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Identifying and characterizing places for the targeted control of heterosexual HIV transmission in urban areas

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Abstract

Places with active HIV transmission may serve as key locations for targeted control. In 2008–2009, heterosexual sex partner venues in Baltimore, MD were identified using a three-phase process and characterized by the presence or absence of HIV cases. 1,594 participants aged 18–35 years were enrolled at 87 venues. The study yielded an overall HIV prevalence of 3.7%; 42% of venues had 1 case of HIV (i.e., HIV positive venues). In final age-adjusted models, HIV positive venues had 10% more high HIV-risk sexual partnering (95% CI: 1.01, 1.19) and more than twice as much drug market activity (95% CI: 1.04, 6.46) compared to HIV negative venues. Commercial sex work, parenteral risk behavior and venue-level sex market activity were not significantly associated with HIV status of the venues. This study highlights characteristics of venues, such as drug market activity, that may be important in identifying places with active HIV transmission.

Keywords

HIV; epidemiology; heterosexual; venue-based

INTRODUCTION

High-risk heterosexual contact, defined as sexual contact with an injection drug user (IDU) or HIV positive sex partner, is responsible for about 30% of all new HIV infections in the United States (US) [1]. For women, especially young black women for whom HIV

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prevalence rates are particularly high [2], high-risk heterosexual contact is the primary mode of transmission. Ninety-one percent of all infections among women in 2006 were attributed to high-risk heterosexual contact [1]. The persistent contribution of high-risk heterosexual contact to the burden of HIV infection in the U.S. suggests an ongoing concentrated HIV epidemic at this intersection of drug and sexual networks as well as that current HIV prevention activities aimed at high-risk heterosexual populations have had limited effectiveness [3,4]. Evidence of persistent transmission in combination with a dramatic reduction in funds for HIV/AIDS prevention programs due to the recent recession argues for a shift of public health resources for HIV, from prevention activities to targeted control strategies [5–7].

The aim of targeted HIV control strategies is to reduce HIV transmission. A growing body of research suggests that HIV transmission is associated with specific populations in specific places [8–12]. Canvassing places or venues where people congregate has been shown to be an effective means of identifying sexually transmitted infection cases for public health control and surveillance purposes [13]. Additional research has shown that individuals most likely to transmit HIV are those recently infected, i.e. within six months, whose high viral load increases the likelihood of transmission [14–18]. Thus, one targeted control strategy may be to identify places where drug and sexual networks overlap in the presence of individuals recently infected with HIV where the likelihood of current transmission is high.

The overall goal of this line of research is to identify places likely to have active HIV transmission which may serve as sites of targeted HIV control. The specific objectives of this study were to identify and characterize heterosexual sex partner meeting venues by HIV status, HIV positive (i.e. venues with at least one case of HIV) and negative venues (i.e. venues without any HIV cases), in one U.S. urban area. Characteristics of venues included individual-level behaviors, i.e. recent high risk heterosexual sex and recent parenteral risk behaviors, and venue-level transmission-related activities, i.e. drug and sex market activities.

METHODS

This venue-based, cross-sectional study of adults, 18 to 35 years of age, was conducted in Baltimore, Maryland from October 2008 through December 2009. Potential high-HIV-risk sex partner meeting venues were identified using a three-phase, venue-based methodology [19]. In phase one, multiple sources of information were used to identify specific sex partner meeting venues and high-HIV-risk areas (i.e., census block groups (CBGs)) where sex partner meeting venues might exist. In phase two, brief windshield tours (BWT) were conducted in order to identify venues where people congregated. In phase three, observational data were collected and venue informant interviews were conducted to identify high volume, heterosexual sex partner meeting sites.

