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The Relationship Between Housing Status and Substance Use and Sexual Risk Behaviors Among People Currently Seeking or Receiving Services in Substance Use Disorder Treatment Programs

Yue Pan[1] · Lisa R. Metsch[2] · Weize Wang[3] · Morgan Philbin[2,4] · Tiffany L. Kyle[5] · Lauren K. Gooden[2] · Daniel J. Feaster[1]

Abstract

Although HIV risk behaviors such as substance use and condomless sex are prevalent among people currently seeking or receiving services at substance use disorder (SUD) treatment programs, associations with housing status in this population have not been well studied. We examined the associations between housing status, substance use and HIV-related sexual risk behaviors among 1281 participants from 12 US community-based SUD programs. In addition, substance use was examined as a potential mediator of the relationship between housing status and sexual risk behaviors. We conducted Chi-square, univariate and multivariate logistic regression models on data from the National Drug Abuse Treatment Clinical Trials Network HIV Rapid Testing and Counseling study. Path analysis was used to test the mediation and indirect effects. Unstable housing was significantly associated with having multiple concurrent condomless sex partners, condomless sex with non-primary partners, and partners of unknown HIV serostatus. Homelessness was significantly associated with condomless vaginal sex and condomless sex with any substance use. The path between unstable housing and sexual risk behaviors was mediated by problematic drug use, particularly by cocaine, opioids, and marijuana use. Because housing status impacts HIV risk behaviors for individuals in SUD treatment programs, both housing status and substance use behaviors should be assessed upon program entry in order to identify and mitigate risk behaviors.

Keywords Housing status · Substance use · Sexual risk behavior · Substance use treatment

✉ Yue Pan
    panyue@med.miami.edu

Extended author information available on the last page of the article

Introduction

Substance use and sexual risk behaviors among vulnerable populations represent significant risk factors for HIV/AIDS as well as public health issues more generally (Centers for Disease Control and Prevention [CDC], 2018). In 2017, about 1 in 4 young adults aged 18–25 and 1 in 10 adults aged 26 or older were current users of illicit drugs (Bose, Hedden, Lipari, Park-Lee, & Substance Abuse and Mental Health Services Administration, 2018). An estimated 14.5 million people had an alcohol use disorder and 7.5 million people had an illicit drug use disorder in the United States (US) in 2017 (Bose et al., 2018). While injection drug use is both directly and indirectly associated with new HIV infections, sexual risk behaviors, including condomless sexual intercourse and sex while intoxicated, continue to account for the majority of new HIV infections among all populations (CDC, 2018). Compared to the general population, substance users remain at particularly high risk for contracting HIV through both injection drug use and sexual risk behaviors (Bose et al., 2018).

In 2018, the rate of homelessness in the US population was estimated at 17 per 10,000 (Henry et al., 2018). Many homeless experienced alcohol or drug abuse problems (Paquette, 2011). Recent studies have consistently shown that homelessness and unstable housing are associated with higher incidence of alcohol and drug use, sexual risk behaviors and HIV acquisition, and poorer health outcomes such as mental illness, psychiatric disorders, tuberculosis, asthma, and bronchitis (Aidala, Cross, Stall, Harre, & Sumartojo, 2005; Drake, O'Neal, & Wallach, 2008; Fischer & Breakey, 1991; McMurray-Avila, 2001; Padgett, Stanhope, Henwood, & Stefancic, 2011; Reback, Peck, Fletcher, Nuno, & Dierst-Davies, 2012; Senn, Carey, & Vanable, 2008; Smereck & Hockman, 1998). For example, one study demonstrated that people with unstable housing were 2–4 times more likely to use drugs, including injection drugs or exchanging sex for drugs, compared to people with stable housing (Aidala et al., 2005). Another study found that people admitted to public shelters in Philadelphia had an HIV prevalence nine times higher than the general population (Culhane, Gollub, Kuhn, & Shpaner, 2001).

Higher rates of HIV-related risk behaviors persist for all sub-populations of individuals who are unstably housed or homeless: women (Gelberg et al., 2009; Metsch et al., 1995), African Americans (Wechsberg et al., 2003), and people who inject drugs (Rice et al., 2013; Song, Safaeian, Strathdee, Vlahov, & Celentano, 2000; Susser et al., 1996). However, little attention has been paid to the associations between housing status, substance use, and sexual risk behaviors for patients currently seeking or receiving services in SUD treatment programs. While some research has examined the relationship between the use of a specific drug (Larimer et al., 2009; Milby, Schumacher, Wallace, Freedman, & Vuchinich, 2005) or sexual risk behavior (Wright & Walker, 2006) and homelessness, few previous studies have examined how particular types of substance use or sexual behavior patterns are related to housing status.

