Journal of Ethnicity in Substance Abuse

ISSN: 1533-2640 (Print) 1533-2659 (Online) Journal homepage: https://www.tandfonline.com/loi/wesa20

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To cite this article: Ian Duncan, Patrick Habecker, Dane Hautala, Bilal Khan & Kirk Dombrowski (2019) Injection-related hepatitis C serosorting behaviors among people who inject drugs: An urban/rural comparison, Journal of Ethnicity in Substance Abuse, 18:4, 578-593, DOI: 10.1080/15332640.2018.1425950

To link to this article: https://doi.org/10.1080/15332640.2018.1425950

JOURNAL OF ETHNICITY IN SUBSTANCE ABUSE
2019, VOL. 18, NO. 4, 578–593
https://doi.org/10.1080/15332640.2018.1425950

Injection-related hepatitis C serosorting behaviors among people who inject drugs: An urban/rural comparison

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ABSTRACT

Although previous research has focused on injection drug use behaviors in both urban and rural settings, few have drawn direct comparisons between adjacent rural and urban areas. Using data from the National HIV Behavioral Surveillance study as well as original data collected in a similar fashion, we compare the risk behaviors of people who inject drugs (PWID) in San Juan, Puerto Rico, with those of PWID in nearby rural areas. Specifically, we examine whether one's own hepatitis C (HCV) infection status can be used to predict whether one asked their most recent co-injection partner about their HCV status. Acquiring such information allows injectors to seek out co-injection partners of concordant status as a way to minimize the risk of viral transmission. Results indicate that urban PWID with a known HCV+ status were more likely to know their last co-injector partner's HCV status than were their peers with a negative or unknown HCV status. However, this relationship was not present in the rural data. These findings suggest that there are different risk norms in rural and urban PWID communities and that interventions successful in one type of community may not be so in others.

KEYWORDS
Hepatitis C; injection drugs; Puerto Rico; serosorting

Introduction

In recent decades, a number of practical strategies for preventing viral transmission in the context of injection drug use and sexual risk have been promoted by public health officials. One of these is serosorting—selecting partners of concordant disease status with whom to share injection or sexual risks. Although first proposed as a strategy to prevent sexual transmission of HIV (Philip, Yu, Donnell, Vittinghoff, & Buchbinder, 2010), it has become an important strategy to prevent transmission of other diseases arising from drug co-injection, where two people share drugs and equipment. Such strategies can be imperative as hepatitis C (HCV) rates among people who inject drugs (PWID) have remained high even while HIV rates among this population have fallen. Research into injection serosorting suggests that about half of injectors practice serosorting to some extent, whether to prevent HCV

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(Burt, Thiede, & Hagan, 2009) or HIV (Mizuno et al., 2011) transmission. Both the relative commonality of serosorting and its applicability to various types of viral disease make it an important topic for public health research.

Understanding the contexts under which serosorting takes place provides opportunities for low-cost interventions, such as tests for infection status. Where knowledge of disease status can be linked to individual efforts to reduce risk, testing outreach can potentially help lower incidence by allowing individuals to seek out partners who share their own infection status. A 2013 article by Smith and colleagues examined the relationship between knowledge of hepatitis C (HCV) infection and co-injection partner selection, asking whether people who inject drugs (PWID) knew their own HCV status (i.e., whether they were positive or negative vs. unknown) and therefore attempted to inject with others of concordant status. In that study, Smith et al. (2013) found evidence that PWID who have been tested for HCV are more likely to attempt serosorting than PWID who had not been tested and have no reliable indication of their HCV status. These results lend support to the "testing as intervention" method, which argues that once people are aware of their HCV status, they will attempt to prevent new infections by selecting partners of concordant status.