Study Setting

The setting for the current study affords a unique opportunity to address the study objectives. Host to longstanding syndemics of poverty, illicit drug use and HIV, Baltimore is located in the Mid-Atlantic U.S. with an estimated population in 2009 of 637,418 people [20–23]. Baltimore is the sixth poorest metropolitan area in the U.S. with a poverty rate of

24%, nearly double the national rate [23]. Thirty-five percent of Baltimore's children live below the poverty line, compared to just 11% statewide and 18% nationally [23]. Baltimore has high rates of injection- and non-injection drug use [24–26]. Roughly 10% of Baltimore's population, 60,000 people, have been estimated to be illicit drug addicts – and police report that drugs are a factor in eight of every ten city homicides [27]. 40,000 of the 60,000 addicts are thought to be IDUs with the use of heroin featuring prominently [28,29]. Baltimore also has endemic rates of sexually transmitted infections (STIs) and is a city with racial/ethnic disparities in STIs that are four times the national average. In 2009, Baltimore had the fourth highest HIV incidence rate in the nation [30].

Venue Selection

In phase one (a), primary data were collected from 309 public health STI clinic records from 2003–2004 and 2006, interviews with 26 key informants likely to be knowledgeable about commercial sex work (CSW) or injection drug use, and a 2008 on-line directory of strip clubs to generate a list of potential venues. In phase one (b), secondary data analysis was used to identify high-HIV-risk CBGs with: 1) high (>92nd percentile) gonorrhea rates from 2002–2004 (n=30); 2) high (95th percentile) violent crime counts and high (97.5th percentile) property crime counts from 2004–2005 (n=10); 3) high drug prevalence (n=10) (defined as top ten factor scores based on a factor analysis of average count of narcotics-related 911 calls from 1998–2001 and average count of juvenile drug arrests from 1998–2003); and 4) high (95th percentile) heroin-related overdose fatality counts (n=7) from 2004–2006. De-duplication of 77 CBGs yielded 68 unique CBGs, representing 9.6% (68/710) of CBGs in Baltimore.

In phase two, three BWTs of each venue and high-HIV-risk area were conducted, one each in the morning, afternoon and evening [31]. A BWT consisted of a three-hour driving tour of each venue/area in order to record the locations and times of gatherings of three or more potential age-eligibles exclusive of bus stops, bars, and package stores at which alcohol may be purchased for consumption off site. Bars or package stores were excluded under the assumption that high profile bars had been captured by phase one key informant interviews and the inclusion of strip clubs.

A venue was included in phase three if people were observed to congregate there on more than one occasion.

In phase three, staff administered venue informant interviews to three patrons, passers-by, or business owners at each venue while again assessing the number of people congregating and/or passing by. Based on these data, venues were excluded if 1) all venue informants said no people met sex partners there; or 2) no venue informant said sex partners met there and the interviewer observed less than three people and all venue informants reported less than six people gathered at the venue at any time; or 3) staff reported the venue to be predominantly a meeting place for men who have sex with men (MSM). A venue was included if one or more venue informants reported it to be a sex partner meeting site or it was selected as part of a 66% random sample. The random sample was selected from among venues meeting neither exclusion nor inclusion criteria, i.e. venues where venue informants answered “don't know” or “no” as to whether people met sex partners there and either: 1)

greater than three people were observed by the interviewer; or 2) three venue informants reported at least six people would gather there at any time. All venues at which participants were later recruited met these venue selection criteria regardless of the original method used to identify the venue. Venues included nightclubs, bars, street corners, parks, high schools and a college.

Participant Recruitment and Interview Procedures

Operating from a modified recreational vehicle, a team of three staff members recruited and enrolled participants at the selected venues between 6 p.m. and 9 p.m. on consecutive nights until 20 participants had been recruited. Staff recruited anyone who stepped into the area of sidewalk adjacent to the van. Eligibility criteria included 18 to 35 years of age, English-speaking, and sexually active within the last three months. Eligible and interested participants provided informed consent, completed a brief, staff-administered questionnaire, and were tested for HIV using the OraQuick Rapid Advance test of oral fluid (OraSure). Oral fluid samples were sent to Heritage Lab (Olathe, Kansas) for processing and confirmatory ELISA testing as needed. Study staff reported HIV positive results to the Maryland State AIDS Administration as required by Maryland State law. Study staff reported the HIV positive participant to the Baltimore Health Department for standard of care disease notification including post-test counseling, partner services and linkage to care. Participants received \$20 for their time. The Johns Hopkins School of Medicine Institutional Review Board approved this study.

