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Individual, network, and neighborhood correlates of exchange sex among female non-injection drug users in Baltimore, MD (2005–2007)

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Abstract

The “HIV risk environment” has been characterized as a dynamic interplay between structural and network factors. However, most HIV prevention research has not examined the independent and combined impact of network and structural factors. We aimed to identify individual, network, and neighborhood correlates of exchange sex (1 exchange sex partner, past 90 days) among female non-injection drug users (NIDUs). We used baseline data from 417 NIDUs enrolled in a randomized HIV prevention trial in Baltimore (2005–2007). Surveys ascertained demographic variables, drug/sex risk behaviors, neighborhood perceptions, and social/sexual network characteristics. Correlates of exchange sex were identified with descriptive statistics and log-binomial regression. Our findings suggest that sex and drug relationships among female NIDUs are interlinked and may be difficult to modify without altering social norms. Strengthening ties that provide social support but not drug support and reducing ties that provide both drug and social support may facilitate reductions in individual-level HIV-risk behaviors.

Keywords

Exchange sex; social networks; neighborhood disorder; non-injection drug use; health disparities

INTRODUCTION

Link and Phelan’s seminal paper distinguished between proximal (individual-level) and distal (social/structural) causes of disease, and urged social scientists to contextualize individual-level risk factors in order to determine which social/structural factors shape individual-level risk behaviors [1]. Researchers have since acknowledged the important role that the “risk environment” plays in HIV transmission and prevention through its influence on individual-level risk behaviors [2–7]. More recently, Rhodes and colleagues described the “HIV risk environment” as a dynamic interplay between structural and network factors [8]. Other HIV behavioral intervention researchers have identified three levels that interact with one another to shape HIV-related behaviors: individual, structural, and interpersonal [9]. Drug- and sex-related individual-level risk factors for HIV have been extensively

studied and are well-characterized. From a structural perspective, racial/ethnic disparities in HIV prevalence estimates across the United States (and in a variety of different target populations) can in part be explained by neighborhood-level socioeconomic differences and structural processes which perpetuate health disparities [10–14]. At the interpersonal level, gender disparities in HIV prevalence among drug users may reflect the fact that network influences on individual-level risk behaviors may be more pronounced among females compared with males [15].

Individual-level correlates of exchange sex

Exchanging sex for money and drugs is a high-risk individual-level sexual behavior that has been associated with HIV transmission and it has been commonly reported among female non-injection drug users (NIDUs), particularly those who use crack cocaine [16, 17]. Prior studies have also demonstrated associations between exchanging sex and homelessness [18], housing instability [19, 20], psychiatric co-morbidities [21–24], and poverty [25–27]. As others have suggested [1, 8], it is important to also consider more distal correlates of exchange sex and consequently HIV transmission.

Neighborhood correlates of exchange sex

Structural factors such as neighborhood disorder (increased social incivilities and physical decay) can serve as distal causes of HIV transmission through their influence on individual-level drug and sex behaviors, such as exchange sex, which facilitate disease transmission. For example, neighborhood disorder [28–31] has been associated with poor mental health among inner city residents, including those with a history of drug use [25, 32–34]. Neighborhood disorder has also been associated with drug use and high-risk sexual behaviors, including exchange sex [8, 25, 35–38]. Additionally, the isolation of neighborhoods with poor contextual conditions has been hypothesized to further inhibit positive health behavior changes among residents in those neighborhoods [39].

Network correlates of exchange sex

Based on social influence, social capital, and social support theories, social network characteristics and social norms can also be considered distal causes of HIV transmission via their influence on individual-level drug/sex risk behaviors (e.g., exchange sex). While risk networks consist of those engaged in risk behaviors, social networks are comprised of those providing social support. Among both men and women, those with a greater proportion of high-risk network members reported higher risk sex/drug use practices [15]. Multiplexity (the extent that network members play multiple roles) may also permit HIV and risk behaviors to flow more easily through networks [40, 41]. In a study among Baltimore IDUs, 64% had overlapping risk and social networks and multiplexity was associated with more frequent injection drug use [42]. The influence of having multiplex networks may be more pronounced among female drug users because 1) the overlap between risk and social networks may be higher for women than for men who use drugs [15] and 2) having more multiplex ties may reduce a woman's ability to adopt and maintain safer HIV-related risk behaviors, particularly if those multiplex network members have high-risk behaviors [43].

The social norms within risk networks have also been associated with drug-related risk behaviors and outcomes (e.g., sharing needles [44–48], using syringe exchange programs [49], and drug overdose [50]) and sexual risk behaviors. For example, increased crack use and alcohol use among network members were associated with higher-risk sex behaviors among index participants [51]. Another study among NIDUs showed that those reporting multiple sex partners reported receiving drug or housing support from network members and having larger social networks with more drug using network members and more sex network

members [19]. In another study, those reporting high-risk sexual behaviors reported having more network members who used, provided, or received drugs [20].

The identification of network and neighborhood characteristics that confer risk is needed to 1) better understand the dynamics of health disparities and 2) guide the development of interventions that alter the structural environment and social norms/ties to promote healthier behaviors and reduce disease transmission. This analysis aimed to examine the individual, network, and neighborhood correlates of exchange sex among a sample of female NIDUs in Baltimore, Maryland. We examined two critical social contextual factors: neighborhood disorder and social/risk networks. As networks are more proximal, we hypothesized that when examined together in the same model, the influence of network factors would be stronger than the influence of neighborhood factors on exchange sex.