However, Smith and colleagues' (2013) results may be limited by the aggregate nature of the National HIV Behavioral Surveillance (NHBS) data set, collected annually by the U.S. Centers for Disease Control and Prevention (CDC) to study those at a high risk of contracting HIV. The NHBS relies on a strictly urban sample of PWID, thereby masking local and or rural differences in serosorting behaviors among PWID. Using data collected in a manner similar to CDC's NHBS, we replicated Smith and colleagues' (2013) study using a sample of PWID from rural Puerto Rico. There we found no evidence to suggest that rural PWID who knew their HCV status selected partners differently from those who did not (Duncan et al., 2017). Two possible explanations might be suggested for this difference: (a) differences in behavior between rural and urban PWID or (b) differences in behavior between Puerto Rican PWID and PWID on the U.S. mainland. This study seeks to resolve this question by examining the serosorting behaviors of rural versus urban PWID in Puerto Rico. To the extent that the rural results are matched by similar outcomes from data collected in San Juan, one could surmise that cultural differences play an important role in potentially limiting the effectiveness of testing outreach in stemming HCV incidence. Conversely, to the extent that differences are found between urban and rural venues in Puerto Rico, this difference—between injection risk behaviors in rural versus urban areas—would suggest that other prevention strategies that go beyond simple testing for infection status are needed to prevent HCV incidence in rural locales.

Background

Recent estimates from the U.S. Centers for Disease Control and Prevention (CDC) suggest that between 2.7 and 3.9 million Americans live with chronic hepatitis C (HCV FAQs for Health Professionals | Division of Viral Hepatitis | CDC, n.d.). Global estimates suggest that 2% to 3% of the worldwide population is infected with hepatitis C (HCV) and that it contributes to over 350,000 deaths each year (Averhoff, Glass, & Holtzman, 2012). In addition, a recent CDC report states that between 75% and 85% of people infected with HCV will develop a chronic infection. Such chronic infections are linked to a host of liver-related afflictions, including liver damage, liver failure, and even death. Furthermore, HCV is the leading cause of both liver cirrhosis and liver cancer (United States Centers for Disease Control and Prevention, 2016). In recent years, deaths due to HCV have even outpaced those caused by the human immunodeficiency virus (HIV), another dangerous blood-borne virus (Ly et al., 2012). In short, HCV is a serious public health issue with the potential for serious consequences if left unattended.

In part due to the blood-borne nature of the virus, PWID have a particularly high risk for contracting HCV. In fact, recent research suggests that approximately one-third of PWID under the age of 30 are infected with HCV, which increases to 70% to 90% of older PWID (U.S. Centers of Disease Control and Prevention, 2014). In some communities, HCV infection is so common that many PWID consider it to be an unavoidable consequence of injecting (Rhodes, Davis, & Judd, 2004). Seeing infection as an inevitability, as many as 90% of PWID who become infected fail to get medical treatment (Al-Tayyib, Thiede, Burt, & Koester, 2015).

One reason that HCV is so prevalent in PWID communities is that the virus is more robust than many of the other viral threats related to needle use, such as the HIV virus (Paintsil, He, Peters, Lindenbach, & Heimer, 2010). Although some methods of syringe cleaning do decrease risk of infection, (Gyarmathy, Neaigus, Mitchell, & Ujhelyi, 2009), many common methods were designed to prevent transmission of the weaker HIV virus, allowing the stronger HCV virus to survive them (Abadie, Welch-Lazoritz, Gelpi-Acosta, Reyes, & Dombrowski, 2016). For example, recent research from Europe found that, even among PWID who did not share syringes or needles, those who still shared equipment such as containers and filters had three times the risk of contracting HCV than if they did not share equipment (Palmateer et al., 2014). This is a noteworthy pathway for infection as some research suggests this type of equipment sharing is more common and acceptable than needle or syringe sharing (Rhodes et al., 2004). As a result, the pathway for HCV infection remains open.

Given that the HCV virus is more robust than that of HIV, it comes as little surprise that 80% of PWID who have HIV are co-infected with HCV as well

(U.S. Centers of Disease Control and Prevention, 2014). This number is even higher in some areas. Research by Peters et al. (2016) found that 92.3% of HIV+PWID in Scott County, Indiana—the site of a recent HIV outbreak—were also co-infected with HCV. As such, many PWID have a compromised immune system, further increasing the risks associated with HCV as well as the need for further research into how the virus is contracted.

