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Hepatitis C virus infection and polysubstance use among young adult people who inject drugs in a rural county of New Mexico

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Abstract

Aims: We assessed prevalence and correlates for hepatitis C virus (HCV) infection in young adult people who inject drugs (PWID) in rural New Mexico, where opioid use has been historically problematic.

Methods: Participants were 18-29 years old with self-reported injection drug use in the past 90 days. We conducted testing for HCV antibodies (anti-HCV) and HCV ribonucleic acid (RNA) and assessed sociodemographic and risk exposures. We provided counseling and referrals to

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Contributors

All authors contributed to this paper and fulfill the authorship criteria. Kimberly Page, Eyasu Teshale, Erin L Winstanley, and Katherine Wagner developed and implemented the study protocol with substantial input from Jennifer Hettema, Karla Thornton, and Philip Fiuty. Katherine Wagner, Birgitta Bisztray, and Kirsten White led data collection, with substantial support from Philip Fiuty. Analyses were conducted by Katherine Wagner and Yuna Zhong with substantial input and feedback from Kimberly Page and Eyasu Teshale. Katherine Wagner, Kimberly Page, and Eyasu Teshale worked together on the first draft of this paper and all authors provided feedback. All authors reviewed and approved the final draft.

Conflicts of Interest

No conflict declared.

prevention services and drug treatment. We estimated prevalence ratios (PR) to assess bivariate associations with HCV infection; and adjusted PRs using modified Poisson regression methods.

Results: Among 256 participants tested for anti-HCV, 156 (60.9%) had been exposed (anti-HCV positive), and of 230 tested for both anti-HCV and HCV RNA, 103 (44.8%) had current infection (RNA-positive). The majority (87.6%) of participants were Hispanic. Almost all (96.1%) had ever injected heroin; 52.4% and 52.0% had ever injected methamphetamine or cocaine, respectively. Polysubstance injecting (heroin and any other drug) was associated with significantly higher prevalence of HCV infection (76.0%) compared to injecting only heroin (24.0%) (PR: 3.17 (95% CI: 1.93, 5.23)). Years of injecting, history of non-fatal opioid-involved overdose, polysubstance injecting, and stable housing were independently associated with HCV infection.

Conclusions: HCV is highly prevalent among young adult PWID in rural NM. The high reported prevalence of polysubstance injecting and its association with HCV infection should be considered in prevention planning.

Keywords

HCV; hepatitis; injection drug use; rural; young adults; New Mexico

1. INTRODUCTION

Hepatitis C virus (HCV) incidence in the United States (US) is highest in people who inject drugs (PWID), especially younger, recent initiates to injection drug use (IDU).(Klevens et al. 2012; Hagan et al. 2008) Over the past decade HCV incidence has increased among younger PWID in the United States in both urban and rural areas.(Klevens et al. 2012; Suryaprasad et al. 2014; Zibbell et al. 2018) HCV infection is especially challenging to contain in PWID due to high infectivity, numerous routes of exposure including needles and injecting equipment, and high background population (in PWID) prevalence.(Page et al. 2013; Hagan et al. 2010; MacArthur et al. 2014; Leyva et al. 2020) The expanding HCV epidemic is notable for its linkage to significant increases in prescription opioid medication use in the US and emergent infections in rural areas.(Zibbell et al. 2018; Novak et al. 2016; Monnat and Rigg 2016; Young, Havens, and Leukefeld 2010; Suryaprasad et al. 2014; Zibbell et al. 2015; Hofmeister, Havens, and Young 2017; Havens et al. 2013; Havens, Young, and Havens 2011)

In the few studies conducted in rural areas, prevalence of past or current HCV infection among PWID has been in excess of 50% by anti-HCV testing or self-report.(Havens et al. 2013)(Thrash et al. 2018) Treatment of HCV infection, which is now largely curative, is not readily accessible to many PWID and these HCV infection treatment barriers are exacerbated in rural areas.(Morris et al. 2019; Hagan et al. 2006; Schranz et al. 2018)

HCV infection can lead to serious liver disease and associated mortality and is an important public health concern. Temporally, in PWID, HCV infection almost always precedes HIV infection. For instance, reports of HCV foreshadowed the recent HIV outbreaks in Indiana, (McFarlane 2013; Conrad et al. 2015) and more recently in West Virginia and Massachusetts.(Zibbell et al. 2015; Evans et al. 2018; Centers for Disease Control and

Prevention (CDC) 2011; Freyer 2018; Alpren et al. 2019) Prevention and treatment of HCV infection are effective in reducing risks for both HCV and HIV infection.(Platt et al. 2018; Iversen et al. 2019)

New Mexico (NM) is a large state with approximately two million people, over 50% of whom reside in rural areas. The state has a diverse population with high poverty rates and challenging health disparities, including high prevalence of medically underserved communities (32 of 33 counties)(“What Is a Shortage Designation?” 2016) that contribute to the disparate risk and high population burden of HCV. A recent study ranked NM (2.8% HCV prevalence) among the three states with the highest HCV prevalence in the U.S. (Rosenberg et al. 2018) The NM Department of Health (NMDOH) estimates population prevalence of 280.7 cases/100,000 population.(Scrase et al. 2019) Following national trends among young adults (<30 years of age), acute HCV infection increased by 40% from 2010 to 2015, and the majority of these new patients reported IDU.(Faturos E, Drake A, Thomas J, Smelser C. 30 March, 2018) Using registration and attendance data from the NMDOH Syringe Service Program (SSP) and capture-recapture methods, we have estimated that there are up to 20,000 active past year PWID in New Mexico,(Leyva Y., Zurlo D., Page K. 2017) of whom 10,000-13,000 are HCV-infected.(Rosenberg et al. 2018) HIV infection (192.1/100,000 population) is less prevalent than HCV infection, but 17% of HIV cases in NM are attributed to IDU.(“HIV Surveillance & Epidemiology” 2020)

