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## The association of place characteristics with HIV and HCV risk behaviors among racial/ethnic groups of people who inject drugs in the United States

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### Abstract

**Purpose**—Investigate whether characteristics of geographic areas are associated with condomless sex and injection-related risk behavior among racial/ethnic groups of people who inject drugs (PWID) in the United States.

**Methods**—PWID were recruited from 19 metropolitan statistical areas (MSAs) for 2009 National HIV Behavioral Surveillance. Administrative data described ZIP codes, counties, and MSAs where PWID lived. Multilevel models, stratified by racial/ethnic group, were used to assess relationships of place-based characteristics to condomless sex and injection-related risk behavior (sharing injection equipment).

**Results**—Among black PWID, living in the South (vs. Northeast) was associated with injection-related risk behavior [Adjusted Odds Ratio (AOR)=2.24, 95% Confidence Interval (CI)=1.37,4.34;p-value=0.011] and living in counties with higher percentages of unaffordable rental housing was associated with condomless sex [AOR=1.02, 95% CI=1.00,1.04; p-

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Note: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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value=0.046]. Among white PWID, living in ZIP codes with greater access to drug treatment was negatively associated with condomless sex [AOR=0.93, 95% CI=0.88,1.00;p-value=0.038).

**Discussion**—Policies that increase access to affordable housing and drug treatment may make environments more conducive to safe sexual behaviors among black and white PWID. Future research designed to longitudinally explore the association between residence in the south and injection-related risk behavior might identify specific place-based features that sustain patterns of injection-related risk behavior.

### Keywords

HIV; HCV; injection; condom use; PWID; housing; drug treatment

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### Introduction

HIV incidence among people who inject drugs (PWID) in the United States (US) has declined since the early 1990s<sup>1,2</sup> as a result of targeted HIV prevention strategies and the adoption of safer injection and sexual behaviors among PWID.<sup>3–5</sup> However, PWID still account for a disproportionate share of incident cases of HIV and HCV.<sup>6–8</sup> This reality coupled with recent transitions from opioid pills to injection drug use and related outbreaks of HIV and HCV infection<sup>9–13</sup> warrants sustained vigilance of risky injection behaviors that increase the risk of HIV or HCV transmission and sexual behaviors that increase the risk of HIV transmission among PWID. These trends also highlight the need to identify factors that increase risky injection and sexual behaviors.

According to recent surveillance in 20 metropolitan statistical areas (MSAs), risk behaviors that increase the risk of HIV or HCV transmission (“HIV/HCV risk behaviors”) are prevalent among PWID, with 77% of PWID reporting condomless heterosexual sex or receptive syringe sharing at least once in the past year.<sup>14</sup> Several individual-level factors, including poor socioeconomic status, homelessness, recent incarceration, and low healthcare service use, prevent PWID from consistently engaging in safer injection and sexual behaviors.<sup>15–17</sup> As conceptualized by Rhode’s “risk environment model”, however, these potential individual-level determinants may result from broader economic, social, and political conditions that constrain PWIDs’ ability to earn a living wage, be stably housed, and use health care services.<sup>18–20</sup>

The majority of studies that have investigated the possibility that place-based factors influence HIV/HCV risk behaviors among PWID have evaluated associations of spatial access to healthcare services with injection-related risk behavior.<sup>21–27</sup> A smaller number determined whether other environmental features, including place-based socioeconomic factors, influence injection-related risk behavior and condomless sex among PWID.<sup>28–31</sup> Even fewer determine whether specific place-based features are associated with HIV/HCV risk behavior among different racial/ethnic groups of PWID. One study, for example, demonstrated that greater proximity to syringe exchange programs was associated with less injection-related risk behavior among Latino PWID, but not among black or white PWID.<sup>23</sup>

Similarly, place-based socioeconomic factors may differentially influence HIV/HCV risk behaviors among PWID of different racial/ethnic groups. Because of racial/ethnic residential segregation and housing discrimination, historically, predominantly low-income black and Latino people in US cities have been disproportionately exposed to poor socioeconomic conditions.<sup>32–36</sup> Racial/ethnic residential segregation has been associated with sexual and injection behaviors<sup>37,38</sup> and sexually transmitted diseases, including HIV.<sup>39–41</sup> But residential segregation has also been suggested to discourage risky health behaviors. For example, Bluthenthal and colleagues documented an inverse association between percentages of African American residents in census tracts and injection-related risk behavior among a diverse sample of PWID.<sup>29</sup> The authors suggested that this finding may relate to the concentration of HIV prevention services/strategies in predominantly African American communities because of disproportionately high rates of HIV among African Americans.<sup>29</sup>

Our prior research suggests that the “racialized” distribution of exposure to socio-demographic conditions persists among PWID.<sup>42</sup> This research also documents racial/ethnic differences in spatial access to HIV testing sites, drug treatment and syringe exchange programs among PWID.<sup>42</sup> The differing degrees by which different racial/ethnic groups of PWID encounter socioeconomic affluence, destitution and proximity to harm reduction services may thereby influence whether these conditions differentially influence risk behavior among black, Latino, and white PWID. Further expanding the scope of research on place and HIV/HCV risk behavior to investigate whether place-based features differentially influence risk behavior among Latino, black, and white PWID could possibly help tailor future place-based HIV/HCV prevention strategies.

Guided by the risk environment model, which elaborates connections between social, economic, and housing characteristics to HIV/HCV risk behavior among PWID,<sup>18–20</sup> this analysis sought to advance understanding of the relationships of place-based socioeconomic and healthcare service characteristics at three geographic scales (ZIP code areas, counties, MSAs) to injection-related risk behavior and condomless sex among three racial/ethnic groups of PWID (Hispanic/Latino, non-Hispanic black and non-Hispanic white) recruited from 19 MSAs in the United States in 2009.

## Materials and methods

### Study sample

PWID were recruited by respondent-driven sampling (RDS) for the 2009 cycle of the Centers for Disease Control and Prevention’s National HIV Behavioral Surveillance (NHBS) system. The sampling procedures for NHBS have been described elsewhere.<sup>43</sup> Briefly, 2009 data collection for PWID surveillance was implemented in 20 MSAs with high AIDS prevalences in 2006.<sup>44</sup> RDS chains began with <15 participants (“seeds”) selected based on recommendations from key informants and community-based organizations. Seeds were invited to recruit 5 PWID from their personal networks, and recruits who completed surveys were given the same opportunity. Approximately 500 PWID were enrolled in each MSA as result of these recruitment efforts.<sup>45</sup>

Study eligibility criteria stipulated that participants had not already participated in the 2009 cycle of NHBS; be 18 years; report injection drug use in the past year; demonstrate evidence of injection (e.g., track marks); reside in an NHBS-eligible MSA; and provide oral consent. The San Juan-Bayamon MSA in Puerto Rico was excluded because it lacked ethnic diversity (98% were Latino) and therefore would not permit assessment of racial/ethnic differences. A total of 9882 participants met eligibility criteria in the remaining 19 MSAs.