METHODS

The data for this analysis are from CHAT, a randomized HIV prevention trial targeting urban HIV-at-risk women and their social network members in Baltimore, Maryland. CHAT methods have been previously described [20, 52–54]. In brief, index participants were recruited through targeted street outreach, posted flyers, and referrals from local health clinics and community agencies, and were randomly assigned to a peer educator training or control condition. Eligible index participants were females (18–55 years of age) who had not injected drugs in the past 6 months, self-reported heterosexual sex in the past 6 months, and had 1 of the following sexual risk factors: (a) >2 sex partners in the past 6 months, (b) STD diagnosis in the past 6 months, or (c) a high-risk sex partner in the past 90 days (i.e., injected heroin or cocaine, smoked crack, HIV seropositive, or a man who had sex with men). After providing informed consent, eligible participants completed a baseline interview and were asked to invite their network members to participate in the study. As the eligibility criteria and method of recruitment for index and network participants differed, this analysis was restricted to female, non-injecting index participants (N=417).

Baseline data were collected between September 2005 and July 2007. Participants completed a baseline survey which was administered through trained interviewers and Audio Computer Assisted Software (ACASI) and were compensated \$35. Surveys assessed demographic variables, drug use/sex behaviors, perceptions of neighborhood conditions, and social network characteristics. Participants also provided oral specimens to test for HIV antibodies using the Orasure collection device and cocaine and heroin metabolites using Intercept (Orasure Technologies, Inc.). The Johns Hopkins Bloomberg School of Public Health Institutional Review Board approved all protocols.

Measures

Outcome (Exchange Sex)—Participants were asked “How many people did you have sex with in the past 90 days?” and then “How many of these do you consider exchange partners?” An exchange partner was defined as “someone you have sex with in exchange for food, money, shelter, or drugs”. A variable for exchange sex was created (those listing 1 vs. zero exchange partners in the past 90 days).

Individual-level variables—Demographic variables were assessed using face-to-face interviews with a trained interviewer and drug use behaviors were collected through ACASI. Individual-level variables included in this analysis were categorized as follows: age (continuous), race (African American vs. other), incarceration in the past 6 months (yes vs. no), weekly alcohol use (yes vs. no), employment status in the past 6 months (employed vs. unemployed), HIV status (positive vs. negative), marital status (married/in a committed relationship vs. single or separated), current main sex partner (yes vs. no), cocaine

metabolites (positive vs. negative), opiate metabolites (positive vs. negative), education (high school diploma or General Educational Development (GED)) (yes vs. no), heroin use (any route of transmission) in the past 6 months (yes vs. no), crack/cocaine use (any route of transmission) in the past 6 months (yes vs. no), and homelessness in the past 6 months (yes vs. no).

Social Network Variables—Participants provided the first name and last initial for each individual listed in response to 19 questions, such as “During the last 6 months, who could you talk to about things that were personal and private?” or “Who could you get advice from?”. The total number of unique individuals listed in the network inventory was the “overall network size”. Participants were then asked to provide information about each unique individual (i.e., demographic variables, relationship type (e.g., friend, relative, neighbor, sex partner), length of relationship, trust (ranging from 1- “don’t trust at all” to 10- “trust with my life”), employment status, drug use in the past 6 months, and incarceration history). To account for varying sized social networks and significant differences in overall network size by exchange sex, absolute counts of network members were converted to proportions using the “overall network size” as the denominator. Social network characteristics hypothesized to be correlated with exchange sex among index participants included the proportion of network members who provided the index with 1) emotional support (talked to index about things that were personal or private, or gave her advice), financial support (provided index participant with money or valuable items), or housing support (would let the index stay at his/her place). Other social network characteristics hypothesized to be correlated with exchange sex among index participants included the proportion of network members who 1) used drugs or provided drug support for the index participant, 2) had sex with the index participant and 3) lived in the same neighborhood (shared structural environment) as the index participant. Drug support networks were defined as those whom the index 1) could count on for drugs if she were going through withdrawal, 2) used heroin, crack, or cocaine with in the past 6 months, or 3) could usually count on for a blast if she didn’t have money or drugs. Two additional variables were created for 1) network members who provided both social support and drug support and 2) network members who provided social support but not drug support. Network members providing social support (more broadly) were defined as those who 1) she talked to about things that were personal and private or who she got advice from, 2) pitched in to help her do things that she needed some help with, 3) loaned her money or something valuable that she needed, 4) she entrusted with money to get groceries, pay her bills, or run her errands, 5) she socialized with, or 6) she asked for advice or help about health problems.

Sexual Network Variables—Sexual behaviors in the past 90 days were collected via ACASI. Participants reported the total number and type(s) of sex partners (main, casual, exchange) in the prior 90 days. To account for varying sized sexual networks and significant differences in the sexual network size by exchange sex, we created sexual network member proportion variables using the total number of sex network members in the last 90 days as the denominator. Sexual network characteristics hypothesized to be correlated with exchange sex among index participants included: 1) seeing sexual network member(s) more frequently, 2) having sexual network member(s) who also provided emotional support, 3) having sexual network member(s) with whom she felt comfortable talking about STD testing and 4) having sexual network member(s) who a) were previously incarcerated, b) had used heroin, crack or cocaine in the past 6 months and c) had other sexual partners.

