Open Forum Infectious Diseases

MAJOR ARTICLE

An Analysis of Social Determinants of Health and Their Implications for Hepatitis C Virus Treatment in People Who Inject Drugs: The Case of Baltimore

Luis A. Gonzalez Corro,[1] Katie Zook,[1] Miles Landry,[1] Amanda Rosecrans,[1,2] Robert Harris,[1,2] Darrell Gaskin,[3] Oluwaseun Falade-Nwulia,[1] Kathleen R. Page,[1] and Gregory M. Lucas[1]

[1]Johns Hopkins School of Medicine, Baltimore, Maryland, USA, [2]Baltimore City Health Department, Baltimore, Maryland, USA, and [3]Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Background. Sixty-eight percent of the nearly 3.5 million people living with hepatitis C virus (HCV) in the United States are people who inject drugs (PWID). Despite effective treatments, uptake remains low in PWID. We examined the social determinants of health (SDoH) that affect the HCV care cascade.

Methods. We conducted a secondary analysis of data from 720 PWID in a cluster-randomized trial. We recruited PWID from 12 drug-affected areas in Baltimore. Inclusion criteria were injection in the prior month or needle sharing in the past 6 months. Intake data consisted of a survey and HCV testing. Focusing on SDoH, we analyzed self-report of (1) awareness of HCV infection (in those with active or previously cured HCV) and (2) prior HCV treatment (in the aware subgroup). We used descriptive statistics and logistic regression for statistical analyses.

Results. The 342 participants were majority male and Black with a median age of 52 years. Women were more likely to be aware of their status but less likely to be treated. Having a primary care provider and HIV-positive status were associated with increased awareness and treatment. Unhoused people had 51% lower odds of HCV treatment. People who reported that other PWID had shared their HCV status with them had 2.3-fold higher odds of awareness of their own status.

Conclusions. Further study of gender disparities in HCV treatment access is needed. Increased social support was associated with higher odds of HCV treatment, suggesting an area for future interventions. Strategies to identify and address SDoH are needed to end HCV.

Keywords. Hepatitis C, Social Determants of Health, Health Disparities, Health Equity, Implementation Sciences, Substance Use, Community Outreach

An estimated 3.5 million people live with hepatitis C virus (HCV) infection in the United States [1]. HCV incidence dramatically rebounded from 2010 to 2019 [2] largely due to the exacerbation of the opioid epidemic [3]. Highly effective direct-acting antiviral treatments have created a renewed sense of optimism in the fight to eliminate HCV. Although the Viral Hepatitis National Strategic Plan aims to eliminate viral hepatitis by 2030 [4], current projections show that the United States may not achieve this even by 2050 [5, 6]. The high cost of direct-acting antiviral therapeutics has been an obstacle, as well as barriers that prevent individuals from accessing and completing treatment [7–9].

It is estimated that only 55.6% of people living with HCV in the United States are aware of their HCV status [10]. Injection drug use drives new HCV infections and is an important barrier to HCV treatment. HCV elimination is not feasible without effective approaches to treating HCV in people who inject drugs (PWID). Social determinants of health (SDoH) are nonmedical factors that influence health outcomes, defined as "the wider set of forces and systems shaping the conditions of daily life" [11]. In this study, we evaluated the impact of SDoH on the HCV care cascade (HCV awareness and treatment) in PWID in Baltimore City, one of the highest prevalence cities in the United States, with 384.9 HCV cases per 100 000 [12]. Identifying the role of SDoH on HCV treatment is critical to develop strategies to eliminate HCV.

METHODS

This is a secondary analysis of baseline data from the INSITE study (ClinicalTrials.gov NCT03567174), a cluster-randomized trial evaluating the impact of an integrated care van on use of

Received 18 January 2024; editorial decision 05 February 2024; accepted 21 February 2024; published online 2 March 2024

Correspondence: Luis A. Gonzalez Corro, MD, Department of Infectious Diseases, Johns Hopkins School of Medicine, 1830 E Monument St, Fourth Floor, Baltimore, MD 21287 (lgonza35@jhmi.edu).

Open Forum Infectious Diseases®

https://doi.org/10.1093/ofid/ofae107

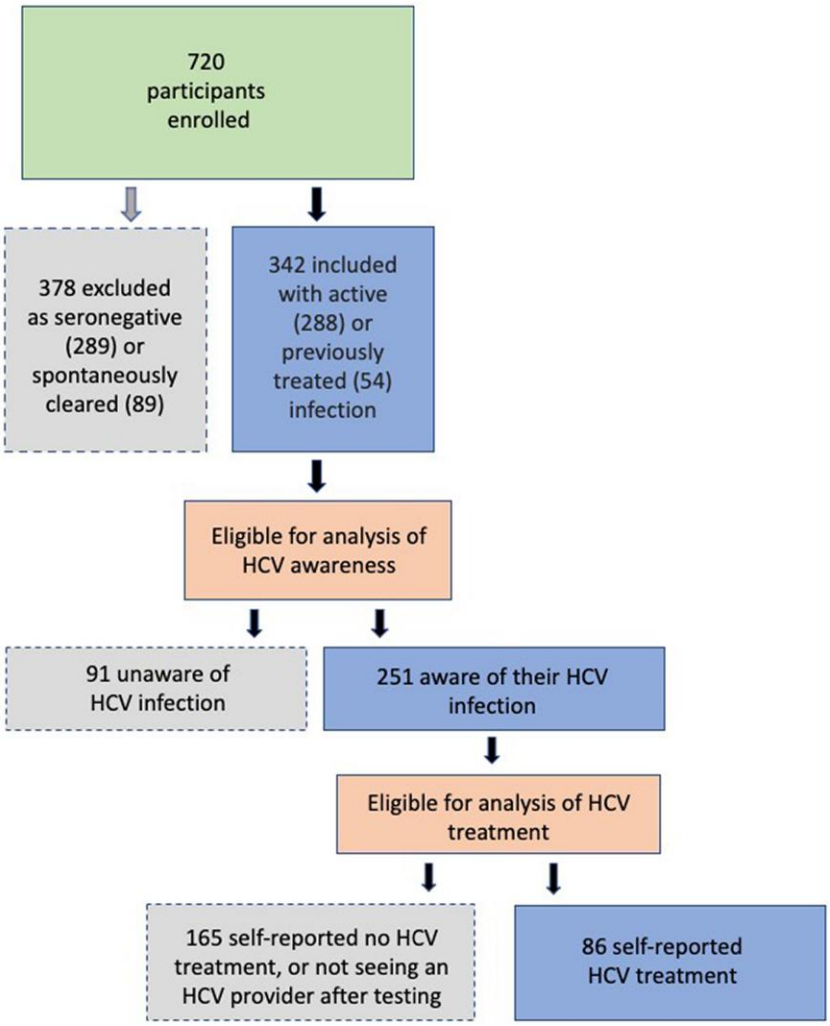

Figure 1. Selection of study participants for analyses of HCV awareness and treatment. HCV, hepatitis C virus.

