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ORIGINAL PAPER

Drug use Discrimination Predicts Formation of High-Risk Social Networks: Examining Social Pathways of Discrimination

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Abstract Experiences of discrimination, or social marginalization and ostracism, may lead to the formation of social networks characterized by inequality. For example, those who experience discrimination may be more likely to develop drug use and sexual partnerships with others who are at increased risk for HIV compared to those without experiences of discrimination. This is critical as engaging in risk behaviors with others who are more likely to be HIV positive can increase one's risk of HIV. We used log-binomial regression models to examine the relationship between drug use, racial and incarceration discrimination with changes in the composition of one's risk network among 502 persons who use drugs. We examined both absolute and proportional changes with respect to sex partners, drug use partners, and injecting partners, after accounting for individual risk behaviors. At baseline, participants were predominately male (70%), black or Latino (91%), un-married (85%), and used crack (64%). Among those followed-up (67%), having experienced discrimination due to drug use was significantly related to increases in the absolute number of sex networks and drug networks over time. No types of discrimination were related to changes in the proportion of high-risk network members. Discrimination may increase one's risk of HIV acquisition by leading them to preferentially form risk relationships with higher-risk individuals, thereby perpetuating racial and ethnic inequities in HIV. Future social network studies and behavioral interventions should consider whether social discrimination plays a role in HIV transmission.

Keywords HIV · Social networks · Discrimination · Substance use · Racial/ethnic inequities

Introduction

Research has not fully considered the underlying drivers of racial and ethnic inequities in HIV transmission. It is well documented that racial/ethnic minorities compared to whites are less likely to engage in high-risk behaviors including unprotected sex and needle sharing [1–4]. For example, about 3% fewer blacks compared to whites engaged in unprotected sex and shared needles [4]. Thus, we desperately need to better understand why racial/ethnic minorities acquire HIV at a higher rate than their white counterparts. A large body of literature on social networks has shown that network size, one's position within the network, proportion of risk partners in one's network and social norms are associated with HIV and higher-risk behaviors [5–8]. But, these characteristics fail to fully explain how racial and ethnic inequities in HIV prevalence and incidence persist. Racial assortative mixing, or sexual mating patterns based on racial homophily, however, has been shown to partially

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explain racial and ethnic inequities in HIV [1, 9, 10]. The central hypothesis of racial assortative mating is that even when risk behaviors with network members are infrequent, rare occasions of risky behaviors with higher risk network members such as those from communities with a higher baseline prevalence of HIV, could contribute to the observed racial and ethnic inequities in HIV [1]. In fact, data from Laumann and Youm showed that blacks are five times more likely to have a sexual partner in the core of the social network where infection with HIV is more likely [1]. In other words, those who are disproportionately linked to higher risk drug use and sexual partners will be at increased risk for acquiring HIV, even when the number of risk partners is low. But, the process that leads blacks to have higher risk partners is unclear.

Homophily, or the tendency of individuals to associate with others who have similar characteristics such as race, is a core feature of understanding social relationships [11]. Most examinations of homophily have been limited to demographic (i.e., race/ethnicity, age, social status) and behavioral (i.e., substance use, occupation) similarities. But, homophily based on stressful life events that require individuals to adapt to alternative lifestyles is under explored [12]. There is a consensus that the aggregation of individuals with similar social standings can hamper the diffusion of information and resources to foster social inequality [13]. Kadushin argues that people who are often targeted for discrimination will maintain disadvantaged social networks that lead to inequality [14]. Decades of research have shown that racial and ethnic minorities are significantly more likely to experience discrimination or social marginalization, ostracism and poor treatment due to stigmatization on the basis of race and/or ethnicity [15, 16]. Yet, we do not fully understand how experiences of discrimination shape the HIV risk environment.