Participant Measures

Demographics—Age, gender and race/ethnicity (Black, White, Asian, Hispanic or Other) were self-reported by the participant and recoded to Black, White and Other. Educational attainment was self-reported as the highest level of schooling completed (less than high school, some high school, high school or general equivalency diploma (GED), some college, bachelor's degree, and graduate studies).

HIV positive—A participant was classified as HIV positive if an ELISA (OraSure) test and confirmatory Western blot were both positive.

Commercial sex work—Participants were classified as having practiced commercial sex work if they reported having exchanged drugs or money for sex or sex for money or drugs in the past 12 months.

Recent high HIV-risk heterosexual sex—Sex with either an IDU or an HIV positive partner in the past 12 months was coded as recent high HIV-risk sexual partnering.

Recent parenteral risks—Participants reporting either injecting drugs or sharing needles in the past six months were classified as having recent parenteral risk for HIV.

Venue Characterization

HIV positive venue—Venues were classified as HIV positive if at least one participant recruited at the venue tested positive for HIV. Venues were classified as HIV negative if no participants recruited at the venue tested positive for HIV.

Sex market venue—A venue was classified as a sex market if any venue informant interviewed in phase three answered yes to the question, “Do women here have sex in exchange for money or drugs?”

Drug market venue—A venue was classified as a drug market if any venue informant reported venue-based drug selling in response to either of the following two questions: (i) “Why do people come here? (to meet new people, to see people they already know, to buy or sell drugs or don’t know)”; (ii) “Are drugs (not including alcohol) sold or bought here?” Additionally, a venue was classified as a drug market if the venue was initially identified for inclusion in the study through the analysis of drug-related secondary data, i.e. Baltimore city violent and property crime counts, drug-related 911 calls, juvenile drug arrests, drug overdose death counts or heroin-related arrests.

We did not include secondary data on gonorrhea rates as an additional indicator of sex markets because gonorrhea cases are geocoded or assigned to primary residential addresses. Residential address locations may not align well with venue-based sex market locations.

In contrast, the definition of drug markets included drug-related secondary data (including Baltimore City violent and property crime counts, drug-related 911 calls, juvenile drug arrests and drug overdose death counts or heroin-related arrests). The drug-related secondary data was assigned to the event locations, i.e. the specific place where the event took place which may align more closely with or be a good indicator of venue-based drug market locations.

Statistical Analysis

The unit of analysis was the venue. The outcome of interest was venue HIV status, whether or not any HIV cases were identified at that venue. The means and prevalence rates of participant self-reported characteristics and behaviors and the presence or absence of venue-based activities were calculated for each venue. For example, venue-level recent parenteral risk was calculated by dividing the number of participants at a given venue reporting recent parenteral risk by the total number of participants recruited at that venue. Bivariate associations between venue HIV status (positive vs. negative) and the venue-level means of participant demographic characteristics venue-level prevalences of high HIV-risk sexual and parenteral transmission behaviors were determined using a t-test or chi-square test as appropriate.

Multivariable logistic regression models were used to determine the association between venue HIV status (dependent variable) and high-HIV-risk behaviors and venue-based activities (independent variables). Multivariable models were adjusted for age according to our hypothesis that the likelihood of HIV infection and behavioral risk would increase with

age. All statistical procedures were performed using STATA (STATA Intercooled, version 11.0; STATA Corp., College Station, TX).