evidence-based services among PWID. Participants were recruited from 12 neighborhood sites in Baltimore City (enrollment target, 60/site) that were served by the city's mobile syringe service program. Eligibility criteria were age ≥18 years and injection drug use on ≥4 days in the prior 30 days or self-reported needle/syringe sharing in the prior 6 months.

At baseline, participants completed an interviewer-administered survey and provided blood and urine samples for biomarker testing, including HCV antibody and HCV RNA. The questionnaire covered the following domains: sociodemographics, substance use, alcohol use (Alcohol Use Disorders Identification Test–Consumption), drug-using network, overdose history, injection practices, sexual transmission risk behaviors, depression, quality of life (SF-12), social support, and health care and social services utilization (Supplementary Table 1). Participants provided written informed consent, and the study was approved by the Johns Hopkins Medicine Institutional Review Board and by a public health review of the Baltimore City Health Department.

Study Questions and Protocol for Categorizing HCV Status

We conducted 2 analyses aimed at identifying factors associated with (1) awareness of HCV infection and (2) prior HCV treatment (Figure 1). For both analyses, we excluded participants who were HCV seronegative (n = 289) and those who were HCV seropositive who likely cleared their HCV infection spontaneously (HCV seropositive with an undetectable HCV RNA and no history of HCV treatment, n = 89) for a total of 378 excluded individuals.

For the analysis of HCV awareness, we included individuals with chronic HCV infection (HCV RNA >15 IU/L) and participants with evidence of previously treated HCV (HCV antibody positive with RNA <15 IU/L and self-reported HCV treatment). The primary outcome—awareness of HCV infection—

was based on an affirmative response to the question "Have you ever tested positive for hepatitis C or been told you were infected with hepatitis C?"

In the analysis of prior HCV treatment, we included (1) participants with HCV viremia who were aware of their positive status and (2) participants who were HCV seropositive and reported HCV treatment irrespective of HCV RNA. Consequently, this analysis included individuals who were aware of their status and would have the opportunity to seek and receive treatment. The primary outcome for this analysis —HCV treatment—was based on the question "Have you ever received treatment for your hepatitis C?"

The US Department of Health and Human Services groups SDoH into 5 domains: economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context. We added additional categories tailored to include SDoH commonly experienced by PWID. We defined our SDoH categories as follows: linkage to medication for opioid use disorder (MOUD) programs, employment/income, social support, health care access, health-related stigma, educational level, housing, and contact with the carceral system.

Rationale for and Definitions of Explanatory Variables

We included demographic characteristics (age, sex, race) as explanatory variables. Next, we selected questions from the baseline survey that captured different SDoH dimensions (Supplementary Table 2).

Linkage to MOUD programs: MOUD has been associated with higher HCV cure rates among PWID treated with direct-acting antivirals [13]. We asked participants if they were currently engaged in a buprenorphine- or methadone-based MOUD program.

Employment/income: Adequate income is linked to greater health care access and social stability [14, 15]. We asked participants if they worked for pay and how much money they earned from work in a month.

Social support: Individuals with broader social networks are more likely to feel supported while making health care decisions [16, 17]. We asked participants about their marital status and to estimate the number of close friends or relatives that they feel comfortable talking with.

Health care access: HCV treatment success depends on access and engagement with health services. We asked participants whether they were enrolled in health insurance and had a primary care provider (PCP) and, if so, how many times they had been seen within the past 6 months. We also asked about the frequency of emergency department use and/or hospitalization in the past 6 months.

Health-related stigma: The presence of stigma negatively affects engagement in health care [18, 19]. We asked participants if they had disclosed their drug use to their primary care physician, felt the need to hide their HCV status from people with whom they use drugs, and would be willing to discuss treatments for HCV with people with whom they use drugs. We also asked participants if any drug use network member had disclosed an HCV-positive status to them.

Educational level: Educational level correlates with greater health literacy, which can influence treatment adherence [20]. We asked participants how much schooling they had completed.

Housing: Stable living conditions can increase the likelihood of sustained engagement in health care [21, 22]. We asked whether participants had a place to live and, if so, whether they currently owned or rented their homes or were staying with someone else and how long they had been in their current dwelling place. Responses were categorized as follows: stable (owning or renting a place), unstable (staying temporarily with a friend or family member or in a drug treatment program/residential facility), and undomiciled (living in the streets or in a shelter).

Contact with the carceral system: Incarcerated individuals are at a higher risk for chronic disease and have greater rates of economic and housing instability [19, 23]. We asked participants if they had ever been in jail or prison for >3 days at a time and when was the last time that they had been in a jail or prison.

Laboratory Testing

Biosamples were tested for HCV antibody (Roche Cobas e801 analyzer with anti-HCV Generation II reagent; Roche Diagnostics), with reflex testing of HCV RNA if seropositive (Abbott RealTime HCV viral load kit, Abbott Laboratories; Roche Cobas 6800 with Roche Cobas reagent, Roche Diagnostics).

Statistical Analysis

We used contingency tables to assess factors associated with awareness of HCV positivity. We used chi-square and *t* tests to compare categorical and continuous variables. Next, we used logistic regression with odds ratios and 95% CIs in bivariate and multivariate models. Multivariate models included statistically significant ($P < .05$) covariates in bivariate analyses, as well as age, race, and gender, irrespective of their statistical significance in bivariate analyses. We followed the same approach for the analysis of prior HCV treatment in participants who were infected and aware of their HCV-positive status. The analysis was conducted with RStudio version 2023.12.0 (an integrated development environment for a programming language for statistical computing and graphics).