Most racial discrimination research has examined discrimination as a psychological stressor and sought to explain how the stressor influences mental and physical health outcomes [17, 18]. Since HIV risk behaviors are not higher among minorities or those that experience racial discrimination [19], other *social* pathways may be operating to influence disparities in HIV because of experiences of discrimination. We argue that experiences of discrimination or unfair treatment that results from stigma or membership in a marginalized group such as a racial minority, person who uses drugs (PWUD), or felons [20, 21] socially exclude individuals from relationships with important health benefits and result in more relationships with people who are marginalized and have a higher risk for HIV (Fig. 1). While these high-risk relationships may confer some support through a common understanding of marginalization [22] they also (1) increase the risk of disease if the baseline HIV prevalence is higher in the marginalized group and (2) replace critical protective resources (i.e., employment, social services) potentially available in lower-risk relationships [23, 24]. For example, if an individual is treated poorly because of their drug use in a medical setting, this might influence their decisions to self-medicate, which could increase the number of people in their network that they use drugs with or that know how to access drugs. Another example is someone who is denied employment because they have been previously incarcerated. In this case, a lack of formal employment might lead to illegal sources of income through transactional sex or stealing that could shape an entirely different set of relationships than if the same person not been treated negatively in an employment setting. Indeed, recent cross-sectional evidence has shown that lifetime discrimination because of one's race and drug use is significantly related to more high-risk relationships [24].

Most studies that have examined *changes* in social networks have been among *older adults* and *adolescents*. Studies among adults have shown positive effects of increases in the number of social networks related to lower mortality [25], fewer depressive symptoms [26], and better functional and self-rated health [26]. These studies conceptualize the addition of network members leading to improvements in social capital and social cohesion. Among adolescents, however, studies have shown that newly formed relationships are characterized by similar risky behaviors and add to "collective risk" [27]. Substance use research has shown that in order to improve substance use outcomes, breakages with high-risk social networks are needed [28]. Thus, PWUD who experience discrimination may need targeted intervention strategies that reduce their networks who have high HIV risk.

The purpose of this analysis is to address gaps in the social network and discrimination literatures by examining social mechanisms that link experiences of discrimination with higher HIV risk. We hypothesize that because of the degrading nature of discrimination, individuals who are added to the network will be higher risk and potentially pose health consequences rather than advantages. This analysis builds on the evidence linking discrimination and social networks by testing whether recent (i.e., past 6 months), rather than lifetime, experiences of discrimination influence the formation of relationships with higher-risk individuals (e.g., individuals who use drugs, have multiple sexual partners, or who have recently been incarcerated) over a 6-month period. We focus on discrimination based on race/ethnicity, perceived or actual history of drug use, and prior incarceration because they are most relevant to urban, drug using populations [29, 30]. We hypothesize that experiencing any of these forms of discrimination will be positively associated with an increase in the number and proportion of high-risk network members over time.

