HHS Public Access

Author manuscript

AIDS Behav. Author manuscript; available in PMC 2016 October 11.

Published in final edited form as:

AIDS Behav. 2014 April ; 18(Suppl 3): 266–275. doi:10.1007/s10461-013-0614-x.

Correlates of HIV Infection Among African American Women from 20 Cities in the United States

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Abstract

Little research has been conducted to investigate multiple levels of HIV risk—individual risk factors, sex partner characteristics, and socioeconomic factors—among African American women, who, in 2010, comprised 64 % of the estimated 9,500 new infections in women. Respondent-driven sampling was used to recruit and interview women in 20 cities with high AIDS prevalence in the United States through the National HIV Behavioral Surveillance System. We assessed individual risk factors, sex partner characteristics, and socioeconomic characteristics associated with being HIV-positive but unaware of the infection among African American women. Among 3,868 women with no previous diagnosis of HIV, 68 % had high school education or more and 84 % lived at or below the poverty line. In multivariable analysis, women who were 35 years or older, homeless, received Medicaid, whose last sex partner ever used crack cocaine or was an exchange sex partner were more likely to be HIV-positive-unaware. Developing and implementing strategies that address socioeconomic factors, such as homelessness and living in poverty, as well as individual risk factors, can help to maximize the effectiveness of the public health response to the HIV epidemic.

Keywords

HIV; Women; African American; Unaware; NHBS

Introduction

Despite substantial advances in testing, treatment, and prevention strategies over the course of the HIV epidemic [1], significant inequities persist along racial/ethnic lines, especially among women. In 2010, although African American women comprised only 13 % of the female population [2], 64 % of the estimated 9,500 new infections in women occurred in African Americans [3]. In the same year, the rate of new HIV infections among African American women was 15 times that of white women, and over 3 times the rate of Hispanic/Latina women [3].

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This study was conducted for the NHBS Study Group. Members of the NHBS Study Group are given in Appendix.

Multiple factors contribute to the elevated HIV rates among African American women. These factors can be grouped into three major categories for the purpose of targeting interventions: individual risk factors, sex partner characteristics, and socioeconomic/ contextual factors [4–7]. There is a large body of research that identifies individual risk factors that contribute to the disproportionate HIV rates among African American women. Among these factors are injection drug use [8, 9], crack cocaine use [10–13], exchanging sex for money or drugs [14], having concurrent sexual relationships [12, 15], not communicating sensitive issues with sex partners [16], and reporting prior incarceration [7]. However, risk of HIV infection is not solely a product of individual risky behavior.

Provided that 89 % of new HIV diagnoses estimated in African American women were transmitted via heterosexual contact [17], sex partner behaviors are also important factors that impact HIV risk among African American women [18]. Evidence from mathematical modeling suggests that an individual's HIV and STI risk depends as much on a sex partner's behavior as on the individual's own behavior [19–22]. Partner and network characteristics that have been found to increase HIV risk among women include having a male sex partner who has sex with men, sex partner concurrency [15, 23–25], and partner incarceration [7]. Sexual mixing between high-risk and low-risk groups of African Americans has also been found to contribute to the elevated HIV rate among African Americans [26].

Although individual risk factors and sex partner characteristics are strong predictors of HIV infection, they do not explain the elevated rates of HIV among African American women. It has been reported that African Americans are at increased risk of HIV infection, even when their behaviors are consistent with other racial groups [27]. Furthermore, it has been reported that differences in sexual partners and relationships do not explain the racial disparities in sexually transmitted infections between African American and white women [28]. Therefore, contextual factors play a key role in the disparate impact of the HIV epidemic on African American women. Factors such as socioeconomic status (SES) [29], living in poverty [4, 5, 7, 30], a higher background prevalence of HIV among African Americans [17], and a sex ratio imbalance in African American communities [18] have been found to contribute to HIV risk among African American women. Given the complex interaction between individual, sex partner, and socioeconomic factors, it is necessary to evaluate variables from each of the categories to determine their independent impact on HIV risk among African American women. This will help public health professionals identify areas where targeted prevention efforts will be most effective, or where the development of new prevention strategy is needed.

To our knowledge, only one study has been conducted that identifies correlates of HIV infection using multiple categories of HIV risk—individual, sex partner, and socioeconomic factors—among African American women. This study relied on a smaller state-based sample [12]. To investigate the correlates of HIV infection among African American women in urban centers throughout the United States (US), we compared individual risk factors, sex partner characteristics, and socioeconomic characteristics of HIV-positive African American women who were unaware of their infection to those of uninfected women recruited in 20 US cities.

Methods

National HIV Behavioral Surveillance System (NHBS)

NHBS monitors HIV-associated behaviors and HIV prevalence among populations at high risk for acquiring HIV in metropolitan statistical areas (MSAs) with high prevalence of AIDS [31]. During 2010, NHBS collected data and conducted HIV testing among heterosexuals using respondent driven sampling (RDS), a peer-referral sampling method [32], in 21 MSAs. Because results from the pilot study in 2006 demonstrated that individuals with low SES were more likely than persons with high SES to be infected [33], the 2010 cycle of NHBS focused on a low SES population [34]. Low SES was defined as an individual having a household income (adjusted for household size) at or below the federal poverty guidelines [35] or no more than a high school education.

Initial respondents (seeds) were selected from poverty areas, which are defined by the US Census Bureau as census tracts where 20 % or more of the residents lived below the poverty threshold [35]. These respondents completed the survey and were asked to recruit up to five individuals from their social networks. Their peers then completed the survey, and those who reported a low SES and no injection drug use (IDU) in the preceding 12 months were also asked to recruit individuals from their social networks. Respondents whose income exceeded federal poverty guidelines, whose educational attainment was greater than high school, or who reported injection drug use within 12 months of interview were allowed to participate in the survey but were not allowed to recruit others. These recruitment criteria, in conjunction with RDS methodology, helped ensure that our sample consisted of persons at increased risk of HIV infection through heterosexual transmission [33].

