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Hepatitis C virus care cascade among people who inject drugs in puerto rico: Minimal HCV treatment and substantial barriers to HCV care

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HIGHLIGHTS

- The prevalence of HCV RNA among PWID in Puerto Rico is very high (53%).
- Significant gaps exist along the HCV cascade of care among PWID in Puerto Rico.
- Barriers included transportation (79%), drug abstinence requirement (75%) and stigma (38%).
- Significant lack of knowledge exists regarding HCV testing (71%) and treatment sites (79%).

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ABSTRACT

Background: People who inject drugs (PWID) in Puerto Rico are disproportionately affected by the hepatitis C virus (HCV) epidemic. However, there is a scarcity of data on the HCV care cascade among PWID in Puerto Rico. This study aims to describe the HCV cascade of care among PWID in Puerto Rico, identify gaps, and explore barriers to HCV care.

Methods: Participants were recruited using respondent-driven sampling and tested for both HCV antibodies (Ab) and RNA (ribonucleic acid) using rapid testing and dried blood spot samples (DBS). The cascade of care was estimated based on the DBS HCV Ab and RNA results, as well as self-reported data on HCV screening, linkage to care, treatment uptake and sustained virologic response collected through a questionnaire. The cascade was constructed sequentially, with each step using the number of people from the preceding step as the base denominator. The survey also assessed participants' perceived barriers to HCV care.

Results: Out of 150 participants, 126 (84%) had previously been HCV screened, 87% (109/126) were HCV Ab positive, 72% (79/109) were RNA positive,48% (38/79) were linked to care, 32% (12/38) initiated treatment, 58% (7/12) finished treatment, and 71% (5/7) achieved SVR. Barriers to HCV care included concerns about drug abstinence requirements, access to transportation, stigma in healthcare settings, and lack of knowledge about HCV treatment sites.

Conclusion: This study provides insights into the HCV cascade of care among PWID in Puerto Rico for the first time and highlights limited diagnosis, treatment uptake, and barriers to care.

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1. Introduction

Hepatitis C (HCV) constitutes a major health problem worldwide. Globally, an estimated 58 million individuals are living with chronic HCV infection, placing them at risk for life-threatening conditions such as cirrhosis and hepatocellular carcinoma (Stasi et al., 2020; World Health Organization, 2022). HCV disproportionately impacts people who inject drugs (PWID; Thomas, 2019), with an estimated 52% of PWID being HCV Ab+ and 39% being viremic (Grebely et al., 2019). Additionally, most new HCV infections occur among PWID (Stasi et al., 2020; WHO, 2018), with sharing of drug injection equipment being a significant risk factor (Diaz et al., 2001; Hagan et al., 2001).

With the development of direct-acting antiviral (DAA) treatments, chronic HCV infections can be cured with fewer significant side effects, higher cure rates, and shorter treatment duration compared to interferon-based treatment(Geddawy et al., 2017; Kowdley et al., 2014) driving the World Health Organization to call for the elimination of HCV by 2030 (WHO, 2016). The global elimination targets include an 80% reduction in new HCV infections, a 65% reduction in mortality, as well as increasing HCV diagnoses to 90% and HCV treatment to 80% (WHO, 2016). PWID are considered a key population to achieve WHO elimination targets, yet treatment uptake among PWID remains low (Tsui et al., 2019; Jordan et al., 2017).

The HCV care cascade has been increasingly used to assess engagement in HCV care and treatment among people living with HCV, including PWID. The cascade of care tracks different stages, from screening, diagnosis, and care linkage to treatment initiation, completion, and the achievement of HCV cure. The HCV care cascade provides a framework for monitoring progress and identifying gaps that will be useful to prioritize and target resources toward HCV elimination (Folch et al., 2021). Previous studies have identified numerous barriers that PWID experience along the HCV cascade of care, including lack of HCV diagnosis, lack of information and referrals to treatment, substance use restrictions, negative interactions with medical providers, and lack of financial and social support for accessing HCV care (Amoako, 2021; Bincarelli et al., 2019; Grebely et al., 2013; Harris & Rhodes 2013; Thinh et al., 2020; Zeremski et al., 2013).