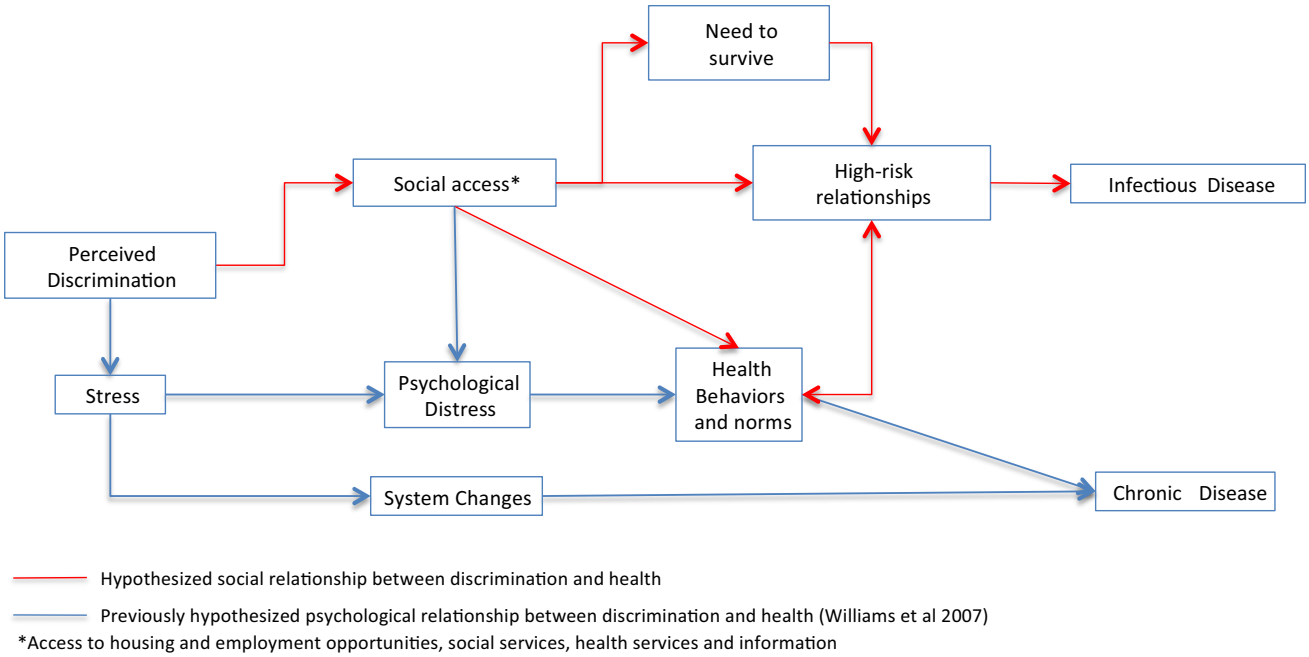

Fig. 1 Social mechanisms through which perceived discrimination might exert effects on health

Methods

The Social Ties Associated with Risk of Transition (START) study includes a prospective cohort of persons who use non-injection drugs followed up every 6 months for 18 months. The institutional review board of the New York Academy of Medicine approved this study and the researchers obtained a Certificate of Confidentiality.

Recruitment

Participants were recruited between July 2006 and June 2009 using targeted street outreach (TSO) and respondent driven sampling (RDS) strategies. Methods have been described in detail elsewhere [31–33]. In brief, TSO was conducted in five ethnographically mapped New York City neighborhoods with high drug use activity: Harlem, Lower East Side, South Bronx, Jamaica-Queens and Bedford-Stuyvesant-Brooklyn. We supplemented TSO with RDS, a chain-referral sampling referral strategy, to increase sample diversity. Additional details of the sampling procedures have been published previously [31–33].

Sample

Participants were eligible for participation if they reported non-injection use of heroin, crack or cocaine for 1 year or more and reported using at least two to three times a week in the past 3 months. Drug use for each participant was verified with a rapid drug test that detected opiate and cocaine metabolites in the urine.

Data Collection

All participants completed face-to-face, interviewer-administered 90-minute baseline and 60-minute 6-month, 12-month and 18-month questionnaires in a centrally located research storefront. Consistent with public health critical race praxis guidelines [34, 35], the study interviewers were residents of the communities from which participants were recruited. Some interviewers were formerly incarcerated and/or former substance users who received intensive training in interviewing, recruiting and retention by the study principal investigator and graduate-level staff members. Previous investigations have shown that interviewers with similar identities as the respondents can reduce reporting biases in some, though not all cases [36].

Study Instruments

The survey questionnaires assessed demographic, behavioral and social network information. Detailed methods of the social network inventory have been described previously [37]. In brief, the baseline assessment included information on social network relationships in the past year and experiences of discrimination over the past 6-months, while the follow-up surveys collected information on social

network members in the past 6 months (since the previous assessment). Participants were compensated 30 dollars and round trip public transportation fare for completing each survey.

Measures

Outcomes: Change in the Number and Proportion of Network Members

At baseline, participants were asked to provide the names of up to ten people in their personal network during the last year for each of eight different name-generating questions. This recall technique has been shown to yield valid responses over a 10-year period [38, 39]. Individuals were then asked to report the socio-demographic characteristics and risk behaviors for each individual listed. At the 6-month follow-up interview, participants were asked to provide the names of up to ten network members during the past 6 months for each of the same name-generating questions used in the baseline survey. After providing a list of names, individuals were asked to report demographic and behavioral risk characteristics over the past 6 months for each individual named. Of note, although name data was collected in the survey, our IRB required that the name data be discarded after data collection and were not used in the analyses. We created three outcome measures: number of sex networks, number of drug use networks and number of injecting network members. Sex networks were defined as the total number of networks the participant had sex with in the past year. Drug networks were defined as the total number of networks the participant used drugs with in the past year. And injecting network members were defined as the total number of network members who the participant reported injecting drugs in the past year. Injecting network members were assessed separately from drug partners because these networks represent a group with higher risk of disease transmission in the event of an exposure [40]. Hereafter each social network outcome will be referred to as sex, drug and injecting networks, respectively.