In contrast to an emphasis on the individual, the "context of risk" model is suggested for housing factors (O'Leary, 2001). Contexts marked by pervasive risk,

competing needs, few personal resources, and few community resources can lead to unstable housing (e.g., lacking financial resources, facing housing discrimination) as well as sexual risk behaviors (e.g., exchanging sex for money, using drugs to self-medicate emotional distress); both thus contribute to increased risk for HIV infection or transmission of HIV to others (Aidala & Sumartojo, 2007). Therefore, we examined how and whether housing status is related to specific substance use and sexual risk behaviors among patients currently seeking or receiving services in SUD treatment programs. We hypothesized that substance use will mediate pathways from housing status to sexual risk behaviors (see Fig. 1). Three specific questions were addressed: (1) does the prevalence of substance use and sexual risk behaviors vary by housing status among people seeking/receiving services in SUD treatment programs; (2) are substance use and sexual risk behaviors independently associated with housing status; and (3) does substance use mediate the relationship between housing status and sexual risk behaviors? Our findings are presented to inform the conceptualization of future prospective research on the associations between housing status and HIV risk behaviors.

Figure 1 This schematic shows that housing status affects substance use (a), substance use affects sexual risk behaviors (b), and the indirect mediation effects of substance use (a*b) between housing status and sexual risk behaviors.

Method

These data come from a randomized clinical trial conducted between January and December 2009 at 12 US community-based SUD treatment programs in the National Drug Abuse Treatment Clinical Trials Network (NIDA CTN 0032; Metsch et al., 2012). This trial sought to examine the most optimal strategies to increase HIV testing uptake and decrease sexual risk behaviors. Participating sites included outpatient psychosocial, intensive outpatient, outpatient methadone/other narcotic replacement, and residential programs that had not offered on-site HIV testing in the 6 months prior to study participation. Inclusion criteria were: (1) being 18 years of age or older, (2) reporting HIV negative or unknown serostatus, (3) having not been tested and received HIV test results within the last year, and (4) being willing and able to provide informed consent. All study procedures were reviewed, approved
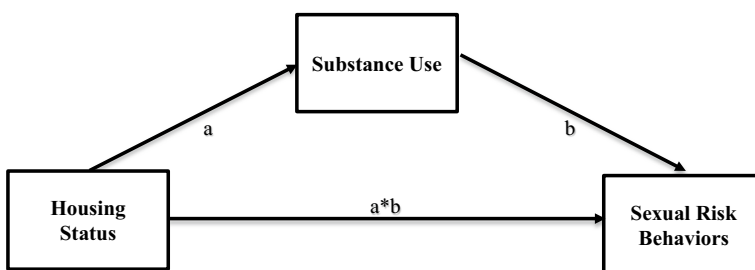

Fig. 1 Mediation model for substance use, between housing status and sexual risk behaviors

and overseen by local institutional review boards. A more detailed description of the study and primary outcomes findings can be found in Metsch et al. (2012).

Data Collection and Measures

Audio computer-assisted self-interviews (ACASIs) were used at baseline to obtain participants' social-demographic characteristics, HIV testing history, and substance use and sexual risk behaviors. Demographic characteristics were gender, race/ethnicity, age, education, marital status, and income. Participants were categorized as having been incarcerated in the past 6 months, having ever been incarcerated but not in the past 6 months, or never having been incarcerated.

We asked about housing status with this question: "During the past 6 months, where did you live or sleep most of the time?" Although the important role of housing status in HIV prevention and care has been recognized, much of this attention has focused on homeless individuals as a special risk group (Aidala et al., 2016). Recognition of the instability of an individual's living arrangement is crucial to understanding the role of housing in the lives of persons infected with HIV/AIDS (Song, 1999; Song et al., 2000), as the HRSA Bureau of Primary Care has emphasized. Analyses have less often addressed community housing availability and conditions as factors influencing population health or unstable, inadequate, or unaffordable housing as a situation or temporary state (Aidala et al., 2016). Therefore, we defined our participants who were "stably housed" only if they had secure, permanent housing in a house, apartment or flat that they owned or rented. We created a housing status categorical variable with four levels: (1) stably housed—living in a house, apartment or flat that they owned or rented; (2) unstably housed—living in a lover or sexual partner's house, apartment or flat, someone else's (such as a relative or friend's) house or apartment, or a rented room (such as a hotel, motel or rooming house); (3) homeless—living in car, bus, truck or other vehicle, abandoned buildings (such as squatting or having no fixed address), shelter and welfare residence, or on the streets (including park, bus or train station, under a highway overpass, alleys, or rooftops); or (4) controlled environment—living in jail (such as a prison or detention center), treatment facility, or halfway house.

Risky drinking was defined as greater than 14 standard drinks for men and greater than 7 standard drinks for women per week, which was consistent with standards utilized by the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2005). Substance use was assessed by asking participants whether they had used any of the following substances in the past 6 months: club drugs (GHB, ketamine, and ecstasy), cocaine (crack or powdered cocaine), amphetamines, opioids, stimulants and opioids, marijuana, tranquilizers/barbiturates and other drugs. Injection drug use (IDU) history was also assessed and categorized into never IDU, prior IDU (but not in the last 6 months), and current IDU (in the last 6 months). Each substance use question was recoded as a dichotomized variable with '1' indicating substance use in the past 6 months, and '0' indicating no substance use. We also used the 10-item Drug Abuse Screening Test-10

(DAST10; Skinner, 1982, 2001) to assess severity of drug use. Problematic drug use was defined as a DAST-10 score ≥ 6 (Yudko, Lozhkina, & Fouts, 2007).

