeds recruited into the study, 850 (84%) were eligible and completed the survey; of those, 827 (97%) completed an HIV test and were included in this analysis. Table 1 shows the weighted demographics, sexual risks, and substance use by gender. There were similar proportions of men (52%) and women (48%) in the study. Most were black (70%) or Hispanic (22%), with fewer whites (6%) or other races (2%). Overall, 28% were 18–29 years old, 20% were 30–39 years old, and 52% were 40–50 years old. Most participants were recently homeless or in poverty, and nearly one-third had been arrested. Nearly all participants had unprotected vaginal or anal intercourse in the past year (94%), and over half had unprotected vaginal or anal intercourse with a casual/exchange sex partner or had at least 3 total sex partners. One-fifth reported a same-sex partner in the past year; among men, 8% reported any MSM activity (16% of men had a lifetime MSM history). One-third of women and 23% of men were diagnosed with a sexually transmitted disease (STD) in the past year. For past-year substance use, 15% injected drugs (24% had a lifetime history), 70% used noninjection drugs, and 57% engaged in binge alcohol use.

TABLE 1. Characteristics of HRH From New York City Tested in the NHBS Study, 2006–2007, Stratified by Gender, n = 827

	Total	Men	Women
	Weighted %	Weighted %	Weighted %
Gender			
Male	51.9	—	—
Female	48.1	—	—
Race/ethnicity			
Black	69.7	68.9	70.4
Hispanic	22.3	24.0	20.5
White	5.9	4.4	7.3
Other	2.2	2.7	1.8
Age			
18–29	28.2	19.7	36.6
30–39	19.7	48.0	20.3
40–50	52.1	61.2	43.1
Sociodemographics*			
Income <$10,000	71.4	65.8	77.1
Homeless	54.4	52.5	56.4
Arrested	32.2	40.2	24.2
Sexual risks*			
Unprotected intercourse	94.0	93.7	94.4
UI with casual/exchange partner	58.9	55.7	62.2
≥3 Total partners	57.3	54.8	59.8
Same-sex partners	20.5	8.4	32.7
STD diagnosis	27.8	22.5	33.2
Substance use*			
Injection drug use	15.3	17.1	13.4
Noninjection drug use	69.9	69.6	70.1
Binge alcohol use	57.3	58.0	56.6

*Timeframe is the past 12 months.
UI, unprotected vaginal or anal intercourse.

As Table 2 shows, 71 (8.6%) participants tested HIV positive. Among all participants, HIV prevalence was significantly higher ($P < 0.01$) among blacks (10.1%) compared with non-blacks (4.3%), and significantly higher ($P < 0.01$) among those aged 40–50 (13.6%) compared with those aged 18–39 (3.3%). Of the 71 who tested HIV positive, 12 (16.9%) were recently infected as determined through detuned assay testing. Only 4 of the 71 participants (6%) who tested HIV positive self-reported as positive; all 4 were nonrecent infections according to detuned assay testing. For incidence rate calculations, the total sample size was 768 (12 recently infected and 756 HIV-negative participants). The overall annualized incidence rate was 3.31% per year (95% CI = 1.43 to 6.47). The rate was higher, but not significantly, in females (3.75% per year) than males (2.83% per year), blacks (3.40% per year) than non-blacks (3.08% per year), and those aged 40–50 (4.98% per year) than those aged 18–39 (1.64% per year).

Among participants with no lifetime history of MSM or IDU (n = 612), 45 (7.4%) tested HIV positive. HIV prevalence was marginally higher ($P = 0.08$) among blacks (8.3%) compared with non-blacks (3.8%), and significantly higher ($P < 0.01$) among those aged 40–50 (12.7%) compared with those aged 18–39 (2.7%). Of the 45 who tested HIV positive, 7 (15.5%) were recently infected. The overall annualized incidence rate was 2.59% per year (95% CI = 0.84 to 6.06). The rates were statistically similar when comparing males (2.60% per year) to females (2.58% per year), blacks (2.38% per year) to non-blacks (3.31% per year), and those aged 18–39 (1.33% per year) with those aged 40–50 (4.18% per year).

The RDS-weighted HIV prevalence was 8.2% for all participants (RDS weight = 0.926) and 6.7% for participants with no MSM or IDU history (RDS weight = 0.905). When the annualized incidence rates above were multiplied by these RDS weights, the weighted incidence rates were 3.07% per year for all participants and 2.34% per year for non-MSM/IDU.

DISCUSSION

In our study of HRH, we found high levels of HIV risk and prevalence, and high incidence rates, even after removing MSM and IDU, suggesting that the multidimensional sampling design in our study is an efficient means for targeting adults at high risk for heterosexually acquired HIV infection. The very high levels of previously undiagnosed infection indicate the need for increased HIV testing in this population.[10]

To identify HRH, we focused sampling efforts in geographic areas with known concentrations of HIV infection and poverty, using network-based recruitment. Furthermore, MSM and IDU were allowed to participate in the study if they were heterosexually active, and the large proportion of these groups in the sample may be a principal reason for the high prevalence and incidence among those with no MSM or IDU history because they were all socially and sexually linked.