For this analysis, we examined changes in the absolute number and proportion of all sex, drug and injecting networks from 1 year prior to study entry to the 6-months follow-up interview. We also assessed changes in the overall number of network members listed at each time point. Absolute changes were calculated by subtracting the number of each specific type of network member listed in the baseline survey from the number listed at the 6-months follow-up. This measure provides information on whether an increase or decrease in a specific type of risk (e.g., sexual or drug use risk behavior) has occurred in the network regardless of any latent increases and decreases in the overall network size. Proportional changes were calculated by taking the difference in the proportion of a specific type of network member (e.g., sex, drug, or incarcerated network member) relative to the overall network size between baseline and the 6-months follow-up assessments. Therefore proportional changes denoted fluctuations in the relative composition of risk in the network.

Exposures

Self-reported discrimination exposures due to race, drug use and incarceration in the past 6 months were the three main exposures of interest. Incarceration discrimination was limited to individuals who reported ever spending time in jail or prison (n = 237). Each form of discrimination was self-reported in response to a one-item stem question that was modified from previous discrimination studies for use with populations who use drugs [29, 41]. The question asked: "In the past 6 months, have you ever been discriminated against, prevented from doing something, or been hassled or made to feel inferior because of any of the following?" Participants could respond yes or no to an experience of discrimination by age, race, sex (gender), sexual orientation, poverty, drug use, having been in jail or prison, religion, mental illness, physical illness or other attribute.

Covariates

In this analysis, we assessed the impact of various individual-level demographic, substance use, social and sexual risk behavior characteristics that may have confounded the relationship between discrimination and changes in one's network, based on previous literature assessing these cross-sectional relationships. Individual-level demographic characteristics included age (continuous), race/ethnicity (Hispanic, black and white/other), gender (female/male), education (less than high school education/general equivalency degree (GED), high school education or more), legal income (less than or equal to $5000 per year/greater than $5000 per year) marital status (married/unmarried) and sampling strategy (RDS/TSO). Substance use characteristics included primary drug used (powder cocaine, crack cocaine, heroin or poly drug use all types equally) and drug treatment enrollment in the past 6 months (yes/no). Recent (in the past 6 months) social risk behaviors included homelessness (yes/no) and arrest (yes/no). We also assessed recent HIV testing (yes/no) and recent depression status (yes/no) which was ascertained using four questions from the composite international diagnostic interview (CIDI) [42]. Recent depression was defined as having a period of at least 2 weeks when the participant (1) felt sad, depressed or empty most of the time and (2) lost interest in most things or got no pleasure from things which

usually made them happy. Additionally, the participant had to report thinking about committing suicide or trying to end her/his own life in the past 6 months. Finally, baseline sexual risk behavior characteristics included number of female sex partners (continuous), number of male partners (continuous), age at sexual debut (continuous), self-reported HIV positive status (yes/no), lifetime HIV testing frequency (≤3/≥4 times), and 100% condom use (yes/no).

Statistical Analysis

Descriptive statistics including medians and interquartile ranges for continuous variables and frequencies for categorical variables were generated to characterize the sample. We report the mean and standard deviation for the change in the number and proportion of network members reported at the baseline and 6-month interviews. *T* tests were performed to determine whether differences in the mean change in the number and proportion of risk network members was significantly different for those with and without each type of discrimination. All significant covariates ($p < 0.05$ in bivariate analyses) were included in the final adjusted model. Unadjusted and adjusted log-binomial regression models were performed to assess the relationship between experiences with each form of discrimination and changes in the number and proportion of sex partners, drug use partners, and injecting network members. All models controlled for age, race/ethnicity and gender regardless of significance in the bivariate analysis. In preliminary analyses [37], we confirmed that there were no differences in changes in the proportion of risk network members by recruitment strategy of RDS versus TSO. Moreover, because the weighted and un-weighted RDS estimates yielded no difference and because there is no comparable weighting strategy for TSO, we did not adjust the models for recruitment strategy nor apply sample weights to the RDS sample [43]. Although we considered the measure of recent discrimination exposures more relevant for short-term changes in social relationships, as a sensitivity analysis we also examined the relationship between discrimination and changes in the number and proportion of risk network members at the 12- and 18-months follow-up periods (Appendix 1).