RESULTS

Of 720 participants recruited between June 2018 and August 2019, 342 were included in the analysis (Table 1). Participants

Table 1. Baseline Characteristics of People Who Inject Drugs Recruited in Baltimore, Maryland, Between June 2018 and August 2019 (N = 342)

Baseline Characteristics	No. (%) or Median (IQR)
Gender[a]	
Men	221 (64.7)
Women	121 (35.4)
Age, y	52 (40–57)
Race	
Black or African American	231 (67.6)
White	96 (28.1)
Other [b]	15 (4.4)
Sexual identity	
Heterosexual	315 (92.2)
Nonheterosexual	27 (7.9)
HIV status [c]	
Seronegative	283 (82.8)
Seropositive	59 (17.3)
HCV status	
Seronegative	…
Seropositive with undetectable HCV RNA	
Treated	54 (37.8)
Cleared	…
Seropositive with detectable HCV RNA	
Treated	32 (11.1)
Not treated	256 (88.9)
Marital status	
Married	39 (11.5)
Never married	216 (63.2)
Divorced/separated, widowed	87 (25.5)
At-risk alcohol use [d]	
Low risk	149 (43.6)
Moderate or high risk	193 (56.5)
Educational level	
Less than high school graduate	135 (39.5)
High school graduate or GED	131 (38.4)
College or beyond	76 (22.3)
Work for pay	
No	308 (90.1)
Yes	34 (10)
Injection drug use–related characteristics	
Frequency of injection	
Daily	180 (52.7)
Less than daily	162 (47.4)
Days injected in prior 30 d	30 (23.5–30)
Injection events per day	
<5	226 (66.1)
≥5	116 (34)
Drugs injected in the prior 6 mo	
Cocaine	
Yes	281 (82.2)
No	61 (17.9)
Heroin	
Yes	338 (98.9)
No	4 (1.2)
Speedball (concurrent heroin and cocaine)	
Yes	253 (74)
No	89 (26.1)
Prescription opioids	
Yes	77 (22.6)
No	265 (77.5)
Fentanyl	
Yes	83 (24.3)
No	259 (75.8)
Needle/syringe used after someone else in prior 6 m	
No	113 (33.1)
Yes	229 (67)
Currently on a buprenorphine/methadone program	
No	199 (58.2)
Yes	143 (41.9)
Used syringe service program in last 6 mo	
No	73 (21.4)
Yes	269 (78.7)

Abbreviation: HCV, hepatitis C virus.

[a]Transgender individuals were included in their respective genders.

[b]Asian, American Indian/Alaskan Native, Native Hawaiian or Pacic Islander, >1 race.

[c]Rapid point-of-care HIV test (INSTI HIV-1/HIV-2 Antibody Test; bioLytical Laboratories), with confirmatory testing in case of positive result.

[d]Alcohol Use Disorders Identification Test–Concise.

were mainly Black or African American and male. An overall 67.6% were HCV seropositive and 17.3% were HIV seropositive. Most participants (52.7%) reported daily injection drug use, with approximately one-third (34.0%) injecting ≥5 times daily, and 67.0% shared a needle/syringe in the prior 6 months. Over 98.9% reported heroin use, 82.2% cocaine use, and 74.0% speedball use (concurrent heroin and cocaine). When compared with the 378 excluded participants, those who were included had a higher HIV prevalence (17.3% vs 6.1%) and a higher rate of receptive needle sharing (67.0% vs 49.0%). They also had higher levels of engagement in MOUD programs (41.9% vs 31.3%) and syringe exchange programs (78.7% vs 64.5%; Supplementary Table 3).

Factors Associated With Awareness of HCV-Positive Status

Table 2 shows factors associated with HCV status awareness among the 342 participants with chronic HCV who may or may not have been treated previously. Women, people living with HIV, and those with a PCP were more likely to be aware of their HCV status. Participants who reported that other people who use drugs had confided their HCV-positive status with them were also more likely to be aware of their own status, as were those who had lived in their current domicile for <6 months and those who were unemployed.

We found no significant relationship between age, race, or enrollment in an MOUD program and HCV awareness status. Regarding support systems, there was no significant

Table 2. Associations of Social Determinants of Health and Awareness of HCV Status Among Participants With HCV Viremia or Previous HCV Treatment (N = 342)