Men and women aged 18–60-years-old, who resided in the MSA, had at least one sex partner of the opposite sex in the past 12 months, had not already participated in 2010, and were able to complete the survey in English or Spanish were eligible to participate. Following informed consent and using a standardized, anonymous questionnaire, respondents were interviewed about sexual behaviors, drug use, HIV testing behaviors, and use of HIV prevention services. All respondents who agreed to be interviewed were offered anonymous HIV testing, regardless of self-reported HIV infection status. HIV testing was performed by collecting blood or oral specimens for either conventional laboratory testing or point of contact rapid testing. A non-reactive rapid test was considered a negative test result. For persons with reactive rapid test results, final positive test results were determined based on supplemental Western blot or immunofluorescence assay. Respondents received compensation for completing the survey and taking an HIV test, and received incentives for recruiting their peers. NHBS activities were reviewed at the Centers for Disease Control and Prevention (CDC) as non-engaged research and were approved by the local institutional review boards for each participating MSAs.

Analysis Inclusion Criteria

Respondents were included in this analysis if they reported being a female and being black or African American only (women who reported more than one race or reported Hispanic

ethnicity were excluded); consented to both the survey and HIV test; were recruited in the contiguous US (20 MSAs); and had a positive or negative HIV test result.

Analysis Variables

Variables for this analysis were categorized as socioeconomic/demographic, partner risk factor, or individual risk factor. Demographic and socioeconomic variables included age, region of residence, education, annual income, poverty, employment status (‘‘other’’ status included full-time student, retired, homemaker, and other), homelessness status (currently or in the past 12 months), and health insurance type. Health insurance other than Medicaid included private insurance, TRICARE, Medicare, Veterans Administration coverage, and other insurance. Respondents were asked to report on the perceived risk factors of their last male sex partner (including current partner). Male partner characteristics and behaviors include HIV status, age, sex with others during relationship, last sex partner type (main, casual, and exchange) and lifetime practice of the following: injection drug use, crack cocaine use, incarceration, and sex with men. Exchange sex partner was defined as a partner with whom the women exchanged sex for things like drugs or money. Individual risk factors included recent (past 12 months) crack cocaine use, lifetime injection drug use, number of recent sex partners, recent exchange sex for things like drugs or money, having only one main sex partner recently, and recent sexually transmitted disease diagnosis.

Data Analysis

The outcome variable for this analysis was being HIV-positive but unaware of one’s HIV infection status (HIV-positive-unaware). HIV-positive-unaware was defined as an HIV-positive test result among women who did not report a previous positive HIV test, which included women who reported their most recent test result was negative or indeterminate, women who did not receive their test results or who did not know their test results, or who never tested. We compared the characteristics of African American women who were HIV-positive-unaware to the characteristics of HIV-uninfected women. Self-reported HIV-positive respondents were excluded from bivariate and multivariable analysis. HIV-positive-unaware was the focus of this analysis because the objective was to examine possible risk factors for HIV infection, and individuals who know their HIV-positive status may change their behaviors.

Multiple approaches to multivariable estimation of RDS data have been used in previous research [36–38]. We used multivariable analysis to determine factors that independently predict HIV-positive-unaware among African American women. To adjust for the RDS study design, generalized estimating equations (GEE) with an independent correlation matrix were used to conduct a modified Poisson regression analysis with robust standard errors [39, 40], accounting for non-independence of network data by clustering on recruitment tree [41, 42]. The procedure described above was used to account for clustering in bivariate analysis, where variables that were reported by previous research as potential or known risk factors were evaluated for their association with HIV-positive-unaware. Multivariable analysis adjusted for homophily, the tendency for people tied to one another in social networks to be more similar than chance would predict [43], and for the direct dependence among recruiter and recruit by including the recruiter’s HIV status as a variable in the model [44, 45]. GEE

models were not weighted because weights require the relative population size of high-risk heterosexual African American women in each MSA, which is not available. However, we adjusted for differing sample inclusion probabilities by including respondents' personal network size [46], and for the multi-site nature of the study by including region of respondent's residence (Northeast, South, Midwest, and West) [47] as independent variables in the model. Multivariable model development was conducted in a manual stepwise fashion, adding variables that were statistically significant in bivariate analysis ($p < 0.05$) to the multivariable model in stages according to categories of variables. Model development began with the socioeconomic and demographic variables, followed by last sex partner characteristics, and then individual risk behavior variables. Variables that were no longer significant were removed from the final model. Rate ratios and 95 % confidence intervals ($\alpha = 0.05$) are reported. Satterthwaite *t* test for unequal variances was used to compare means. Pearson Chi square test was used to test differences between categorical variables. All analyses were performed using SAS (SAS Institute, Inc., version 9.2).

Results

Of the 4,463 African American women recruited, 3,951 (89 %) women consented to the survey, were eligible, had a positive or negative HIV test result, and reported at least one male sex partner in the past 12 months. Of these 3,951 women, 138 (4 %) were HIV-positive, 58 (42 %) of whom were HIV-positive and unaware of their HIV infection. Among HIV-positive women, those who had been previously diagnosed with HIV infection were similar to those who were HIV-positive-unaware with respect to the all demographic and economic variables evaluated in this investigation ($\chi^2 = 0.05–7.68$; *p*-value > 0.05), with the exception of region of residence ($\chi^2 = 16.77$; *p*-value < 0.01). The remainder of this analysis will focus on the 3,868 respondents who did not report a previous HIV-positive test during the NHBS survey. The proportion of participants who were HIV-positive-unaware was 1.5 % (Table I). More than half of women in the sample were between 35 and 60 years old (51 %), and most resided in the South (41 %), followed by the Midwest (22 %). The majority of women had a high school education or more (68 %), earned less than $10,000 annually (62 %), and lived at or below the poverty line (84 %). About one-third of the sample reported being homeless, either currently or in the past 12 months (30 %).