Neighborhood (Block-level) Variables—A 10-item, 3 point neighborhood scale [55] was administered. Participants were asked if the following items were “not a problem”, “somewhat of a problem”, or “a big problem” on their block: vandalism, vacant housing,

people who don't keep up their property or yards, people who say insulting things or bother other people when they walk down the street, litter/trash in the streets, groups of teenagers hanging out on the street, people fighting and arguing, burglary, people selling drugs, or people getting robbed or beaten up on the street. The 10 items were summed to create a score, with higher scores indicating more negative perceptions of one's neighborhood. This score was then standardized by z-score, yielding a normally distributed scale.

Analysis—Descriptive statistics were used to characterize the sample. Because 13 network proportion variables shared the same denominator (overall network size), we evaluated their significance using a more conservative approach that accounted for multiple comparisons with a Bonferroni correction. The significance-level for this family of tests (overall network proportions) was set at 0.05. Consequently, the Bonferroni corrected alpha-level for each individual test was $0.05/13$ ($\alpha = 0.004$). Similarly, as 6 sex network variables shared the same denominator (number of sex networks in the past 90 days), the corrected alpha-level for each individual test was $0.05/6$ ($\alpha = 0.008$).

Because the prevalence of exchange sex was high (31%), we used log-binomial regression models. A final multivariable model was built to examine the independent correlates of exchange sex. Because of its theorized importance, the standardized neighborhood disorder scale variable was forced into the multivariable model regardless of its significance. Other variables were selected for inclusion in the final model based on their significance (alpha-level > 0.05 or Bonferroni corrected alpha-level $> 0.05/n$) in the unadjusted models or because of their hypothesized importance based on prior literature. For example, priority was given to drug support and social support variables. Variables that were not significant using the more conservative Bonferroni corrected alpha-level after adjusting for other covariates were not retained in the multivariable model.

RESULTS

Overall (Table I), the sample was predominately African American (96.9%), the median age was 42 years (IQR:38–47), 10.8% reported being HIV positive, and 30.7% reported 1 exchange sex partner in the last 90 days. With respect to network characteristics, the median network size was 8 (IQR:6–11) and the median number of sex network members in the past 90 days was 1 (IQR:1–2). With respect to neighborhood characteristics, women reported living in their current neighborhood for a median of 12 months (IQR:4–60) and 65.1% reported spending most/all of their time in that neighborhood. When asked about the problems on their block, more than half referenced 1) selling drugs (71.2%), 2) groups of teenagers hanging out on the street (66.2%), 3) litter/trash on the streets (58.5%), 4) people fighting/arguing (54.7%), 5) people saying insulting things or bothering other people when they walk down the street (54.6%), and 6) vacant housing (53.3%) as problems.

Individual

In the bivariate analysis (Tables I and II), those reporting exchange sex were significantly less likely to report being in a committed relationship (Prevalence Ratio [PR]=0.71; 95% Confidence Interval [95%CI]:0.51–0.98) and similarly less likely to report currently having a main sex partner (PR=0.67; 95% CI:0.50–0.90). They were significantly more likely to report being HIV positive (PR=1.55; 95% CI:1.04–2.31), to report using cocaine/crack in the past 6 months (PR=1.43; 95% CI:1.01–2.03), and to report homelessness in the past 6 months (PR=1.67; 95% CI:1.26–2.21).

Network

Those reporting 1 exchange sex partner in the past 90 days reported more overall network members ($p=0.003$) and more sex network members in the past 90 days ($p<0.001$). As seen in Tables I and II, the associations between network proportion variables and exchange sex were evaluated using a more conservative level-of-significance ($\alpha>0.004$). Those reporting exchange sex reported the following: sex with a greater proportion of their network members (median:25% vs. 17%; PR:6.69), a greater proportion of network members who used heroin, crack or cocaine (median:32% vs. 25%; PR:2.66), and receiving drug support from (median:20% vs. 14%; PR:2.94) and both drug support and social support from (median:8% vs. 0%; PR:3.14) a greater proportion of their network members. Using the same level of significance, those reporting exchange sex reported a significantly lower proportion of network members who were kin (median:38% vs. 50%; PR:0.35) and a significantly lower proportion of network members who provided social support but not drug support (median:29% vs. 38%; PR:0.18).

As seen in Tables I and II, the associations between sex network proportion variables and exchange sex were evaluated using a more conservative level-of-significance ($\alpha>0.008$). Women reporting an exchange sex partner in the past 90 days reported a smaller proportion of sex network members who 1) she saw daily (median:33% vs. 100%; PR:0.45), 2) were previously incarcerated (median:33% vs. 100%; PR:0.63), and 3) she had talked with about getting tested for STDs (median:0% vs. 100%; PR:0.52). Women reporting exchange sex also reported having a significantly greater proportion of sex network members who had other sex partners (median:33% vs. 0%; PR:2.29) and lower mean trust scores for their sex partners in the past 90 days (PR=0.90).