	HCV Status Awareness		Analysis, Odds Ratio (95% CI)	
	Not Aware (n = 91)	Aware (n = 251)	Univariate	Multivariate
Baseline characteristics				
Age, y	52 (40.5–56.5)	51 (40–57)	1.04 (.93–1.16)[a]	1.02 (.99–1.05)[a]
Gender[b]				
Men	71 (32.2)	150 (67.9)	0.42 (.24–.72)	0.41 (.22–.74)
Women	20 (16.6)	101 (83.5)	1 [Reference]	1 [Reference]
Race				
Black or African American	59 (25.6)	172 (74.5)	1 [Reference]	1 [Reference]
White	29 (30.3)	67 (69.9)	0.8 (.48–1.36)	0.90 (.45–1.79)
Other[c]	3 (20)	12 (80)	1.38 (.42–6.18)	1.57 (.43–7.55)
HIV status[d]				
Nonreactive	84 (29.7)	199 (70.4)	1 [Reference]	1 [Reference]
Reactive	7 (11.9)	52 (88.2)	3.14 (1.46–7.83)	2.73 (1.19–7.15)
At-risk alcohol use				
Low risk	46 (30.9)	103 (69.2)	0.69 (.42–1.11)	…
Moderate or high risk	45 (23.4)	148 (76.7)	1 [Reference]	
Injection frequency				
Daily	47 (26.2)	133 (73.9)	1 [Reference]	…
Less than daily	44 (27.2)	118 (72.9)	0.95 (.59–1.54)	
Needle sharing, 6 mo	1 (1–2)	1 (1–2)	1.11 (.88–1.56)	
Social determinants of health				
Currently enrolled in a MOUD [e] program				
No	54 (27.2)	145 (72.9)	1 [Reference]	…
Yes	37 (25.9)	106 (74.2)	0.94 (.66–1.75)	
Financial: work for pay				
No	75 (24.4)	233 (75.7)	1 [Reference]	1 [Reference]
Yes	16 (47.1)	18 (52.9)	0.37 (.18–.76)	0.34 (.15–.76)
Support systems				
Marital status				
Married	15 (38.5)	24 (61.6)	0.61 (.28–1.37)	…
Never married	52 (24.1)	164 (76)	1.21 (.68–2.1)	
Divorced, separated, or widowed	24 (27.6)	63 (72.5)	1 [Reference]	
Friends and/or relatives you can talk to				
Below median (3)	30 (23.1)	100 (77)	1 [Reference]	…
Above median (3)	61 (28.8)	151 (71.3)	1.35 (.82–2.26)	
Health care utilization				
Health insurance status				
No	8 (30.8)	18 (69.3)	1 [Reference]	…
Yes	83 (26.3)	233 (73.8)	1.25 (.5–2.9)	
PCP				
No	35 (34.4)	67 (65.7)	1 [Reference]	1 [Reference]
Yes	56 (23.4)	184 (76.7)	1.72 (1.04–2.85)	1.97 (1.10–3.58)
Visits to PCP in 6 mo	2 (1–4)	2 (1–4)	1.05 (.95–1.19)	…
Emergency department in 6 mo				
No	46 (24.4)	143 (75.7)	1 [Reference]	…
Yes	45(29.5)	108 (70.6)	0.78 (.48–1.25)	
Visits in 6 mo	2 (1–3)	2 (1–2)	1.03 (.97–1.21)	
Hospitalization status in the last 6 mo				
No	57 (24.8)	173 (75.3)	1 [Reference]	…
Yes	34 (30.4)	78 (69.7)	0.76 (.46–1.26)	
Days hospitalized in 6 mo	4 (2–6.8)	4 (3–9.8)	1.01 (1–1.04)	
Stigma				
Disclosure to PCP of injection drug use status				
No	48 (34.1)	93 (66)	1 [Reference]	…
Yes	43 (21.4)	158 (78.7)	1.84 (.86–3.83)	
Other (not PCP)				

Table 2. Continued

	HCV Status Awareness		Analysis, Odds Ratio (95% CI)	
	Not Aware (n = 91)	Aware (n = 251)	Univariate	Multivariate
Other drug users shared HCV-positive status with participant				
No	39 (34.6)	74 (65.5)	1 [Reference]	1 [Reference]
Yes	52 (22.8)	177 (77.3)	1.8 (1.09–2.95)	2.27 (1.31–3.99)
Willingness to talk about HCV treatment [f]				
Disagree	8 (34.8)	15 (65.3)	0.68 (.29–1.74)	…
Neutral	2 (14.3)	12 (85.8)	2.17(.58–14.14)	
Agree	81 (26.6)	224 (73.5)	1 [Reference]	
Education				
Less than high school graduate	34 (25.2)	101 (74.9)	1.07 (.56–2.01)	…
High school and GED	37 (28.3)	94 (71.8)	0.91 (.48–1.71)	
College and beyond	20 (26.4)	56 (73.7)	1 [Reference]	
Housing				
Housing status [g]				
Stable	52 (29.4)	125 (70.7)	1 [Reference]	…
Unstable	32 (24.5)	99 (75.6)	1.29 (.78–2.17)	
Undomiciled	7 (20.6)	27 (79.5)	1.61 (.69–4.21)	
Time in the current living place				
<6 mo	14 (16.7)	70 (83.4)	1 [Reference]	1 [Reference]
≥6 mo	77 (29.9)	181 (70.2)	0.48 (.25–.87)	0.35 (.17–.67)
Contact with the incarceration system				
Ever incarcerated				
No	11 (27.5)	29 (72.5)	1 [Reference]	…
Yes	80 (26.5)	222 (73.6)	1.06 (.49–2.16)	
Last time incarcerated				
30 d to 1 y	9 (18.8)	39 (81.3)	1 [Reference]	…
>1 y/unknown	71 (28)	183 (72.1)	0.6 (.26–1.25)	
Never	11 (27)	29 (72.5)	0.61 (.22–1.66)	

Data are presented as No. (%) or median (IQR).

Abbreviations: HCV, hepatitis C virus; MOUD, medication for opioid use disorder; PCP, primary care provider.

[a]Odds ratio by 5-year age increase.

[b]Transgender individuals were included in their respective genders.

[c]Asian, American Indian/Alaskan Native, Native Hawaiian or Pacific Islander, >1 race.

[d]Rapid point-of-care HIV test (INSTI HIV-1/HIV-2 Antibody Test; bioLytical Laboratories), with confirmatory testing in case of positive result.

[e]Food and Drug Administration–approved medication treatment options for opioid use disorder (methadone, buprenorphine, and naltrexone).

[f]Willingness to talk about HCV treatment to people with whom the participant uses drugs.

[g]Housing definition: *stable*, own my home (condo or house), renting an apartment/house (alone or with others) or a single room; *unstable*, staying with family or friends, in a drug treatment/residential program, or in a shelter; *undomiciled*, homeless (living on street, park, abandoned building) or other.

relationship between marital status or number of close friends or relatives and HCV status awareness. All factors associated with HCV awareness in univariate analysis remained significantly associated in multivariable analysis (Table 2).

Factors Associated With HCV Treatment Among Those Aware of Their HCV-Positive Status

Among the 251 participants with chronic HCV who were aware of their status, 86 (34.3%) reported prior HCV treatment (Table 3), and among those treated, 54 (62.8%) had undetectable HCV RNA (Supplementary Table 3). There were several notable differences between the treated and untreated groups. Older participants, males, people living with HIV, and Black or African American participants were more likely to be treated. Having a greater number of trusted friends was also associated with increased treatment likelihood (41.1% vs 24.0%, $P = .01$).

Among the SDoH, stable housing status and having a PCP were associated with HCV treatment, and having health insurance was associated with a higher likelihood of treatment that approached statistical significance. We did not find a statistically significant association between HCV treatment status and MOUD program enrollment, employment/income, support systems, stigma, educational level, or contact with the carceral system.