Various demographic/socioeconomic factors were significantly associated with being HIV-positive-unaware (Table I). These factors included being 35 years or older compared to those under 35 years old (rate ratio, RR = 10.3; 95 % confidence interval (CI) 4.4–23.8), having less than a high school education (RR = 2.0; 95 % CI 1.2–3.1), being homeless (RR = 2.4; 95 % CI 1.5–3.8), receiving Medicaid compared to those with other types of health insurance (RR = 4.2; 95 % CI 1.4–12.2), and being unemployed (RR = 3.0; 95 % CI 1.1–8.0), disabled (RR = 5.1; 95 % CI 2.1–12.2), or ''other'' employment status (RR = 3.3; 95 % CI 1.3–8.0) compared to those who reported full- or part-time employment.

Individual risk factors were also associated with being HIV-positive-unaware in bivariate analysis, particularly drug use and exchange sex. Women who reported crack cocaine use in the past 12 months (RR = 3.4; 95 % CI 2.0–5.8), or ever injecting illicit drugs (RR = 3.9; 95 % CI 2.1–7.3) were significantly more likely to be HIV-positive-unaware. Three percent

of women reported recent injection drug use (data not shown). Furthermore, women who reported exchange sex in the past 12 months were significantly more likely to be HIV-positive-unaware than women who did not report exchange sex (RR = 2.3; 95 % CI 1.4–3.9).

Regarding sex partner characteristics, several variables were significant factors in bivariate analysis (Table II). These variables included reporting one's last sex partner as HIV-positive (RR = 11.2; 95 % CI 2.4–52.1), or not knowing the HIV status of one's last partner (RR = 2.0; 95 % CI 1.2–3.3) compared to those who reported their last partner was HIV-negative (Table II). Three percent of women reported they believed their last male sex partner had ever had sex with another man. These women were significantly more likely to be HIV-positive-unaware (RR = 3.9; 95 % CI 1.5–10.0), compared to the 75 % of women who reported that their last male partner never had sex with men. The last sex partner behaviors ''ever injected drugs'' (RR = 2.5; 95 % CI 1.2–5.2) and ''ever used crack cocaine'' (RR = 4.0; 95 % CI 2.5–6.6) were both significantly associated with the outcome. Of the 319 (8 %) women who categorized their last sex partner as an exchange partner, 4 % were HIV-positive-unaware (RR = 3.6; 95 % CI 2.1–6.1), significantly more than those who categorized their last sex partner as a ''main'' partner (1 %). Follow-up analysis revealed that women who reported that their last sex partner was an exchange partner had significantly more exchange sex partners in the past 12 months than women who reported exchange sex in the past 12 months but their last sex partner was not an exchange partner (mean: 15 and 9, respectively; t-value = −2.62, p-value = 0.0089).

In multivariable analysis, which accounted for recruiter HIV status, network size, region, and other variables in the model, women who were recently homeless (adjusted rate ratio, ARR = 1.8; 95 % CI 1.1–2.7) and those who received Medicaid (compared to those with other health insurance) (ARR = 2.9; 95 % CI 1.0–8.5) were significantly more likely to be HIV-positive-unaware (Table III). Women who were 35 years or older were over seven times as likely to be HIV-positive-unaware as younger women (ARR = 7.6; 95 % CI 3.3–17.5). None of the individual risk factors that were significant in bivariate analysis maintained a significant association with the outcome in multivariable analysis. However, compared to those who reported their last sex partner was a main partner, women who reported their last sex partner was an ''exchange'' partner were over twice as likely to be HIV-positive-unaware (ARR = 2.2; 95 % CI 1.3–3.8). Moreover, reporting that their last sex partner used crack cocaine was significantly associated with the outcome (ARR = 1.7; 95 % CI 1.1–2.5).

Discussion

Of the 138 African American women who were diagnosed with HIV infection in this investigation, 42 % of were unaware of their infection. CDC estimates that 15 % of women and 19 % of African Americans who are HIV-positive are undiagnosed [48]. Women in this analysis were recruited using personal networks and were particularly economically disadvantaged, with 62 % earning less than $10,000 annually, and 84 % living at or below the poverty threshold. Thus, the women in our investigation are likely to have less access to healthcare and HIV testing than women in the general population. However, this segment of African American women was targeted because of their vulnerability to HIV, making the

percentage of women who are HIV-positive but unaware of their infection particularly relevant.

In this analysis of low-income African American women, age, socioeconomic characteristics, and last sex partner characteristics were more strongly associated with being HIV-positive-unaware than were individual risk factors. Although risk factors such as drug use, especially crack cocaine use [14], and injection drug use [49] are well-researched risk factors of HIV transmission and were significant in bivariate analysis, these variables did not maintain statistical significance after accounting for last sex partner variables (crack cocaine use and partner type) and socioeconomic variables (homelessness and Medicaid receipt). One exception persisted in this analysis—exchange sex with last sex partner. Describing their last sex partner as an exchange partner, which is both an individual behavior and partner characteristic, remained a significant contributor to being HIV-positive-unaware in multivariable analysis. Therefore, the risk behaviors partners engage in while under the influence may put African American women at risk for HIV infection.