Sexual risk behavior was assessed using validated instruments that correlate with HIV seroconversion [e.g., from Project MIX (Koblin et al., 2011; Mansergh et al., 2010) and Project EXPLORE (Colfax et al., 2004; Koblin et al., 2003)]. Sexual risk behaviors in the past 6 months were determined by asking the following questions about each type of partner (i.e., primary partners, non-primary partners, and partners who were HIV-positive, HIV-negative, and unknown serostatus): (1) whether a condom was used; (2) the sex act (i.e., anal or vaginal insertion); and (3) if sex was performed within 2 h of drug or alcohol use. Based on this information condomless sex behaviors were recoded and dichotomized into the following yes/no variables: (1) whether participants had multiple condomless sex partners; (2) any condomless sex act with non-primary partner(s); (3) condomless vaginal sex with any partner; (4) condomless anal sex with any partner; (5) condomless sex within 2 h of substance use (drug or alcohol); and (6) condomless sex with a partner of unknown HIV serostatus.

Statistical Analysis

Descriptive statistics were used to characterize participant demographics. We assessed univariate and multivariable association tests of participants' demographics and housing status using Chi-square and one-way analyses of variance (ANOVAs). The prevalence of substance use and condomless sex behaviors for each housing status category was reported. We then performed univariate and multiple logistic regressions. Multiple logistic analyses adjusting for demographic characteristics and IDU history were conducted using SAS 9.3 statistical software package (SAS Institute, Cary, NC, USA).

Path analysis in Mplus 7.11 was used to evaluate indirect mediation effects of substance use between housing status and sexual risk behaviors (Muthén & Muthén, 2013). Only significant associations between substance use (risky drinking, problematic drug use, and drug use) and sexual risk behaviors with housing status from univariate analysis were assessed for possible mediating effects using path analysis models. To assess mediation, the significance of the path from the housing status to the substance use ('a' path) and that from the substance use to the sexual risk behaviors ('b' path) was examined through the indirect path, $\beta = a*b$ (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). We assessed mediation models using 2000 bootstrap replicates to obtain bias-corrected bootstrap confidence intervals for the indirect effects (Mackinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2008). We present odds ratios (ORs) and 95% confidence intervals (CIs). Any p values < 0.05 on two-sided tests were considered statistically significant. To protect against the false discovery rate due to multiple comparisons, probability values were also checked using the Benjamini–Hochberg procedure (Benjamini & Hochberg, 1995).

Results

Sample Characteristics

The 1281 participants were predominantly male (60.7%) and White (59.2%; see Table 1). Housing status was as follows: 59.3% were stably housed, 31.7% were unstably housed, 5.5% were homeless and 3.6% were in a controlled environment. The mean age by housing status was 41.5 years ($SD = 11.1$), 36.8 years ($SD = 11.0$). 43.6 years ($SD = 10.7$) and 37.4 years ($SD = 11.0$), respectively. Factors such as gender, race/ethnicity, age, education, marriage status, income, incarceration history, and IDU history were differentially distributed by housing status, and therefore controlled in the multiple logistic regression models. Prevalence of substance use was the highest among the unstably housed and included risky drinking (35.2%), any drug use (82.5%), club drug (9.1%), cocaine (44.8%), opioids (41.9%), marijuana (50.3%), and tranquilizers/barbiturates (24.1%). Individuals who were unstably housed also reported higher frequency of sexual risk behaviors as a whole, including having multiple condomless sex partners (29.1%), condomless sex with a non-primary partner (31.3%), condomless vaginal sex (62.8%), condomless sex with substance use (49.3%), and condomless sex with a partner of unknown HIV serostatus (32.0%), compared to participants who were stably housed, homeless, and in a controlled environment. Homeless individuals reported the highest use of other drugs (14.3%) amongst participants of all housing status. Participants in a controlled environment reported a higher prevalence of problematic drug use (50%), speed (17.4%), stimulants and opioids drug use (26.1%), and condomless anal sex (23.9%), compared to participants who were stably housed, unstably housed, and homeless.

Association Analysis

Results from univariate and multiple logistic regression models that focused on alcohol use, drug use and condomless sex behaviors are presented in Tables 2 and 3. In the univariate analysis (see Table 2), unstably housed individuals were more likely than stably housed individuals to be problematic drug users, report substance use, and report engaging in various condomless sex behaviors. Homeless individuals were most likely to report using 'other drugs,' but less likely than the stably housed to report having condomless vaginal sex, or condomless sex that involved substance use. Participants in a controlled environments were least likely to report risky drinking.