In multivariable analysis, factors associated with HCV treatment were male gender (adjusted odds ratio, 2.6; 95% CI, 1.37–5.24), HIV-positive status (2.33; 95% CI, 1.15–4.84), and having a PCP (2.32; 95% CI, .99–5.91). White participants were less likely to report treatment than Black or African American

Table 3. Associations of Social Determinants of Health and HCV Treatment Status Among Participants With HCV Viremia or Previous HCV Treatment

	Treatment Status (n = 251)		Analysis, Odd Ratio (95% CI)	
	Not Treated (n = 165)	Treated (n = 86)	Univariate	Multivariate
Baseline characteristics				
Age, y	48 (38–56)	55 (50.2–60.8)	1.49 (1.29–1.75)[a]	1.03 (.98–1.07)[a]
Gender[b]				
Men	85 (56.7)	65 (43.4)	2.93 (1.66–5.29)	2.64 (1.37–5.24)
Women	80 (79.3)	21 (20.8)	1 [Reference]	1 [Reference]
Race				
Black or African American	94 (54.7)	78 (45.4)	1 [Reference]	1 [Reference]
White	59 (88.1)	8 (12)	0.17 (.07–.34)	0.37 (.13–.97)
Other[c]	12 (100)	0	…	…
HIV status[d]				
Nonreactive	142 (71.4)	5 (28.7)	1 [Reference]	1 [Reference]
Reactive	23 (44.3)	29 (55.8)	3.15 (1.69–5.94)	2.33 (1.15–4.84)
At-risk alcohol use				
Low risk	70 (68)	33 (32.1)	0.85 (.5–1.44)	…
Moderate or high risk	95 (64.2)	53 (35.9)	1 [Reference]	
Injection frequency				
Daily	95 (71.5)	38 (28.6)	1 [Reference]	1 [Reference]
Less than daily	70 (59.4)	48 (40.7)	1.72 (1.02–2.92)	1.10 (.59–2.04)
Needle sharing, 6 mo	1 (1–2)	1 (1–2)	1.09 (.89–1.34)	…
Social determinants of health				
Currently enrolled in a MOUD[e] program				
No	99 (68.3)	46 (31.8)	1 [Reference]	…
Yes	66 (62.3)	40 (37.8)	1.31 (.77–2.21)	
Financial: work for pay				
No	156 (67)	77 (33.1)	1 [Reference]	…
Yes	9 (50)	9 (50)	2.03 (.77–5.39)	
Support systems				
Marital status				
Married	19 (79.2)	5 (20.9)	0.36 (.11–1)	…
Never married	110 (67.1)	54 (33)	0.66 (.37–1.2)	
Divorced, separated, or widowed	36 (57.2)	27 (42.9)	1 [Reference]	
Friends and/or relatives you can talk to				
Below median (3)	76 (76)	24 (24)	0.46 (.26–.79)	0.76 (.39–1.46)
Above median (3)	89 (59)	62 (41.1)	1 [Reference]	1 [Reference]
Health care utilization				
Health insurance status				
No	16 (88.9)	2 (11.2)	1 [Reference]	1 [Reference]
Yes	149 (64)	84 (36.1)	4.52(1.25–28.97)	1.61 (.32–12.02)
Unknown/refused				
PCP				
No	59 (88.1)	8 (12)	1 [Reference]	1 [Reference]
Yes	106 (57.7)	78 (42.4)	5.43(2.59–12.89)	2.32 (.99–5.91)
Visits to PCP in 6 mo	2 (1–3)	2 (1–4)	1.07 (.98–1.19)	…
Emergency department in 6 mo				
No	87 (60.9)	56 (39.2)	1 [Reference]	…
Yes	78 (72.3)	30 (27.8)	0.6 (.35–1.02)	
Visits in 6 mo	2 (1–2.8)	1 (1–2)	1.04 (.99–1.17)	
Hospitalization status in the last 6 mo				
No	111 (64.2)	62 (35.9)	1 [Reference]	…
Yes	54 (69.3)	24 (30.8)	0.8 (.45–1.41)	
Days hospitalized in 6 mo	5.5 (3–13)	4 (3–7.3)	0.99 (.96–1.01)	
Stigma				
Disclosure to PCP injection drug use status				
No	16 (61.6)	10 (38.5)	1 [Reference]	…
Yes	90 (57)	68 (43.1)	1.21 (.53–2.92)	

Table 3. Continued

	Treatment Status (n = 251)		Analysis, Odd Ratio (95% CI)	
	Not Treated (n = 165)	Treated (n = 86)	Univariate	Multivariate
Other (no PCP)	59 (88.1)	8 (12)	…	…
Hide HCV status among drug users				
No	119 (65.8)	62 (34.3)	1 [Reference]	…
Yes	46 (65.8)	24 (34.3)	1.01 (.56–1.78)	
Disclosure of HCV status among drug users				
No	48 (64.9)	26 (35.2)	1 [Reference]	…
Yes	117 (66.2)	60 (33.9)	0.95 (.54–1.69)	
Willingness to talk about HCV treatment [f]				
Disagree	9 (60)	6 (40)	1.33 (.43–3.82)	…
Neutral	7 (58.4)	5 (41.7)	1.42 (.41–4.6)	
Agree	149 (66.6)	75 (33.5)	1 [Reference]	
Educational level				
Less than high school graduate	70 (69.4)	31 (30.7)	0.69 (.35–1.37)	…
High school and GED	61 (64.9)	33 (35.2)	0.84 (.43–1.67)	
College and beyond	34 (60.8)	22 (39.3)	1 [Reference]	
Housing				
Housing status[g]				
Stable	74 (59.2)	51 (40.8)	1 [Reference]	1 [Reference]
Unstable	66 (66.7)	33 (33.4)	0.73 (.42–1.26)	0.88 (.48–1.68)
Undomiciled	25 (92.6)	2 (7.5)	0.12 (.02–.42)	0.49 (.07–2.26)
Time in the current living place				
<6 mo	49 (70)	21 (30)	1 [Reference]	…
≥6 mo	116 (64.1)	65 (36)	1.31 (.73–2.41)	
Contact with the incarceration system				
Ever incarcerated				
No	20 (69)	9 (31.1)	1 [Reference]	…
Yes	145 (65.4)	77 (34.7)	1.19 (.53–2.85)	
Last time incarcerated				
30 d to 1 y	26 (66.7)	13 (33.4)	1 [Reference]	…
>1 y/unknown	119 (65.1)	64 (35)	1.08 (.53–2.3)	
Never	20 (69)	9 (31.1)	0.9 (.32–2.52)	

Data are presented as No. (%) or median (IQR).