Opioid-involved overdoses and IDU have been historically high in NM; however, HCV infection has not been well studied.(Trujillo 2010; Garcia 2010; Ruhm 2017; Levy et al. 2016) A serosurvey conducted in NM in the early 1990s reported HCV infection prevalence of 82.2% among PWID ranging in ages from 15 to 68 years old.(Samuel et al. 2001) Among those 15-30 years old (n=203), HCV infection prevalence was 62.6%. Ten years later, a small serosurvey in a border region, found 80% HCV infection prevalence.(Baumbach et al. 2008) As national trends have indicated increasing HCV infection in rural areas, the purpose of this study was to determine the prevalence of past and current HCV infection in young adult PWID in rural areas of NM and assess associated risk exposures. Information regarding HCV infection prevalence will help drive prevention and treatment efforts.

2. METHODS

The study, named *¡VÁLE!*, a Spanish term for “it’s worth it” or “go for it” and also “valley,” was primarily conducted in Rio Arriba County (in the upper Rio Grande Valley) at The Mountain Center from September 2016 through May 2018. The Mountain Center is a community-based program that hosts an SSP. Other prevention, recovery, and drug treatment programs for PWID often co-locate at the Mountain Center (with inconsistency due to funding) including: counseling, a buprenorphine provider, Pathways navigators (community health workers that assess needs and help connect participants with services), and a community-based organization that offers weekly HIV/HCV rapid testing. Participants in Rio Arriba County, in Northern New Mexico, were recruited by screening interested clients of The Mountain Center. Additional participants were recruited through referrals from current participants. Additionally, research staff occasionally accompanied The Mountain Center’s mobile outreach team to areas within Rio Arriba County to recruit study

participants and to conduct testing. A secondary study site in Southern NM -Doña Ana County (in the Mesilla Valley), also a drop-in center offering harm reduction and health referral services, was a recruitment site from September 2016 through July 2017. The outreach team was stationed in the parking lot of the drop-in center and approached clients that were in the area. Prior to the implementation of the study, HCV screening had not been available at the Dona Ana study site, nor consistently at the Mountain Center.

2.1 ¡VÁLE! Study Procedures

The study was designed as a prospective observational study with study visits scheduled 3 months apart for one year. Eligible participants were 18-29 years old with self-reported IDU in the past 90 days and with no plans of leaving the general area within the next year. Those who provided written informed consent were enrolled and underwent testing for anti-HCV using a rapid point-of-care antibody test (anti-HCV; OraSure© Technologies; Bethlehem, PA) from capillary blood samples obtained using a fingerstick. Study personnel trained in phlebotomy performed venipuncture to obtain blood to test for HCV ribonucleic acid (RNA) to determine current infection status. All participants received counseling about infection prevention and referrals to local services for harm reduction, drug treatment, hepatitis B vaccination, and behavioral health care. Participants were interviewed using a structured questionnaire about sociodemographic characteristics, exposure risk, drug use history and injecting-related exposures. After completing the interview and rapid anti-HCV testing, participants were asked to return within two weeks to the study site to receive their HCV RNA results. If HCV RNA tests were negative, participants were asked to return in three months. If HCV RNA test results were positive, indicating current HCV infection, participants underwent a one-on-one HCV education session and received a referral for further HCV assessment and care. Participants received a $15 Visa merchandise card for completing the baseline visit and another $15 card for returning for their HCV results. HCV RNA positive participants were offered small incentives ranging from $10 to $25 to attend their HCV treatment visits at their chosen clinic. Study personnel obtained releases of information from the HCV RNA positive participants to contact the clinic and obtain the HCV-related portion of the medical records from those visits as well as any documentation of treatment and testing for sustained virologic response at 12 weeks post-treatment.

2.2 Analyses

All analyses in this paper are from baseline interviews. Descriptive statistics including means and medians and statistical dispersion were tabulated on demographic and risk exposure measures reported by participants. Associations with two outcomes of interest were examined: (1) positive anti-HCV status, indicating past and current HCV infection and (2) positive HCV RNA status, indicative of current (acute or chronic) infection. Bivariate associations with prevalence ratios (PR), and 95% confidence intervals (95% CI) were estimated and were considered significant at $p \leq 0.05$. Multivariable analyses were conducted using modified Poisson regression methods to identify factors independently associated with past or current HCV infection and to estimate adjusted PRs.(Barros and Hirakata 2003; Zou 2004). We estimated APRs following methods described by Zhao (Zhao 2013) using a modified Poisson regression model with a robust error variance. Variables included in the multivariable models were those found to be significant in bivariate analyses at $p \leq 0.10$,

known confounders/associations (e.g., age, sex, years injecting), and those hypothesized a priori to be potentially associated (e.g., a family member assisted with drug initiation, polysubstance use, especially injecting both heroin with other drugs compared to only heroin, frequency of injecting, and injecting prescription opioids to self-treat heroin withdrawal). We selected a final parsimonious model after comparing full and nested models and examining likelihood ratio tests. All analyses were conducted with SAS 9.4 (SAS Institute, Cary, NC).

2.3 Ethics Approval

The University of New Mexico Health Sciences Center Institutional Review Board reviewed and approved the study. All participants provided written informed consent to participate. We received a Federal Certificate of Confidentiality for the study to enhance privacy protections due to the sensitive nature of the data collected.