Analysis was restricted to 9,702 Hispanic/Latino PWID, non-Hispanic/Latino black PWID, and Non-Hispanic/Latino white PWID (hereto referred to as Latino, black, and white PWID, respectively). “Plurality” guidelines from the Federal Office of Management and Budget were used to group Non-Hispanic biracial participants into the white and black racial categories.<sup>46</sup> Participants were excluded from the analytic sample if they had invalid/incomplete surveys (n=26); invalid or missing ZIP code information (n=499); participants who identified as transgender or did not report a gender identity (n=51) because they were not asked questions about sexual behavior during data collection; or were missing information on key covariates (n=340). The final analytic sample for the injection-related risk behavior outcome included 8,786 participants. The analytic sample used to evaluate condomless sex further excluded 1085 participants who did not report having sex in the past year (n=7,701). Characteristics of participants included in the analytic sample did not differ considerably (<10% difference) from the characteristics of participants who were excluded.

### Data collection and measures

Trained interviewers administered standardized questionnaires to collect participant information, including the ZIP codes and counties where they lived. Participants were assigned to MSAs and regions based on interview site and those who reported being homeless at the time of the interview were asked where they most frequently slept and were assigned to a ZIP code based on this information. Participants included in the analytic sample reported more homelessness than participants who did not provide ZIP codes (>10% difference). When participants lived in ZIP codes that crossed county lines, they were assigned to the county where most participants living in that ZIP code reported residing (n=341).

The first outcome, injection-related risk behavior, was defined as using syringes, cookers, cotton, or water after someone else used them in the process of injecting--or using drugs that had been divided by a used syringe--in the past year. The second outcome, condomless sex, was defined according to separate questions in the questionnaire that asked participants to report whether they had vaginal or anal intercourse without a condom with at least one heterosexual partner, or same-sex partner (among men), in the past year.

Based on their theoretical significance, several ZIP-, county-, and MSA-level measures of socioeconomic (e.g., residential isolation, economic deprivation), housing (e.g., unaffordable rental housing) and healthcare service characteristics (e.g., presence of a syringe exchange program) were collected from existing administrative sources (e.g., the US Census Bureau). These characteristics were measured on the scales at which they were conceptualized to be operating, according to the literature (e.g., residential isolation measured at the level of MSAs) or the scale at which data were available. The definitions and sources of the place-

based features are shown in Table 1. Individual-level factors that were hypothesized to be potential confounders or mediators based on prior literature<sup>15–20,47</sup> are also shown in Table 1.

The Institutional Review Boards (IRBs) of Emory University and each NHBS site approved the NHBS protocol.

## Analysis

The distributions of all characteristics by race/ethnicity were examined. The correlations between place-based characteristics were assessed to determine potential multicollinearity among variables. A series of logistic multilevel models stratified by race/ethnicity were used to assess the relationships of place characteristics to the odds of each outcome (condomless sex, sharing injection equipment) within each racial/ethnic group of PWID. First, unconditional multilevel analysis was conducted for each outcome, and variance components (Appendix A) were calculated for each geographic scale. Random intercepts were included in subsequent models for geographic scales for which variance components were not negligible (e.g., >0.01). Second, bivariate associations of each individual-level and place-based characteristic with each outcome were analyzed. The third set of models assessed the relationships of place-based characteristics significant in bivariate analysis (OR 1 and p-value 0.05 in bivariate analysis) to each outcome, controlling for individual-level confounders. Participant characteristics were excluded from multivariable analyses if they were hypothesized to be mediators. In addition, same sex behavior among men was solely analyzed for descriptive purposes and excluded from multivariable analyses, which included men and women. Stata was used (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

## Results

Overall, the distribution of characteristics did not vary across the two analytic samples for the injection-related risk and condomless sex outcomes. The distribution of characteristics among participants included in the injection-related risk behavior sample is presented in Table 2.

### Region and place characteristics

Most black PWID were recruited from the South (56%); white PWID were predominately recruited from western MSAs (41%). Black and Latino PWID respectively resided in MSAs with a mean black isolation score of 0.51(SD=0.18) and mean Latino isolation score of 0.48 (SD=0.16). Black PWID resided in ZIP codes with higher percentages (>10% difference) of black residents as compared to white and Latino PWID. Racial/ethnic minority PWID also lived in ZIP codes with greater economic deprivation than white PWID. On average, PWID tended to reside in counties with high levels of unaffordable rental housing (~85% of low-income households), but on average, Latino PWID lived in counties with longer times on waiting lists for subsidized housing and lived in ZIP codes with more overcrowding; black PWID were exposed to larger densities of ZIP code-level vacant housing. Spatial access to drug treatment at the ZIP code level (defined in Table 1) was highest among Latino and

white PWID as compared to black PWID, and white PWID lived in ZIP codes with higher spatial access to syringe exchange programs (SEPs) than Latino and black PWID.

The distribution of participants across each geographic scale and by race/ethnicity is shown in Appendix B.

### Participant characteristics

The majority of participants were black (52%), male (68–77%), middle aged, and impoverished (<6% of participants reported current full-time employment at the time of the interview and 36–47% earned an annual personal income of \$5,000 USD or less). Slightly more than half of participants reported experiencing homelessness at some point during the last year; 70–84% reported non-injection drug use and approximately 55% reported binge drinking in the past year. Approximately, 4–7% received a positive result on their most recent HIV test, 39–47% received clean syringes from a SEP or pharmacy, 48–52% received condoms from a health care organization in the past year, and 73–82% reported lifetime alcohol or drug treatment utilization. White PWID reported injection-related risk behavior more than Latino or black PWID. Approximately 81% of participants who reported sex in the past year reported condomless sex at least once; less than 10% difference was observed across racial/ethnic groups in the percentage who reported condomless sex at least once.

### Injection-related risk behavior

Variance in injection-related risk behavior was apportioned to MSAs and ZIP codes among all PWID. In bivariate analysis (Table 3), among black PWID, living in the South was associated with more than twice the odds of injection-related risk behavior compared to black PWID living in the northeast (OR=2.44; CI=1.37, 4.34;  $p=0.002$ ). This association remained statistically significant in multivariable analysis (AOR=2.24; CI=1.21, 4.17;  $p=0.011$ ).

No place-based characteristic was associated with injection-related risk behavior among Latino or white PWID. Variance continued to be apportioned to MSAs and ZIP codes among all three racial/ethnic groups in multivariable analysis.

### Condomless sex

Variance in condomless sex was apportioned to counties among Latino PWID and to MSAs among black PWID. Variance in condomless sex was apportioned to MSAs and ZIP codes among white PWID. In bivariate analysis (Table 4), higher county-level drug arrest rates and higher ZIP code-level density per square mile of off-premise alcohol outlets were associated with lower odds of condomless sex among Latino PWID (drug arrest rates: OR=0.97; CI=0.94, 1.00;  $p=0.042$ ; off-premise alcohol outlets: OR=0.99; CI=0.99, 1.00;  $p=0.047$ ), but these associations were no longer significant in multivariable analysis (drug arrest rates: AOR=0.97; CI=0.93, 1.01;  $p=0.132$ ; off-premise alcohol outlets: AOR=1.00; CI=0.99, 1.01;  $p=0.955$ ). Among black PWID, higher percentages of unaffordable rental units at the county level were associated with higher odds of condomless sex among black PWID (OR=1.03; CI=1.00, 1.05;  $p=0.027$ ). This association remained statistically significant in multivariable analysis (AOR=1.02; CI= 1.00, 1.04;  $p=0.046$ ).