Neighborhood (Block-level)

Those reporting exchange sex were more likely to report feeling a part of the block where they lived (PR=1.47) and to live in neighborhoods that they perceived as having more disorder (PR=1.18). Among the variables comprising the neighborhood disorder scale, those reporting exchange sex were more likely to report the following as problems in their neighborhood: 1) vacant housing ($p=0.04$), 2) people who say insulting things or bother other people when they walk down the street ($p=0.004$) and 3) groups of teenagers hanging out on the street ($p=0.04$).

Final Model

As seen in Table III, after adjusting for network and neighborhood correlates of exchange sex, homelessness in the past 6 months remained significantly associated with exchange sex in the past 90 days (Adjusted Prevalence Ratio [APR]=1.25; 95% CI:1.00–1.57). After adjusting for neighborhood and individual correlates of exchange sex, those who reported having a greater proportion of network members who provided social support but not drug support (APR=0.33; 95% CI:0.18–0.61) and those who reported seeing a greater proportion of their sex network members daily were significantly less likely to report exchange sex (APR=0.64; 95% CI:0.49–0.82). In the multivariable model, those reporting that a greater proportion of their sex network members had other sex partners were significantly more likely to report exchange sex (APR=1.54; 95% CI:1.20–1.99). When the final model was re-run using the more conservative Bonferroni corrected alpha-levels ($\alpha>0.004$ for overall network proportion variables and $\alpha>0.008$ for sex network proportion variables), all variables remained significantly associated with exchange sex in the past 90 days. After adjusting for individual and network correlates of exchange sex, the neighborhood disorder scale variable did not remain significantly associated with exchange sex in the past 90 days (APR=1.06; 95% CI:0.95–1.18).

DISCUSSION

In this sample of predominantly African American female NIDUs, exchange sex was frequently reported (30.7%). Consistent with prior research findings of individual-level risk factors, crack/cocaine use, HIV infection, and homelessness were associated with exchange sex in the unadjusted models. However, after adjusting for distal factors (i.e., network correlates of exchange sex and neighborhood disorder), only homelessness remained significantly associated with exchange sex. As Pilowsky and colleagues explained, 1) individuals who are particularly vulnerable to homelessness may feel powerless to refuse sex in exchange for a place to stay and 2) housing instability may be part of a lifestyle that includes instability in many spheres including sexuality [19]. Others similarly suggest that exchanging sex is related to economic power and those who are more economically disadvantaged are more easily exploited by those with access to drugs [56]. After adjusting for neighborhood disorder and network correlates of exchange sex, the magnitude of the effect size for homelessness was reduced (PR=1.67 and APR=1.25). This suggests that some of the unadjusted association between individual-level variables such as homelessness and exchange sex may be explained by distal factors (i.e., perceived neighborhood disorder and social network variables). This is in agreement with an explanation proposed by Sterk and colleagues, which suggests that individuals who have lower social capital and/or live in neighborhoods with greater disorder may be more susceptible to poor health-related conditions, such as homelessness [39, 57].

Consistent with prior findings demonstrating that individuals with high-risk network members and multiplex networks participate in higher risk sexual behaviors [15, 43], having a greater proportion of network members who used drugs (PR:2.66) and who provided both social support and drug support (PR:3.14) were associated with an increased likelihood of exchange sex in the unadjusted models. However, the association between multiplex networks and exchange sex did not remain significant after adjusting for individual, neighborhood, and other network characteristics associated with exchange sex. Interestingly, while having social support networks that also provided drug support was positively associated with exchange sex (PR:3.14), having social support networks that did not provide drug support was negatively associated with exchange sex (PR:0.18) in the unadjusted analysis. In the adjusted model, the negative association between exchange sex and reporting having a greater proportion of social support networks that did not provide drug support remained significant (APR:0.33; 95%CI:0.18–0.61). These findings support the explanation provided by Valente (1996), which suggests that behavior change may be more difficult when support networks also engage in high-risk behaviors. Thus, before individual behaviors can be changed, one's network structure may need to be modified so that her network members can better support risk reduction efforts. It is a noteworthy finding that having more social support network members who did not provide drug support was protective. These network members may promote social norms that militate against exchanging sex and may also be a source of social capital by providing resources that reduce the economic need for such exchanges.

Parallels can be drawn with the drug cessation literature. For example, a study examining the association between drug relapse and social support networks among those who had completed treatment found that drug use by personal networks was associated with a higher risk of relapse [58]. Similarly, a Baltimore study among illicit drug users found that drug use cessation was associated with a lower proportion of personal network members in one's drug network [59]. Because female NIDUs may exchange sex for drugs or money which may be used to purchase drugs, having overlapping social support and drug support networks may prevent women from reducing risk behaviors that are related to their drug use (e.g., exchange sex). Therefore, interventions that increase the proportion of social support

networks that do not also provide drug support should be encouraged. Our findings further demonstrate that 1) sex and drug relationships (and consequently risk behaviors) among NIDUs are interrelated and should not be examined in isolation and 2) behaviors may be difficult to modify without altering network social norms. Thus, in order to address individual-level risk behaviors, interventions that aim to change features of the social and structural environment may be more effective.