After adjusting for social demographic factors and potential confounders in the multiple logistic regressions (see Table 3), we found that unstably housed individuals were significantly more likely than stably housed persons to report cocaine use, and to have multiple condomless sex partners, condomless sex with non-primary partners, and condomless sex with partners of unknown HIV serostatus. Problematic drug use approached significance between stably housed and unstably housed individuals. Homeless participants were significantly more likely to report other drug

Table 1 Characteristics of participants stratified by housing status

	Stably housed n (%)	Unstably housed n (%)	Homeless n (%)	Controlled environment n (%)	p value
	759 (59.3%)	406 (31.7%)	70 (5.5%)	46 (3.6%)	
Gender					0.0054
Male	430 (56.7%)	268 (66.0%)	48 (68.6%)	31 (67.4%)	
Female	329 (43.4%)	138 (34.0%)	22 (31.4%)	15 (32.6%)	
Race					0.0160
Hispanic	92 (12.1%)	35 (8.6%)	13 (18.6%)	7 (15.2%)	
Black	156 (20.6%)	97 (23.9%)	21 (30.0%)	11 (23.9%)	
White	452 (59.6%)	254 (62.6%)	29 (41.4%)	23 (50.0%)	
Other	59 (7.8%)	20 (4.9%)	7 (10.0%)	5 (10.9%)	
Age					
Mean (SD)[a]	41.5 (11.1)	36.8 (11.0)	43.6 (10.7)	37.4 (11.0)	<0.0001
≤29	132 (17.4%)	127 (31.3%)	9 (12.9%)	17 (37.0%)	<0.0001
30–39	182 (24.0%)	106 (26.1%)	11 (15.7%)	7 (15.2%)	
40–49	259 (34.1%)	112 (27.6%)	31 (44.3%)	14 (30.4%)	
50+	186 (24.5%)	61 (15.0%)	19 (27.1%)	8 (17.4%)	
Education					0.0194
Less than high school	193 (25.4%)	125 (30.8%)	20 (28.6%)	15 (32.6%)	
High school, no college	480 (63.2%)	258 (63.6%)	47 (67.1%)	28 (60.9%)	
College or more	86 (11.3%)	23 (5.7%)	3 (4.3%)	3 (6.5%)	
Marriage status					<0.0001
Married	164 (21.6%)	30 (7.4%)	5 (7.1%)	5 (10.9%)	
Unmarried, living w/partner	80 (10.5%)	32 (7.9%)	5 (7.1%)	2 (4.4%)	
Widowed	36 (4.7%)	10 (2.5%)	2 (2.9%)	1 (2.2%)	

Table 1 (continued)

	Stably housed n (%)	Unstably housed n (%)	Homeless n (%)	Controlled environment n (%)	p value
	759 (59.3%)	406 (31.7%)	70 (5.5%)	46 (3.6%)	
Divorced or separated	196 (25.8%)	123 (30.3%)	21 (30.0%)	16 (34.8%)	
Single	283 (37.3%)	211 (52.0%)	37 (52.9%)	22 (47.8%)	
Income					<0.0001
Missing	10 (1.3%)	4 (1.0%)	1 (1.4%)	1 (2.2%)	
Less than $10,000	401 (52.8%)	311 (76.6%)	62 (88.6%)	43 (93.5%)	
$10,001–$40,000	291 (38.3%)	87 (21.4%)	7 (10.0%)	1 (2.2%)	
Greater than $40,000	57 (7.5%)	4 (1.0%)	–	1 (2.2%)	
Ever tested for HIV					0.2468
Missing	5 (0.7%)	2 (0.5%)	–	–	
No HIV test before	214 (28.2%)	136 (33.5%)	18 (25.7%)	14 (30.4%)	
HIV test before	540 (71.2%)	268 (66.0%)	52 (74.3%)	32 (69.6%)	
Ever in jail					<0.0001
Never	203 (26.8%)	96 (23.7%)	5 (7.1%)	1 (2.2%)	
Jailed history not in the last 6 months	414 (54.6%)	194 (47.8%)	48 (68.6%)	16 (34.8%)	
Jailed current in the last 6 months	142 (18.7%)	116 (28.6%)	17 (24.3%)	29 (63.0%)	
IDU history					0.0344
Never IDU	375 (49.4%)	229 (56.4%)	33 (47.1%)	22 (47.8%)	
IDU history not in the last 6 months	220 (29.0%)	94 (23.2%)	28 (40.0%)	16 (34.8%)	
IDU current in the last 6 months	164 (21.6%)	83 (20.4%)	9 (12.9%)	8 (17.4%)	
Substance use					
Risky drinking	236 (31.1%)	143 (35.2%)	23 (32.9%)	8 (17.4%)	0.0800
Problematic drug use (Dast-10 ≥ 6)	301 (39.7%)	186 (45.8%)	32 (45.7%)	23 (50.0%)	0.0996

Table 1 (continued)