Previous research has demonstrated the significance of socioeconomic and structural factors and partner characteristics in HIV transmission among African Americans [4, 5], especially women [7, 18, 50, 51]. This was true for this analysis as well, even when considering individual risk factors. Reporting homelessness and receipt of Medicaid were significant predictors of HIV infection in multivariate analysis. Homelessness and unstable housing have been found to be associated with a variety of high-risk behaviors such as exchange or survival sex, illicit drug use, and having multiple sex partners [52]. Additionally, homeless women are more susceptible to victimization, and have significant difficulty accessing healthcare, which tends to be emergency-based, inadequate, and less consistent than those used by sheltered individuals [52]. Just as homelessness is a social circumstance that occurs with low SES, receipt of Medicaid is also a proxy for low SES and poverty. Medicaid is a state- and federally-funded healthcare program that provides access to healthcare services for eligible persons. Currently, eligibility varies by state but generally includes people with disabilities, pregnant women, and families with children living in or near poverty [53].

Although income has been established as a significant factor in HIV transmission among African Americans [5, 7, 18, 54], it was not significantly associated with the outcome in this analysis. On the other hand, reporting current or recent homelessness, a more disadvantaged circumstance, and Medicaid receipt were significant contributors. This result may be a function of the survey design. African American women in this analysis were recruited during the second round of data collection among heterosexuals in NHBS [34]. By design, low-income heterosexuals were targeted for recruitment during this cycle of NHBS. Therefore, there was limited sample variability regarding income and education. Nevertheless, our findings suggest that even within a low SES sample, living in poverty and having limited access to resources may still play significant roles in African American women’s risk for HIV infection.

Over 80 % of new infections in African American women are due to heterosexual transmission [55]; therefore, women’s sex partner risk is a particularly important factor in HIV transmission. In this analysis, perceived sex partner crack cocaine use was a significant

contributor to being HIV-positive-unaware in multivariable analysis. Previous research has found increased risky sexual behavior among men who use crack cocaine [56]. Furthermore, this finding highlights the importance of sexual partner behavior on individual risk and underscores the need for the development of gender-sensitive strategies to empower African American women to communicate sensitive topics with their sexual partners.

In our investigation, 22 % of the women reported having an exchange partner in past 12 months. Unexpectedly, reporting any exchange sex in past 12 months was not associated with being HIV-positive-unaware in multivariable analysis, although reporting that their last sex partner was an exchange partner was significant. The difference between these findings may lie in the frequency of exchange sex. In our analysis, women who reported that their last sex partner was an exchange partner had significantly more exchange sex partners in the past 12 months than women whose last sex partner was not an exchange sex partner but who reported having exchange sex in the past 12 months. Thus, reporting that her last partner was an exchange partner may be a marker for a higher frequency of exposure to exchange sex partners, consequently increasing the risk of HIV transmission. More research is needed to fully understand the role that exchange sex plays in HIV transmission among African American women.

There are limitations to this analysis that should be considered. Since the heterosexual cycle of NHBS targets low-income and low-education heterosexuals, variability of SES in the sample was limited and our ability to detect significant associations with related variables may have been reduced. Additionally, individual behaviors were self-reported and may be subject to recall or social desirability bias. Sex partner characteristics were also reported by respondents, and therefore may be inaccurate or subject to recall or personal bias. Injection drug use may have been underestimated in this analysis due to the study design. Furthermore, these findings may not be representative of all African American women in urban environments because aggregate estimates were not weighted due to lack of population size information, and the RDS methodology relied on participant recruitment through personal networks in 20 MSAs. Lastly, since data from this analysis are cross-sectional, we cannot infer causality.

It is important to note the degree to which being HIV-positive and unaware of one’s infection status may be fueling the HIV epidemic among low-income African Americans in urban environments. In this analysis, 42 % of African American women were unaware of their HIV infection. This suggests that there may be missed opportunities by the public health system to effectively locate and test African American women at high risk for HIV infection in urban environments. Since HIV testing, diagnosis, and linkage to care are central to HIV prevention [57, 58], enhancing these initiatives and combining them with effective public health messaging in high-risk, urban environments may be effective at reducing HIV transmission in this community.

Socioeconomic/demographic variables and partner risk characteristics remained associated with being HIV-positive-unaware in multivariate analysis while individual risk factors did not. This suggests that living in poverty and having limited access to health resources independently increases HIV vulnerability among African American women. Thus,

combating the HIV epidemic by addressing only individual-level factors is an incomplete strategy. There is growing evidence that interventions that address the contextual factors that influence behavior are more successful in reducing HIV transmission than interventions that address individual behavior only [59]. For instance, provision of housing can be an effective strategy to reduce HIV risk behaviors and increase access to care and adherence to antiretroviral medications [60, 61]. This evidence suggests that a public health strategy that addresses the complex interaction between high-risk behaviors and the conditions in which those behaviors take place may be productive for HIV prevention.

The associations found in this analysis between Medicaid receipt and homelessness with being HIV-positive and unaware of one's infection underscore the importance of SES, which is driven by many factors, including education, employment, and income. Although, there has been little research on the effectiveness of structural interventions that address SES in reducing HIV transmission, there is a sound body of literature that suggests they may be beneficial [54]. There is a need to evaluate creative approaches to reduce HIV risk, including initiatives such as expanded early childhood enrichment programs, policy initiatives to eliminate sentencing disparities and reduce disproportionate incarceration rates among African Americans, increasing access to high-quality healthcare, and provisions to encourage and produce academic achievement in urban environments. These initiatives, if effective, could help address economic inequality, as it has been shown to directly impact health at both population [62] and individual levels. Furthermore, if effective, these interventions could be a valuable complement to the Centers for Disease Control and Prevention's High-Impact Prevention approach to achieve the goals of the National HIV/AIDS Strategy [63]. Additionally, partnerships between various disciplines of federal and state agencies and between public and private institutions may have the ability to help officials better address the contextual factors that impact health.