3. RESULTS

A total of 480 unique people were screened for study eligibility, some of whom were rescreened if they did not enroll with-in a three-month time frame from the first screening; 263 (54.8%) were enrolled, 64 (13.3%) were eligible but declined enrollment and 165 (34.4%) were ineligible. Reasons for declining participation included not wanting to take the time to participate, be tested for HCV, or commit to follow-up visits. Ineligibility was due to being out of eligible age range (50.3%), not reporting recent injecting (40.5%) or both (8.5%) (out of age range and not reporting recent injecting). The median age of participants was 26.1 years (Interquartile Range (IQR) 22.6, 28.2), the majority (87.6%) were Hispanic, and had a high school or less level of education (94.9%) (Table 1). Participants' reported median age at injection initiation was 19 years (IQR 17, 23.0). There were no significant differences between eligible enrolled participants and those who were eligible but declined with respect to: age, sex, having had a previous HCV test, the proportion with a reactive HCV test, having family in the area, or median number of days injected in the past 3 months. The median average frequency of injecting was 6 days a week, 3 times per day. Approximately one-third (32.9%) reported that they injected themselves the first time they injected, and 35.7% and 12.9% reported being injected by a friend or family member, respectively. Participants reported a median of twice (IQR 1,3) reuse of needles/syringes before disposing of them. Heroin was the most frequently reported drug injected: 96.1% reported ever, and 92.2% reported recent (last 3 months) use. Polysubstance use (defined as reporting injecting heroin and any other substance use in the same time period) was reported ever and in the last 3 months by 79.8% and 54.1%, respectively. Any lifetime IDU of methamphetamine or cocaine injection was reported by 52.4% and 52.0%, respectively. Just under a third (29.9%) reported ever co-injecting (simultaneous administration) heroin and methamphetamine, and 44.9% reported co-injecting heroin and cocaine together. More than half (59.8%) reported being previously tested for HCV and approximately half (49.8%) had ever been tested for HIV. The majority (96.9%) of participants reported currently having health insurance, 54.6% had received medication(s) for opioid use disorder (MOUD), and three of four (74.6%) participants reported having attended an SSP in the past three months. Prevalence of anti-HCV, indicating past or current infection, was 60.9% (95% CI: 54.7,

67.0). Of the 263 participants in the study, 230 (87.5%) were tested for both anti-HCV and HCV RNA; 105 (45.7%) had evidence of current infection (RNA-positive), ten of whom were in the acute infection phase (anti-HCV negative/RNA-positive).

In bivariate analyses of demographic variables and HCV infection outcomes, older age ($p<0.001$) and having been on probation or parole ($p=0.05$) were significantly associated with HCV infection (Table 2). Those reporting living in a shelter or on the street (unhoused) were less likely to have been HCV infected relative to those reporting being housed (owning or renting a home; $p=0.03$). Older age, male sex ($p=0.001$) and having a history of probation or parole were associated with having current HCV infection ($p=0.02$).

Table 3 shows bivariate analyses of drug use related exposures and HCV infection outcomes. Years since first injection, more frequent injecting (days per week and times per day), sharing injection equipment (including receptive syringe/needle sharing (RNS) and distributive syringe/needle sharing (DNS), sharing a 'cooker', injecting someone else's rinse, backloading or piggybacking to split drugs), and having ever experienced a non-fatal opioid-involved overdose were associated with HCV infection. Both past and current HCV infection were significantly associated with years since first injection, RNS and DNS, sharing a cooker, ever have had a non-fatal opioid overdose, polysubstance use, and co-injecting heroin and stimulants (heroin and methamphetamine, or heroin and cocaine). Participants who reported injecting prescription opioid medication to self-treat withdrawal were more likely to be HCV infected relative to those who did not report this behavior.

Table 4 shows factors found to be independently associated with past or current HCV infections (anti-HCV positive). Years of injecting, ever injecting a prescription opioid medication to self-treat opioid withdrawal, and polysubstance injecting were positively associated with HCV infection. Unstable housing relative to stable housing was associated with lower HCV infection.

4. DISCUSSION

Results from this research demonstrate that HCV infection is highly prevalent among young adult PWID in rural NM: three out of five (60.9%) participants had serological evidence of past or current infection and almost half (45.7%) were currently infected. HCV infection was higher than observed in young adult PWID in urban areas including San Francisco (38.6%)(Page et al. 2009; Morris et al. 2019), Baltimore (53%) and Chicago (13.7%). (Boodram, Golub, and Ouellet 2010) In a recent systematic review, Paquette and Pollini documented five studies, with three since 2010, that specifically recruited and tested non-urban PWID for HCV infection (and/or HIV). (Paquette and Pollini 2018) These more recent studies included a total of 961 PWID and HCV (anti-HCV) prevalence ranged from 34% in young adult PWID sampled in rural New York,(Zibbell et al. 2014) to 55% in Kentucky,(Havens et al. 2013) though this latter sample included older PWID (median age of 31 years). It is understandable that HCV infection may be higher in rural areas compared to urban areas, as prevention services are likely less established.(Jarlais et al. 2015) However, the higher prevalence of HCV infection in this New Mexican sample, compared to prevalence reported in other rural areas, remains paradoxical given the prevailing availability

of evidence-based strategies to reduce transmission. Harm reduction services in NM have been widely supported by the NMDOH since 1978 (The Harm Reduction Act was passed in 1997 and services began in February of 1998) and are largely accessible, including in some rural areas.(Rekart 2005) The majority (74.6%) of respondents in this study report using SSP (although we did not collect data on frequency of SSP use) so these findings raise questions about how to ensure effective SSP coverage. MOUD, which can decrease HCV incidence, (Platt et al. 2018) is also available in NM, however, many participants said they had difficulty accessing it, despite a majority of participants reporting having health insurance. Indeed, in 2018, eight of NM's counties had no buprenorphine prescribers, and fewer than 20% of OUD providers offered buprenorphine treatment.("Buprenorphine Practitioner Locator | SAMHSA - Substance Abuse and Mental Health Services Administration" 2020) Further, there are 12 locations in the State of NM that offer methadone treatment, 10 of which are located in Albuquerque, the primary metropolitan area in the state and one in each of the counties where this study was conducted.(New Mexico Department of Health 2020)