TABLE 2. HIV Prevalence and Incidence Rates Among HRH From New York City Tested in the NHBS Study, 2006–2007

	Total		HIV-Infected			Recently Infected	Annualized Incidence Rate*	
	n	%	n	%	*P*	n	Per 100 Person-Years	95% CI
All participants								
Overall	827	100.0	71	8.6	—	12	3.31	1.43 to 6.47
Gender								
Males	401	48.5	32	8.0	0.55	5	2.83	0.71 to 7.59
Females	426	51.5	39	9.2		7	3.75	1.21 to 8.79
Race/ethnicity								
Black	615	74.4	62	10.1	<0.01	9	3.40	1.28 to 7.30
Non-black	212	25.6	9	4.3		3	3.08	0.45 to 10.51
Age								
18–39	399	48.6	13	3.3	<0.01	3	1.64	0.24 to 5.60
40–50	428	51.8	58	13.6		9	4.98	1.87 to 10.68
Removing MSM/IDU†								
Overall	612	100.0	45	7.4	—	7	2.59	0.84 to 6.06
Gender								
Males	260	42.5	18	6.9	0.73	3	2.60	0.38 to 8.85
Females	352	57.5	27	7.8		4	2.58	0.53 to 7.64
Race/ethnicity								
Black	481	78.6	40	8.3	0.08	5	2.38	0.60 to 6.38
Non-black	131	21.4	5	3.8		2	3.31	0.27 to 14.09
Age								
18–39	329	53.8	9	2.7	<0.01	2	1.33	0.10 to 5.65
40–50	283	46.2	36	12.7		5	4.18	1.05 to 11.20

*The rate of recent infections was annualized by multiplying the proportion of recent infections by the quotient of the point estimate for detecting recent infection, in days, and days per year.

†Participants with a lifetime history of male-to-male sex or injection drug use.

HIV incidence rates in our study were in the range of several cohort studies of heterosexuals in Africa[14] and Brazil.[15] Because of the complicated evolution of the heterosexual HIV epidemic in the United States, however, current estimates of HIV incidence are limited to specific subgroups. Our incidence estimates were higher than those observed in cohort studies among heterosexual STD clinic patients and prison inmates[4] but lower than rates for crack cocaine users.[16] Compared with other STARHS-based incidence estimates of heterosexuals in NYC, our estimates were much higher than the 0.12% annualized incidence found among STD clinic patients seeking voluntary HIV testing.[12] In addition to the STARHS limitations mentioned below, the difference may partially reflect the strict categorization of heterosexual transmission under the CDC surveillance definition used in that study.[3]

Heterosexual transmission occurs not only from partners with known risk factors like drug injection captured by the CDC standard,[17] but also between partners with other behavioral risks like incarceration and commercial sex work (not included in that standard). Furthermore, heterosexual transmission occurs within the context of racially segregated sexual networks in urban communities with an elevated HIV prevalence and with the highest rates of poverty, incarceration, and other structural factors contributing to higher transmission risk.[5,6,18] Although the HIV prevalence in our study was higher than levels found in population-based studies in NYC and nationally,[19,20] the racial disparities in HIV infection are consistent.

LIMITATIONS

First, the findings in this study are a product of the multidimensional sampling design and network-based recruitment method and are not necessarily generalizable to all NYC heterosexuals or heterosexuals living in HRAs. However, this design succeeded as a targeted but systematic method to reach heterosexuals with high levels of HIV risk and prevalence. It is unknown whether this "geosocial" design is appropriate for all cities, but the high HIV prevalence found in the NHBS study nationally,[21] and specifically in other NHBS cities with similar sociodemographics to NYC,[22] suggests it may be. Further research is needed to investigate whether other geographic units or social network frameworks perform better. Second, recent studies have raised questions about the validity of STARHS testing within the voluntary testing setting[23] and when elite controllers or those with advanced HIV disease are tested.[24] Although those biases are unlikely in our study design, a persistent issue with STARHS is the requirement for large sample sizes to achieve narrow CIs,[7] which prevented us from comparing recent infections by more specific demographics and risk factors. However, incidence research in lower prevalence groups like HRH requires large sample sizes regardless of the study design. Third, our findings are subject to reporting bias, which could overestimate incidence among the non-MSM/IDU group if some participants did not disclose these behaviors.

CONCLUSIONS

As our understanding of the social epidemiology of the heterosexual HIV epidemic in the United States progresses, so should our definitions of HRH, and with that, study designs to estimate HIV prevalence and incidence among the most at-risk groups. This will set the stage for innovative prevention interventions and other prevention activities, such as those with a multidimensional approach to reducing individual, partner, community, and structural risks.[25] The sampling design, recruitment method, and incidence rate estimation approach should be replicated in other areas and settings to understand and evaluate its broader utility for studying heterosexual HIV transmission.

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