RESULTS

We enrolled 1,641 participants from 87 venues. Participants were excluded due to missing interview data (n=19) or missing HIV testing results (n=28). The final study sample size was 1,594 (97%) at 87 venues. Analyses of venue-based activities, sex and drug market activity, were limited to 85 venues as 2 venues lacked venue informant interviews. Fifty-nine HIV cases were identified yielding a mean venue prevalence of 3.6% (range: 0 to 25%). The distribution of HIV cases across the 87 venues was as follows: 57.5% (50) had no HIV, 28.7% (25) had one case of HIV, 8.1% (7) had two cases of HIV and 5.7% (5) had greater than two cases of HIV (Figure 1).

The mean age of study participants was 27.4 years; more than half of participants were male (55.8%) (Table 1). The majority of participants were Black (83.2%) and had earned a high school diploma or GED (60.4%). Demographic characteristics of the venues did not differ by HIV status of the venue.

Unadjusted bivariate analysis showed significant associations between HIV positive compared to HIV negative venues and recent high risk heterosexual sex and parenteral risk behaviors (Table 2). Commercial sex work (OR: 1.04; 95% CI: 1.01, 1.08), high HIV-risk sexual partnering (OR: 1.11; 95% CI: 1.03, 1.20), and recent parenteral risk behavior (OR: 1.05; 95% CI: 1.01, 1.10) were reported significantly more frequently at HIV positive versus HIV negative venues.

Unadjusted bivariate analysis showed significant and nonsignificant associations between HIV positive compared to HIV negative venues and drug and sex market activity (Table 2). Drug market activity was reported by participants and key informants significantly more frequently at HIV positive versus HIV negative venues (OR: 2.67; 95% CI: 1.09, 6.52). Sex market activity was reported more frequently at HIV positive versus HIV negative venues (OR: 1.68; 95% CI: 0.70, 4.06), but this finding was not significant.

In final age-adjusted models, HIV positive venues had 10% more high HIV-risk sexual partnering (95% CI: 1.01, 1.19) and more than twice as much drug market activity (95% CI: 1.04, 6.46) compared to HIV negative venues. Commercial sex work, parenteral risk behavior, and venue level sex market activity were not significantly associated with venue HIV status.

DISCUSSION

Targeted control has been used as an effective and comparatively cost-effective tool in the management of disease outbreaks for centuries [32,33]. Prior to initiating targeted control activities, it is crucial to identify places where outbreaks persistently occur, i.e. where there is ongoing transmission. This concept was successfully applied in the Partners PrEP intervention in which the rate of heterosexual HIV transmission was reduced by 73% among serodiscordant couples [34].

The HIV seroprevalence rate of 3.7% at urban heterosexual sex partner meeting venues in this sample of 18–35 year old adults is the same as that reported for high-risk heterosexuals from the National Health Behavioral Surveillance conducted in Baltimore in 2007 [35]. We attribute high rates of case identification in these two studies to their shared approach of initially identifying high HIV-risk areas and then in the current study of identifying sex partner meeting venues within these areas and sampling from the sexual and drug-related networks associated with these places. Very low HIV seroprevalence rates have been found in this urban area using other sampling methods such as population-based (i.e. household) studies [9] and clinic-based samples (e.g. public STD clinics) (unpublished data).

The findings of this study can be used to further refine venue-identification methods which are critical to the success of targeted control. HIV was identified at 43% of the venues in this sample. HIV positive venues were distinct from HIV negative venues in their high rates of participant self-reported recent high risk heterosexual sex. Venue-level drug trade activity, as reported by venue informants, was also significantly associated with HIV case finding. These findings suggest that drug markets may serve as sites for HIV targeted control programs.