Among white PWID, in bivariate analysis higher spatial access to drug treatment at the ZIP code level was significantly associated with lower odds of condomless sex (OR=0.93, CI=0.88, 0.99; p=0.025), as was higher spatial access to SEPs (OR=0.70, CI=0.51, 0.96; p=0.025). To avoid multicollinearity (ZIP code-level drug treatment and SEP access were correlated at  $r=0.53$ ,  $p<0.001$ ), separate multivariable models were run to assess relationships of these characteristics to condomless sex among white PWID. The association of spatial access to drug treatment with condomless sex among white PWID remained statistically significant in multivariable analysis (AOR= 0.93; CI=0.88, 1.00; p=0.038). The association between spatial access to SEPs and condomless sex among white PWID was no longer significant in multivariable analysis (AOR=0.82; CI=0.59, 1.13; p=0.227).

Variance continued to be apportioned to counties among Latino PWID and MSAs among black and white PWID in multivariable analysis. Variance also continued to be apportioned to ZIP codes among white PWID.

## Discussion

To our knowledge this is among the first studies to assess whether certain place-based factors are associated with HIV/HCV risk behavior among specific racial/ethnic groups, and extends the analyses of place-based correlates of HIV/HCV risk behavior to multiple geographic scales. Two novel findings were observed among black PWID: residing in southern MSAs was associated with higher odds of injection-related risk behavior than residing in northeastern MSAs, and residing in counties with higher proportions of unaffordable rental housing was associated with higher odds of reporting condomless sex. Among white PWID, spatial access to drug treatment was associated with self-reported condom use. No place characteristic analyzed here was associated with either outcome for Latinos.

The potential for characteristics of southern MSAs to encourage injection-related risk behavior warrants future research to identify specific place-based determinants in the south, which may influence patterns of injection-related risk behavior. None of the MSA-level measures in this study were observed to have a relationship with injection-related risk behavior among black PWID and variance continued to be apportioned to MSAs in multivariable analysis. Therefore, it is possible that other MSA-level characteristics that we did not measure, including investments in public health infrastructure (e.g., departments of health, drug treatment programs, etc.) and social welfare programs and conservative legislation, including laws that ban syringe exchange programs, may explain these associations.<sup>48–54</sup> Future research should explore these possibilities.

Although the relationship of county-level proportions of unaffordable housing to higher odds of condomless sex among black PWID was modest in this analysis, this finding is supported by prior studies suggesting stable housing and housing subsidies reduce sexual risk behaviors.<sup>55,56</sup> Homelessness in the general population has been suggested to result from reductions in affordable housing stock, and individual-level homelessness among PWID has been associated with risky sexual behaviors and correlates of risky sexual behaviors (e.g., poor mental health and interactions with law enforcement).<sup>15,27,55–60</sup> Unaffordable housing

may also bear negative health consequences for low-income PWID who are not experiencing homelessness. For instance, self-reported unaffordable housing among low-income residents has been associated with poor mental health,<sup>61</sup> and low-income residents living in neighborhoods with high housing costs and prevalent homelessness may frequently interact with law enforcement and establish relationships with precariously housed individuals who are more likely to engage in risky sexual behaviors.<sup>62,59</sup>

In sub-analyses that included participants' homelessness status and sex exchange behaviors in multivariable models, these individual characteristics did not substantially change the parameter estimate of the relationship between county-level unaffordable housing and condomless sex among black PWID in this sample. We could not include measures of mental health status in sub-analyses because they were not captured by the study questionnaire. The observation that higher rental costs were associated with condomless sex among black PWID and no other racial/ethnic group in this study may reflect differential access to affordable housing within counties due to discriminatory housing policies, including redlining, subprime mortgage lending practices, and disproportionate targeting of urban redevelopment strategies.<sup>63–68</sup>

This study also demonstrated that spatial access to drug treatment was associated with condom use among white PWID, a finding that is consistent with prior literature.<sup>69</sup> Drug treatment programs are settings where prevention of HIV and other sexually transmitted diseases may be promoted, and condoms are provided. Additionally, participation in drug treatment may be prompted by an overall readiness to abstain from risky behaviors, including condomless sex.<sup>70</sup>

No association between spatial access to drug treatment and condom use was observed among Latino and black PWID. This finding may relate to lower drug treatment utilization among these groups as compared to white PWID in this study. Racial/ethnic disparities in drug treatment utilization have been demonstrated in prior studies<sup>71</sup> and have been conceptualized as resulting from several factors. For example, compared to racial/ethnic minority substance users, white substance users who enter the criminal justice system are more likely to receive court-ordered drug treatment referrals than imprisonment, and perceive greater drug-related discrimination,<sup>72</sup> which has been associated with drug treatment utilization.<sup>73</sup> Racial/ethnic differences in the type of treatment accessed by participants in this study may also relate to the findings observed. White substance users have been shown to have greater access to drug treatment services integrated with mental health care;<sup>74</sup> which have been suggested to be more effective in promoting positive sexual behaviors than drug treatment alone.<sup>75</sup>

In contrast to prior studies,<sup>76,77</sup> we observed no association between drug treatment access and injection-related risk behavior among all PWID in this study; as described above, lower drug treatment utilization among Latino and black PWID may partly contribute to the lack of association observed in these groups.

Similarly, in contrast to prior research,<sup>21–23</sup> we observed no association of spatial access to SEPs with condomless sex and injection-related risk behavior in this sample of PWID. The



non-significant association between SEP access and HIV/HCV risk behavior among PWID in this study does not discount the importance of this intervention, however. A considerable amount of research has documented that utilization of SEPs is associated with safe injection behavior and condom use among PWID.<sup>4,25,26,78–82</sup> The discrepancy between this study's findings and other studies<sup>21–23</sup> may result from the cross-sectional nature of this study and differences in how spatial access to SEPs was measured in this study as compared to other studies (distance measures vs. gravity-based measures<sup>42</sup>). Additionally, PWID in this study may rely on other sources for their syringes, including “secondary exchangers” (e.g., needle sellers, family members/friends),<sup>83,84</sup> and drug-related law enforcement strategies may discourage some PWID from utilizing SEPs.<sup>21,85</sup>

## Limitations

This study is cross-sectional, therefore temporal associations that might otherwise be observed in longitudinal analysis may go undetected and causal interpretations cannot be made. We also could not explore the extent to which participants moved across different MSAs, counties and ZIP codes over time. The average duration of living in the selected MSAs was approximately 30 years; thus movement of participants across MSAs may have occurred less frequently than movement across smaller spatial scales.

Because NHBS was conducted in MSAs with high AIDS prevalences in 2006, the findings from this study may not be generalizable to PWID living outside of these MSAs. Additionally, because individual-level behavioral characteristics were self-reported and had a reporting period of one year, social desirability bias and recall bias may have influenced participants' responses.

This study did not explicitly account for clustering of observations within RDS chains due to the number of intercepts that would be required for cross-classified modelling. However, by adjusting for place and socio-demographic factors, intra-chain clustering may have been partially accounted for. Prior research suggests recruitment chains established from RDS are influenced by geography and demographic characteristics; thus by controlling for geographic variance and individual-level demographic information, we may have partly accounted for potential bias established through RDS.<sup>86–88</sup> Log binomial and modified Poisson models did not converge to generate estimates of prevalence ratios in this sample in which both outcomes were prevalent.