There are several potential reasons for the elevated prevalence of HCV infection even in the context of extensive prevention and treatment services in NM. First, HCV infection has been established for decades in association with the state's long standing opioid crisis.(Samuel et al. 2001) This high background prevalence and high infectivity,(Leyva et al. 2020) combined with a high rate of sharing injecting equipment, including syringes/needles as well as ancillary equipment, has likely resulted in an endemic state. Secondly, social factors, including social mixing patterns (referring to how people sort and intermingle based on social, demographic and behavioral factors they know about each other; for example PWID may be more or less likely to form injecting partnerships based on partners' age or knowledge of HCV status), and incarceration may increase risk transmission dynamics in this state.(Morris et al. 2015; Young, Rudolph, and Havens 2018; Spelman et al. 2019; Stone et al. 2018; Page et al. 2019) NM has the highest prevalence (>40%) of HCV infection among incarcerated persons in the country.(Spaulding et al. 2019; Varan et al. 2014) Thirdly, while MOUD is associated with reduced HCV infection incidence,(Tsui et al. 2014; Platt et al. 2018) this may not have effectively impacted population prevalence in NM if exposure rates (e.g., frequent injecting, sharing I DU equipment) and stimulant use are high. The prevalence of any reported polysubstance use was high (79.8%) and rates of co-injection of heroin and stimulants (cocaine and or methamphetamine) in this sample (>84%) are higher than reported in Tijuana, Mexico (69.6%) and San Diego (41.2%).(Meacham et al. 2016) Stimulant injection can involve more frequent injecting than heroin alone and co-injection has been shown to be associated with higher risk injection and sexual risk behaviors. (Meacham et al. 2016)(Al-Tayyib et al. 2017) Over a third of participants in our study reported injecting prescription pain medications to stave withdrawal, which may also contribute to higher HCV infections, since the preparation methods to inject prescription opioids are associated with higher HCV risk and persons experiencing opioid withdrawal may be more likely to engage in high risk injecting practices including sharing drug preparation equipment.(Zibbell et al. 2014) Our data also suggest that there is a lack of MOUD treatment in this group. Overall, 98% of the total sample reported any type of opioid use, and 49% of those reported having ever received MOUD, however only 21.9% were currently on MOUD. Retention in MOUD treatment is critical for young adult PWID in

order to reduce HCV infection incidence.(Curtin, Tejada-Vera, and Warmer 2017; Wu et al. 2011) High HCV infection rates in this sample likely exist not only because of fragmented access to MOUD services, but also due to the limitations of both targeting and sustaining behavioral prevention efforts in young adult PWID.

The high reported prevalence of polysubstance use, especially with stimulants is important to consider in NM and elsewhere. Numerous national and regional indicators point to increases in stimulant use and associated negative health outcomes, including increases in stimulant-associated deaths and in the percentage of primary heroin treatment admissions reporting methamphetamine use.(Twillman et al. 2020)(“Products - Data Briefs - Number 356 - January 2020” 2020; Ellis, Kasper, and Cicero 2018) (Jones, Underwood, and Compton 2019)(“Teds” 2019) The CDC recently reported that from 2012 through 2018, the rate of drug overdose deaths involving cocaine more than tripled (from 1.4/100,000 to 4.5/100,000 deaths) and the age-adjusted death rate (per 100,000) involving psychostimulants with abuse potential (e.g., methamphetamine, methylphenidate) increased nearly five-fold (from 0.8 to 3.9).(“Products - Data Briefs - Number 356 - January 2020” 2020). Methamphetamine use has been recognized as a Southwest regional problem for many years, as a result of relatively high purity production and low-priced Mexican-sourced product reaching markets in the Southwest.(Shukla, Crump, and Chrisco 2012) The large proportion of people who use cocaine in our study sample, however, was less expected. Increases in cocaine manufacturing, reported by the United Nations Office on Drugs and Crime (Crime and United Nations Office on Drugs and Crime 2019) and Drug Enforcement Agency (“DEA Releases 2019 National Drug Threat Assessment” 2020) may be impacting rural areas as seen here in NM similar to what has been observed in urban areas.(Glick et al. 2018; Jones, Einstein, and Compton 2018) This evolution could presage an increase in HCV infection among PWID, and potentially the very real risk of HIV outbreaks as well.(Van Handel et al. 2016) All of these factors demonstrate a need to address the increasing prevalence of stimulant use, especially when used in combination with highly potent opioids like illicitly manufactured fentanyl and the disparate public health implications of this trend (Kariisa et al. 2019).

The population sampled in this study was predominantly Hispanic. This ethnic group has long been recognized as having higher rates of HCV infection, as well as lower access to testing and treatment compared to Whites.(Trooskin et al. 2007) While nationally, increases in reported acute HCV infection are most pronounced in American Indians and Whites, (Reilley and Leston 2017) there has been a significant increase in opioid use and HCV infection among Hispanics, coupled with a lower uptake of treatment for substance use disorders compared to other racial/ethnic groups.(Zibbell et al. 2018)

Another interesting finding in our study had to do with housing. While the vast majority of participants reported having housing and less than 10% reported being homeless, the inverse association seen between HCV infection and with stable housing was unexpected. Many studies report poorer health outcomes, including higher HCV infection incidence among PWID with unstable housing.(Schanzer et al. 2007; Kim et al. 2009) We hypothesize that the strong familial relationships that exist in Hispanic groups in our area may be additionally sustained by interfamilial drug use, contributing to this contrary effect.(Trujillo 2010) Many

residents in rural areas of NM have families that have lived in these locations for multiple generations, and homes and property are kept within families for centuries. It is possible that young adult PWID are less likely to be “pushed-out” of the house, explaining the higher prevalence among those who report stable housing. Persons who are experiencing homelessness may be protected if they mostly sleep in a shelter since injection inside the shelter may be unlikely. Unmeasured confounding by income or social class might be present as well. Additional exploration of this result may contribute to potential family- or community-based interventions.