Although cleaning syringes, needles, and other equipment has had mixed results for reducing HCV transmission, some other policies borrowed from HIV prevention still hold potential. One such policy is the "testing as intervention" method, often discussed as a way of preventing sexual transmission (Khanna et al., 2015) In this method, PWID are encouraged to only co-inject with partners who have the same infection status as themselves. This process is known as "serosorting" because PWID sort potential risk partners by their serostatus on a virus, in this case, HCV. Some communities have seen successful examples of this method, such as in Seattle where a 2009 study found that 53% of respondents who shared equipment had knowledge of their last partner's HCV status, with 39% saying they intentionally pick partners with concordant HCV status (Burt et al., 2009).

There are several reasons a focus on rural/urban comparisons of PWID risk and prevention behaviors is justified. Previous research suggests that norms about injection risk vary between communities of PWID (Golub et al., 2007); there are even regional differences within countries that are relatively small, such as Poland (Rosińska, Sierosławski, & Wiessing, 2015). In addition, prior studies on opioid users revealed that rural users have higher rates of overdose (Dunn et al., 2016) despite being less likely to misuse opioids overall (Rigg & Monnat, 2015). Dunn and colleagues also found that rural opioid users—69% of whom had injected—were less knowledgeable on the risks associated with use than their urban peers, suggesting that information may play a role in urban/rural differences.

Rural areas also have fewer opportunities for drug treatment (Hirchak & Murphy, 2017), potentially facilitating these information shortcomings. Even if such treatment facilities are available, rural locations may not have as many options available, such as a doctor who can prescribe medically assisted addiction treatments such as buprenorphine (Jones, 2017; Rosenblatt, Andrilla, Catlin, & Larson, 2015). In addition, it is important to shed additional light on PWID in nonurban areas, as they account for approximately half of all PWID in the United States and its surrounding territories (Oster et al., 2015), despite a notable absence in drug use–related studies. Research focusing on rural drug use is increasing (Keyes, Cerdá, Brady, Havens, & Galea, 2013), though it is largely limited to certain areas, such as rural Kentucky (Havens et al., 2013; Smith, Young, Mullins, & Havens, 2017). Furthermore, it is important to ensure that all communities affected by the ongoing opioid epidemic (Rudd, Aleshire, Zibbell, & Gladden, 2016) are accounted for in research.

The current analysis uses data from one NHBS city: San Juan, Puerto Rico. We compare serosorting behavior in this urban sample with serosorting behavior in a rural Puerto Rico sample. Similarities and differences between the samples have been discussed elsewhere (Abadie, Welch-Lazoritz, Khan, & Dombrowski, 2017; Welch-Lazoritz et al., 2017). Overall, the two data sets provide comparable data that were collected with similar recruitment strategies and research instruments. This is a unique research opportunity as it is the first study to our knowledge that directly compares urban and rural PWID HCV prevention strategies (e.g., serosorting) on such similar measures. In particular, we examine potential differences between urban and rural PWID in regard to their knowledge of their last co-injection partner's HCV test status.

Methods

Rural data collection

Interviews with 315 participants were completed between April 19, 2015, and June 15, 2015, in a rural area approximately 30 miles from San Juan, Puerto Rico, drawing participants from several connected towns to make up a single rural network. Eligible participants met respondent-driven sampling (RDS) recruitment criteria (Heckathorn, 2002), were alert, 18 years of age or older, and reported injecting drugs within the past 30 days. Visual inspections for injection signs, as well as questionnaires about drug injection knowledge, were used to confirm this. Upon completing the questionnaire, participants were compensated with $25. Recruitment into the sample was managed using RDS, whereby participants who completed the survey were given three referral coupons they could pass out to other qualified individuals who had not previously participated in the project (Heckathorn, 2011). For every referral that then completed the survey, the referee could earn an additional $10. This method of recruitment is often preferred for stigmatized populations (Heckathorn, 2002). The study received institutional review board (IRB) approval through the University of Nebraska-Lincoln (IRB# 20131113844FB) and the University of Puerto Rico School of Medicine (IRB# A8480115).