Last, ZIP codes were the smallest geographic unit to describe participants' residential environments. ZIP codes were established to facilitate mail delivery; they may not adequately capture the boundaries within which social interactions and activity spaces of PWID are grounded. Thus, spatial misclassification may have influenced the findings from this study.<sup>89</sup> Because ZIP codes are more heterogeneous than census tracts and census block groups, ZIP codes may trend findings closer to the null as compared to these smaller spatial units.

We also did not measure characteristics of non-residential areas or analyze spatial variation (e.g., autocorrelation) across areas of each spatial unit. White PWID tend to travel farther from their homes to obtain drugs as compared to Latino and black PWID.<sup>23,84</sup> Therefore not

capturing exposure to non-residential features may have underestimated the association of place characteristics to injection and sexual risk behaviors if the impact of features of non-residential areas are more salient to injection and sexual risk behaviors. Furthermore, treating residential areas as independent may underestimate standard errors of the parameter estimates.<sup>90,91</sup> Future studies should explore whether the association of activity space-based exposures with risk behaviors differs from the association of residential-based exposures with risk behaviors among PWID and utilize spatial modelling techniques that adjust for spatial autocorrelation.

## Conclusions

Findings from this study suggest that efforts to increase access to affordable housing and drug treatment support safe sexual behaviors among PWID. Future research should further investigate these associations and determine whether regional differences in social and political climates influence injection-related risk behavior among black PWID and further investigate the relationship of diverse place characteristics to HIV/HCV risk behavior. Additional knowledge of the structural determinants of injection-related and sexual risk behaviors can inform the development of multi-level HIV and HCV prevention strategies.

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## List of Abbreviations

<b>AOR</b>	Adjusted odds ratio
<b>HIV</b>	Human immunodeficiency virus
<b>HCV</b>	hepatitis C virus
<b>IRB</b>	Institutional Review Board
<b>MSA</b>	Metropolitan statistical area
<b>NHBS</b>	National Behavioral Surveillance System

<b>OR</b>	Odds ratio
<b>PWID</b>	People who inject drugs
<b>RDS</b>	Respondent Driven Sampling
<b>SEP</b>	syringe exchange program
<b>US</b>	United States

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## Appendix A

Variance estimates derived from each multilevel model for random intercepts across ZIP codes ( $\Psi^{(2)}$ ), counties ( $\Psi^{(3)}$ ), and MSAs ( $\Psi^{(4)}$ ), and individual residual error ( $\pi^2/3$ ), were used to calculate variance components for each geographic scale<sup>1–3</sup>:

$$\text{variance component (ZIP code)} = \frac{\Psi^{(2)}}{\Psi^{(2)} + \Psi^{(3)} + \Psi^{(4)} + \pi^2/3} \quad (\text{A.1})$$

$$\text{variance component (County)} = \frac{\Psi^{(3)}}{\Psi^{(2)} + \Psi^{(3)} + \Psi^{(4)} + \pi^2/3} \quad (\text{A.2})$$

$$\text{variance component (MSA)} = \frac{\Psi^{(4)}}{\Psi^{(2)} + \Psi^{(3)} + \Psi^{(4)} + \pi^2/3} \quad (\text{A.3})$$

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## Appendix B

**Table B.1**

Distribution of participants across geographic scales

	Injection-related risk behavior sample		Condomless sex sample	
<i>Non-Hispanic Whites</i>				
<b>Geographic characteristics</b>	<b>Total no. geographic units</b>	<b>Mean no. participants (SD; 25,50,75 Percentiles)</b>	<b>Total no. geographic units</b>	<b>Mean no. participants (SD; 25,50,75 Percentiles)</b>
ZIP code	575	4.62 (9.71; 1, 2, 4)	549	4.29 (8.78; 1, 2, 4)
County	43	61.77 (83.44; 2,20,91)	41	57.41 (75.36; 2, 18, 88)
MSA	19	139.79 (88.33; 75,128,185)	19	123.90 (79.01; 73, 119, 261)
<i>Non-Hispanic Blacks</i>				
<b>Geographic characteristics</b>	<b>Total no. geographic units</b>	<b>Mean no. participants (SD; 25,50,75 Percentiles)</b>	<b>Total no. geographic units</b>	<b>Mean no. participants (SD; 25,50,75 Percentiles)</b>
ZIP code	529	8.58 (16.15; 1, 2, 8)	502	7.87 (14.18; 1,2,7)
County	38	119.40 (148.01; 3,28.50,222)	38	104.03 (128.92; 1, 27, 197)
MSA	19	238.79 (134.28; 115, 222, 353)	19	208.05 (117.68; 95, 197, 324)



	Injection-related risk behavior sample		Condomless sex sample	
<i>Latinos</i>				
Geographic characteristics	Total no. geographic units	Mean no. participants (SD)	Total no. geographic units	Mean no. participants (SD; 25,50,75 Percentiles)
ZIP code	410	3.89 (6.97; 1, 2, 4)	374	3.73 (6.35; 1, 2, 4)
County	34	46.85 (61.81; 1, 11, 78)	34	41.00 (53.71; 1, 10, 70)
MSA	18	88.50 (77.70; 13, 73.5, 150)	18	77.44 (67.76; 13, 65, 129)

### Highlights

- This study reveals a relationship between living in the southern region of the United States and sharing injection equipment among non-Hispanic black people who inject drugs
- This study demonstrates an association between living in counties with unaffordable housing and condomless sex among non-Hispanic black people who inject drugs
- This study suggests greater ZIP code-level access to drug treatment is associated with condom use among non-Hispanic white people who inject drugs

Table 1

Definition and sources of place-based exposures and participant-level confounders and mediators

Place characteristic	Measure	Source
<i>Metropolitan statistical area</i>		
Racial/ethnic residential isolation <sup>1</sup>	Black isolation	2007–2011 American Community Survey
	Latino isolation	2007–2011 American Community Survey
<i>County</i>		
Percent unaffordable rental units among low income residents	Number of occupied rental units where $\geq 35\%$ of household income was spent on rent among households earning a median household income less than \$10,000 USD divided by the total number of households earning a median household income less than \$10,000 USD	2007–2011 American Community Survey
Average number of months on waiting lists for assisted housing	Average months on waiting lists among new admissions for Department of Housing and Urban Development assisted housing programs	2009 Picture of Subsidized Households, Department of Housing and Urban Development
Drug arrest rates per 1,000 residents	Total drug arrests per 1,000 residents	Numerator: Inter-university Consortium for Political and Social Research (ICPSR) county-level detailed arrest and offense data. Denominator: population size, drawn from the 2007–2011 American Community Survey
<i>ZIP code</i>		
Access to alcohol	Density per square mile of businesses licensed to sell alcohol for off-premises consumption (ZIP)	Numerator (premises): 2009 U.S Census Bureau's Zip Code Business Patterns Denominator (square miles): US Census Tiger Files
Abandoned residential units	Density per square mile of abandoned residential units	Numerator (housing): 2009 United States Postal Service Delivery Statistics Product Denominator (square miles): US Census Tiger Files
Household crowding	Percent of occupied housing units with $>1.5$ people per room	2007–2011 American Community Survey
Percent non-Hispanic black residents	Percent of total population who are non-Hispanic black	2007–2011 American Community Survey
Economic deprivation <sup>2</sup>	Index of % residents employed in low-wage occupations (e.g., service, sales, construction, manufacturing, transportation), % households in poverty, % female-headed households with dependent children $<18$ years, % households on public assistance, % low-income households, % without high school diploma/GED, % unemployed	2007–2011 American Community Survey
Gentrification <sup>3</sup>	Index of percent change in the following characteristics between 1990 and 2009: % poverty, % college or more among adults aged $\geq 25$ , % white residents, median household income, median monthly rent. Economic factors adjusted for inflation using the Consumer Price Index.	Geolytics 1990 Long Form in 2010 Boundaries; 2007–2011 American Community Survey
Spatial access to drug treatment	Calculated using gravity-based methods. <sup>4</sup>	Street address data on substance use treatment programs were from the National Directory of Drug and Alcohol Abuse Treatment Programs, Office of Applied Studies in the Substance Abuse and Mental Health Services Administration 2010
Spatial access to syringe exchange programs (SEP)	Calculated using gravity-based methods and dichotomized as zero or greater than zero. <sup>4</sup>	Street address data on syringe exchange programs were from Des Jarlais' 2009 "Dave Purchase Memorial Syringe Exchange Program Survey"