This study has strengths and limitations to note. Few studies have examined HCV infection in rural populations, and most data from these are limited to antibody testing. This study examined prevalence of both past and current infection in a young adult rural PWID population and we are not aware of other similar studies. The study is limited by relatively modest sample size and non-randomness which limits generalizability not only in other rural areas of NM, but also the U.S. Further, 13.3% of eligible individuals screened refused to participate and it is unknown if there was any associated differential risk in this group. However, the sample is reflective of the population in Rio Arriba County with the majority identifying as Hispanic (~71.2)%, insured (88.5%) and with a high owner-occupancy rate (77%).(“United States Census Bureau QuickFacts” n.d.)(Department of Health 2018) In comparison, education level was slightly lower (62.9% with a high school or higher level) compared to the county (86.2%) which may be due to the overall young age of the sample. The Mountain Center reports that 93% of their clients are Hispanic and that 65% are male, slightly higher than the 57% male in this study, and the 96% health insurance coverage is realistic (P. Fiuty, personal communication; 12/02/2020). Additionally, self-reported risk behaviors and drug use may be under-reported as a result of social-desirability bias. To minimize this, participants were tested and counseled on their risk behaviors following the interview. Under-reporting of risk behaviors, such as sharing needles and injection equipment sharing is plausible. If non-differential, this would cause bias to the null, making our PRs conservative. Since more than half (58.8%) of participants had previously been tested for HCV, knowledge of HCV status could result in differential reporting potentially biasing the observed PRs upward or downward. However, previous research has not shown differences in self-reported drug use after HCV infection disclosure. (Spelman et al. 2015; Tsui et al. 2009) Due to the cross-sectional nature of the data analyzed here, it is not possible to determine temporal associations between covariates. However, the associations between drug use and HCV infection are consistent with other studies regarding correlates of and risk for HCV infection in this population. The small sample size also makes it difficult to detect associations between particular drug classes and HCV infection in a sample with widespread polysubstance use. The associations between housing and HCV infection may also be impacted by both the non-random sampling and small sample size resulting in low numbers of unstably housed participants.

This study of HCV infection sheds light on numerous gaps and emerging issues associated with substance use in rural NM. As a result of resource and programmatic prioritization, driven by large increases in opioid-involved overdoses there has been an almost exclusive focus on problematic opioid use in the United States, possibly limiting attention on other drugs. Results of this study are consistent with recent data showing that polysubstance use,

especially co-injection of heroin and stimulants, is also increasingly troublesome. The significant ramifications of polysubstance use on rural communities are compounded by significant disparities in the medical consequences of IDU, likely other co-occurring conditions such as mental health, and limited access to prevention and treatment. The results of this study suggest that prevention and harm reduction services need to emphasize the risks of HCV infection associated with sharing any injecting equipment and provide explicit messaging regarding risk to persons who inject stimulants. There is also an urgent need to improve the engagement in and continuity of MOUD treatment within communities to ensure population-level benefits. Although treatment of HCV infection is increasing in NM, (Scrase et al. 2019) it is not clear that these resources are reaching high risk populations such as PWID in rural areas and further research will inform whether treatment of HCV as prevention is viable.

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Highlights

- Hepatitis C is prevalent among young adults who inject in rural New Mexico
- Polysubstance injection appears to increase risk of hepatitis C infection
- HCV infection was associated with stable housing in the study population
- Opioid use prevention and treatment work should expand to stimulants

Table 1:

Demographics, behavioral characteristics and substance use among young adult people who inject drugs in rural New Mexico. (N=263)

	N	% (or median)	95% CI (or IQR)
HCV outcomes			
Exposed (anti-HCV positive) (n=256)	156	60.9	54.7, 67.0
HCV infected (HCV RNA positive) (n=230)	105	45.7	39.1, 52.3
Acute HCV infection (anti-HCV negative & HCV RNA positive; n=230)	10	4.3	2.1, 7.9
Demographics			
Median age, years (n=261) (median, IQR)		26.07	22.62, 28.19
Age <25 years	107	41.0	35.0, 47.2
Age ≥25 years	154	59.0	52.8, 65.0
Sex/Gender (n=261)			
Male	149	57.1	50.8, 63.2
Female	112	42.9	36.8, 49.2
Hispanic ethnicity (n=259)	227	87.6	83.0, 91.4
Race (n=257)			
White	151	58.8	52.5, 64.8
Black	7	2.7	1.1, 5.5
Other (includes American Indian, Asian/Pacific Islander, mixed	99	38.5	32.5, 44.8
Education (n=256)			
Less than high school	95	37.1	31.2, 43.3
High school diploma or GED	148	57.8	51.5, 63.9
Some college or higher	13	5.1	2.7, 8.5
Housing (n=253)			
Own/rent apartment, room or house	108	42.7	36.5, 49.0
Someone else's apartment/room/house	121	47.8	41.5, 54.2
Other/Shelter/Street/outdoors	24	9.5	6.2, 13.8
Ever been on probation/parole (n=251)	138	55.0	48.6, 61.2
Injecting practices (ever and of those – in the last 3 months)			
Median age at first injection drug use (IQR) (n=254)		19	17.0, 23.0
Median years since first injection drug use (n=254)		4.2	2.0, 8.6
Median "Average" number of days injected per week (IQR) (n=255)		6.0	3.0, 6.0
Median "Average" number of times injected per day (IQR) (n=253)		3.0	2.0, 4.0
Median "Average" number of times used a syringe before disposing (IQR) (N=247)		2.0	1.0, 3.0
Median "Average" number of injecting partners in the past 3 month (IQR) (n=202)		2.0	1.0, 2.0
Last 3 months: Median frequency of pooling money to buy drugs to inject in the last 3 months (n=248)		2	1.0, 4.0
Ever: receptive syringe sharing[#] (n=253)	135	53.4	47.0, 59.6
Last 3 months: receptive[#] syringe sharing (n=135)	63	46.7	38.0, 55.4