Several limitations of this study merit mention. We were unable to distinguish recent versus prevalent HIV infections and thus HIV positive venues may have been misclassified as transmission venues when in fact they had prevalent cases of HIV and no ongoing transmission. The cross-sectional design precludes drawing conclusions about causation. Self-reported data on demographic and HIV-risk behaviors which were used to characterize venues may be misreported due to social-desirability or poor recall. The association between individual-level HIV-associated risk behaviors and HIV status may have been underestimated due to the focus on recent participant risk behaviors. Misclassification of venues may have distorted associations between venue-level drug exposure and HIV status. Participants were not asked how frequently they attended the venue at which they were recruited. As such, venue-level risk may be overestimated if participants reporting high-risk behaviors visited the venue less frequently. Finally, the results may be generalizable to similar U.S. cities, i.e. those with mature HIV epidemics and significant IDU, but not to all U.S. cities. These limitations should be addressed in future studies of this important topic.

The next step in evaluating this method of identifying venues for targeted control is to evaluate whether it can be used to identify newly infected individuals and active HIV transmission. Such an evaluation would require repeat HIV testing and should include technology sufficient to measure the timing of HIV infection [36], to provide information on the recentness of HIV seroconversion which influences transmission risk. Additionally, cases should be linked to public records of reported cases to determine whether new or confirmed cases are being identified. This study highlights the importance of identifying and characterizing HIV-risk venues for the screening and treatment of HIV positive individuals.

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References

1. Hall HI, Song R, Rhodes P, et al. Estimation of HIV incidence in the United States. *JAMA*. 2008; 300(5):520–9. [PubMed: 18677024]
2. Rosenberg PS, Biggar RJ. Trends in HIV incidence among young adults in the United States. *JAMA*. 1998; 279(23):1894–9. [PubMed: 9634261]
3. Galbraith JS, Stanton B, Boekeloo B, et al. Exploring implementation and fidelity of evidence-based behavioral interventions for HIV prevention: Lessons learned from the focus on kids diffusion case study. *Health Educ Behav*. 2009; 36(3):532–49. [PubMed: 18445739]
4. Ellen JM. The next generation of HIV prevention for adolescent females in the United States: Linking behavioral and epidemiologic sciences to reduce incidence of HIV. *J Urban Health*. 2003; 80(4 Suppl 3):iii40–9. [PubMed: 14713670]
5. DeGruttola V, Smith DM, Little SJ, Miller V. Developing and evaluating comprehensive HIV infection control strategies: Issues and challenges. *Clin Inf Dis*. 2010; 50(Suppl 3):S102–7.
6. Lasry A, Sansom SL, Hicks KA, Uzunangelov V. A model for allocating CDC's HIV prevention resources in the United States. *Health Care Manag Sci*. 2011; 14(1):115–24. [PubMed: 21184183]
7. The White House Office of National AIDS Policy. National HIV/AIDS Strategy for the United States. Washington, DC: The White House; 2010.
8. Polk S, Ellen JM, Fichtenberg C, Huettnner S, Jennings JM. HIV prevalence overall and among high HIV-risk behaviorally-defined subgroups among heterosexuals at community-based venues in a Mid-Atlantic, U.S. city. *J Urban Health*. 2013; 90(4):747–57. [PubMed: 23135804]
9. Jennings JM, Taylor R, Iannacchione VG, et al. The available pool of sex partners and risk for a current bacterial sexually transmitted infection. *Ann Epidemiol*. 2010; 20(7):532–8. [PubMed: 20538196]
10. Jennings JM, Taylor RB, Salhi RA, Furr-Holden CD, Ellen JM. Neighborhood drug markets: A risk environment for bacterial sexually transmitted diseases among urban youth. *Soc Sci Med*. 2012; 74(8):1240–50. [PubMed: 22386616]
11. Denning, P.; DiNenno, E. Communities in crisis: Is there a generalized HIV epidemic in impoverished urban areas of the United States?. 2010.
12. Weir SS, Pailman C, Mahlalela X, Coetzee N, Meidany F, Boerma JT. From people to places: Focusing AIDS prevention efforts where it matters most. *AIDS*. 2003; 17(6):895–903. [PubMed: 12660537]
13. Michaud JM, Johnson SM, Ellen J. Comparison of sex partner meeting venues and residences of syphilis cases in Baltimore. *Sex Transm Dis*. 2004; 31(4):239–42. [PubMed: 15028939]
14. Wawer MJ, Gray RH, Sewankambo NK, et al. Rates of HIV-1 transmission per coital act, by stage of HIV-1 infection, in Rakai, Uganda. *J Infect Dis*. 2005; 191(9):1403–9. [PubMed: 15809897]
15. Pilcher CD, Tien HC, Eron JJ Jr, et al. Brief but efficient: Acute HIV infection and the sexual transmission of HIV. *J Infect Dis*. 2004; 189(10):1785–92. [PubMed: 15122514]
16. Quinn TC, Wawer MJ, Sewankambo N, et al. Viral load and heterosexual transmission of Human Immunodeficiency Virus type 1. Rakai project study group. *N Engl J Med*. 2000; 342(13):921–9. [PubMed: 10738050]
17. Cohen MS, Pilcher CD. Amplified HIV transmission and new approaches to HIV prevention. *J Infect Dis*. 2005; 191(9):1391–3. [PubMed: 15809893]
18. Brenner BG, Roger M, Routy JP, et al. High rates of forward transmission events after acute/early HIV-1 infection. *J Infect Dis*. 2007; 195(7):951–9. [PubMed: 17330784]
19. Weir SS, Tate JE, Zhusupov B, Boerma JT. Where the action is: Monitoring local trends in sexual behavior. *Sex Transm Infect*. 2004; 80(Suppl 2):ii63–8. [PubMed: 15572642]