Place characteristic	Measure	Source
<b>Participant characteristic</b>	<b>National HIV Behavioral Surveillance Questionnaire</b>	
Current age	Years since date of birth	
Sex	Male vs. female	
Men who had sex with men	Men who had sex with men more than 1 year ago; men who had sex with men in the past year; men who never had sex with men	
Current marital status	Married or living as married vs. separated, divorced, widowed, never married	
Annual income	Annual income that participant reported that he/she earned. Dichotomized at the median (\$5,000 USD)	
Current employment status	Participant reports full-time employment at the time of the interview (yes/no)	
Incarceration	Held in a jail or prison for at least one day in the last 12 months (yes/no)	
Homelessness	Resided on the street; in a shelter, single room occupancy (SRO), or car; or temporarily resided with friends or relatives in the last 12 months (yes/no)	
Daily injection drug use	Daily vs. less than daily	
Binge drinking	Among females: drank 4 or more alcoholic drinks in one sitting in the last 12 months (yes/no) Among males: drank 4 or more alcoholic drinks in one sitting in the last 12 months (yes/no)	
Non-injection drug use	Use of any non-injection drugs in the last 12 months (yes/no)	
Receipt of free clean syringes	Received any new sterile needles for free in the last 12 months, not including those provided by a friend, relative or sex partner (yes/no)	
Exchanged sex for money or drugs	Exchanged sex for money or drugs or had an exchange sex partner who the participant paid with money or drugs in the last 12 months (yes/no)	
Receipt of free condoms	Received any free condoms in the last 12 months, not including those provided by a friend, relative or sex partner (yes/no)	
Result from most recent HIV test	Never obtained test result or indeterminate; negative; positive	

<sup>1</sup> Isolation was calculated for black and Latino residents. Number of persons in X racial/ethnic group in ZIP code/number of persons in X racial/ethnic group in MSA \* number of persons in X racial/ethnic group in Zip code/total number of persons in Zip code (from Massey DS, Denton NA. The dimensions of residential segregation. *Social Forces* 1988; 67: 281–315).

<sup>2</sup> The economic deprivation index was informed by: Messer L, Laraja B, Kaufman J, et al. The development of a standardized neighborhood deprivation index. *J Urban Health* 2006;83:1041–62; Krieger N, Barbeau EM, Soobader M-J. Class matters: U.S. versus U.K. measures of occupational disparities in access to health services and health status in the 2000 U.S. National Health Interview Survey. *International Journal of Health Services* 2005;35:213–36. Principle components analysis (PCA) was conducted to confirm the dimensionality of the items across ZIP codes of all MSAs. Once confirmed through PCA, items were standardized by z-score, weighted by factor loadings, and summed to create the index.

<sup>3</sup> The gentrification measure was informed by: Freeman L, Braconi F. Gentrification and displacement - New York City in the 1990s. *Journal of the American Planning Association* 2004;70:39–52.; Marcuse P. Gentrification, Abandonment, and Displacement: Connections, Causes, and Policy Responses in New York City. *Journal of Urban and Contemporary Law* 1985;28:195–240.; Huynh M, Maroko AR. Gentrification and Preterm Birth in New York City, 2008–2010. *J Urban Health* 2013. Principle components analysis (PCA) was conducted to confirm the dimensionality of the items across ZIP codes of all MSAs. Once confirmed through PCA, items were standardized by z-score, weighted by factor loadings, and summed to create the index.

<sup>4</sup> Gravity-based methods assume that spatial access to health service providers is a function of (a) the travel distance between participant's home and each service site that is within a "reasonable travel distance" of his/her home; (b) a distance decay weight that allows access to decline with distance from home; and (c) the number of service opportunities at each site. Participant's home address was approximated using the population-weighted center of his/her ZIP code area. Population-weighted centroids and drug treatment and syringe exchange program addresses were geocoded to their latitude and longitude. "Reasonable travel distance" between home and service sites was set to 3 miles. Program sites located <3 miles of a ZIP code area's population-weighted centroid along the local road network was included in that ZIP code area's GBM calculation. The distance decay weight was set to 1.5. Because the number of treatment slots for each drug treatment program and number of syringes distributed per syringe exchange site were unknown, the number of service opportunities was set at 1 for each site. See the following citation for more information: Cooper, H. L. F., et al. "Racialized risk environments in a large sample of people who inject drugs in the United States." *International Journal of Drug Policy*.

Distribution of place and participant characteristics among people who inject drugs from 19 US metro areas in 2009, stratified by race/ethnicity<sup>5,6</sup>

**Table 2**

	Injection related-risk behavior sample		
	Latino N (%) or Mean (SD) N=1,593	Black N (%) or Mean (SD) N=4,537	White N (%) or Mean (SD) N=2,656
<b>Region<sup>7</sup></b>			
Northeast	574 (36.03)	716 (15.78)	786 (29.59)
South	317 (19.90)	2,559 (56.40)	638 (24.02)
Midwest	169 (10.61)	598 (13.18)	150 (5.65)
West	533 (33.46)	664 (14.64)	1,082 (40.74)
<b>Metropolitan statistical area</b>			
Black isolation	0.45 (0.19)	0.51 (0.18)	0.40 (0.20)
Latino isolation	0.48 (0.16)	0.36 (0.17)	0.36 (0.17)
<b>County</b>			
Percent unaffordable rental units among low income residents	84.94 (7.29)	85.55 (6.53)	84.65 (7.17)
Average number of months on waiting lists for assisted housing	35.29 (18.69)	28.23 (15.99)	30.03 (18.96)
Drug arrest rates per 1000 residents	10.97 (5.21)	11.36 (10.58)	9.34 (7.54)
<b>ZIP code</b>			
Density per square mile of off-premise alcohol outlets	19.57 (26.94)	8.50 (10.87)	17.14 (26.97)
Density per square mile of abandoned residential units	91.84 (105.80)	176.07 (206.32)	83.38 (106.48)
Percent of housing units with >1.5 people per room	3.76 (3.79)	1.95 (2.52)	2.59 (3.00)
Percent non-Hispanic black residents	22.75 (21.73)	56.76 (29.91)	20.53 (21.72)
Economic deprivation	2.57 (2.34)	2.80 (2.03)	1.23 (2.15)
Gentrification	0.48 (1.67)	0.33 (1.75)	0.62 (1.56)
Spatial access to drug treatment	2.64 (3.09)	1.58 (1.95)	2.50 (2.76)
Spatial access to syringe exchange programs	0.15 (0.24)	0.16 (0.35)	0.18 (0.32)
<b>Participant characteristics</b>			
Mean current age (SD)	41.80 (9.89)	50.22 (8.21)	40.34 (11.10)
Male sex	1,222 (76.71)	3,269 (72.05)	1,815 (68.34)
Men who ever had sex with men	260 (21.28)	494 (15.11)	481 (26.50)