Additionally, in both the unadjusted and adjusted models, there were several characteristics of sex partners that were associated with exchange sex. Seeing a greater proportion of sex network members daily was negatively associated with exchange sex. Seeing a greater proportion of sex networks daily may be a proxy for having a main sex partner. For example, of the 308 individuals who reported seeing 1 sex partner(s) daily, 246 (79.9%) reported seeing only one sex partner daily. Additionally, because we were not able to determine which sex partners were exchange partners (and consequently the network characteristics specific to exchange partners), we were unable to determine whether exchange partners were more likely to provide drug support or both drug support and social support. Further research is needed to better characterize sex partners by partner type (e.g., exchange, casual, regular). Because seeing a greater proportion of one's sex network members daily may also represent other factors (e.g., trust, intimacy, satisfaction with relationship, communication, commitment, power [60], and the type of support provided by that network member) that we were unable to measure directly in this analysis, more research is needed to better understand this association.

Our findings also demonstrate that women reporting that a greater proportion of their sex partners had other partners were more likely to exchange sex, which suggests an increased risk for HIV/STI transmission. This variable may be a proxy for other factors that we were unable to measure/evaluate. For example, other studies have shown that women with sex partners who had other sex partners were more likely to be the victims of intimate partner violence [61, 62] which has been shown to be associated with homelessness and housing instability, substance abuse, and HIV infection [63–65]. Further, community-based samples among low-income African American women in other cities have found associations between intimate partner violence and increased sexual coercion, decreased sexual and condom negotiation practices, and a history of sexually transmitted infections [61]. Therefore, future studies that examine correlates of exchange sex should also examine reports of intimate partner violence with different partner types.

Finally, other studies have demonstrated an association between physical forms of neighborhood disorder (e.g., vacant property or lots) and high-risk sexual behaviors including exchange sex. While increased neighborhood disorder was associated with exchange sex in the unadjusted models, this association was not significant in the multivariable model. This may be due to some overlap in the risk that network and neighborhood factors measure. For example, network dynamics may be influenced by neighborhood characteristics and similarly, neighborhood characteristics may influence partner selection. This hypothesis is supported by the change in the magnitude of the effects for sex network characteristics after accounting for perceived neighborhood disorder. The effect size for the association between seeing a greater proportion of sex networks daily was reduced from PR=0.45 to APR=0.64 after adjusting for neighborhood disorder. Similarly, the effect size for the association between having a greater proportion of sex networks who had other partners was reduced from PR=2.29 to APR=1.53 after accounting for neighborhood disorder. The same was true for the association between providing social support but not drug support and exchange sex (PR=0.18 and APR=0.34). Alternatively, it is possible that after accounting for homelessness, the other factors driving the association between neighborhood disorder and exchange sex (people who say insulting things or bother

other people when they walk down the street and groups of teenagers hanging out on the street) were not correlated with exchange sex enough to maintain a significant association. Vacant housing is one of the major drivers of the association between perceived neighborhood disorder and exchange sex and in this sample, vacant housing was correlated with homelessness in the past 6 months ($\rho=0.13$). Therefore, in adjusting for homelessness, vacant housing was partially accounted for.

In this analysis, neighborhood disorder was characterized from the perspective of the study participant and measured only her perception of the neighborhood where she lived. While Curry and colleagues found that both subjective and objective measures of neighborhood factors were associated with mental health [66], individuals living in the same neighborhood may have different perceptions about their neighborhood. Using an objective measure for neighborhood disorder (e.g., NIfETy [67]) may remove this bias and provide information about which particular objective aspects of the structural environment are most correlated with exchange sex. Further, because women may exchange sex in neighborhoods where they do not live, obtaining objective neighborhood measurements for the neighborhoods where women report living, spending most of their time, and engaging in exchange sex would also be informative. Such information could be used to guide future structural interventions that target modifiable neighborhood characteristics. Of note, we measured time spent in one's neighborhood and homelessness and the associations that accounted for these variables together did not differ appreciably from those presented here.

Our findings should be interpreted in light of several limitations. First, the generalizability of our findings is limited because the study sample was restricted to inner-city sexually active high-risk women who were predominately African American. While other studies have shown that poverty, race, depression, income, education, and crack use were correlates of exchange sex, these factors were not significantly correlated with exchange sex in our sample, which may reflect homogeneity in our sample with respect to these variables. Consequently, our results are not generalizable outside of the study's sampling frame. Additionally, because incentives were provided for study participation, female NIDUs with higher levels of poverty may have been over-represented in our study sample. Similarly, less visible drug users (e.g., those with daytime jobs or who use drugs in private) are likely underrepresented. Another limitation of our analysis is that the outcome of interest, exchange sex, was measured in the past 90 days while many correlates were measured in the past 6 months. This study also relies on self-reported data, which may be influenced by recall and social desirability biases. However, these biases are believed to be minimal because a number of high-risk behaviors were reported in this sample and ACASI was used, which has been found to reduce apprehension toward reporting sensitive information [68]. Finally, the data used were cross-sectional, so we were unable to assess temporality of the relationships evaluated.