As in many countries around the globe, injection drug use has been the principal driver of HCV in Puerto Rico. Specifically, HCV has been identified as a public health problem among 28,000 PWID (Degenhardt et al., 2017). Studies have documented extremely high HCV-conducive risk behaviors among Puerto Rican PWID; this includes sharing injection equipment through *caballo*, which is when PWID pool their money to buy and inject drugs together, share drugs, and/or use shooting galleries (Abadie et al., 2016; Gelpí-Acosta et al., 2019; Hernández et al., 2017; Pérez et al., 2015; Reyes et al., 2006). Furthermore, substantial increases in the consumption of fentanyl-laced heroin and cocaine (Gelpí-Acosta et al., 2020; Abadie et al., 2022) and the reuse of needles among PWID have been reported after Hurricane Maria (Abadie et al, 2022).

HCV antibody prevalence estimates among PWID in Puerto Rico are high at 76.5–78.4% (Abadie et al., 2016; Colón-López et al., 2022). Despite the high HCV antibody prevalence among Puerto Rican PWID, HCV RNA (ribonucleic acid) prevalence and HCV care cascade data are unknown. In Puerto Rico, until 2020, public health insurance-imposed substance use restrictions for HCV treatment. For patients with a history of substance use, public insurance companies required six months of abstinence from drug use and alcohol to be eligible for HCV treatment. Although substance use is no longer an exclusion requirement, public insurance plans require patients to sign a consent form that states that they are committed to avoiding drug or alcohol use while receiving HCV treatment (First Medical Health Plan, 2020). Additionally, Puerto Rico is still imposing additional restrictions for HCV treatment, such as prior authorization for treatment from the patient's health insurance, prescriber restrictions (i.e., treatment must be prescribed by an infectious disease physician, gastroenterologist, or HCV-certified primary care provider), genotype documentation, and some laboratory testing results (e.g., bilirubin levels, etc.) within 30 days of a prior authorization request (National Viral Hepatitis Roundtable 2023). Furthermore, media reports indicate that public health insurance plans are also a major barrier to HCV treatment access since the approval of treatment can often take months (in some cases up to eight months; Univisin Puerto Rico, 2021).

Despite the fact that PWID represent a major factor for HCV transmission on the archipelago, similar to many states in United States (Jordan et al., 2017), engagement in HCV related-services and treatment for PWID remains low. While Puerto Rico lacks epidemiological data about the number of PWID treated for HCV, reports from local syringe service programs and public health researchers have shown a lack of access to HCV services (El Punto en la Montana, 2023; Burgos, 2021; Abadie et al.,2020, Colón-López et. al, 2020; Gelpí- Acosta et. al, 2020). In addition, PWID-specific access barriers along the cascade of care are not documented, limiting the development of effective interventions to increase access. Now, with the advent of DAA, there exists an urgency to identify and link to care HCV-positive PWID in Puerto Rico. Hence, the aim of this descriptive study is to assess, for the first time, Puerto Rico's HCV cascade of care, and identify gaps and barriers affecting PWID. Understanding the HCV care cascade and PWID-perceived barriers to HCV care may help guide efforts to improve engagement across the HCV care continuum.