20. Simon, D.; Burns, E. *The corner: A year in the life of an inner-city neighborhood*. 1. New York: Broadway Books; 1997.
21. Agar M, Reisinger H. Numbers and patterns: Heroin indicators and what they represent. *Hum Organization*. 1999; 58:365–74.
22. Gleghorn AA, Jones TS, Doherty MC, Celentano DD, Vlahov D. Acquisition and use of needles and syringes by injecting drug users in Baltimore, Maryland. *J Acquir Immune Defic Syndr Hum Retrovirol*. 1995; 10(1):97–103. [PubMed: 7648292]
23. United States Census Bureau. Census 2000, summary file 3 (SF 3). <http://www.geolytics.com/Default.asp>. Updated 2003. Accessed February 12, 2003
24. Doherty MC, Garfein RS, Monterroso E, Brown D, Vlahov D. Correlates of HIV infection among young adult short-term injection drug users. *AIDS*. 2000; 14(6):717–26. [PubMed: 10807195]
25. Mehta SH, Galai N, Astemborski J, et al. HIV incidence among injection drug users in Baltimore, Maryland (1988–2004). *J Acquir Immune Defic Syndr*. 2006; 43(3):368–72. [PubMed: 16980912]
26. Vlahov D, Anthony JC, Munoz A, et al. The ALIVE study, a longitudinal study of HIV-1 infection in intravenous drug users: description of methods and characteristics of participants. *NIDA Res Monogr*. 1991; 109:75–100. [PubMed: 1661376]
27. Craig T. Drugs worsen in city, U.S. says: Traffic in cocaine, heroin, ecstasy assessed by DEA. *Baltimore Sun*. 2000
28. Associated Press. Baltimore leads in ER cases tied to drugs. *Baltimore Sun*. 1998
29. United States National Drug Intelligence Center. Heroin in the northeast. 2003
30. Centers for Disease Control and Prevention. Diagnoses of HIV infection among adults and adolescents, by sex and age group, 2008–37 states and 5 U.S. dependent areas. http://www.cdc.gov/hiv/topics/surveillance/resources/slides/adolescents/slides/Adolescents_6.pdf
31. MacKellar DA, Gallagher KM, Finlayson T, Sanchez T, Lansky A, Sullivan PS. Surveillance of HIV risk and prevention behaviors of men who have sex with men—a national application of venue-based, time-space sampling. *Public Health Rep*. 2007; 122(Suppl 1):39–47. [PubMed: 17354526]
32. Fenner F. A successful eradication campaign. *Global eradication of smallpox*. *Rev Infect Dis*. 1982; 4(5):916–30. [PubMed: 6293036]
33. Kahn JG. The cost-effectiveness of HIV prevention targeting: How much more bang for the buck? *Am J Public Health*. 1996; 86(12):1709–12. [PubMed: 9003125]
34. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011; 365(6):493–505. [PubMed: 21767103]
35. Towe VL, Sifakis F, Gindi RM, et al. Prevalence of HIV infection and sexual risk behaviors among individuals having heterosexual sex in low income neighborhoods in Baltimore, MD: The BESURE study. *J Acquir Immune Defic Syndr*. 2010; 53(4):522–28. [PubMed: 19875965]
36. Brookmeyer R, Konikoff J, Laeyendecker O, Eshleman SH. Estimation of HIV incidence using multiple biomarkers. *Am J Epidemiol*. 2013; 177:264–72. [PubMed: 23302151]