CONCLUSION

Despite these limitations, our findings provide support for the implementation of 1) structural interventions, such as microeconomic strategies (which may reduce the likelihood of homelessness and crack use) and 2) network based interventions which modify network relationships to create a social environment which can facilitate individual-level behavior changes [69]. These findings are consistent with the theoretic model outlined by Latkin and colleagues which views individual, dyad, and structural factors as part of a system in which none function in isolation and there is bidirectional feedback between levels [70].

Structural interventions

Because women who exchange sex and have histories of crack use may be ineligible for subsidized housing programs and other forms of public assistance [71], structural interventions that provide targeted assistance or referrals to subsidized assistance to these women may be warranted. In a study of unstably housed women, those who had an income largely based on subsidies (vs. those who did not) were less likely to exchange sex [72]. Structural interventions that ensure that women who exchange sex are safe and have the power to obtain and use HIV prevention materials are also needed. Structural interventions that target neighborhoods are also warranted. Neighborhood-based interventions to address social disorder could focus on increasing employment, quality of housing stock, and educational opportunities in efforts to reduce neighborhood physical decay and provide residents with work opportunities outside of the drug economy.

Network-based interventions

Our findings also support the importance of networks in shaping individual-level risk behaviors and suggest that strengthening ties with those who provide social support but not drug support and reducing those that provide both drug support and social support may facilitate behavior changes that reduce participation in exchange sex. More research is needed to better characterize exchange sex partners and to describe how they differ from other types of partners so that more effective network-based interventions can be developed. The fact that the influence of individual-level risk factors for exchange sex were reduced (e.g., homelessness) or removed (e.g., cocaine/crack use, HIV status) after accounting for network-level measures suggests that both risk behaviors and disease transmission are dependent on more distal social factors (e.g., network relationships and network social norms). Thus, interventions which act at the network level may likely remove or reduce risk at multiple levels.

Finally, our findings highlight the complex interaction between sex/drug-related risk behaviors, risk networks, social support networks, and the structural environment. More work is needed to understand their interdependence so that future interventions can be developed to modify the factors that will most effectively facilitate risk reduction among those most at risk.

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Table 1

Network, individual, and neighborhood correlates of exchange sex among female non-injection drug users in Baltimore, MD (2005–2007)

NETWORK	All N=417		Had not exchanged sex N=276		Had exchanged sex N=128		P-value
	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	P-value	
Number of network members named by client	8 (6–11)	8 (6–11)	9 (7–12)	0.0034			
Number of sex network members in the last 90 days	1 (1–2)	1 (1–2)	2 (1–3)	<.0001			
Proportion of network members who _____ ^(a)							
She got advice from or talked to (past 6 months)	0.17 (0.11–0.25)	0.18 (0.13–0.25)	0.16 (0.10–0.25)	0.0685			
Loaned her money (past 6 months)	0.15 (0.10–0.25)	0.17 (0.09–0.25)	0.14 (0.10–0.29)	0.4217			
She asked for health advice (past 6 months)	0.14 (0.08–0.25)	0.14 (0.08–0.25)	0.13 (0.08–0.20)	0.3563			
Would let her stay at their place	0.17 (0.10–0.33)	0.18 (0.11–0.33)	0.14 (0.09–0.25)	0.0397			
Were a sex network member (past 90 days)	0.17 (0.11–0.27)	0.17 (0.11–0.22)	0.25 (0.15–0.38)	<.0001			
Used heroin, cocaine, or crack (past 6 months)	0.25 (0.11–0.43)	0.25 (0.08–0.40)	0.32 (0.17–0.48)	0.0024			
Lived in the same neighborhood as her	0.53 (0.27–0.73)	0.50 (0.27–0.73)	0.57 (0.29–0.75)	0.4350			
Currently live with her	0.17 (0.09–0.29)	0.17 (0.10–0.29)	0.13 (0.07–0.25)	0.0168			
Were close friends with her	0.25 (0.14–0.43)	0.25 (0.14–0.43)	0.23 (0.13–0.40)	0.5088			
Were in her drug support network	0.17 (0–0.29)	0.14 (0–0.26)	0.2 (0–0.33)	0.0024			
Provided social support but not drug support	0.33 (0.22–0.50)	0.38 (0.25–0.50)	0.29 (0.14–0.40)	<.0001			
Provided both social support and drug support	0 (0–0.15)	0 (0–0.14)	0.08 (0–0.21)	0.0123			
Were kin	0.43 (0.25–0.60)	0.5 (0.30–0.63)	0.38 (0.21–0.50)	0.0007			
Proportion of sex network members in the past 90 days who _____ ^(b)							
She saw daily	0.5 (0–1.00)	1 (0–1.00)	0.33 (0–0.67)	<.0001			
Had been incarcerated	0.5 (0–1.00)	1 (0–1.00)	0.33 (0–1.00)	0.0021			
Had other sex partners	0 (0–0.50)	0 (0–0)	0.33 (0–0.67)	<.0001			
She had talked to about each other getting tested for sexually transmitted diseases	0.33 (0–1.00)	1 (0–1.00)	0 (0–1.00)	<.0001			
Used heroin, cocaine, or crack (past 6 months)	0 (0–1.00)	0 (0–1.00)	0.33 (0–0.67)	0.7303			
Provided emotional support (past 6 months)	0 (0–0.33)	0 (0–0.50)	0 (0–0.29)	0.0053			
Mean trust score for sex partners	8.5 (6–10)	9 (7–10)	7 (5.24–8.83)	<.0001			
Mean trust score for non-sex partners	8.5 (7.25–9.50)	8.50 (7.28–9.53)	8.33 (7–9.22)	0.1469			
INDIVIDUAL	N (%)	N (%)	N (%)	p-value			