2. Methods

2.1. Study design and participants

Participants were recruited from two study sites in the Puerto Rican municipalities of Cidra and Caguas from February 2022 to July 2022. Both municipalities are located in the central mountainous region of the Puerto Rican archipelago called *La Cordillera Central (Central Mountain Range)*. Caguas is a peri-urban municipality (hybrid of rural and urban) while Cidra is completely rural. Both are located about 30–40 miles south of San Juan, Puerto Rico's capital. To be eligible for this study, participants were required to be 21 or older and to have reported drug injection in the past 90 days. Participants were recruited using respondent-driven sampling (RDS), a form of chain-referral sampling designed to engage difficult-to-reach populations. Six participants were initially recruited directly by research staff from community settings where people who use drugs live or congregate. Each participant was given three coupons and invited to refer up to three eligible peers. This recruitment process was repeated until the desired sample size was reached. Participants were offered an economic incentive of $30 as compensation for their time and $10 for each referred peer who qualified for the study. Verification of drug injection use was conducted through visual inspection of injection track marks in arms or legs as well as a screening questionnaire assessing drug injection in the past 90 days and knowledge of injection practices.

2.2. Data collection

Participants completed in Spanish an interviewer-administered survey that lasted 60–90 minutes. The survey included sections on sociodemographics, substance use, and HCV, including questions on lifetime history of HCV screening, linkage to care and treatment. Regarding self-reported of HCV screening and status the following question were asked: "Have you ever been tested for HCV?" "What were the results the last time you were tested before the study?" To assess linkage to HCV care, participants were asked if they had been referred to a healthcare provider that specializes in HCV care. Regarding HCV treatment, participants were asked if they had ever undergone treatment, completed treatment, or achieved SVR. In addition, participants who reported having completed treatment were asked about the medication given and the location where treatment was provided.

2.3. Blood specimen and tests

After the interview, research staff collected a finger-prick blood sample from each participant for OraQuick rapid HCV antibody (Ab) testing and a dried blood spot (DBS) test. The OraQuick rapid test took approximately 20 minutes to process, after which the results were reported to participants. Pre- and post-test counseling was provided to all participants, and referrals were offered to public health clinics for HCV confirmatory testing. DBS specimens were sent to the New York State Department of Health's Bloodborne Viruses Laboratory. The laboratory tested each DBS specimen for HCV antibodies using in-house-developed Luminex assays that screen for IgG antibodies. Participants were considered HCV antibody positive if the Luminex assay was reactive. Participants were considered indeterminate if Luminex assay was indeterminate and nonreactive results were considered HCV antibody negative. HCV Ab reactives were tested for HCV RNA using the Aptima HCV Quant Dx test with modifications for DBS. The limit of detection for the HCV RNA assay with DBS is 250 IU/mL. All participants provided written consent for participation in the survey and the collection of blood samples. This study received IRB approval from the CUNY Graduate School of Public Health and Health Policy.

2.4. Estimation of the HCV cascade of care

This study utilizes self-reported data from the study survey and DBS testing data to estimate the stages of HCV cascade of care among PWID. HCV testing, linkage to care and treatment were identified as measures for inclusion in the HCV cascade of care (Iversen et al., 2017; Folch et al., 2021). Based on self-reported responses from the study survey and DBS results, we assessed each step along the HCV cascade of care. The steps in the cascade of care were (1) HCV Ab screened, (2) HCV Ab positive, (3) HCV RNA positive, (4) linked to HCV care, (5) initiated HCV treatment, (6) finished HCV treatment, and (7) achieved sustained virologic response (SVR). Firstly, "PWID recruited at study", which was the total number of PWID participants in the study (N = 150). Secondly, "HCV-Ab screened" was calculated from the proportion of PWID who self-reported prior history of HCV screening. Thirdly, results from DBS antibody testing determined the proportion of PWID who were "HCV Ab positive". Fourthly, DBS HCV RNA testing determined the portion of PWID who were "HCV RNA positive". Fifthly, self-reported data estimated the proportion of PWID who were linked to care. Finally, HCV treatment was calculated from the portion of PWID who self-reported "initiated", "finished" and "achieved" SVR. "Initiated treatment" was calculated from the proportion of PWID who self-reported ever initiating HCV treatment. "Finished treatment" and "SVR" was calculated from the proportion of participants who self-reported finishing "HCV treatment" and reaching SVR respectively. The cascade was constructed via a sequential approach where for each cascade step, the number of people from the preceding step served as the base denominator.