Figure 1.

Distribution of HIV cases in a venue-based study of HIV, Baltimore, MD, 2008–09 (n=87).

Table 1

Demographic characteristics of venues with an HIV positive venue (i.e. 1 HIV case) compared to an HIV negative venue (i.e. no HIV cases), Baltimore, MD, 2008–2009 (n=87).

	Overall (n=87)	HIV positive venue (n=37)	HIV negative venue (n=50)	P value
Age, mean years (SD)	27.4 (2.7)	28.1 (3.0)	27.0 (2.3)	0.06
Sex, %				
Male	55.8	52.4	58.3	
Female	44.2	47.6	41.7	0.15
Race, %				
Black	83.2	84.5	82.3	0.66
White	13.4	12.4	14.1	0.70
Other	2.5	2.2	2.7	0.64
High school diploma or GED, %	60.4	57.2	62.8	0.12

Table 2

Prevalence and odds ratios (OR) of HIV risk-related behaviors and activities of venues associated with an HIV positive venue (i.e. 1 HIV case) compared to an HIV negative venue (i.e. no HIV cases), Baltimore, MD, 2008–2009.

	HIV positive venues	HIV negative venues	OR	95% CI	Adjusted OR ^a	95% CI
Individual-level behaviors	n=37 mean	n=50 mean				
Commercial sex work ^b	19.9	12.9	1.04	1.01, 1.08	1.04	1.00, 1.08
High HIV-risk sexual partnering ^c	8.8	3.8	1.11	1.03, 1.20	1.10	1.01, 1.19
Recent parenteral risk ^d	13.1	5.0	1.05	1.01, 1.10	1.05	1.00, 1.09
Venue-level activities	n=36 % (n)	n=49 % (n)				
Drug market ^e	66.7 (24)	42.9 (21)	2.67	1.09, 6.52	2.59	1.04, 6.46
Sex market ^f	47.2 (17)	34.7 (17)	1.68	0.70, 4.06	1.58	0.64, 3.88

^a All multivariable models include adjustment for age.

^b Participant reported having exchanged drugs or money for sex or sex for money or drugs in the past 12 months.

^c Participant reported sex with an IDU or HIV positive in the past 12 months.

^d Participant reported either injected drugs or shared injection drug needles in the past six months.

^e A venue was classified as a drug market if any venue informant reported venue-based drug selling in response to either of the following two questions: (i) “Why do people come here? (to meet new people, to see people they already know, to buy or sell drugs or don’t know)” ; (ii) “Are drugs (not including alcohol) sold or bought here?” Additionally, a venue was classified as a drug market if the venue was initially identified for inclusion in the study through the analysis of drug-related secondary data, i.e. Baltimore city violent and property crime counts, drug-related 911 calls, juvenile drug arrests, drug overdose death counts or heroin-related arrests.

^f A venue was classified as a sex market if any venue informant interviewed in phase 3 answered yes to the question, “Do women here have sex in exchange for money or drugs.”