	Injection related-risk behavior sample		
	Latino N (%) N= 1,593	Black N (%) N=4,537	White N (%) N=2,656
Currently married or living as married	279 (17.51)	603 (13.29)	275 (10.35)
Annual income ( < 5,000 USD vs. > 5,000 USD)	592 (37.16)	1,609 (35.46)	1,237 (46.57)
Currently employed full-time	56 (3.52)	181 (3.99)	146 (5.50)
Incarceration	618 (38.79)	1,454 (32.05)	1,143 (43.03)
Homelessness	1,000 (62.77)	2,479 (54.64)	1,796 (67.62)
Daily injection drug use	301 (18.90)	1,107 (24.40)	840 (31.63)
Injection-related risk behavior	1,019 (63.97)	2,668 (58.81)	1,812 (68.22)
Binge drinking	859 (53.92)	2,530 (55.76)	1,451 (54.63)
Non-injection drug use	1,121 (70.37)	3,256 (71.77)	2,239 (84.30)
Receipt of free clean syringes	716 (44.95)	1,776 (39.14)	1,253 (47.14)
Ever received alcohol or drug treatment	1,168 (73.32)	3,411 (75.18)	2,171 (81.74)
Condomless sex	1,108 (69.60)	3,106 (68.50)	1,903 (71.70)
Exchanged sex for drugs or money	322 (20.21)	1,205 (26.56)	556 (20.93)
Receipt of free condoms	763 (47.90)	2,366 (52.16)	1,299 (48.91)
Negative result on most recent HIV test	1,232 (77.34)	3,497 (77.08)	2,088 (78.61)
Positive result on most recent HIV test	70 (4.39)	301 (6.63)	111 (4.18)

Note: estimates for men who had sex with men, drug treatment, condomless sex, and receipt of free condoms do not add up to 100% due to missing observations

<sup>5</sup> Refer to table 1 for definitions of place characteristics measured at MSA, county, and ZIP code levels and participant characteristics

<sup>6</sup> "Plurality" guidelines from the Federal Office of Management and Budget were used to group Non-Hispanic biracial participants to the white and black racial categories. See the following citation for additional information: OMB. Provisional guidance on the implementation of the 1997 standards for federal data on race and ethnicity, Executive Office of the President, December 15. : U.S. Office of Management and Budget, 2000.

<sup>7</sup> The Northeast region includes the MSAs of Boston, Massachusetts; Nassau-Suffolk, New York; New York, New York; Newark, New Jersey; and Philadelphia, Pennsylvania. South region includes Atlanta, Georgia; Baltimore, Maryland; Dallas, Texas; Houston, Texas; Miami, Florida; New Orleans, Louisiana; and District of Columbia. Midwest region includes Chicago, Illinois and Detroit, Michigan. West region includes Denver, Colorado; Los Angeles, California; San Diego, California; San Francisco, California; and Seattle, Washington.

Table 3

Association of place and participant characteristics with injection-related risk behavior among people who inject drugs from 19 US metro areas in 2009, stratified by race/ethnicity<sup>8,9,10</sup>

	Latino (N=1,593)		Black (N=4,537)		White (N=2,656)	
	Odds ratio (95% Confidence interval)	Adjusted odds ratio/CI (95% Confidence interval)	Odds ratio (95% Confidence interval)	Adjusted odds ratio (95% Confidence interval)	Odds ratio (95% Confidence Interval)	Adjusted odds ratio (95% Confidence interval)
MSA variance (variance component)	0.35 (0.10)	0.30 (0.08)	0.36 (0.10)	0.25 (0.07)	0.39 (0.10)	0.36 (0.10)
County variance (variance component)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
ZIP code variance (variance component)	0.07 (0.02)	0.06 (0.02)	0.05 (0.01)	0.03 (0.01)	0.05 (0.01)	0.02 (0.01)
Intercept	1.86 (1.34, 2.57)	1.24 (0.59, 2.61)	1.29 (0.97, 1.71)	0.61 (0.31, 1.21)	2.07 (1.53, 2.81)	2.50 (1.35, 4.64)
<b>Region</b>						
Northeast (Reference)	1.00	--	1.00	1.00	1.00	--
South	1.90 (0.90, 4.01)	--	2.44 (1.37, 4.34)*	2.24 (1.21, 4.17)*	1.49 (0.70, 3.18)	--
Midwest	0.86 (0.27, 2.71)	--	1.14 (0.51, 2.55)	1.14 (0.48, 2.73)	0.91 (0.30, 2.74)	--
West	1.84 (0.91, 3.72)**	--	1.77 (0.94, 3.35)	1.87 (0.95, 3.71)	1.14 (0.52, 2.51)	--
<b>Metropolitan statistical area</b>						
Black isolation	0.41 (0.08, 2.13)	--	0.68 (0.17, 2.77)	--	0.96 (0.21, 4.41)	--
Latino isolation	2.14 (0.30, 15.26)	--	0.76 (0.14, 4.13)	--	1.05 (0.17, 6.37)	--
<b>County</b>						
Percent of unaffordable rental units among low income households	0.99 (0.95, 1.03)	--	1.03 (0.99, 1.06)	--	1.00 (0.96, 1.02)	--
Average number of months on waiting lists for assisted housing	1.00 (0.99, 1.02)	--	1.00 (0.98, 1.01)	--	1.00 (0.98, 1.01)	--
Drug arrest rates per 1,000 residents	1.00 (0.94, 1.06)	--	1.00 (0.97, 1.02)	--	1.00 (0.97, 1.03)	--
<b>ZCTA</b>						
Density per square mile of off-premise alcohol outlets	0.99 (0.99, 1.00)	--	1.00 (0.99, 1.01)	--	1.00 (1.00, 1.01)	--
Density per square mile of abandoned residential units	1.00 (1.00, 1.00)	--	1.00 (1.00, 1.00)	--	1.00 (1.00, 1.00)	--
Percent of housing units with >1.5 people per room	1.01 (0.97, 1.05)	--	1.03 (0.99, 1.07)	--	0.98 (0.94, 1.02)	--
Percent non-Hispanic black residents	1.00 (1.00, 1.01)	--	1.00 (1.00, 1.00)	--	1.00 (1.00, 1.01)	--





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8 Refer to table 1 for definitions of place characteristics measured at MSA, county, and ZIP code levels and participant characteristics

Note:

\* indicates significance at  $p < 0.05$  and

\*\* indicates significance at  $p < 0.10$ ; some estimates labeled as significant at  $p < 0.05$  include confidence intervals that include a value of 1.00 due to rounding of the confidence intervals.