	Stably housed n (%)	Unstably housed n (%)	Homeless n (%)	Controlled environment n (%)	p value
	759 (59.3%)	406 (31.7%)	70 (5.5%)	46 (3.6%)	
Any drug use	575 (75.8%)	335 (82.5%)	56 (80.0%)	32 (69.6%)	0.0283
Club drugs	49 (6.5%)	37 (9.1%)	1 (1.4%)	1 (2.2%)	0.0416
Cocaine	272 (35.8%)	182 (44.8%)	28 (40.0%)	20 (43.5%)	0.0248
Speed	77 (10.1%)	43 (10.6%)	4 (5.7%)	8 (17.4%)	0.2455
Opioids	271 (35.7%)	170 (41.9%)	18 (25.7%)	15 (32.6%)	0.0309
Stimulants and opioids	162 (21.3%)	103 (25.4%)	10 (14.3%)	12 (26.1%)	0.1353
Marijuana	307 (40.5%)	204 (50.3%)	27 (38.6%)	21 (45.7%)	0.0109
Tranquilizers/barbiturates	157 (20.7%)	98 (24.1%)	9 (12.9%)	9 (19.6%)	0.1592
Other	57 (7.5%)	27 (6.7%)	10 (14.3%)	2 (4.4%)	0.1254
Sexual risk behaviors (condomless sex with)					
Multiple partner	131 (17.3%)	118 (29.1%)	11 (15.7%)	11 (23.9%)	<0.0001
Non-primary partner	153 (20.2%)	127 (31.3%)	14 (20.0%)	12 (26.1%)	0.0003
Vaginal sex	431 (56.8%)	255 (62.8%)	29 (41.4%)	26 (56.5%)	0.0067
Anal sex	143 (18.8%)	91 (22.4%)	10 (14.3%)	11 (23.9%)	0.2623
Substance use	300 (39.5%)	200 (49.3%)	18 (25.7%)	20 (43.5%)	0.0004
HIV unknown serostatus partner	181 (23.9%)	130 (32.0%)	15 (21.4%)	12 (26.1%)	0.0182

[a] ANOVA test was used

Table 2 Univariate odds ratios for housing status on substance use and sexual risk behavior

Stably housed (n = 759) as reference	Unstably housed n = 406		Homeless n = 70		Controlled environment n = 46	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Substance use						
Risky drinking	1.21 (0.93, 1.56)	0.15	1.08 (0.64, 1.83)	0.76	0.47 (0.21, 1.02)	0.05
Problematic drug use (Dast-10 ≥ 6)	1.28 (1.00, 1.63)	0.05	1.39 (0.84, 2.30)	0.2	1.62 (0.88, 2.97)	0.12
Any drug use	1.51 (1.11, 2.05)	0.01	1.28 (0.70, 2.35)	0.43	0.73 (0.38, 1.40)	0.34
Club drugs[a]	1.45 (0.93, 2.27)	0.10	0.21 (0.03, 1.54)	0.13	0.32 (0.04, 2.39)	0.27
Cocaine	1.45 (1.14, 1.86)	0.00	1.19 (0.72, 1.97)	0.49	1.38 (0.75, 2.51)	0.30
Speed[a]	1.05 (0.71, 1.56)	0.81	0.54 (0.19, 1.51)	0.24	1.86 (0.84, 4.14)	0.13
Opioids	1.30 (1.01, 1.66)	0.04	0.62 (0.36, 1.09)	0.10	0.87 (0.46, 1.64)	0.67
Stimulants and opioids	1.25 (0.94, 1.66)	0.12	0.61 (0.31, 1.23)	0.17	1.30 (0.66, 2.57)	0.45
Marijuana	1.49 (1.17, 1.90)	0.00	0.92 (0.56, 1.53)	0.76	1.24 (0.68, 2.25)	0.49
Tranquilizers/barbiturates[a]	1.22 (0.92, 1.63)	0.17	0.57 (0.27, 1.16)	0.12	0.93 (0.44, 1.97)	0.86
Other[a]	0.88 (0.55, 1.41)	0.59	2.05 (1.00, 4.23)	0.05	0.56 (0.13, 2.37)	0.43
Sexual risk behaviors (condomless sex with)						
Multiple partner	2.03 (1.48, 2.79)	0.00	0.67 (0.33, 1.35)	0.26	1.41 (0.65, 3.05)	0.38
Non-primary partner	1.80 (1.37, 2.37)	0.00	0.99 (0.54, 1.83)	0.97	1.40 (0.71, 2.76)	0.34
Vaginal sex	1.29 (1.00, 1.65)	0.05	0.54 (0.33, 0.88)	0.01	0.99 (0.54, 1.80)	0.97
Anal sex	1.24 (0.93, 1.67)	0.15	0.72 (0.36, 1.44)	0.35	1.35 (0.67, 2.73)	0.40
Substance use	1.49 (1.17, 1.89)	0.00	0.53 (0.30, 0.92)	0.02	1.18 (0.65, 2.15)	0.60
HIV unknown serostatus partner	1.50 (1.15, 1.96)	0.00	0.87 (0.48, 1.58)	0.65	1.13 (0.57, 2.22)	0.73

[a]Exact multiple logistic regression model was fitted

Table 3 Multiple logistic regression for housing status on substance use and sexual risk behavior