Abbreviations: HCV, hepatitis C virus; MOUD, medication for opioid use disorder; PCP, primary care provider.

[a]Odds ratio by 5-year age increase.

[b]Transgender individuals were included in their respective genders.

[c]Asian, American Indian/Alaskan Native, Native Hawaiian or Pacific Islander, >1 race.

[d]Rapid point-of-care HIV test (INSTI HIV-1/HIV-2 Antibody Test; bioLytical Laboratories), with pre- and posttest counseling.

[e]Food and Drug Administration–approved medication treatment options for opioid use disorder (methadone, buprenorphine, and naltrexone).

[f]Willingness to talk about HCV treatment to people with whom the participant uses drugs.

[g]Housing definition: *stable*, own my home (condo or house), renting an apartment/house (alone or with others) or a single room; *unstable*, staying with family or friends, in a drug treatment/residential program, or in a shelter; *undomiciled*, homeless (living on street, park, abandoned building) or other.

participants (0.37; 95% CI, .13–.97). Age was not associated with HCV treatment in multivariate analysis, while the effect sizes for race and gender were only modestly attenuated. Additional associations between covariates of interest are presented in Supplementary Table 4.

Supplemental Analyses of Race and Sex Differences

Subgroup analysis demonstrated that women were significantly less likely than men to have a PCP, among those aware of their chronic HCV (63.4% vs 80%, $P = .01$). Women generally had more adverse SDoH than men. As compared with men, women had fewer close friends/relatives, were less likely to work for pay, and were more likely to engage in sex work.

Comparison of demographic and SDoH variables by race showed that White participants had higher levels of social vulnerability. When compared with Black or African American participants, White participants were significantly more likely to be undomiciled and report daily injection drug use or transactional sex; they were less likely to have health insurance or a PCP; and they had lower levels of social connections (Table 4). Black or African American participants were significantly older than White participants (median age, 52 vs 37 years; $P = .01$).

Table 4. Subgroup Analysis of Awareness of HCV Status Among Participants With HCV Viremia or Previous HCV Treatment by Race

Factor	People Asked About Awareness of Their HCV Status (n = 342)		*P* Value
	Black	Non-Black	
Total	231 (67.6)	111 (32.5)	…
Age, y	55 (50–59)	38 (33–47)	.01
Female	76 (33)	45 (40.6)	.21
HIV positive	53 (23)	6 (5.5)	.01
Daily injection drug use	105 (45.5)	75 (67.6)	.01
Currently in a MOUD program[a]	92 (39.9)	51 (46)	.34
Working for pay	25 (10.9)	9 (8.2)	.56
Have insurance	220 (95.3)	96 (86.5)	.01
Have a PCP	177 (76.7)	63 (56.8)	.01
Friends/relatives you can talk to (≥3)	159 (68.9)	53 (47.8)	.01
Currently undomiciled	5 (2.2)	29 (26.2)	.01
Disclosure of HCV status among drug users	140 (60.7)	89 (80.2)	.01
Exchange for money, drugs, or other goods for sex	77 (33.4)	46 (41.5)	.18

Data are presented as No. (%) or median (IQR).

Abbreviations: HCV, hepatitis C virus; MOUD, medication for opioid use disorder; PCP, primary care provider.

[a]Food and Drug Administration–approved medication treatment options for opioid use disorder (methadone, buprenorphine, and naltrexone).

DISCUSSION

With a focus on SDoH, we examined factors associated with HCV awareness and treatment in a community-based sample of PWID in Baltimore, Maryland. We used street-based recruitment from 12 neighborhoods in Baltimore, and demographic factors (age, sex, race, education) were quite similar to those of the long-running ALIVE study (AIDS Linked to the Intravenous Experience) [24].

We found that women were more likely to be aware of their HCV status but less likely to have been treated. There was no difference in HCV awareness by race or age, but White PWID were less likely to be treated, as were those experiencing homelessness. Not surprising, access to care, health insurance, and social support were associated with increased HCV awareness and treatment.

Increased awareness of chronic HCV among women as compared with men may be due to gynecologic or obstetric care, as the current guidelines of the Infectious Diseases Society of America recommend universal HCV screening in women with each pregnancy [25]. Despite greater awareness of HCV status, however, women were less likely to be treated. Other studies have also documented gender disparities in HCV treatment [26, 27]. This may be related to gender-based barriers to care (in our sample, women were less likely to have a PCP), lower economic and educational opportunities, caregiving responsibilities, or increased burden of stigma for women who inject drugs, among others. Women in our sample were more likely to engage in sex work than men, suggesting a significant level of social vulnerability.

While there were no differences in HCV awareness by race, White PWID were less likely than Black/African American PWID to have been treated for HCV. This finding was unexpected given that Black or African Americans in the United States have higher rates of medical neglect and adverse SDoH than White people [28]. In our sample, however, we found that White PWID were more likely than Black/African American PWID to have characteristics that have been identified as barriers to treatment, such as younger age, lower HIV coinfection, higher frequency of injection drug use, higher unemployment, less access to PCP or health insurance, smaller social networks, and more homelessness [29, 30]. These findings are consistent with other studies noting that White PWID are less likely to have an HCV care provider [31]. In addition, these findings may reflect the large shift in the demographics of PWID over the past decade, with a disproportionate increase in injection drug use among White people [32, 33].

Lower health-related stigma, assessed by willingness among peer networks to share information regarding their HCV status, was associated with higher HCV awareness. Others have identified stigma as an important factor in HCV treatment seeking [34]. As expected, greater levels of social support were associated with higher levels of HCV awareness and treatment. In contrast, homelessness was associated with a much lower likelihood of HCV treatment. Housing instability has been linked to up to 20% of HIV and HCV transmission globally, and people experiencing homelessness are much more likely to have poor health outcomes and be less connected to health care [21, 35].