Results

Characteristics of the sample at baseline and over time are shown in Table 1. Five hundred and two persons who use non-injection drugs were enrolled at baseline; 67% of the sample completed a 6-month follow-up survey (n = 336). The median age of the sample at baseline was 35 years. Most participants were male, black or Latino, made ≤$5000 in legal income, un-married, primarily used crack, and recruited through RDS (vs.TSO). Half of the sample did not have a high school degree, and about one-third experienced a recent depressive episode. At the 6-month follow-up, most participants reported having received an HIV test since baseline, nearly a quarter had enrolled in drug treatment since baseline, nearly half had been homeless since baseline, and approximately a third had been arrested since baseline. No differences between those retained and lost to follow-up at the 6-months visit were seen with respect to sex, education, income, marital status or reports of any time of discrimination. Participants who were loss to follow-up and thus not included in this analysis were younger, more likely to be Latino, heroin or poly drug users and HIV negative.

Recent reports of discrimination varied by the type of discrimination reported. About 9% percent reported experiencing recent racial discrimination, 16.80% reported experiencing recent drug use discrimination, and 10.71% reported experiencing recent incarceration discrimination (Table 1). Baseline and 6-month changes in the number and proportion of risk network members are shown in Table 2. At baseline, participants had an average of 3.80 people in their entire social network. Of those, an average of 1.45 individuals represented sex partners, 1.15 represented drug use partners, and <1.0 represented network members who inject drugs. Between the baseline and 6 month follow-up assessments, the average number of sex partners increased by 0.04 individuals, drug use partners increased an average of 0.02 individuals, and injecting network members decreased by an average of 0.02 individuals. The proportion of sex and drug partners reported at the 6-month follow-up assessment was 3% less than the proportion reported at baseline. Very small changes were seen in the proportion of network members who injected drugs. Overall, these changes reflect network fluctuations of ±2 network members over a 6-month period.

The relationships between any discrimination exposures and changes in the absolute number and proportion of risk network members are shown in Tables 3 and 4. Experiencing discrimination due to drug use in the 6 months prior to the study baseline was significantly associated with changes in the absolute number of sex partners (adjusted incidence rate ratio [AIRR] 1.92; 95% confidence interval [CI] 1.08–3.39), drug using network members (AIRR 2.09; 95%CI 1.17–3.72) and network members who inject (AIRR 3.29 (95%CI 1.09–9.89), after controlling for sociodemographic characteristics. No forms of discrimination were related to changes in the proportion sex, drug using, or injecting network members.

We also examined the influence of discrimination on longer 12- and 18-months changes in the number and proportion of risk network members. There were no

Table 1 START sample characteristics for persons who use drugs (PWUD), NYC 2006–2009 (n = 333)

Baseline characteristics	n	Median (IQR)
Age	333	35 (30–38)
Female sex partners	332	1 (0–2)
Male sex partners	329	0 (0–1)
Age at sexual debut	329	14 (12–16)
	n	%
Baseline characteristics		
Race/ethnicity		
Hispanic	79	23.72
Black	227	67.17
White/other	27	8.11
Gender		
Female	113	33.93
Male	220	66.07
Education		
<High school	161	48.35
≥GED, High school or more	172	51.65
Legal Income (past year)		
≤5000	259	81.96
>$5000	57	18.04
Marital status		
Married	54	16.36
Un-married	276	83.64
Primary drug used		
Powder cocaine	36	11.46
Crack cocaine	215	68.47
Heroin	40	12.74
Poly drug use	23	7.32
Lifetime HIV testing frequency		
≤3 times	141	45.48
≥4 times	169	54.52
Past 6 months depression	98	29.43
Condom use	82	24.62
HIV Positive	43	13.87
Sampling strategy		
RDS	237	72.48
TSO	90	27.52
Recent racial discrimination	31	9.45
Recent drug use discrimination	51	15.55
Recent incarceration discrimination	33	14.29
Follow-up characteristics		
Past 6-months HIV testing		
Yes	247	74.70
No	85	25.60
Past 6-months drug treatment		
Yes	62	81.38
No	271	18.62
Past 6-months homelessness		
Yes	147	44.14
No	186	55.86
Past 6-months jail time		
Yes	65	34.76
No	122	65.24

significant relationships for any type of discrimination and changes in the number or proportion of risk network members of any type from baseline to 12 months or baseline to 18 months (Appendix 1).