9 Multilevel analysis was conducted to assess the associations of place and participant characteristics with injection-related risk behavior; random intercepts were included for MSAs and ZIP codes for each racial/ethnic group

10 "Plurality" guidelines from the Federal Office of Management and Budget were used to group Non-Hispanic biracial participants to the white and black racial categories. See the following citation for additional information: OMB. Provisional guidance on the implementation of the 1997 standards for federal data on race and ethnicity, Executive Office of the President, December 15. : U.S. Office of Management and Budget; 2000.

11 Adjusted models assessed the relationships of place-based characteristics significant in bivariate analysis (OR 1 and p-value 0.05 in bivariate analysis) to each outcome, controlling for the following individual-level confounders: age, sex, current marital status, annual income, currently employed, result from the most recent HIV test, and the following characteristics in the last 12 months, incarceration, homelessness, daily injection, binge drinking, non-injection drug use, receipt of free clean syringes, and exchanged sex for money or drugs

Table 4

Association of place and participant characteristics with condomless sex among people who inject drugs from 19 US metro areas in 2009, stratified by race/ethnicity<sup>1,2,13,14</sup>

	Latino (N=1,394)		Black (N=3,953)		White (N=2,354) <sup>15</sup>	
	Odds ratio (95% Confidence interval)	Adjusted odds ratio <sup>16</sup> (95% Confidence interval)	Odds ratio (95% Confidence interval)	Adjusted odds ratio <sup>17</sup> (95% Confidence interval)	Odds ratio (95% Confidence interval)	Adjusted odds ratio <sup>18</sup> (95% Confidence interval)
MSA variance (variance component)	0.00 (0.00)	0.00 (0.00)	0.11 (0.03)	0.04 (0.01)	0.31 (0.08)	0.24 (0.06)
County variance (variance component)	0.10 (0.03)	0.04 (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Zip code variance (variance component)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.05 (0.01)	0.01 (0.00)
Intercept	4.16 (3.38, 5.11)	9.35 (3.81, 22.99)	4.07 (3.42, 4.84)	1.48 (0.25, 8.81)	4.98 (3.72, 6.67)	8.70 (4.10, 18.46)
<b>Region</b>						
Northeast (Reference)	1.00	--	1.00	--	1.00	--
South	1.23 (0.74, 2.06)	--	1.39 (0.91, 2.13)	--	0.85 (0.42, 1.68)	--
Midwest	0.76 (0.39, 1.49)	--	1.19 (0.67, 2.13)	--	0.47 (0.17, 1.30)	--
West	1.14 (0.73, 1.79)	--	1.35 (0.83, 2.21)	--	0.71 (0.35, 1.42)	--
<b>Metropolitan statistical area</b>						
Black isolation	0.52 (0.18, 1.48)	--	0.64 (0.27, 1.53)	--	1.21 (0.28, 5.24)	--
Latino isolation	1.92 (0.48, 7.68)	--	1.04 (0.37, 2.92)	--	0.57 (0.11, 3.09)	--
<b>County</b>						
Percent of unaffordable rental units among lowest income households	0.98 (0.96, 1.02)	--	1.03 (1.00, 1.05)*	1.02 (1.00, 1.04)*	0.98 (0.95, 1.02)	--
Average number of months on waiting lists for assisted housing	1.00 (0.99, 1.01)	--	1.00 (0.99, 1.01)	--	0.99 (0.98, 1.01)	--
Drug arrest rates per 1,000 residents	0.97 (0.94, 1.00)*	0.97 (0.93, 1.01)	0.99 (0.97, 1.01)	--	1.01 (0.97, 1.04)	--
<b>ZCTA</b>						
Density per square mile of off-premise alcohol outlets	0.99 (0.99, 1.00)*	1.00 (0.99, 1.01)	1.00 (0.98, 1.00)	--	0.99 (0.99, 1.00)	--
Density per square mile of abandoned residential units	1.00 (1.00, 1.00)	--	1.00 (1.00, 1.00)	--	1.00 (1.00, 1.00)	--
Percent of housing units with >1.5 people per room	0.98 (0.94, 1.02)	--	1.02 (0.98, 1.06)	--	0.97 (0.93, 1.02)	--