Stably housed (n = 759) as reference	Unstably housed n = 406		Homeless n = 70		Controlled environment n = 46	
	aOR (95% CI)	p value	aOR (95% CI)	p value	aOR (95% CI)	p value
Substance use						
Risky drinking	1.14 (0.87, 1.48)	0.35	1.09 (0.63, 1.86)	0.77	0.35 (0.15, 0.80)	0.01
Problematic drug use (Dast-10 ≥ 6)	1.28 (0.99, 1.66)	0.06	1.36 (0.81, 2.30)	0.24	1.36 (0.72, 2.58)	0.34
Any drug use	1.22 (0.88, 1.68)	0.22	1.31 (0.69, 2.49)	0.42	0.43 (0.21, 0.88)	0.02
Club drugs[a]	0.90 (0.55, 1.47)	0.68	0.22 (0.01, 1.14)	0.15	0.12 (0.01, 0.60)	0.04
Cocaine	1.35 (1.04, 1.75)	0.03	1.01 (0.60, 1.71)	0.96	0.96 (0.51, 1.83)	0.91
Speed[a]	0.90 (0.58, 1.38)	0.62	0.58 (0.20, 1.71)	0.32	1.30 (0.54, 3.16)	0.56
Opioids	1.24 (0.95, 1.62)	0.11	0.73 (0.41, 1.32)	0.30	0.83 (0.41, 1.65)	0.59
Stimulants and opioids	1.16 (0.86, 1.58)	0.33	0.63 (0.31, 1.28)	0.20	1.01 (0.48, 2.09)	0.98
Marijuana	1.09 (0.83, 1.43)	0.52	0.94 (0.55, 1.63)	0.84	0.62 (0.31, 1.24)	0.18
Tranquilizers/barbiturates[a]	1.26 (0.93, 1.72)	0.14	0.73 (0.34, 1.54)	0.40	0.92 (0.41, 2.06)	0.84
Other[a]	0.91 (0.56, 1.50)	0.73	2.31 (1.10, 4.85)	0.03	0.73 (0.17, 3.19)	0.68
Sexual risk behaviors (condomless sex with)						
Multiple partner	1.49 (1.04, 2.12)	0.03	0.65 (0.31, 1.38)	0.26	0.80 (0.34, 1.88)	0.61
Non-primary partner	1.47 (1.10, 1.97)	0.01	1.08 (0.57, 2.04)	0.82	0.93 (0.45, 1.94)	0.85
Vaginal sex	1.09 (0.83, 1.42)	0.53	0.57 (0.34, 0.96)	0.03	0.73 (0.38, 1.40)	0.34
Anal sex	1.09 (0.80, 1.50)	0.58	0.77 (0.37, 1.57)	0.46	1.17 (0.55, 2.46)	0.69
Substance use	1.23 (0.95, 1.60)	0.12	0.54 (0.30, 0.97)	0.04	0.78 (0.40, 1.51)	0.46
HIV unknown serostatus partner	1.33 (1.00, 1.77)	0.05	0.99 (0.53, 1.85)	0.98	0.74 (0.35, 1.55)	0.42

Note. Demographic characteristics and IDU history were controlled

[a]Exact multiple logistic regression model was fitted

use compared to the stably housed, but were significantly less likely to report con-domless vaginal sex and condomless sex that involved substance use. Participants in controlled environments were significantly less likely than the stably housed to report risky drinking or any drug use. This relationship was particularly strong for club drug use.

Mediation Analysis

We assessed 27 potential mediation models, of which 15 showed significant indi-rect effects (see Table 4). Housing status was indirectly related to sexual risk behav-iors through problematic drug use, particularly cocaine, opioids, and marijuana use. Through problematic drug use, there were significant indirect effects between being unstably housed and having multiple condomless sex partners, condomless sex with a non-primary partners, and condomless sex that involved substance use. Similarly, through any drug use, significant indirect effects were also shown between being unstably housed and having multiple condomless sex partners, condomless sex with a non-primary partner, and condomless sex that involved any substance use.

Specifically, the associations between being unstably housed were mediated by cocaine use for multiple condomless sex partner, condomless sex with a non-primary partner, condomless sex that involved substance use, and condomless sex with a partner of unknown HIV serostatus. The association between being unsta-bly housed and having condomless sex that involved substance use was mediated by opioid use. Marijuana use mediated the associations between being unstably housed

Table 4 Significant mediated indirect effects from housing status on sexual risk behaviors through drug use

Predictor	Mediator	Outcome[a]	β (95% CI)	p value
Unstably housed	Problematic drug use	Multiple partner	0.04 (0.01, 0.08)	0.05
		Non, primary partner	0.05 (0.00, 0.09)	0.04
		Substance use	0.06 (0.00, 0.12)	0.04
	Any drug use	Multiple partner	0.06 (0.01, 0.11)	0.03
		Non, primary partner	0.07 (0.01, 0.13)	0.03
		Substance use	0.11 (0.02, 0.22)	0.02
	Cocaine	Multiple partner	0.08 (0.03, 0.14)	0.01
		Non, primary partner	0.08 (0.03, 0.14)	0.01
		Substance use	0.09 (0.03, 0.16)	0.01
		HIV unknown serostatus partner	0.08 (0.02, 0.13)	0.01
	Opioids	Substance use	0.06 (0.00, 0.11)	0.05
	Marijuana	Multiple partner	0.07 (0.03, 0.12)	0.01
		Non, primary partner	0.06 (0.03, 0.12)	0.02
		Substance use	0.07 (0.03, 0.13)	0.01
		HIV unknown serostatus partner	0.05 (0.02, 0.10)	0.02

[a]Sexual risk behaviors (reporting having condomless sex with)

and having multiple condomless sex partners, condomless sex with a non-primary partner, condomless sex that involved substance use, and condomless sex with a HIV unknown serostatus partner. However, we did not find that substance use mediated the relationships between sexual risk behaviors and being stably housed, homeless, or in a controlled environment.