NETWORK	All N=417		Had not exchanged sex N=276		Had exchanged sex N=128		P-value
	Median(IQR)	N (%)	Median(IQR)	N (%)	Median(IQR)	N (%)	
Age (Median, IQR)	42 (38-47)		42 (38-47)		41 (37-47)		0.3651
Married/in a committed relationship vs. single or separated	149 (35.7)		108 (39.1)		36 (28.1)		0.0317
Current main sex partner	322 (77.2)		225 (81.5)		90 (70.3)		0.0114
Cocaine/crack use (past 6 months)	292 (70.0)		183 (66.3)		98 (76.6)		0.0371
Cocaine metabolites	145 (45.6)		95 (45.7)		46 (45.5)		0.9830
Heroin use (past 6 months)	189 (45.3)		118 (42.8)		65 (50.8)		0.1315
Opiate metabolites	34 (10.7)		28 (13.5)		6 (5.9)		0.0475
Unemployed (past 6 months)	383 (91.9)		252 (91.3)		118 (92.2)		0.7661
Race							
African American	404 (96.9)		265 (96.0)		126 (98.4)		0.0731
White/Other	13 (3.1)		11 (4.0)		2 (1.6)		
Incarcerated (past 6 months)	70 (16.8)		40 (14.5)		28 (21.9)		0.0650
Alcohol use							
<Weekly	271 (65.0)		80 (29.0)		80 (62.5)		0.4555
Weekly	146 (35.0)		183 (66.3)		48 (37.5)		
Education							
High school diploma/GED	234 (56.4)		155 (56.4)		71 (55.9)		0.9314
Homeless (past 6 months)	140 (33.6)		76 (27.5)		58 (45.3)		0.0004
HIV Positive	35 (10.8)		18 (8.5)		16 (15.8)		0.0490
NEIGHBORHOOD	N (%)		N (%)		N (%)		p-value
Time spent in neighborhood							
None	10 (2.4)		8 (2.9)		1 (0.8)		0.1029
Some	135 (32.5)		81 (29.4)		49 (38.6)		
Most	167 (40.1)		111 (40.2)		52 (40.9)		
All	104 (25.0)		76 (27.5)		25 (19.7)		
Feel a part of the block							
Yes	113 (27.1)		84 (30.4)		26 (20.3)		0.0335
No, it is just a place to live	304 (72.9)		192 (69.6)		102 (79.7)		
Do you consider_____a problem on your block?							
Vandalism, like people breaking windows or spray painting buildings							

NETWORK	All N=417		Had not exchanged sex N=276		Had exchanged sex N=128		P-value
	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	
Not a problem	255 (61.2)	170 (61.6)	79 (61.7)	0.7271			
Somewhat of a problem	118 (28.3)	80 (29.0)	34 (26.6)				
A big problem	44 (10.6)	26 (9.4)	15 (11.7)				
Vacant housing							
Not a problem	195 (46.8)	140 (50.7)	49 (38.3)	0.0391			
Somewhat of a problem	97 (23.3)	56 (20.3)	38 (29.7)				
A big problem	125 (30.0)	80 (29.0)	41 (32.0)				
People who don't keep up their property or yards							
Not a problem	215 (51.6)	146 (52.9)	62 (48.4)	0.5783			
Somewhat of a problem	112 (26.9)	75 (27.2)	35 (27.3)				
A big problem	90 (21.6)	55 (19.9)	31 (24.2)				
People who say insulting things or bother other people when they walk down the street							
Not a problem	231 (55.4)	162 (58.7)	60 (46.9)	0.0044			
Somewhat of a problem	119 (38.5)	80 (29.0)	36 (28.1)				
A big problem	67 (16.1)	34 (12.3)	32 (25.0)				
Litter or trash in the streets							
Not a problem	173 (41.5)	121 (43.8)	47 (36.7)	0.3291			
Somewhat of a problem	131 (31.4)	85 (30.8)	41 (32.0)				
A big problem	113 (27.1)	70 (25.4)	40 (31.3)				
Groups of teenagers hanging out on the street							
Not a problem	141 (33.8)	104 (37.7)	32 (25.0)	0.0428			
Somewhat of a problem	114 (27.3)	71 (25.7)	40 (31.3)				
A big problem	162 (38.9)	101 (36.6)	56 (43.8)				
People fighting and arguing							
Not a problem	189 (45.3)	132 (47.8)	51 (39.8)	0.1708			
Somewhat of a problem	145 (34.8)	95 (34.4)	45 (35.2)				
A big problem	83 (19.9)	49 (17.8)	32 (25.0)				
Burglary							
Not a problem	302 (72.4)	206 (74.6)	87 (68.0)	0.0861			
Somewhat of a problem	86 (20.6)	56 (20.3)	27 (21.1)				