Discussion

These findings help to illuminate how recent experiences of discrimination may influence the relationship formation of high HIV risk social networks, which has implications for understanding the social context of the U.S. epidemic. We observed an association between experiencing discrimination based on drug use and an increase in the number of sexual and drug use partners among a sample of majority Black and Latino PWUD in NYC, over time. We assessed both changes in the absolute number and proportion of risk network members between the baseline and 6-month visits. While discrimination prior to the baseline was associated with absolute changes in the number of high-risk network members, changes in the proportion of risk network members were not associated with discrimination prior to the baseline interview. The significant relationship for changes in the number but not proportion of network members highlights a critically important point about the dynamic nature of social networks and how we operationalize network change, particularly those of PWUD. While it is important to know the proportion of risk network members in one's network, such measures do not account for both in and out flow of people in one's network (Fig. 2). For example, in Fig. 2 (top) we see an increase in the number but not proportion of risk network members between visits. This pattern could be the result of one newly added risk network member or the addition of some and the loss of others for a net gain of one risk network member (Fig. 2 bottom). In these examples, it is important to understand that absolute changes in the number of risk network members provide information about new relationships and thus new opportunities for exposure to HIV that are developed regardless of changes in previous relationships.

Homophily by demographic and behavioral characteristics is well established in the literature [44–47]. Yet,

Table 2 Changes in the absolute number and proportion of sex, drug using, and injecting network members between baseline and 6 months among PWUD, NYC 2006–2009 (n = 333)

	Baseline Mean (standard deviation)	6-months	Average absolute change	Proportional change
Total network	3.80 (2.90)	3.95 (2.76)	0.14 (3.35)	–
Sex network members	1.49 (1.70)	1.52 (1.56)	0.04 (1.90)	−0.0283 (0.3359)
Drug network members	1.19 (1.39)	1.22 (1.60)	0.02 (1.93)	−0.0299 (0.3428)
Injecting network members	0.09 (0.44)	0.06 (0.29)	−0.02 (0.51)	0.0003 (0.068)

Table 3 Unadjusted and adjusted incidence rate ratios (and 95% confidence intervals) of the relationship between discrimination and changes in the *absolute* number of risk network members over 6 months among PWUD, NYC 2006–2009

	Sex network members[1]		Drug use network members[2]		Injecting network members[3]	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Racial discrimination	1.39 (0.67–2.86)	–	1.05 (0.50–2.21)	–	2.19 (0.44–10.91)	–
Drug use discrimination	1.89 (1.07–3.32)*	1.92 (1.08–3.39)*	2.10 (1.18–3.74)**	2.09 (1.17–3.72)**	2.41 (0.65–8.91)¥	3.29 (1.09–9.89)*
Incarceration discrimination[4]	1.25 (0.60–2.63)	–	1.02 (0.44–2.34)	–	0.48 (0.05–4.82)	–

Adjusted IRRs not computed where the unadjusted relationship was insignificant $p > 0.05$

¥ $p < 0.20$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[1] Adjusted for age, race, sex and number of male sex partners in the past 2 months

[2] Adjusted for age, race, sex and education

[3] Adjusted for age, race and sex

[4] Only includes those who reported spending time in jail or prison in their lifetime (n = 237)

Table 4 Unadjusted and adjusted incidence rate ratios (and 95% confidence intervals) of the relationship between discrimination experiences and changes in the *proportion* of risk network members between baseline and the six-month follow-up among PWUD, NYC 2006-2009

	Sex network members		Drug network members		Injecting network members	
Adjusted	Unadjusted Unadjusted		Adjusted Adjusted		Unadjusted	
Racial Discrimination	1.47 (0.54–3.99)	–	1.51 (0.55–4.20)	–	2.10 (0.11–40.56)	–
Drug use Discrimination (n =)	1.20 (0.50–2.88)	–	1.95 (0.84–4.50)	–	2.75 (0.25–30.14)	–
Incarceration Discrimination[1]	1.78 (0.69–4.61)	–	0.99 (0.23–4.14)	–	0.33 (0.00–136.56)	–

Adjusted IRRs not computed where the unadjusted relationship was insignificant $p > 0.05$

¥ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[1] Only includes those who reported spending time in jail or prison in their lifetime (n = 237)

few have empirically examined how and whether social experiences such as discrimination facilitate development of relationships. There are two overarching explanations for why individuals who experience discrimination have a higher likelihood of forming relationships with higher-risk individuals: *preference* (e.g., local choices such as individual desires) and *availability* (e.g., proximity to other marginalized individuals and global attributes such as geographic location) [48, 49].