The questionnaire was interviewer administered and based on the CDC NHBS IDU Round 3 Questionnaire version 13. The instrument asked questions about injection behavior, prior HCV and HIV status and testing, and several other topics related to drug use and HIV/HCV risk. In addition to recording the participants' self-reported HCV and HIV status prior to participating in the study, the project provided rapid testing for both HIV and HCV: INSTI Rapid HIV antibody tests (Biolytical Laboratories) and OraQuick HCV Rapid antibody tests (OraSure Technologies). Participants were compensated an additional $5 for each test completed. Participants who tested positive for HCV or HIV were offered referral and transportation to a primary care doctor for confirmatory testing and link to care.

Urban NHBS data collection

The urban data were collected in the third round of the National HIV Behavioral Surveillance (NHBS) study that focused on injecting drug users (IDU). The study is performed by the U.S. Centers for Disease Control. Data were collected in 2012 from 20 urban locations in the United States. Respondents were recruited through respondent-driven sampling (RDS), a sampling technique that is common for surveying hard-to-reach or "hidden" populations, such as PWID (United States Centers for Disease Control and Prevention, 2011, p. 3). The San Juan sample included 512 respondents. Persons were eligible if they injected drugs in the past 12 months and were aged ≥18 years, current residents of the San Juan-Caguas-Guaynabo Metropolitan Statistical Area, able to complete the survey in either English or Spanish, and able to provide informed consent. Drug injection in the past 12 months was confirmed by observing physical evidence of recent injection (e.g., track marks) and by assessing knowledge of injection practices. Because the San Juan-Caguas-Fajardo Combined Statistical Area is geographically large, encompassing approximately half of the island, it was possible that participants from the Rural Sample may have qualified for participation in the San Juan NHBS survey. However, none of the members of the rural sample reported having participated in the IDU Round 3 CDC study or in any previous round of NHBS data collection.

Modeling

We ran logistic regressions using both sets of data, with the dependent variable *serocheck* measuring whether respondents knew whether their most recent co-injection partner had had an HCV test. This is referred to below as a reported "test state," a binary variable, with "1" indicating that the respondent indicated knowning whether his or her last co-injection partner had been tested for HCV, and "0" indicating not knowing. Data were not collected on the results of the test.

Our main independent variable is the respondent's self-reported HCV status prior to the administration of the rapid HCV antibody test. We use dummy variables as there are three possible categories: positive, negative, and unknown.

We include several control variables, again following the model of Smith and colleagues. These controls include gender (1 = female), age category (1 = under 34, 2 = 35–44, 3 = 45–54, and 4 = 55+), age at first injection (1 = under 18, 2 = 18–24, 3 = 25 +), education level (1 = high school diploma or greater), annual income (1 = $5,000+), homelessness status (1 = been homeless), and employment status (dummy variables for unemployed, disabled, or other with employed as the omitted category). There is one notable distinction between the data sets: the youngest age in the urban sample is 20, whereas it is 18 in the rural sample. Our final analytical sample for the rural data is 121, and 295 for the urban sample. Cases with missing data were omitted. This was predominately due to skip patterns on our outcome variable, as skip patterns in the survey resulted in many respondents not being asked about their last co-injection partner at all.

Results

Two results indicate substantial differences in serosorting behavior between the urban and rural samples. In the rural sample, having a known HCV status of any kind was not predictive of knowing whether one's last partner had been tested for HCV when compared to respondents who did not know their HCV status (Table 1). By contrast, in the urban sample, HCV+ status respondents had 3.565 ($p = .002$) times the odds of knowing their last partner's HCV test state when compared to respondents who did not know their own HCV status (Table 2). There was no association between HCV- respondents and knowing their last partner's HCV test state in the urban sample when compared with those whose status was reported as unknown.

In the rural sample, when HCV+ status is set as the omitted category, neither unknown nor negative status is predictive for knowing one's last partner's HCV test state (Table 3). In the urban sample (Table 4), however, both negative and unknown HCV statuses were strongly associated with not knowing one's last partner's test state. Furthermore, similar effect sizes

Table 1. Logistic Regression on Knowledge of Last Injection Partner's HCV Test State, Rural Sample, Unknown Omitted ($N = 121$).