	N	% (or median)	95% CI (or IQR)
Ever: distributive syringe sharing[≠] (n=252)	107	42.5	36.3, 48.8
Last 3 months: distributive syringe sharing[≠] (n=107)	67	62.6	52.7, 71.8
Ever: shared a 'cooker' to mix drugs in (n=253)	168	66.4	60.2, 72.2
Last 3 months: shared a 'cooker' to mix drugs in	126	75.0	67.8, 81.4
Ever: injected someone else's 'rinse' (n=254)	87	34.3	28.4, 40.4
Last 3 months: injected someone else's 'rinse	59	67.8	56.9, 77.4
Last 3 months: backloaded or piggy-backed w/syringe to split drugs piggy-backed (n=253)	108	43.0	36.5, 49.0
Ever: had an opioid overdose (n=251)	115	45.7	39.5, 52.2
Drugs injected (n=254)			
Ever: heroin (n=254)	244	96.1	92.9, 98.1
Last 3 months: heroin (n=244)	224	92.2	88.1, 95.2
Ever: Heroin polysubstance use (heroin with other drugs) (n=247)	150	79.8	74.2, 84.6
Last 3 months: Heroin polysubstance use (229)	124	54.1	47.4, 60.7
Ever: cocaine (n=254)	132	52.0	45.6, 58.3
Last 3 months: cocaine (n=132)	49	37.1	28.9, 46.0
Ever: methamphetamine (n=254)	133	52.4	46.0, 58.6
Last 3 months: methamphetamine (n=133)	83	62.4	53.6, 70.7
Ever: heroin mixed with cocaine (n=254)	114	44.9	38.7, 51.2
Last 3 months: heroin mixed with cocaine (n=114)	32	28.1	20.1, 37.3
Ever: heroin and methamphetamine (n=254)	76	29.9	24.4, 36.0
Last 3 months: heroin and methamphetamine (n=76)	39	51.3	39.6, 63.0
Ever: crack (n=254)	29	11.4	7.8, 16.0
Last 3 months: crack (n=29)	6	20.7	8.0, 39.7
Ever: prescription opioids medication (n=254)	40	15.7	11.5, 20.8
Last 3 months: prescription opioids medications (n=40)	8	20.5	9.3, 36.5
Ever: Injected prescription medications to self-treat opioid withdrawal (n=254)	120	47.2	41.0, 53.6
Last 3 months: Injected prescription medications to self-treat opioid withdrawal (n=120)	45	37.5	28.8, 46.8
Ever: benzodiazepines (tranquilizers)(n=254)	12	4.8	2.5, 8.1
Last 3 months: benzodiazepines (tranquilizers) (n=12)	1	7.7	0.2, 36.0
Health care utilization			
Saw a health care provider in the past year (n=255)	149	58.4	52.1, 64.6
Has seen a health care provider in the past 30 days	30	11.8	8.1, 16.4
Can get to medical appointments (car, walking, a ride, public transportation) (n=256)	240	93.8	90.1, 96.4
Ever previously tested for HCV (n=255)	150	58.8	52.5, 64.9
Ever been tested for HIV (n=255)	127	49.8	43.5, 56.1
Currently has health insurance (n=255)	247	96.9	93.9, 98.6
Ever received any kind of treatment or counseling for drug or alcohol use (n=253)	173	68.4	62.3, 74.1
Ever received any medication for opioid use use disorder (n=251 ever opioid users)	123	49.0	42.7, 55.4
Currently taking medication for opioid use disorder (n=251 ever opioid users)	55	21.9	17.0, 27.6
Wanted to get treatment for drug use in the past 3 months but did not go (n=233)	98	42.2	35.8, 48.9

	N	% (or median)	95% CI (or IQR)
Harm reduction services			
Attended a syringe service program (SSP) in the past 3 months (n=240)	179	74.6	68.6, 80.0
On average, how many times went to SSP in the past week (median, IQR) (n=95)		1	1, 1
On average, how many syringes obtained in one visit to SSP? (n=165)		100	40.0, 200.0

3 month measures are in those who responded affirmatively to ‘ever’.

[#] used a syringe/needle (rig) that someone else used before you

[±] let someone use your syringe/needle (rig) after you used it.

Table 2:

Bivariate associations of demographic characteristic and past or present HCV (anti-HCV positive) and current HCV infection (HCV RNA positive)