Interestingly, time lived in the current place <6 months was associated with greater HCV status awareness when compared with individuals who had resided in the same place for ≥6 months (83.4% vs 72.2%). We speculate that, similar to unemployment, unstable housing may increase likelihood of participation in community-based HCV testing initiatives. However, as we tested for associations with multiple variables, it is possible that the observed association between time in current residence and HCV awareness was spurious.

Although attenuated in the multivariate model, older age was strongly associated with HCV treatment in univariate analysis, a finding that is consistent with prior reports [36, 37]. Older age correlates with a reduction in risk behaviors and increased social stability, which increases treatment access and success for HCV and HIV [38]. In addition, as HCV infection is asymptomatic for a prolonged period, a length time bias is likely as older individuals have more opportunity to be treated [39].

People living with HIV were more likely to be aware of their HCV status and treated. This is not surprising as people living with HIV are usually linked to health services and HCV

treatment is prioritized in people who are coinfected due to increased risk of liver disease progression [38]. In addition, early in the era of direct-acting antiviral policy, choices affected HCV care. Coverage for treatment was available for individuals who were coinfected regardless of liver damage but was restricted by fibrosis score for individuals who were HCV monoinfected. As expected, we found that access to a PCP was associated with increased HCV awareness and treatment but, unfortunately, engagement in MOUD programs was not. The absence of an association between MOUD and HCV treatment is a missed opportunity to provide integrated HCV and SUD treatment in a "1-stop shop."

This study has strengths and weaknesses. Our recruitment strategy allowed us to assess the HCV care cascade in a community-based sample of PWID who may not access facility-based studies or health services. We relied on self-report for outcome and explanatory variables. However, HCV and HIV status was confirmed by testing biosamples from all participants. Our study was subject to potential recall bias, social desirability bias, and temporal bias. In addition, this study was conducted in a single US city, and the findings may not generalize to other settings.

CONCLUSION

In this sample of PWID from an urban setting, we found disparities in HCV status awareness and treatment related to SDoH. Social determinants are foundational drivers of health outcomes, and our findings call for efforts to strengthen programs targeted to improve the health of PWID, including addressing their social determinants, such as housing and access to care.

Perhaps most notably, while a higher proportion of women were aware of their HCV diagnosis than men, they were far less likely than men to have obtained treatment (Supplementary Table 4). Also unexpected was that despite what we know about racial inequities in access to health care, African American and Black people were more likely to have received HCV treatment than White people (Table 4). Women and White PWID were more marginalized than men and Black/African American PWID in our study, which correlated with lower rates of HCV treatment. In direct comparison, White PWID differed from Black PWID across multiple factors that have historically been identified as barriers to HCV treatment—younger age, more frequent injection, poorer social support, unstable housing, and absence of health insurance or PCP.

Further study of gender disparities in HCV treatment access is needed. Notably, increased social support was associated with higher odds of HCV treatment, suggesting an area for future interventions. Models of care that provide comprehensive services—such as housing support, medical care including primary care and infectious disease services, as well as integrated harm reduction services—should be expanded. Finally, engagement in an MOUD program was not associated with increased odds of HCV treatment, suggesting a missed opportunity for HCV treatment that should be explored further.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Author contributions. L. A. G. C.: conceived and designed the analysis, performed the analysis, wrote the manuscript. K. Z.: contributed data or analysis tools. M. L.: contributed data or analysis tools. A. R.: collected data, edited the manuscript. R. H.: collected data. D. G.: conceived and designed the analysis. O. F.-N.: collected data, edited the manuscript. K. R. P.: conceived and designed the analysis, collected data, edited the manuscript. G. M. L.: conceived and designed the analysis, collected data, edited the manuscript.

Disclaimer. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Financial support. This work was supported by the National Institute on Drug Abuse (grants R01DA045556, K24DA035684, K24NR020508) of the National Institutes of Health; the Johns Hopkins University Center for AIDS Research (P30AI094189); and the National Institutes of Health (grant T32 AI007291 to L. A. G. C.).

Potential conflicts of interest. O. F.-N.: AbbVie Inc and consulting fees from Gilead. All other authors report no potential conflicts.

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Centers for Disease Control and Prevention. New hepatitis C infections nearly tripled over five years. 2017. Available at: https://www.cdc.gov/nchhstp/newsroom/2017/Hepatitis-Surveillance-Press-Release.html. Accessed 21 December 2023.
2. Centers for Disease Control and Prevention. 2019 viral hepatitis surveillance report—hepatitis C. 2021. https://www.cdc.gov/hepatitis/statistics/2019surveillance/index.htm. Accessed 20 November 2023.
3. Zibbell JE, Asher AK, Patel RC, et al. Increases in acute hepatitis C virus infection related to a growing opioid epidemic and associated injection drug use, United States, 2004 to 2014. Am J Public Health **2018**; 108:175–81.
4. World Health Organization. Hepatitis C fact sheet. 2021. Available at: https://www.who.int/news-room/fact-sheets/detail/hepatitis-c Google Scholar. Accessed 26 September 2021.
5. Sulkowski M, Cheng WH, Marx S, Sanchez Gonzalez Y, Strezewski J, Reau N. Estimating the year each state in the United States will achieve the World Health Organization's elimination targets for hepatitis C. Adv Ther **2021**; 38: 423–40.
6. Gamkrelidze I, Pawlotsky J-M, Lazarus JV, et al. Progress towards hepatitis C virus elimination in high-income countries: an updated analysis. Liver Int **2021**; 41: 456–63.
7. Mehta SH, Genberg BL, Astemborski J, et al. Limited uptake of hepatitis C treatment among injection drug users. J Community Health **2008**; 33:126–33.
8. Gonzalez Corro L, Rios Gutierrez N, O'Cunningham C, Litwin AH, Norton BL, Norton BL. 1071. Social determinants of health (SDOH) among PWID living with HCV. Open Forum Infect Dis **2020**; 7(suppl 1):S563–4.
9. Ziff J, Vu T, Dvir D, et al. Predictors of hepatitis C treatment outcomes in a harm reduction–focused primary care program in New York City. Harm Reduct J **2021**; 18:38.
10. Kim HS, Yang JD, El-Serag HB, Kanwal F. Awareness of chronic viral hepatitis in the United States: an update from the National Health and Nutrition Examination Survey. J Viral Hepat **2019**; 26:596–602.