Discussion

Our purpose was to examine whether housing status was related to substance use and sexual risk behaviors for participants recruited from SUD treatment programs, and to determine whether substance use mediated pathways between housing status and sexual risk behaviors. We found a clear distinction in risk behaviors between individuals who reported being unstably housed and those who were homeless. Specifically, the results demonstrated a high prevalence of substance use and sexual risk behaviors among unstably housed individuals, but not among homeless persons or people in controlled environments.

The finding that unstable housing was closely associated with substance use and increased sexual risk behaviors aligns with previous research (Dickson-Gomez, Convey, Hilario, Weeks, & Corbett, 2009; Dickson-Gomez, Hilario et al., 2009; Dickson-Gomez, McAuliffe, Convey, Weeks, & Owczarzak, 2011). Dickson-Gomez et al. posit that individuals who are unstably housed have higher rates of sexual risk than those who are homeless, because they live with acquaintances or sex partners and may thus be expected to contribute to household expenses or to share drugs, which may result in exchanging sex, in order to retain a place to sleep (Dickson-Gomez, Convey et al., 2009; Dickson-Gomez, Hilario et al., 2009; Dickson-Gomez et al., 2011). In addition, the prevalence of problematic drug use and cocaine use, and sexual risk behaviors including having multiple condomless sex partners, condomless sex with non-primary partners and HIV unknown serostatus partners, was significantly higher among unstably housed individuals than in the stably housed in our sample.

Substance users, particularly those living in unstable housing and homeless conditions, remain vulnerable to outbreaks of HIV infection. More residential instability is associated with more substance use and sexual risk behaviors, and may also independently contribute to HIV risk. Previous research has shown that 50–75% of unstably housed or homeless individuals engage in illicit drug use behaviors (Palepu et al., 2013; Royse et al., 2000). We found that some drugs were significant mediators between being unstably housed and sexual risk behaviors. Unstably housed participants were at increased risk of engaging in sexual risk behaviors related to substance use, particularly when using cocaine, opioids, or marijuana. Similar to our findings, Corneil et al. (2005) also reported that daily cocaine injections were significantly associated with unstable housing. In another qualitative study, all opioid injectors described unstable housing and unreliable income sources (Firestone & Fischer, 2008). Substance users with decreased housing stability, such as those facing imminent eviction, often report increased stress and substance use which may lead to increased sexual risk behaviors. A more recent study showed that people

with any positive reason for moving used drugs more frequently in the past 30 days, while those with a greater number of moves in the last 6 months were more likely to have had condomless sex with an increased number of partners (Dickson-Gomez, McAuliffe, & Quinn, 2017). They also reported that living with drug users, contributing money to household expenses, or having conflict over household expenses was associated with more hard drug use, and more condomless sex partners (Dickson-Gomez et al., 2017). Perhaps, a lack of stable housing may increase the likelihood of trading sex for money, drugs, or shelter (Reback, Kamien, & Amass, 2007; Surratt & Inciardi, 2004), or of sexual assaults for both men and women (Aidala et al., 2005).

However, due to the cross-sectional nature of the design, it is difficult to know the order in which unstable housing and substance use emerged. The increased substance use among unstably housed participants could be the reason that such people have come to rely on unstable housing arrangements (Wechsberg et al., 2003). It is probable that unstably housed individuals, in contrast to those who are homeless or in controlled environment, have some resources including social support or financial support from partners or friends that enable them to engage in substance use and sexual risk behaviors. Aidala and Sumartojo (2007) argued that people are homeless or unstably housed not simply because of their individual traits or characteristics, but because of a confluence of interacting environmental influences, including economic and political contexts, inequality of opportunities and conditions, social processes of discrimination, and exclusion.

Homeless individuals were more likely to use condoms during vaginal sex and sex that involved substance use compared to stably housed persons. This finding contrasts with other research that found homeless individuals at a potentially elevated risk for substance use and sexual risk behaviors (Aidala et al., 2005; Coady et al., 2007; Kidder, Wolitski, Pals, & Campsmith, 2008). For example, Coady et al. (2007) reported an association between illegal drug use, alcohol use, and sex work among equivocally housed and homeless; homeless IDUs had the highest levels HIV risk. Furthermore, Kidder et al. (2008) found that homeless HIV-positive individuals reported more sex partners and more condomless sex with a partner of unknown HIV status in the past 12 months compared to stably housed individuals. Research suggests a few pathways to explain the inverse relationship between homelessness and condomless sex. First, the lack of privacy that comes from not having a steady dwelling may decrease the opportunity for sex; and second, previous studies have indicated that homeless suffer from multiple comorbidities, such as high rates of food-insecurity and health problems (Baggett et al., 2011; Lee & Greif, 2008), which may hinder their sexual interactions. In the present analysis, individuals in controlled environment settings also showed a decreased likelihood of risky drinking, any drug use, and club drug use compared to stably housed persons. This is not unexpected, given that they are likely to have reduced access to substances while incarcerated or engaged in treatment.