		Confidence interval		
Variable	Odds ratio	lower limit	upper limit	*p* value
HCV status				
Positive	1.490	0.435	5.101	.526
Negative	2.252	0.598	8.488	.230
Female	6.297	1.702	23.303	.006
Age	1.249	0.795	1.964	.335
Age at first injection	0.631	0.343	1.160	.139
High school diploma	1.583	0.674	3.718	.292
Annual income $5,000+	1.857	0.704	4.900	.211
Homeless, past year	0.600	0.186	1.932	.392
Employment status				
Unemployed	1.257	0.270	5.850	.771
Disabled	1.110	0.120	10.315	.927
Other employment status (e.g., student, etc.)	1.138	0.125	10.388	.908

$+p = .1$; $*p = .05$; $**p = .01$; $***p = 0.001$.

Table 2. Logistic Regression on Knowledge of Last Injection Partner's HCV Test State, Urban Sample, Unknown Omitted (*N* = 295).

		Confidence interval		
Variable	Odds ratio	Lower limit	Upper limit	*p* value
HCV status				
Positive	3.565	1.595	7.967	.002
Negative	1.30	0.457	3.695	.623
Female	2.725	1.204	6.169	.016
Age	0.910	0.627	1.321	.622
Age at first injection	1.088	0.698	1.694	.710
High school diploma	0.711	0.373	1.355	.300
Annual income $5,000+	2.010	0.728	5.550	.178
Homeless, past year	0.951	0.454	1.991	.894
Employment status				
Unemployed	1.440	0.272	7.628	.668
Disabled	1.216	0.147	10.041	.856
Other employment status (e.g., student, etc.)	14.119	0.724	275.358	.081

+$p = .1$; *$p = .05$; **$p = .01$; ***$p = 0.001$.

were found for both negative and unknown statuses. This suggests that there is little difference between PWID with unknown HCV status and PWID with an HCV- status with regard to serosorting behaviors and a substantial difference between both of them and PWID with an HCV+ status.

In the rural sample, the only control variable that yielded a significant relationship with knowing the last partner's HCV test state was gender, with females being over six times as likely to have this knowledge. A similar pattern was found in the urban data, though the relationship was somewhat weaker—women were only 2.725 ($p = .016$) times as likely to have this knowledge in the urban sample. In addition, having an employment status of "Other" was borderline significant in comparison to being employed, either full- or part-time. No other relationships were significant. Finally, frequency distributions for all variables can be found in Table 5.

Table 3. Logistic Regression on Knowledge of Last Injection Partner's HCV Test State, Rural Sample, Positive Omitted (*N* = 121).

		Confidence interval		
Variable	Odds ratio	Lower limit	Upper limit	*p* value
HCV status				
Negative	1.512	0.559	4.089	.415
Unknown	0.671	0.196	2.298	.526
Female	6.297	1.702	23.303	.006
Age	1.249	0.795	1.964	.335
Age at first injection	0.631	0.343	1.160	.139
High school diploma	1.583	0.674	3.718	.292
Annual income $5,000+	1.857	0.704	4.900	.211
Homeless, past year	0.600	0.186	1.932	.392
Employment status				
Unemployed	1.257	0.270	5.850	.771
Disabled	1.110	0.120	10.315	.927
Other employment status (e.g., student, etc.)	1.138	0.125	10.388	.908

+$p = .1$; *$p = .05$; **$p = .01$; ***$p = 0.001$.

Table 4. Logistic Regression on Knowledge of Last Injection Partner's HCV Test State, Urban Sample, Positive Omitted ($N = 295$).

Variable	Odds ratio	Confidence interval Lower limit	Confidence interval Upper limit	p value
HCV status				
Negative	0.365	0.154	0.860	.021
Unknown	0.281	0.126	0.627	.002
Female	2.725	1.204	6.169	.016
Age	0.910	0.627	1.321	.622
Age at first injection	1.088	0.698	1.694	.710
High school diploma	0.711	0.373	1.355	.300
Annual income $5,000+	2.010	0.728	5.550	.178
Homeless, past year	0.951	0.454	1.991	.894
Employment status				
Unemployed	1.400	0.272	7.628	.668
Disabled	1.216	0.147	10.041	.856
Other employment status (e.g., student, etc.)	14.119	0.724	275.358	.081

$+p = .1$; $*p = .05$; $**p = .01$; $***p = 0.001$.