Acknowledgments

The authors would like to thank the members of the NHBS Study Group for the 2010 sampling period for their contributions.

References

1. Centers for Disease Control and Prevention. Twenty-five years of HIV/AIDS–United States, 1981–2006. MMWR Morb Mortal Wkly Rep. 2006; 55(21):585–9. [PubMed: 16741493]
2. U.S. Census Bureau. Current population survey. Annu Soc Econ Suppl. 2010
3. Centers for Disease Control and Prevention. Estimated HIV incidence in the United States, 2007–2010. HIV Surveillance Supplemental Report. 2012; 17(4)
4. Adimora AA, Schoenbach VJ, Floris-Moore MA. Ending the epidemic of heterosexual HIV transmission among African Americans. Am J Prev Med. 2009; 37(5):468–71. [PubMed: 19840704]
5. Aral SO, Adimora AA, Fenton KA. Understanding and responding to disparities in HIV and other sexually transmitted infections in African Americans. Lancet. 2008; 372(9635):337–40. [PubMed: 18657713]
6. Hader SL, Smith DK, Moore JS, Holmberg SD. HIV infection in women in the United States: status at the Millennium. JAMA. 2001; 285(9):1186–92. [PubMed: 11231749]

7. Hodder SL, Justman J, Haley DF, et al. Challenges of a hidden epidemic: HIV prevention among women in the United States. J Acquir Immune Defic Syndr. 2010; 55(Suppl 2):S69–73. [PubMed: 21406990]
8. Centers for Disease Control and Prevention. HIV/AIDS Surveillance Report. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2009. HIV/AIDS Surveillance Report, 2007.
9. Kilmarx, P. Acquired immunodeficiency syndrome. In: Heymann, DL., editor. Control of communicable diseases manual. 19. Washington, DC: APHA Press; 2008.
10. Ellerbrock TV, Lieb S, Harrington PE, et al. Heterosexually transmitted human immunodeficiency virus infection among pregnant women in a rural Florida community. N Engl J Med. 1992; 327(24):1704–9. [PubMed: 1308669]
11. Edlin BR, Irwin KL, Faruque S, et al. Intersecting epidemics—crack cocaine use and HIV infection among inner-city young adults. Multicenter crack cocaine and HIV infection study team. N Engl J Med. 1994; 331(21):1422–7. [PubMed: 7969281]
12. Adimora AA, Schoenbach VJ, Martinson FE, et al. Heterosexually transmitted HIV infection among African Americans in North Carolina. J Acquir Immune Defic Syndr. 2006; 41(5):616–23. [PubMed: 16652036]
13. Wohl AR, Johnson DF, Lu S, et al. HIV risk behaviors among African American men in Los Angeles County who self-identify as heterosexual. J Acquir Immune Defic Syndr. 2002; 31(3): 354–60. [PubMed: 12439213]
14. Marx R, Aral SO, Rolfs RT, Sterk CE, Kahn JG. Crack, sex, and STD. Sex Transm Dis. 1991; 18(2):92–101. [PubMed: 1862466]
15. Adimora AA, Schoenbach VJ, Bonas DM, et al. Concurrent sexual partnerships among women in the United States. Epidemiology. 2002; 13(3):320–7. [PubMed: 11964934]
16. Theall KP, Sterk CE, Elifson KW, Kidder D. Factors associated with positive HIV serostatus among women who use drugs: continued evidence for expanding factors of influence. Public Health Rep. 2003; 118(5):415–24. [PubMed: 12941854]
17. Centers for Disease Control and Prevention. [Accessed 29 May 2013] HIV Surveillance Report. 2011. Available at: http://www.cdc.gov/hiv/topics/surveillance/resources/reports/
18. McNair LD, Prather CM. African American Women and AIDS: factors influencing risk and reaction to HIV disease. J Black Psychol. 2004; 30(1):106–23.
19. Chick SE, Adams AL, Koopman JS. Analysis and simulation of a stochastic, discrete-individual model of STD transmission with partnership concurrency. Math Biosci. 2000; 166(1):45–68. [PubMed: 10882799]
20. Ferguson NM, Garnett GP. More realistic models of sexually transmitted disease transmission dynamics: sexual partnership networks, pair models, and moment closure. Sex Transm Dis. 2000; 27(10):600–9. [PubMed: 11099075]
21. Ghani AC, Garnett GP. Risks of acquiring and transmitting sexually transmitted diseases in sexual partner networks. Sex Transm Dis. 2000; 27(10):579–87. [PubMed: 11099073]
22. Kretzschmar M, Morris M. Measures of concurrency in networks and the spread of infectious disease. Math Biosci. 1996; 133(2):165–95. [PubMed: 8718707]
23. Adimora AA, Schoenbach VJ, Martinson FE, et al. Concurrent partnerships among rural African Americans with recently reported heterosexually transmitted HIV infection. J Acquir Immune Defic Syndr. 2003; 34(4):423–9. [PubMed: 14615661]
24. Morris M, Kretzschmar M. Concurrent partnerships and the spread of HIV. Aids. 1997; 11(5):641–8. [PubMed: 9108946]
25. Watts CH, May RM. The influence of concurrent partnerships on the dynamics of HIV/AIDS. Math Biosci. 1992; 108(1):89–104. [PubMed: 1551000]
26. Laumann EO, Youm Y. Racial/ethnic group differences in the prevalence of sexually transmitted diseases in the United States: a network explanation. Sex Transm Dis. 1999; 26(5):250–61. [PubMed: 10333277]
27. Hallfors DD, Iritani BJ, Miller WC, Bauer DJ. Sexual and drug behavior patterns and HIV and STD racial disparities: the need for new directions. Am J Public Health. 2007; 97(1):125–32. [PubMed: 17138921]