We found no increased risk of substance use, sexual risk behaviors or indirect effects through substance use for homeless participants or those in controlled environments. The results also suggested that they were less likely to access drugs or engage in sexual risk behaviors compared to stably housed individuals. Since there

were fewer individuals in these two categories, however, we may have lower power to detect significant mediation effects. In addition, though non-significant, participants who were homeless or living in controlled environments reported higher problematic drug use scores compared to stably housed individuals. Therefore, while being homeless or in a controlled environment may limit the opportunity for substance use and engaging in sex, these participants have a history of elevated substance use risk.

Limitations

Our study findings should be interpreted in light of several limitations. First, individual characteristics were determined on the basis of self-report. Responses to questions related to sensitive topics may be subject to response bias and social desirability bias. However, questions were administered in an ACASI format, which has been shown to be more reliable than face-to-face interviews (Ghanem, Hutton, Zenilman, Zimba, & Erbelding, 2005). Second, the cross-sectional design of the study limits our ability to assess the causal relationships between housing status and sexual risk behaviors. Our conceptual model examines the causal association between housing status and substance use problems, despite the knowledge that substance use problems could have precipitated unstable housing or homelessness (Zerger, 2002). Third, we did not include mental health problem measures in the analysis to determine if severe psychotic symptoms may have affected the mediation model. Fourth, despite the multi-site design and large sample size, the original study was not designed to evaluate the role of housing. Therefore, results may not be generalizable to other populations or other settings. In addition, the sample included individuals recruited at all types of treatment programs including outpatient methadone/narcotic replacement, outpatient counseling, residential, and partial hospitalization or intensive outpatient. Participants could also have been seeking or receiving services in SUD treatment programs at the time of our study. However, time and duration of enrollment was not known and cannot be controlled in the analyses. Furthermore, data were collected over 10 years ago and findings may not generalize to the present time suggesting this study should be replicated. Finally, the small numbers of participants who were homeless or living in controlled environments and the small numbers within certain substance use categories may have yielded insufficient power to determine potential mediation effects.

Conclusion

In summary, there were mixed results regarding the association between housing status and substance use and sexual risk behaviors. We found elevated rates of problematic drug use, cocaine use, and sexual risk behaviors, including having multiple condomless sex partners, condomless sex with non-primary partners and partners of unknown HIV status among unstably housed individuals compared to those who were stably housed. Our results also highlighted that being unstably housed was

indirectly related to an increased risk of engaging in several particular sexual risk behaviors and this relationship was mediated by drug use, particularly use cocaine, opioids, or marijuana. However, we found no increased risk of drug use, or sexual risk behaviors among homeless participants and those in controlled environments, perhaps due to their relatively low numbers. It is therefore important to conduct additional research specifically designed to assess the relationship between housing and substance use and sexual risk behaviors among SUD treatment populations in order to ensure adequate power. This paper shows that unstably housed individuals have increased levels of substance use, which, in turn, is associated with sexual risk behaviors. These relationships can help inform interventions aimed at assessing and ameliorating sexual risk behaviors for individuals currently seeking or receiving services in SUD treatment programs.

Compliance With Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Research Involving Human Participants and/or Animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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Affiliations

Yue Pan¹ [ORCID] **· Lisa R. Metsch² · Weize Wang³ · Morgan Philbin²,⁴ · Tiffany L. Kyle⁵ · Lauren K. Gooden² · Daniel J. Feaster¹**

Lisa R. Metsch
lm2892@cumc.columbia.edu

Weize Wang
wwang033@fiu.edu

Morgan Philbin
mp3243@cumc.columbia.edu

Tiffany L. Kyle
Tiffany.Kyle@aspirehp.org

Lauren K. Gooden
lkg2129@cumc.columbia.edu

Daniel J. Feaster
DFeaster@biostat.med.miami.edu

¹ Department of Public Health Sciences, University of Miami Miller School of Medicine, Clinical Research Building, Room 1034, 1120 N.W. 14th ST, Miami, FL 33136, USA

² Department of Sociomedical Sciences, Mailman School of Public Health, Columbia University, New York, NY, USA

³ Department of Biostatistics, Center for Research on US Latino HIV/AIDS and Drug Abuse, Robert Stempel College of Public Health & Social Work, Florida International University, Miami, FL, USA

⁴ The HIV Center for Clinical and Behavioral Studies, New York State Psychiatric Institute, Columbia University, New York, NY, USA

⁵ Aspire Health Partners, 5151 Adanson Street, Orlando, FL, USA