Table 5. Frequencies.

Variable	Rural analytic	Rural total	Urban analytic	Urban total
Knew last partner's HCV test status				
Yes	39	49	58	60
No	82	113	237	244
HCV status				
Positive	68	152	147	216
Negative	30	74	60	101
Unknown	23	69	88	134
Gender				
Female	14	29	39	87
Male	107	285	256	411
Age				
18–34	35	81	81	128
35–44	33	99	125	196
45–54	38	101	73	142
55+	15	34	16	35
Age, 1st injection				
Under 18	31	89	101	156
18–24	57	154	128	191
25+	33	72	66	107
Education				
Graduated high school	57	165	165	248
Did not graduate	64	150	130	207
Annual income				
$5,000+	36	59	26	39
Less than $5,000	85	183	269	415
Homeless history				
No	96	193	65	99
Yes	25	121	230	356
Employment				
Employed	10	23	12	21
Unemployed	94	268	264	400
Disabled	9	12	15	24
Other	8	11	4	10

Discussion

While urban HCV+ respondents were more likely than their peers to know their last co-injection partner's HCV status test history, we find no such relationship in our rural sample. This is an important distinction as the collection methods used were similar for both samples. This suggests that such a distinction is due to real-world differences between the urban and rural populations, either in risk acceptance or structural constraints, and not simply an artifact of varying methodologies. However, one finding did hold across both samples: female PWID are more likely than their male counterparts to know their last co-injection partner's HCV test history. Such a relationship between gender and serosorting behavior has been found in previous research as well (Smith et al., 2013). It is possible that women are more aware of the benefits of serosorting as they also share equipment more often than men (Frajzyngier, Neaigus, Gyarmathy, Miller, & Friedman, 2007), including borrowing needles (Evans et al., 2003).

Our findings also suggest that rurality, rather than cultural differences, plays the larger role in HCV prevention behaviors associated with serosorting. In the urban sample, we were able to find a robust relationship between knowing one's HCV status and knowledge of last co-injection partner's HCV test state. Those respondents who knew they had an HCV+ status were more likely to know their last co-injection partner's HCV test state than were those whose HCV status was unknown, though no difference was found between HCV- respondents and those whose HCV status was unknown or negative.

While HCV+ urban PWID showed comparatively greater attention to their co-injection partner's HCV status, no relationship was found for people who were HCV- compared to an unknown status, suggesting that uninfected urban PWID are less concerned about transmission than their HCV+ counterparts. One likely cause of this is the common conception among PWID that HCV infection is inevitable (Al-Tayyib et al., 2015; Rhodes et al., 2004). However, it should be noted that some research suggests that PWID in general expect potential co-injectors who are HCV+ to reveal this prior to injection (Treloar, McCredie, & Lloyd, 2015). This would suggest that the patterns seen in urban Puerto Rico reveal a similar prevention ethos wherein it remains the burden of those already infected with HCV to start a conversation about infection risk. It is worth noting, in this regard, that the serosorting patterns discovered in urban Puerto Rico conform to results from other urban areas across the United States (Smith et al., 2013).

Data from the rural area show that no similar interpretation is possible for rural PWID. There, neither positive nor negative (nor unknown) HCV status was associated with knowledge of last partner's HCV test state. Unlike their urban counterparts in Puerto Rico, and unlike urban PWID more generally, rural injectors pay less attention to knowledge of HCV status among their co-injection partners. Such results argue for greater attention to the specific prevention needs of rural PWID.

It would be a mistake to see a lack of rural serosorting behaviors as a blanket sign of indifference to infection, however. In seeking to explain the differences between rural and urban risk patterns related to serosorting, the potential influence of different levels of health care infrastructure is significant. Recent research finds that key perceived barriers to drug treatment are organized around system-wide shortcomings (Notley, Maskrey, & Holland, 2012). Rural infrastructure in particular is lacking compared to urban counterparts in a number of ways, such as fewer centers available (Hirchak & Murphy, 2017) and fewer drug treatment options available (Rosenblatt et al., 2015). Thus, one possibility is that reduced access to drug treatment serves as a barrier to status concern or disclosure. Such considerations are largely unknown at present given the lack of attention to rural injection risk. Where clear differences with both local and national urban PWID are clear, greater attention to rural differences seems warranted.