11. Centers for Disease Control and Prevention. Social determinants of health at CDC. Available at: https://www.cdc.gov/about/sdoh/index.html. Accessed 26 August 2023.
12. Maryland Department of Health. Maryland hepatitis C strategic plan. 2019. https://health.maryland.gov/phpa/OIDPCS/AVHPP/Documents/Maryland_Hepatitis_C_Strategic_Plan_FINAL_2019.pdf.
13. Rosenthal ES, Silk R, Mathur P, et al. Concurrent initiation of hepatitis C and opioid use disorder treatment in people who inject drugs. Clin Infect Dis **2020**; 71: 1715–22.
14. Office of Disease Prevention and Health Promotion, US Department of Health and Human Services. Healthy People 2023. Available at: https://health.gov/healthypeople. Accessed 20 August 2023.
15. Galea S, Vlahov D. Social determinants and the health of drug users: socioeconomic status, homelessness, and incarceration. Public Health Rep **2002**; 117(suppl 1):S135–45.
16. Zhou ES. Social support. In: Michalos AC, ed. Encyclopedia of quality of life and well-being research. Dordrecht: Springer, **2014**:6161–6164.
17. Phillips FH, Barnes D. Social support and adherence for military veterans with hepatitis C. Clin Nurse Spec **2016**; 30:38–44.
18. Weiss MG, Ramakrishna J, Somma D. Health-related stigma: rethinking concepts and interventions. Psychol Health Med **2006**; 11:277–87.
19. Marinho RT, Barreira DP. Hepatitis C, stigma and cure. World J Gastroenterol **2013**; 19:6703–9.
20. Younus I, Sarwar S, Qaadir A, Butt Z, Nazir A, Choudry A. Correlation of literacy and awareness regarding hepatitis C: a survey of family members of hepatitis C patients. Int J Med Res Rev **2016**; 4:1576–81.
21. Stone J, Artenie A, Hickman M, et al. The contribution of unstable housing to HIV and hepatitis C virus transmission among people who inject drugs globally, regionally, and at country level: a modelling study. Lancet Public Health **2022**; 7: e136–45.
22. Office of Disease Prevention and Health Promotion, US Department of Health and Human Services. Healthy People, housing and homes. Available at: https://health.gov/healthypeople/objectives-and-data/browse-objectives/housing-and-homes. Accessed on 28 August 2023.
23. Reindollar RW. Hepatitis C and the correctional population. Am J Med **1999**; 107(6B):100–3.
24. Vlahov D, Anthony JC, Munoz A, et al. The ALIVE study, a longitudinal study of HIV-1 infection in intravenous drug users: description of methods and characteristics of participants. NIDA Res Monogr **1991**; 109:75–100.
25. Infectious Diseases Society of America. HCV guidance: recommendations for testing, managing, and treating hepatitis C. Available at: https://www.hcvguidelines.org/unique-populations/pregnancy. Accessed 25 August 2023.
26. Daher M, Al Rifai M, Kherallah RY, et al. Gender disparities in difficulty accessing healthcare and cost-related medication non-adherence: the CDC Behavioral Risk Factor Surveillance System (BRFSS) survey. Prev Med **2021**; 153:106779.
27. SteelFisher GK, Findling MG, Bleich SN, et al. Gender discrimination in the United States: experiences of women. Health Serv Res **2019**; 54(suppl 2):1442–53.
28. Williams DR, Rucker TD. Understanding and addressing racial disparities in health care. Health Care Financ Rev **2000**; 21:75–90.
29. Robards F, Kang M, Usherwood T, Sanci L. How marginalized young people access, engage with, and navigate health-care systems in the digital age: systematic review. J Adolesc Health **2018**; 62:365–81.
30. Hargreaves DS, Greaves F, Levay C, et al. Comparison of health care experience and access between young and older adults in 11 high-income countries. J Adolesc Health **2015**; 57:413–20.
31. Wejnert C, Hess KL, Hall HI, et al. Vital signs: trends in HIV diagnoses, risk behaviors, and prevention among persons who inject drugs—United States. MMWR Morb Mortal Wkly Rep **2016**; 65:1336–42.
32. Martins SS, Sarvet A, Santaella-Tenorio J, Saha T, Grant BF, Hasin DS. Changes in US lifetime heroin use and heroin use disorder: prevalence from the 2001–2002 to 2012–2013 National Epidemiologic Survey on Alcohol and Related Conditions. JAMA Psychiatry **2017**; 74:445–55.
33. Van Handel MM, Rose CE, Hallisey EJ, et al. County-level vulnerability assessment for rapid dissemination of HIV or HCV infections among persons who inject drugs, United States. J Acquir Immune Defic Syndr **2016**; 73:323–31.
34. Jones AA, Schneider KE, Falade-Nwulia O, Sterner G, Tobin K, Latkin CA. Social networks, stigma, and hepatitis C care among women who inject drugs: findings from a community recruited sample. J Psychoactive Drugs **2023**; 55:464–70.
35. Morris MD, Yen IH, Shiboski S, Evans JL, Page K. Housing stability and hepatitis C infection for young adults who inject drugs: examining the relationship of consistent and intermittent housing status on HCV infection risk. J Urban Health **2020**; 97:831–44.
36. Corcorran MA, Tsui JI, Scott JD, Dombrowski JC, Glick SN. Age and gender-specific hepatitis C continuum of care and predictors of direct acting antiviral treatment among persons who inject drugs in Seattle, Washington. Drug Alcohol Depend **2021**; 220:108525.
37. Morris MD, Mirzazadeh A, Evans JL, et al. Treatment cascade for hepatitis C virus in young adult people who inject drugs in San Francisco: low number treated. Drug Alcohol Depend **2019**; 198:133–5.
38. Falade-Nwulia O, Irvin R, Merkow A, et al. Barriers and facilitators of hepatitis C treatment uptake among people who inject drugs enrolled in opioid treatment programs in Baltimore. J Subst Abuse Treat **2019**; 100:45–51.
39. Fattovich G, Giustina G, Degos F, et al. Morbidity and mortality in compensated cirrhosis C: a retrospective follow-up study of 384 patients. Gastroenterology **1997**; 112:463–72.