	Latino (N=1,394)	Black (N=3,953)	White (N=2,354) <sup>15</sup>	Adjusted odds ratio <sup>16</sup> (95% Confidence interval)	Odds ratio (95% Confidence interval)	Adjusted odds ratio <sup>17</sup> (95% Confidence interval)	Odds ratio (95% Confidence interval)	Adjusted odds ratio <sup>18</sup> (95% Confidence interval)	Adjusted odds ratio <sup>19</sup> (95% Confidence interval)
Percent non-Hispanic black residents	1.00 (0.99, 1.00)	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)	--	1.00 (1.00, 1.00)	--	1.00 (0.99, 1.00)	--	--
Economic deprivation	0.98 (0.92, 1.05)	1.00 (0.96, 1.05)	1.05 (0.99, 1.13)	--	1.00 (0.96, 1.05)	--	1.05 (0.99, 1.13)	--	--
Gentrification	0.99 (0.91, 1.08)	0.99 (0.94, 1.04)	0.95 (0.87, 1.04)	--	0.99 (0.94, 1.04)	--	0.95 (0.87, 1.04)	--	--
Spatial access to drug treatment	0.99 (0.94, 1.04)	1.02 (0.96, 1.08)	0.93 (0.88, 0.99) <sup>*</sup>	--	1.02 (0.96, 1.08)	--	0.93 (0.88, 0.99) <sup>*</sup>	0.93 (0.88, 1.00) <sup>*</sup>	--
Spatial access to syringe exchange programs	0.73 (0.53, 1.02)	0.96 (0.75, 1.22)	0.70 (0.51, 0.96) <sup>*</sup>	--	0.96 (0.75, 1.22)	--	0.70 (0.51, 0.96) <sup>*</sup>	--	0.82 (0.59, 1.13)
<b>Participant characteristics</b>									
Current age	0.98 (0.97, 1.00) <sup>*</sup>	0.98 (0.97, 0.99) <sup>*</sup>	0.97 (0.96, 0.98) <sup>*</sup>	0.99 (0.97, 1.00)	0.98 (0.97, 0.99) <sup>*</sup>	0.98 (0.97, 0.99) <sup>*</sup>	0.97 (0.96, 0.98) <sup>*</sup>	0.98 (0.97, 0.99) <sup>*</sup>	0.98 (0.97, 0.99) <sup>*</sup>
Sex (male=1)	1.52 (1.07, 2.16) <sup>*</sup>	1.63 (1.34, 1.98) <sup>*</sup>	2.62 (1.98, 3.46) <sup>*</sup>	1.60 (1.11, 2.32) <sup>*</sup>	1.63 (1.34, 1.98) <sup>*</sup>	1.62 (1.31, 1.99) <sup>*</sup>	2.62 (1.98, 3.46) <sup>*</sup>	2.30 (1.70, 3.12) <sup>*</sup>	2.27 (1.68, 3.07) <sup>*</sup>
Men who had sex with men	1.00	1.00	1.00	--	1.00	--	1.00	--	--
Men who had sex with men more than 1 year ago (reference)	0.32 (0.17, 0.61) <sup>*</sup>	0.31 (0.19, 0.51) <sup>*</sup>	0.16 (0.10, 0.27) <sup>*</sup>	--	0.31 (0.19, 0.51) <sup>*</sup>	--	0.16 (0.10, 0.27) <sup>*</sup>	--	--
Men who had sex with men in the past year	1.04 (0.58, 1.86)	0.57 (0.37, 0.86) <sup>*</sup>	1.09 (0.64, 1.83)	--	0.57 (0.37, 0.86) <sup>*</sup>	--	1.09 (0.64, 1.83)	--	--
Men who never had sex with men	1.65 (1.12, 2.45) <sup>*</sup>	2.22 (1.70, 2.95) <sup>*</sup>	3.49 (2.09, 5.84) <sup>*</sup>	1.84 (1.21, 2.78) <sup>*</sup>	2.22 (1.70, 2.95) <sup>*</sup>	2.18 (1.63, 2.91) <sup>*</sup>	3.49 (2.09, 5.84) <sup>*</sup>	3.78 (2.18, 6.55) <sup>*</sup>	3.86 (2.22, 6.70) <sup>*</sup>
Currently married or living as married	0.88 (0.67, 1.16)	1.06 (0.89, 1.25)	0.88 (0.70, 1.09)	0.86 (0.64, 1.16)	1.06 (0.89, 1.25)	1.04 (0.87, 1.24)	0.88 (0.70, 1.09)	0.88 (0.69, 1.12)	0.89 (0.69, 1.14)
Annual income (5,000 USD vs. more)	1.25 (0.57, 2.71)	1.04 (0.69, 1.58)	0.94 (0.59, 1.49)	1.24 (0.55, 2.79)	1.04 (0.69, 1.58)	0.96 (0.63, 1.47)	0.94 (0.59, 1.49)	0.79 (0.48, 1.29)	0.77 (0.47, 1.26)
Currently employed full-time	1.36 (1.02, 1.81) <sup>*</sup>	1.30 (1.09, 1.55) <sup>*</sup>	1.71 (1.36, 2.16) <sup>*</sup>	--	1.30 (1.09, 1.55) <sup>*</sup>	--	1.71 (1.36, 2.16) <sup>*</sup>	1.45 (1.13, 1.87) <sup>*</sup>	--
Incarceration	1.51 (1.14, 1.99) <sup>*</sup>	1.20 (1.02, 1.41) <sup>*</sup>	1.25 (0.99, 1.58)	--	1.20 (1.02, 1.41) <sup>*</sup>	--	1.25 (0.99, 1.58)	1.06 (0.81, 1.38)	1.11 (0.85, 1.44)
Homelessness	0.71 (0.50, 1.00)	0.87 (0.72, 1.05)	0.69 (0.54, 0.88) <sup>*</sup>	0.80 (0.55, 2.79)	0.87 (0.72, 1.05)	0.96 (0.79, 1.16)	0.69 (0.54, 0.88) <sup>*</sup>	0.85 (0.65, 1.10)	0.86 (0.66, 1.13)
Daily injection use	1.76 (1.33, 2.31) <sup>*</sup>	1.41 (1.20, 1.66) <sup>*</sup>	1.39 (1.11, 1.74) <sup>*</sup>	1.82 (1.36, 2.44) <sup>*</sup>	1.41 (1.20, 1.66) <sup>*</sup>	1.38 (1.16, 1.63) <sup>*</sup>	1.39 (1.11, 1.74) <sup>*</sup>	1.33 (1.04, 1.71) <sup>*</sup>	1.31 (1.02, 1.68) <sup>*</sup>
Binge drinking	1.08 (0.80, 1.46)	1.14 (0.95, 1.36)	1.17 (0.86, 1.58)	0.97 (0.70, 1.35)	1.14 (0.95, 1.36)	1.05 (0.87, 1.26)	1.17 (0.86, 1.58)	1.22 (0.88, 1.69)	1.20 (0.87, 1.66)
Non-injection drug use	1.43 (1.01, 2.02) <sup>*</sup>	1.52 (1.26, 1.84) <sup>*</sup>	1.74 (1.30, 2.33) <sup>*</sup>	--	1.52 (1.26, 1.84) <sup>*</sup>	--	1.74 (1.30, 2.33) <sup>*</sup>	1.27 (0.92, 1.74)	1.31 (0.95, 1.80)
Exchanged sex for money or drugs	0.64 (0.49, 0.85) <sup>*</sup>	0.71 (0.60, 0.84) <sup>*</sup>	0.61 (0.49, 0.77) <sup>*</sup>	0.69 (0.51, 0.92) <sup>*</sup>	0.71 (0.60, 0.84) <sup>*</sup>	0.77 (0.65, 0.92) <sup>*</sup>	0.61 (0.49, 0.77) <sup>*</sup>	--	--
Acquired condoms for free in the past year									
Result of most recent HIV test									

	Latino (N=1,394)	Black (N=3,953)	White (N=2,354) <sup>15</sup>	Adjusted odds ratio <sup>19</sup> (95% Confidence interval)
Indeterminate result on most recent HIV test/or did not receive result (Reference)	1.00	1.00	1.00	1.00
Negative result on most recent HIV test	1.01 (0.70, 1.45)	1.06 (0.73, 1.54)	1.02 (0.81, 1.28)	0.83 (0.59, 1.16)
Positive result on most recent HIV test	0.11 (0.05, 0.21) <sup>*</sup>	0.13 (0.06, 0.26) <sup>*</sup>	0.26 (0.18, 0.37) <sup>*</sup>	0.06 (0.03, 0.11) <sup>*</sup>

Note:

<sup>\*</sup> indicates significance at p<0.05; some estimates labeled as significant at p<0.05 include confidence intervals that include a value of 1.00 due to rounding to the second decimal place.

<sup>12</sup> Multilevel analysis was conducted to assess the associations of place and participant characteristics with injection-related risk behavior. Among white PWID, random intercepts were included for MSAs and ZIP codes. Among Latino and black PWID random intercepts were respectively included for counties and MSAs

<sup>13</sup> Refer to table 1 for definitions of place characteristics measured at MSA, county, and ZIP code levels and participant characteristics

<sup>14</sup> "Plurality" guidelines from the Federal Office of Management and Budget were used to group Non-Hispanic biracial participants to the white and black racial categories.

<sup>15</sup> Separate multivariable models were analyzed for density of drug treatment and syringe exchange program exposures to avoid multicollinearity

<sup>16</sup> Homelessness, sex exchange, and incarceration were excluded from multivariable analysis because they were hypothesized to mediate the relationship of drug-related arrests to condomless sex.

<sup>17</sup> Homelessness, sex exchange, and incarceration were excluded from multivariable analysis because they were hypothesized to mediate the relationship of housing affordability to condomless sex.

<sup>18</sup> Receipt of condoms was excluded from multivariable analysis because it was hypothesized to mediate the relationship of drug treatment density to condomless sex

<sup>19</sup> Incarceration and receipt of condoms were excluded from multivariable analysis because they were hypothesized to mediate the relationship of SEP density to condomless sex.