28. Harawa NT, Greenland S, Cochran SD, Cunningham WE, Visscher B. Do differences in relationship and partner attributes explain disparities in sexually transmitted disease among young white and black women? J Adolesc Health. 2003; 32(3):187–91. [PubMed: 12606112]
29. Wohl AR, Lu S, Odem S, et al. Sociodemographic and behavioral characteristics of African-American women with HIV and AIDS in Los Angeles County, 1990–1997. J Acquir Immune Defic Syndr Hum Retrovirol. 1998; 19(4):413–20. [PubMed: 9833752]
30. Adimora AA, Schoenbach VJ. Social context, sexual networks, and racial disparities in rates of sexually transmitted infections. J Infect Dis. 2005; 191(Suppl 1):S115–22. [PubMed: 15627221]
31. Gallagher KM, Sullivan PS, Lansky A, Onorato IM. Behavioral surveillance among people at risk for HIV infection in the U.S.: the National HIV Behavioral Surveillance System. Public Health Rep. 2007; 122(Suppl 1):32–8. [PubMed: 17354525]
32. Ramirez-Valles J, Heckathorn DD, Vazquez R, Diaz RM, Campbell RT. From networks to populations: the development and application of respondent-driven sampling among IDUs and Latino gay men. AIDS Behav. 2005; 9(4):387–402. [PubMed: 16235135]
33. Dinenno EA, Oster AM, Sionean C, Denning P, Lansky A. Piloting a system for behavioral surveillance among heterosexuals at increased risk of HIV in the United States. Open AIDS J. 2012; 6:169–76. [PubMed: 23049666]
34. Centers for Disease Control and Prevention. Characterisitcs associated with HIV infection among heterosexuals in urban areas with high AIDS prevalence—24 cities, United States, 2006–2007. Morb Mortal Wkly Rep. 2011; 60(31):1045–9.
35. U.S. Department of Health and Human Services. Annual update of the HHS poverty guidelines. Federal Register. 2009:4199–4201.
36. Johnston L, O'Bra H, Chopra M, et al. The associations of voluntary counseling and testing acceptance and the perceived likelihood of being HIV-infected among men with multiple sex partners in a South African township. AIDS Behav. 2010; 14(4):922–31. [PubMed: 18270809]
37. Pollini RA, Brouwer KC, Lozada RM, et al. Syringe possession arrests are associated with receptive syringe sharing in two Mexico-US border cities. Addiction. 2008; 103(1):101–8. [PubMed: 18028520]
38. Risser JM, Padgett P, Wolverton M, Risser WL. Relationship between heterosexual anal sex, injection drug use and HIV infection among black men and women. Int J STD AIDS. 2009; 20(5): 310–4. [PubMed: 19386966]
39. Zou G. A modified poisson regression approach to prospective studies with binary data. Am J Epidemiol. 2004; 159(7):702–6. [PubMed: 15033648]
40. Zou GY, Donner A. Extension of the modified Poisson regression model to prospective studies with correlated binary data. Stat Methods Med Res. [Epub ahead of print].
41. Liang KY, Zeger SL. Longitudinal data-analysis using generalized linear-models. Biometrika. 1986; 73(1):13–22.
42. Wagner KD, Pollini RA, Patterson TL, et al. Cross-border drug injection relationships among injection drug users in Tijuana, Mexico. Drug Alcohol Depend. 2011; 113(2–3):236–41. [PubMed: 20889270]
43. McPherson M, Smith-Lovin L, Cook JM. Birds of a feather: homophily in social networks. Annu Rev Sociol. 2001; 27:415–44.
44. Frost SD, Brouwer KC, Firestone Cruz MA, et al. Respondent-driven sampling of injection drug users in two U.S.–Mexico border cities: recruitment dynamics and impact on estimates of HIV and syphilis prevalence. J Urban Health. 2006; 83(6 Suppl):i83–97. [PubMed: 17072761]
45. Szwarcwald CL, de Souza PR Jr, Damacena GN, Junior AB, Kendall C. Analysis of data collected by RDS among sex workers in 10 Brazilian cities, 2009: estimation of the prevalence of HIV, variance, and design effect. J Acquir Immune Defic Syndr. 2011; 57(Suppl 3):S129–35. [PubMed: 21857308]
46. Jenness SM, Neaigus A, Hagan H, Murrill CS, Wendel T. Heterosexual HIV and sexual partnerships between injection drug users and noninjection drug users. AIDS Patient Care STDS. 2010; 24(3):175–81. [PubMed: 20214485]
47. Kerr LR, Mota RS, Kendall C, et al. HIV among MSM in Brazil. AIDS. 2013; 27(3):427–35. [PubMed: 23291540]