With respect to preference, it is possible that marginalized individuals maintain relationships with other marginalized individuals as a means of coping with the negative treatment that their stigmatized group encounters [22]. Underlying this argument is the premise that individuals do in fact seek some value in their relationships, whether that be coping or financial stability, regardless of the consequences these relationships may pose. This warrants further investigation since experiences of

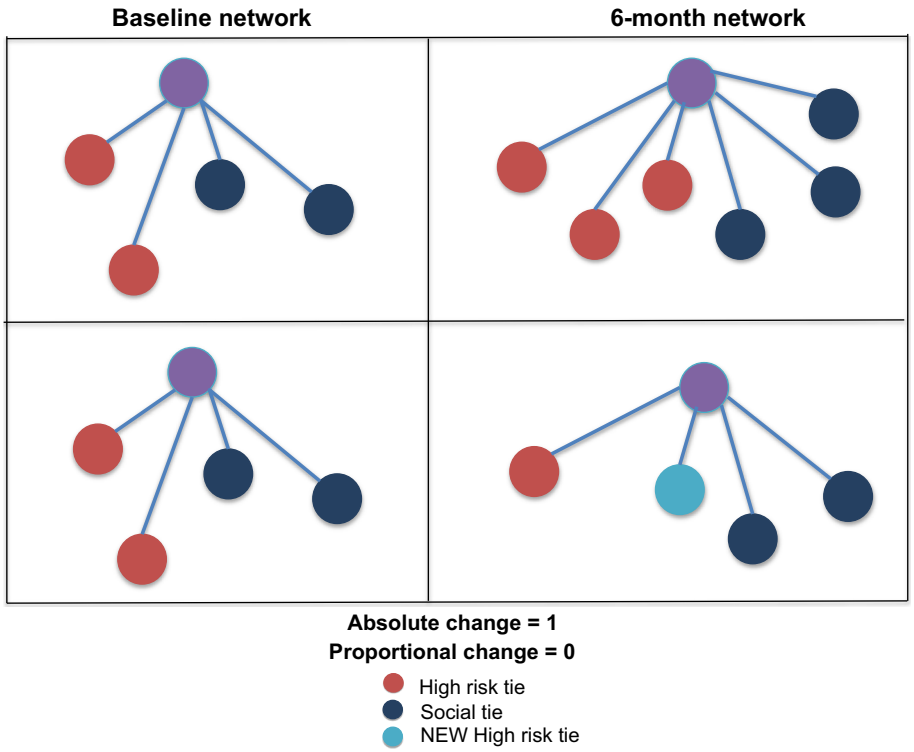

Fig. 2 Hypothetical depiction of change in absolute and proportional network members

discrimination may impede the success of peer driven and behavioral interventions that attempt to reduce HIV risk behaviors and transmission. Specifically, longer-term studies that can better disentangle the social and psychological benefits that these relationships confer are needed.

The limited availability and access to beneficial social relationships may be another driving force for how social networks are formed. According to Rothenberg and colleagues, geographic space creates a tangible limitation of physical boundaries for available relationships among PWUD [50]. However, we are aware of no evidence that similar geographic spaces and distances explain the relationship between discrimination and relationship formation. Earlier work on this topic provides evidence that both discrimination [24] and spatial context [51] may limit the type of risk relationships that can be developed, but these examinations were limited to cross-sectional analyses. Future studies should examine the combined effect of discrimination and geographic availability on the formation of high-risk relationships.

Loss to follow-up is a limitation of this analysis. Non-response due to loss to follow-up may have under or over estimated the results of this study. While the 18-month follow-up rate of this study was higher, the one-item stem question used to assess discrimination required assessment of short-term changes in network composition [18]. We assessed the relationship between our measure of recent discrimination with changes in network composition over a 12 and 18-month period and did not find a significant relationship. Chronic experiences of discrimination may impact longer-term changes in relationship formation and dissolution, and this warrants investigation. Our measure of discrimination is limited in that it does not capture the frequency, intensity or salience of the type of discrimination experienced. It is also possible that individuals from multiple disadvantaged groups have difficulty assigning which identity was the source of the discrimination they experienced, which may affect their reporting in this study. Other self-reporting biases may have resulted in under-reporting of discrimination experiences, sex and drug use behaviors and the number of risk network members, which may have resulted in an underestimation of the true effect since differences in their report of networks were non-differential by discrimination exposures. Moreover, participant reports of their network members' injection drug use behaviors may have been inaccurate and this could result in an under or over estimation of the true effect. While more of a nuisance than a limitation, unique identifiers for each named network member had to be discarded and could not be used to discern which network members were present at both time points and newly formed or dissolved at the follow-up surveys. Therefore these results reflect either a change in the "role" of the same network member named at baseline and follow-up or the addition of a "new" relationship formed between the baseline visit and the 6-month follow-up visit.