NETWORK	All N=417		Had not exchanged sex N=276		Had exchanged sex N=128		P-value
	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	Median(IQR)	
A <u>big</u> problem	29 (7.0)	14 (5.1)	14 (10.9)				
Selling drugs							
<u>Not</u> a problem	120 (28.8)	84 (30.4)	32 (25.0)				0.3211
<u>Somewhat</u> of a problem	93 (22.3)	63 (22.8)	26 (20.3)				
A <u>big</u> problem	204 (48.9)	129 (46.7)	70 (54.7)				
Getting robbed or beaten up on the street							
<u>Not</u> a problem	253 (60.7)	172 (62.3)	74 (57.8)				0.3455
<u>Somewhat</u> of a problem	109 (26.1)	73 (26.5)	33 (25.8)				
A <u>big</u> problem	55 (13.2)	31 (11.2)	21 (16.4)				
Months in neighborhood (Median, IQR)	12 (4, 60)	12 (4, 63)	14 (3, 60)				0.5263
Months in neighborhood among those not homeless (Median, IQR)	24 (6-84)	24 (6-84)	24 (8-84)				0.9025
Standardized Neighborhood disorder scale variable (Median, IQR)	-0.06 (-0.94-0.82)	-0.24 (-0.95-0.65)	0.11 (-0.77-1.00)				0.0252

^aBonferroni corrected $\alpha=0.003846154$

^bBonferroni corrected $\alpha=0.008333333$

Table II

Prevalence ratios for network, individual, and neighborhood correlates of exchange sex among female NIDUs in Baltimore MD (2005–2007)

NETWORK	Prevalence Ratio	95%CI
Proportion of network members who _____		
She got advice from or talked to (past 6 months)	0.33	(0.10–1.09)
Loaned her money (past 6 months)	1.53	(0.57–4.08)
She asked for health advice (past 6 months)	0.63	(0.22–1.74)
Would let her stay at their place	0.40	(0.15–1.04)
Were a sex network member (past 90 days)	6.69	(4.65–9.63) ^a
Used heroin, crack or cocaine (past 6 months)	2.66	(1.44–4.89) ^a
Lived in the same neighborhood as her	1.23	(0.74–2.04)
Currently live with her	0.26	(0.09–0.77)
Were close friends with her	0.82	(0.44–1.50)
Were in her drug support network	2.94	(1.64–5.27) ^a
Provided social support but not drug support	0.18	(0.09–0.37) ^a
Provided both social support and drug support	3.14	(1.51–6.50) ^a
Were kin	0.35	(0.19–0.65) ^a
Proportion of sex network members in the past 90 days who _____		
She saw daily	0.45	(0.33–0.62) ^b
Had been incarcerated	0.63	(0.46–0.85) ^b
Had other sex partners	2.29	(1.72–3.07) ^b
She had talked to about each other getting tested for sexually transmitted diseases, not HIV	0.52	(0.38–0.71) ^b
Used heroin, cocaine, or crack (past 6 months)	0.95	(0.70–1.30)
Provided emotional support (past 6 months)	0.61	(0.40–0.94)
Mean trust score for sex partners	0.90	(0.86–0.94)
Mean trust score for non-sex partners	0.95	(0.88–1.02)
INDIVIDUAL		
Age	0.99	(0.97–1.01)
Incarceration (past 6 months; Yes vs. No)	1.38	(1.00–1.92)
Alcohol use weekly vs. < weekly	1.04	(0.94–1.15)
Unemployed (past 6 months; Yes vs. No)	1.08	(0.63–1.86)
HIV positive (Yes vs. No)	1.55	(1.04–2.31)
Married/in a committed relationship vs. single or separated	0.71	(0.51–0.98)
Current main sex partner (Yes vs. No)	0.67	(0.50–0.90)
High school diploma or GED (Yes vs. No)	0.99	(0.74–1.32)
Used heroin (past 6 months; Yes vs. No)	1.25	(0.94–1.66)
Used cocaine or crack (past 6 months; Yes vs. No)	1.43	(1.01–2.03)
Homeless (past 6 months; Yes vs. No)	1.67	(1.26–2.21)

NETWORK	Prevalence Ratio	95%CI
NEIGHBORHOOD		
Feels a part of her block vs. it is just a place to live	1.47	(1.01–2.13)
Months in neighborhood	1.00	(1.00–1.00)
Standardized neighborhood disorder scale	1.18	(1.02–1.36)

^aSignificant using a Bonferroni corrected $\alpha=0.003846154$

^bSignificant using a Bonferroni corrected $\alpha=0.008333333$

Table III

Final multivariable models for network, individual, and neighborhood correlates of exchange sex among female NIDUs in Baltimore MD (2005–2007)

	Adjusted Prevalence Ratio (95%CI)
INDIVIDUAL	
Homeless (past 6 months)	1.25 (1.00 – 1.57)
NETWORK	
Proportion of network members who _____	
Provided social support but not drug support	0.33 (0.18 – 0.61)
Proportion of sex network members in the past 90 days who _____	
She sees daily	0.64 (0.49 – 0.82)
Have other sex partners	1.54 (1.20 – 1.99)
NEIGHBORHOOD	
Standardized Neighborhood Disorder Scale	1.06 (0.95 – 1.18)