48. Centers for Disease Control and Prevention. HIV Surveillance Supplemental Report 2012. Centers for Disease Control and Prevention; 2012. Monitoring selected national HIV prevention and care objectives by using HIV surveillance data—United States and 6 U.S. dependent areas—2010.
49. Montoya ID. Infectious diseases and anemia in a sample of out-of-treatment drug users. Am J Manag Care. 1998; 4(9):1257–64. [PubMed: 10185976]
50. El-Bassel N, Caldeira NA, Ruglass LM, Gilbert L. Addressing the unique needs of African American women in HIV prevention. Am J Public Health. 2009; 99(6):996–1001. [PubMed: 19372518]
51. Sharpe TT, Voute C, Rose MA, et al. Social determinants of HIV/AIDS and sexually transmitted diseases among black women: implications for health equity. J Womens Health. 2012; 21(3):249–54.
52. Riley ED, Gandhi M, Hare C, Cohen J, Hwang S. Poverty, unstable housing, and HIV infection among women living in the United States. Curr HIV/AIDS Rep. 2007; 4(4):181–6. [PubMed: 18366949]
53. Centers for Medicare and Medicaid Services. [Accessed 27 Nov 2012] Medicaid and CHIP Program Information. Available at: http://www.medicaid.gov/Medicaid-CHIP-Program-Information/Medicaid-and-CHIP-Program-Information.html
54. Adimora AA, Auerbach JD. Structural interventions for HIV prevention in the United States. J Acquir Immune Defic Syndr. 2010; 55(Suppl 2):S132–5. [PubMed: 21406983]
55. Prejean J, Song R, Hernandez A, et al. Estimated HIV incidence in the United States, 2006–2009. PLoS ONE. 2011; 6(8):e17502. [PubMed: 21826193]
56. Boone MR, Cook SH, Wilson P. Substance use and sexual risk behavior in HIV-positive men who have sex with men: an episode-level analysis. AIDS Behav. 2013; 17(5):1883–7. [PubMed: 22392156]
57. 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]
58. Weinhardt LS, Carey MP, Johnson BT, Bickham NL. Effects of HIV counseling and testing on sexual risk behavior: a meta-analytic review of published research, 1985–1997. Am J Public Health. 1999; 89(9):1397–405. [PubMed: 10474559]
59. Coates TJ, Richter L, Caceres C. Behavioural strategies to reduce HIV transmission: how to make them work better. Lancet. 2008; 372(9639):669–84. [PubMed: 18687459]
60. National AIDS Housing Coalition. NAHC Housing Summit Policy Paper. Washington, DC: National AIDS Housing Coalition; 2005. Housing is the foundation of HIV prevention and treatment: results of the National Housing and HIV/AIDS Research Summit.
61. Wolitski RJ, Kidder DP, Pals SL, et al. Randomized trial of the effects of housing assistance on the health and risk behaviors of homeless and unstably housed people living with HIV. AIDS Behav. 2010; 14(3):493–503. [PubMed: 19949848]
62. Subramanian SV, Chen JT, Rehkopf DH, Waterman PD, Krieger N. Racial disparities in context: a multilevel analysis of neighborhood variations in poverty and excess mortality among black populations in Massachusetts. Am J Public Health. 2005; 95(2):260–5. [PubMed: 15671462]
63. Centers for Disease Control and Prevention. [Accessed 9 Apr 2013] High-impact HIV prevention: CDC's approach to reducing HIV infections in the United States Centers. Available at: http://www.cdc.gov/hiv/strategy/dhap/pdf/nhas_booklet.pdf

Appendix

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Table I

HIV-positive-unaware among African American women at increased risk of infection by demographic and socioeconomic characteristics, and individual risk factors

Variable	All		HIV-positive-unaware					
	No.	%	No.	%	RR	LL	UL	*p*-Value
Total	3,868[a]	100.0	58	1.5				
Age at interview (years)								
18–34	1,903	49.2	5	0.3	1.0	–	–	–
35–60	1,965	50.8	53	2.7	10.3	4.4	23.8	< 0.0001
Region[b]								
Northeast	764	19.8	27	3.5	8.0	2.6	24.8	0.0003
South	1,588	41.1	24	1.5	3.4	1.3	9.3	0.0155
Midwest	834	21.6	4	0.5	1.1	0.3	4.3	0.9015
West	682	17.6	*	*	1.0	–	–	–
Education								
Less than high school	1,252	32.4	28	2.2	2.0	1.2	3.1	0.0054
High school or more	2,616	67.6	30	1.1	1.0	–	–	–
Yearly income								
$0–9,999	2,386	61.7	43	1.8	1.7	0.9	3.3	0.1151
$10,000 or more	1,419	36.7	15	1.1	1.0	–	–	–
Poverty								
At or below poverty	3,233	83.6	53	1.6	1.9	0.8	4.3	0.1331
Above poverty	572	14.8	5	0.9	1.0	–	–	–
Homeless (currently or in past 12 months)								
Yes	1,147	29.7	29	2.5	2.4	1.5	3.8	0.0004
No	2,721	70.3	29	1.1	1.0	–	–	–
Health insurance								
Medicaid	1,891	48.9	39	2.1	4.2	1.4	12.2	0.0090
No health insurance	1,359	35.1	16	1.2	2.4	0.7	8.1	0.1635
Health insurance other than Medicaid[c]	608	15.7	*	*	1.0	–	–	–
Employment status								

Variable	All		HIV-positive-unaware					
	No.	%	No.	%	RR	LL	UL	*p*-Value
Unemployed	1,645	42.5	27	1.6	3.0	1.1	8.0	0.0311
Disabled	466	12.0	13	2.8	5.1	2.1	12.2	0.0003
Other[d]	667	17.2	12	1.8	3.3	1.3	8.0	0.0099
Employed	1,090	28.2	6	0.6	1.0	–	–	–
Crack cocaine use (past 12 months)								
Yes	625	16.2	23	3.7	3.4	2.0	5.8	< 0.0001
No	3,243	83.8	35	1.1	1.0	–	–	–
Ever injected drugs								
Yes	314	8.1	15	4.8	3.9	2.1	7.3	< 0.0001
No	3,554	91.9	43	1.2	1.0	–	–	–
Number of male sex partners (past 12 months)								
1	1,359	35.1	17	1.3	0.7	0.4	1.3	0.2720
2–3	1,354	35.0	20	1.5	0.8	0.4	1.5	0.5009
4 or more	1,155	29.9	21	1.8	1.0	–	–	–
Exchange sex partners (money/drugs for sex in past 12 months)								
Yes	859	22.2	23	2.7	2.3	1.4	3.9	0.0019
No	3,009	77.8	35	1.2	1.0	–	–	–
Only one main sex partner (past 12 months)								
Yes	1,242	32.1	16	1.3	0.8	0.4	1.5	0.4789
No	2,625	67.9	42	1.6	1.0	–	–	–
STD diagnosis (past 12 months)								
Yes	594	15.4	9	1.5	1.0	0.5	2.0	0.9720
No	3,274	84.6	49	1.5	1.0	–	–	–