The findings suggest discrimination based on perceived or actual drug use may be important for understanding how PWUD form relationships with higher risk individuals. Future research should explore whether network-level interventions, rather than interventions that tackle individual-level behavior may be more impactful for reducing racial and ethnic inequities in HIV [52]. Exploring ways to mitigate the negative effects of discrimination, particularly with respect to the formation of higher-risk relationships, could include mental health and social services training for individuals who are members of high-risk networks.

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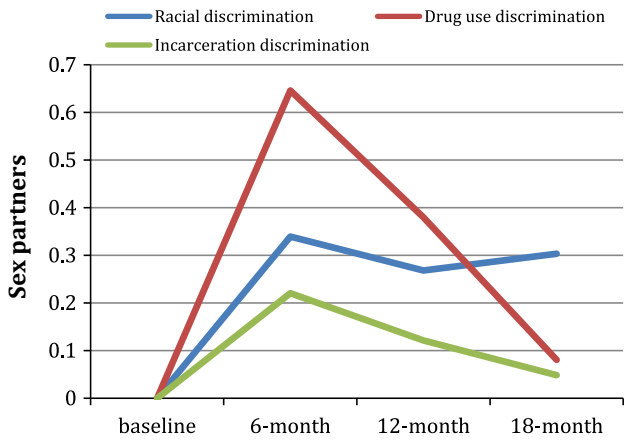
Compliance with Ethical Standards

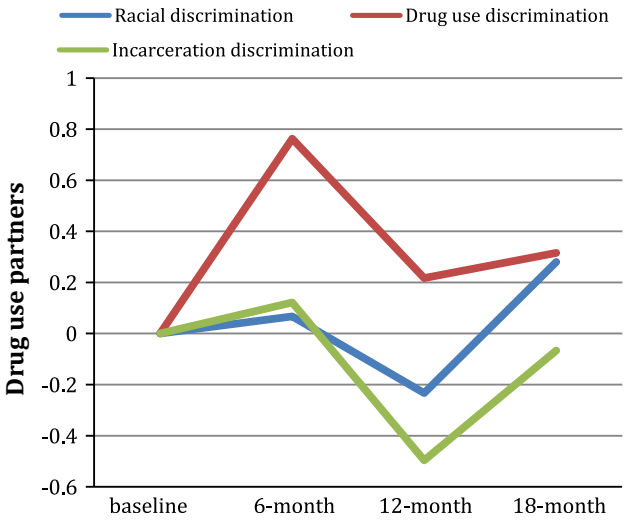
Conflict of interest There are no conflicts of interest to disclose.

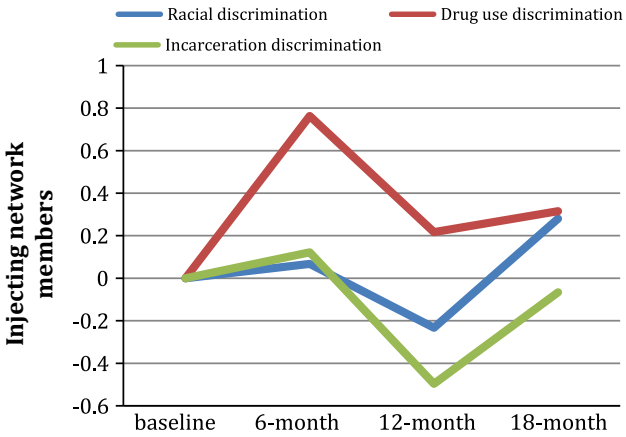
Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional review board of the New York Academy of Medicine and Columbia University Medical Center.

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

Appendix 1: The relationship between experiences of discrimination and changes in the *absolute* number of risk network members over 6, 12 and 18 months among PWUD, NYC 2006–2009







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