	Tested for Anti-HCV (N=263)*			Tested for HCV RNA (N=230)*		
Variables	**Anti-HCV reactive* (n=166)**	**Prevalence Ratio (95% CI)**	**P-value**	**HCV RNA-positive* (n=105)**	**Prevalence Ratio (95% CI)**	**P-value**
Age category at enroll						
Age <25 years	53 (49.5)	1.0		33 (30.8)	1.0	
Age ≥25 years	113 (73.4)	**1.48 (1.20, 1.83)**	<0.001	72 (46.8)	1.52 (1.09, 2.11)	0.014
Sex/Gender						
Male	100 (67.1)	1.0		74 (49.7)	1.0	
Female	66 (58.9)	0.88 (0.73, 1.06)	0.18	31 (27.7)	**0.56 (0.4, 0.78)**	<0.001
Hispanic						
No	21 (65.6)	1.0		15 (46.9)	1.0	
Yes	144 (63.4)	0.97 (0.74, 1.27)	0.80	90 (39.6)	0.85 (0.57, 1.26)	0.41
Race						
White	93 (61.6)	1.0		63 (41.7)	1.0	
Black	2 (28.6)	0.46 (0.11, 1.88)	0.28	1 (14.3)	0.34 (0.05, 2.47)	0.29
Other#	67 (67.7)	1.10 (0.80, 1.50)	0.55	40 (40.4)	0.97 (0.65, 1.44)	0.87
Education						
Did not complete high school	61 (64.2)	1.0		40 (42.1)	1.0	
High school diploma or GED	97 (65.5)	1.02 (0.74, 1.41)	0.9	23 (46.9)	1.1 (0.8 - 1.6)	
Some college or higher	6 (46.2)	0.72 (0.31, 1.66))	0.45	4 (30.8)	0.7 (0.3 - 1.7)	0.57
Housing						
Own/rent apartment, room or house	79 (73.1)	1.0		48 (44.4)	1.0	
Guest in someone else's apartment/room/ house	75 (62.0)	0.85 (0.62, 1.16)	0.3	50 (41.3)	0.93 (0.63, 1.38)	0.72
Shelter/Street/Outdoors/Other	8 (33.3)	**0.46 (0.22, 0.94)**	<0.03*	5 (20.8)	0.47 (0.19, 1.19)	0.11
Ever been on probation/parole						
No	65 (57.5)	1.0		37 (32.7)	1.0	

	Tested for Anti-HCV (N=263)*			Tested for HCV RNA (N=230)*		
Variables	**Anti-HCV reactive* (n=166)**	**Prevalence Ratio (95% CI)**	**P-value**	**HCV RNA-positive* (n=105)**	**Prevalence Ratio (95% CI)**	**P-value**
Yes	96 (69.6)	**1.21 (1.0, 1.47)**	0.054	66 (47.8)	**1.46 (1.06, 2.0)**	0.02

*Column N may not add to full sample size due to missing data

#Other: self-reported as mixed, bi- or multi-racial, or did not specify

Bold type indicates statistically significant associations.

Table 3:

Bivariate associations of injecting exposures and past or present HCV infection (anti-HCV positive) and current HCV infection (HCV RNA positive)

	Tested for Anti-HCV N=263*			Tested for HCV RNA N=230		
Variables	**Anti-HCV reactive (n=166)***	**Prevalence Ratio (95% CI)**	**P-value**	**HCV RNA-positive* (n=101)**	**Prevalence Ratio (95% CI)**	**P-value**
Age at first injection#						
<=19 years	91(69.5)	1.0		60 (45.8)	1.0	
>19 years	71(57.7)	0.83 (0.69, 1.0)	0.055	44 (35.8)	0.78 (0.58, 1.06)	0.11
Years since first injection#						
< 4.2 years	60 (47.2)	1.0		37 (29.1)	1.0	
≥4.2 years	102 (80.3)	1.70 (1.39, 2.08)	<0.001	67 (52.8)	1.81 (1.32, 2.49)	<0.001
Who injected you the first time you injected						
Self	57 (67.9)	1.0		84 (32.9)	1.0	
Friend	52 (57.1)	0.84 (0.58, 1.23)	0.37	34 (37.4)	0.85 (0.53, 1.35)	0.49
Family	24 (72.7))	1.07 (0.67, 1.73)	0.78	14 (72.7))	0.96 (0.52, 1.78)	0.91
Spouse/Sexual partner	23 (82.1)	1.21 (0.75, 1.96)	0.44	13 (82.1)	1.05 (0.56, 1.98)	0.87
Acquaintance/Drug dealer/Stranger/Other	7 (36.8)	0.54 (0.25, 1.19)	0.13	6 (36.8)	0.72 (0.30, 1.7)	0.45
Main reason started injecting heroin						
Ease of access	17 (70.8)	1.0	0.84		1.0	
Cost	30 (66.7)	0.94 (0.51, 1.71)	0.71	10 (41.7)	0.85 (0.39, 1.88)	0.69
I like it better	22 (62.9)	0.89 (0.47, 1.67)	0.83	16 (35.6)	0.75 (0.32, 1.78)	0.52
It’s what my friends were using	19 (76.0)	1.07 (0.55, 2.06)	0.54	11 (31.4)	0.86 (0.35, 2.13)	0.75
Other	42 (58.3)	0.84 (0.47, 1.47)	0.54	9 (36.0)	1.14 (0.56, 2.29)	0.72
Missing/DNA	34 (56.7)	0.80 (0.44, 1.43)	0.45	35 (47.3)	0.96 (0.46, 2.01)	0.94
Average number of injection days/week#						
≤6 days/week	40 (47.1)	1.0		28 (32.9)	1.0	
>6 days/week	123 (72.4)	**1.54 (1.21, 1.96)**	<0.001	76 (44.7)	1.36 (0.96, 1.92)	0.084
Average number of injection times/day#						