RR rate ratio, *LL* lower limit, *UL* upper limit (95 % confidence)

[*] Cells containing less than four cases are suppressed

[a] Excludes three participants who self-reported HIV-positive but tested HIV-negative

[b] Northeast: Boston, MA; Nassau/Suffolk, NY; New York City, NY; Newark, NJ; Philadelphia, PA; South: Baltimore, MD; Atlanta, GA; Dallas, TX; Houston, TX; Miami, FL; New Orleans, LA; Washington, DC; Midwest: Chicago, IL; Detroit, MI; St. Louis, MO; West: Denver, CO; Los Angeles, CA; San Diego, CA; San Francisco, CA; Seattle, WA

[c] Includes private insurance, TRICARE, Medicare, Veterans administration coverage, and other insurance

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[d] Includes full-time student, homemaker, retired, other status

Table II

HIV-positive-unaware among African American women at increased risk of infection by perceived characteristics of last sex partner

Variable	All		HIV-positive-unaware					
	No.	%	No.	%	RR	LL	UL	*p*-Value
Total	3,868[a]	100.0	58	1.5				
Partner's HIV status								
Positive	19	0.5	*	*	11.2	2.4	52.1	0.0020
Negative	1,600	41.4	15	0.9	1.0	–	–	–
Don't know	2,218	57.3	41	1.8	2.0	1.2	3.3	0.0105
Partner's age								
Younger	922	23.8	14	1.5	1.0	0.5	2.0	0.9307
Older	2,175	56.2	32	1.5	0.9	0.5	1.6	0.8236
Same age	765	19.8	12	1.6	1.0	–	–	–
Partner ever had sex with men								
Yes	106	2.7	5	4.7	3.9	1.5	10.0	0.0049
No	2,885	74.6	35	1.2	1.0	–	–	–
Don't know	877	22.7	18	2.1	1.7	1.0	2.8	0.0379
Partner ever in prison								
Yes	2,165	56.0	34	1.6	1.3	0.8	2.3	0.2915
No	1,534	39.7	18	1.2	1.0	–	–	–
Don't know	169	4.4	6	3.6	3.0	1.3	7.3	0.0138
Partner ever injected								
Yes	346	8.9	11	3.2	2.5	1.2	5.2	0.0106
No	3,119	80.6	39	1.3	1.0	–	–	–
Don't know	403	10.4	8	2	1.6	0.8	3.1	0.1765
Partner ever used crack cocaine								
Yes	828	21.4	29	3.5	4.0	2.5	6.6	< 0.0001
No	2,759	71.3	24	0.9	1.0	–	–	–
Don't know	281	7.3	5	1.8	2.0	0.8	5.4	0.1455
Partner had concurrent partners (past 12 months)								
Definitely or probably did	2,219	57.4	36	1.6	1.3	0.8	2.0	0.3622

Variable	All		HIV-positive-unaware					
	No.	%	No.	%	RR	LL	UL	*p*-Value
Don’t know	181	4.7	*	*	1.3	0.4	4.5	0.7016
Definitely or probably did not	1,468	38.0	19	1.3	1.0	–	–	–
Partner type								
Exchange (money/drugs for sex)	319	8.2	14	4.4	3.6	2.1	6.1	< 0.0001
Casual	832	21.5	11	1.3	1.1	0.5	2.2	0.8124
Main	2,714	70.2	33	1.2	1.0	–	–	

RR rate ratio, *LL* lower limit, *UL* upper limit (95 % confidence)

[*] Cells containing less than four cases are suppressed

[a] Excludes three participants who self-reported HIV-positive but tested HIV-negative

AIDS Behav. Author manuscript; available in PMC 2016 October 11.

Table III

Multivariable logistic regression for HIV-positive-unaware among African American women at increased risk of infection by perceived characteristics of last sex partner

Variable	ARR	LL	UL	*p*-Value
Homeless (currently or in past 12 months)				
Yes	1.8	1.1	2.7	0.0104
No	1.0	–	–	–
Health insurance				
Medicaid	2.9	1.0	8.5	0.0455
No health insurance	1.8	0.5	6.6	0.3424
Health insurance other than Medicaid[a]	1.0	–	–	–
Age at interview (years)				
Less than 35	1.0	–	–	–
35 or more	7.6	3.3	17.5	< 0.0001
Last male sex partner type				
Exchange	2.2	1.3	3.8	0.0027
Casual	1.1	0.6	2.2	0.7708
Main	1.0	–	–	–
Last sex partner used crack cocaine				
Yes	1.7	1.1	2.5	0.0137
No	1.0	–	–	–
Don’t know	1.2	0.5	3.2	0.6724

Excludes 20 observations with missing information and three observations with HIV-positive self-report but HIV-negative test result. This analysis includes 3,848 observations and compares 50 HIV-infected women to 3,798 uninfected women

ARR adjusted rate ratio (controlling for recruiter HIV status, network size, region), *LL* lower limit, *UL* upper limit (95 % confidence)

[a]Includes private insurance, TRICARE, Medicare, Veterans Administration coverage, and other insurance