Overall, it is clear that "testing as intervention" may have differential impact in rural versus urban Puerto Rico. In urban areas, prevention strategies employing testing outreach (that reveal positive HCV status) are likely to result in greater attention to risk partner testing state, with potential implications for HCV transmission. In rural areas of Puerto Rico, simply providing HCV tests would appear to have little potential to influence risk behaviors, regardless of the results of those tests. More is required to prevent HCV in rural areas.

Limitations

One important caveat of this study is that it focuses specifically on Puerto Ricans. There is some reason to believe that Puerto Rican PWID may behave uniquely. For example, Puerto Rican PWID living on the U.S. mainland are more likely than their non-Puerto Rican peers to share needles (Deren et al., 2001) and twice as likely to indirectly share equipment (Andía, Deren, Robles, Sung-Yeon, & Colón, 2008). Furthermore, another study found that new Puerto Rican immigrants in New York City took on more injection risks than Puerto Rican immigrants who had lived in New York for some time, suggesting that island-based Puerto Rican norms may be more lax than those on the mainland (Sherry Deren et al., 2003). Thus, this difference between urban and rural PWID may be unique to Puerto Rico. It is worth noting, however, that these studies did not distinguish between rural and urban originating Puerto Ricans. To the extent that these samples included high numbers of rural Puerto Ricans, these differences may reflect similar urban rural dynamics. It is also worth noting that our study found that urban PWID in Puerto Rico conformed to serosorting patterns similar to urban PWID elsewhere.

Another notable limitation is that we did not measure serosorting directly. Rather than asking respondents whether their last co-injection partner was someone with the same HCV status, we (like the NHBS interview) asked respondents whether they knew whether their last partner had had an HCV test. As such it is plausible that some people still injected with a person who had a discordant HCV status, but too few rural respondents reported even knowing their last partner's HCV status to reliably test whether this was common. A lack of such knowledge, however, implies no attempt at serosorting. The discrepancy found here suggests, at minimum, differences in serosorting attempts between rural and urban PWID in Puerto Rico, though those with this knowledge may behave similarly regardless of location.

Finally, the two data sets were not collected in tandem. The urban data were collected a full three years before the rural data. Although this raises the possibility of time period having an influence in differences, comparing the reports from the Round 3 urban data collected in 2012 (United States Centers for Disease Control and Prevention, 2012) with the Round 4 data collected in 2015 (United States Centers for Disease Control and Prevention, 2015) suggests few community-wide changes over these three years.

Conclusions

This study's key contribution to the literature is that it directly compares PWID in an urban area with PWID in a nearby rural area using similar data collection instruments and methods. Given the notable difference between these two areas, future researchers may wish to target specifically urban/rural comparisons, particularly as injection drug use has become a prominent rural health issue on a par with injection risk in urban areas.

Evidence from Puerto Rico suggests that rural PWID behave differently from their urban counterparts with regard to serosorting behaviors related to hepatitis C prevention. We find evidence that HCV+ respondents in the urban sample were more likely than their peers to have knowledge of their last co-injection partner's HCV test state. We found no such relationship in the rural sample. These results indicate that PWID in rural areas may be at an elevated risk of contracting HCV compared to their urban peers and that testing-based prevention strategies that have worked to prevent HIV infection may not be effective for preventing HCV infection in rural areas (though we find evidence to support prior conclusions that they may be effective in preventing HCV infection among urban PWID). These results confirm other findings related to a dearth of prevention information among rural PWID (Dunn et al., 2016). Clearly, public health interventions in rural areas cannot assume that sufficient local means are available to enable testing interventions to succeed. Whether this barrier is related to a lack of education that stresses the benefits of serosorting in prevention efforts, or more deep-seated structural issues related to access to care, remains an open question. Urban data have shown that encouraging PWID to ask potential partners about their HCV status before sharing equipment with them can influence injection-related infection, but whether and to what extent such methods can prove successful in rural venues remains an open question.

Funding

This work was supported by the National Institute on Drug Abuse [Grant Number R01DA037117].

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