	Tested for Anti-HCV N=263*			Tested for HCV RNA N=230		
Variables	**Anti-HCV reactive (n=166)***	**Prevalence Ratio (95% CI)**	**P-value**	**HCV RNA-positive* (n=101)**	**Prevalence Ratio (95% CI)**	**P-value**
≤3 times/day	63 (52.9)	1.0		43 (35.3)	1.0	
>3 times/day	98 (73.1)	**1.38 (1.13, 1.68)**	0.001	60 (44.8)	1.27 (0.93, 1.73)	0.13
Average number of times syringe is used before getting rid of it#						
≤2 times	67 (58.8)	1.0		41 (36.0)	1.0	
>2 times	91 (68.4)	1.16 (0.96, 1.41)	0.12	60 (45.1)	1.25	0.15
Distributive syringe sharing						
No	78 (53.8)	1.0		44 (30.3)	1.0	
Yes	83 (77.6)	**1.46 (1.20, 1.73)**	<0.001	59 (55.1)	**1.82 (1.35, 2.45)**	<0.001
Receptive syringe sharing						
No	61 (51.7)	1.0		31 (26.3)	1.0	
Yes	102 (75.6)	**1.46 (1.20, 1.78)**	<0.001	73 (54.1)	**2.06 (1.47, 2.89)**	<0.001
Ever shared a cooker						
No	40 (47.1)	1.0		25 (29.4)	1.0	
Yes	122 (72.6)	**1.54 (1.21, 1.97)**	<0.001	79 (47.0	**1.6 (1.11, 2.31)**	0.012
Ever injected someones rinse						
No	98 (58.7)	1.0		64 (38.3)	1.0	
Yes	65 (75.9)	**1.27 (1.07, 1.52)**	0.0180	40 (46.0)	1.2 (0.89, 1.62)	0.23
Backloaded or piggy-backed w/syringe in last 3 months						
No	80 (55.2)	1.0		52 (35.9)	1.0	
Yes	82 (75.9)	**1.38 (1.15, 1.65)**	<0.001*	51 (47.2)	1.32 (0.98, 1.77)	0.068
Ever had non-fatal opioid overdose						
No	71 (52.2)	1.0		43 (31.6)	1.0	
Yes	90 (78.3)	**1.50 (1.24, 1.81)**	<0.001	61 (53)	**1.68 (1.24, 2.27)**	<0.001
Drugs injected - Ever						
heroin only	12 (24.0)	1.0		9 (18.0)	1.0	
polysubstance: heroin with other drugs	150 (76.0)	**3.17 (1.93, 5.23)**	<0.001	94 (47.7)	**2.65 (1.44, 4.88**)	0.002

	Tested for Anti-HCV N=263*			Tested for HCV RNA N=230		
Variables	**Anti-HCV reactive (n=166)***	**Prevalence Ratio (95% CI)**	**P-value**	**HCV RNA-positive* (n=101)**	**Prevalence Ratio (95% CI)**	**P-value**
Injected heroin -Ever						
No	2 (20.0)	1.0		2 (20)	1.0	
Yes	161 (66.0)	3.3 (0.95, 11.43)	0.06	102 (41.8)	2.09 (0.6, 7.28)	0.25
Injected cocaine -Ever						
No	51 (41.8)	1.0		34 (27.9)	1.0	
Yes	112 (84.4)	**2.03 (1.63, 2.53)**	<0.001	70 (53.0)	**1.90 (1.37, 2.64)**	<0.001
Injected methamphetamine - Ever						
No	60 (49.6)	1.0		40 (33.1)	1.0	
Yes	103 (77.4)	**1.56 (1.28, 1.91)**	<0.001	64 (48.1)	**1.46 (107, 1.98)**	0.017
Co-Injected heroin & cocaine -Ever						
No	65 (46.4)	1.0		40 (28.6)	10	
Yes	98 (85.0)	**1.85 (1.53, 2.25)**	<0.001	64 (56.1)	**1.96 (1.44, 2.67)**	<0.001
Co-Injected heroin & methamphetamine - Ever						
No	99 (55.6)	1.0		63 (35.4)	1.0	
Yes	64 (84.2)	**1.51 (1.29, 1.78)**	<0.001	41 (53.9)	**1.52 (1.14, 2.03)**	0.004
Injected crack -Ever						
No	138 (61.3)	1.0		80 (52.2)	1.0	
Yes	25 (86.2)	**1.41 (1.18 1.68)**	<0.001	14 (48.3)	1.21 (0.80, 1.82)	0.46
Injected opioid prescription painkillers - Ever						
No	133 (62.1)	1.0		84 (39.3)	1.0	
Yes	30 (75.0)	1.21 (0.98, 1.48)	0.08	20 (50.0)	1.27 (0.90, 1.81)	0.18
Injected prescription meds used to treat opioid withdrawal - Ever						
No	63 (47.0)	1.0		40 (45.3)	1.0	
Yes	100 (83.3)	**1.77 (1.46, 2.16)**	<0.001	30 (66.7)	**1.79 (1.31, 2.43)**	<0.001
Injected tranquilizers/benzos						
No	153 (62.6)	1.0		96 (39.7)	1.0	

	Tested for Anti-HCV N=263*			Tested for HCV RNA N=230		
Variables	**Anti-HCV reactive (n=166)***	**Prevalence Ratio (95% CI)**	**P-value**	**HCV RNA-positive* (n=101)**	**Prevalence Ratio (95% CI)**	**P-value**
Yes	10 (83.3)	**1.32 (101, 1.73)**	0.46	8 (66.7)	**1.68 (1.06, 2.77)**	0.027

*Column N may not add to full sample size due to missing data; # variable is dichotomized by the median

#As of enrolled date

Bold type indicates statistically significant associations.

Table 4:

Exposures independently associated* with past or present HCV infection in a sample of young adult PWID in rural New Mexico (n=249)

Exposure	Adjusted Prevalence Ratio (APR)	95% CI	P-value
Years since first injected (by year)	1.3	1.07, 1.33	0.009
Housing			
Own/rent apartment, room, or house	1.0		
Guest in someone else's apartment, room, or house	0.85	0.72, 0.99	0.040
Shelter/street/ outdoors/other	0.52	0.31, 0.86	0.010
Ever had a non-fatal opioid overdose	1.19	1.00, 1.42	0.057
Ever injected prescription opioids to treat opioid withdrawal	1.21	1.03, 1.44	0.03
Ever Polysubstance use			
Heroin only	1.0		
Heroin with other drugs	2.65	1.56, 4.5	<0.001

* *modified* Poisson regression method