2.5. Barriers to HCV care

We also assessed barriers to HCV care using multiple-choice questions. First, all study participants were asked about factors that would deter them from engaging in HCV care upon clinical diagnosis. This question was worded as follows: "If you were diagnosed with hepatitis C, do you think that any of the following factors may deter you from engaging in hepatitis C care?" Second, the participants who reported never having been tested for HCV were asked about their reasons for not being tested: "Why haven't you been tested for hepatitis C?" Third, participants who were referred to an HCV provider were asked about factors affecting linkage to care with the question: "Have any of the following factors deterred you from following up on your referral for HCV care?"

2.6. Statistical analysis

We reported descriptive statistics for sociodemographics, DBS and Oraquick test results, and the steps of the HCV cascade of care. The HCV care cascade was estimated from DBS HCV Ab and RNA results data and self-reported data regarding lifetime history of HCV screening, linkage to care, and treatment uptake collected through a survey. As indicated above, we used a sequential approach to construct the cascade where the number of people who endorsed the preceding step served as the base denominator. All analyses were conducted using IBM's SPSS software, version 25.0 (IBM Corp., 2017).

3. Results

3.1. Sample characteristics

Participants' demographic characteristics are summarized in Table 1. Of the 150 participants, 41.3% were from Caguas; 25.3% were from Cidra; and 33.3% were from other municipalities. About 89% identified as male and 11% as female. Ages ranged from 23 to 68 years. The median age was 42 years, and 58.7% were single. The educational levels varied from 29.3% who did not complete high school to 39.3% who did, and about 30% had completed at least some college. Most participants (93.3%) reported an income of $10,000 or less, and 44.7% experienced homelessness in the last 12 months. Furthermore, 86% had health insurance, and 92.6% reported a history of arrest. About half the sample (47%) reported having odd and off-the-books jobs, with nearly half (44%) reporting that they were unemployed.

Regarding drug use, 50.7% of the participants injected one to three times per day; 24.3% injected four to six times per day, and 25% injected seven or more times per day in the past 30 days. The main drug injected was speedball (a mix of heroin and cocaine, 79.3%), followed by fentanyl alone (41.3%), heroin alone (32.7%), and cocaine alone (16%). Regarding access to drug treatment and other services, 22% were enrolled in opioid agonist therapy in the past 12 months (methadone and buprenorphine). In addition, 68% were receiving services from syringe service programs in the 90 days prior to the interviews.

3.2. History of HCV Testing and Treatment

Most participants (84%, 126/150) report a lifetime history of HCV Ab screening before the study. As shown in Table 2, 31% (47/150) of those who ever tested, did so recently (in the years 2021–2022). 27% were last tested for HCV between 1985–2015, and 25% received their last test in 2016–2020. Over a fifth of participants (20.7%) had never been tested for HCV. Testing largely took place in prisons (58.7%), followed by public health clinics (26.2%) and drug treatment centers (15.1%). Forty-six of the PWID who self-reported prior history of HCV Ab + results had confirmatory HCV RNA screening, as shown in Fig. 1.

Among the participants who reported receiving treatment for HCV (n = 12), half (n = 6) reported being treated with interferon therapy; three reported being treated with DAA; and three did not recall the medication name. Treatment occurred at prisons (n = 6), followed by doctors' offices (n = 3) and public health clinics (n = 3).

3.3. Blood specimen tests

The onsite OraQuick HCV Rapid Test indicated that 104 out of the 150 participants were positive for HCV antibodies. DBS results from the laboratory indicated that 109 tested positive for the HCV antibody, 39 tested negative, and 2 were indeterminate. One participant with indeterminate HCV antibody in the Luminex test and positive RNA was not included in the RNA total counts. Of the whole study sample (n=150), 79 had detectable RNA (See Fig. 1 for DBS antibody and RNA test results). Five specimens had discordant HCV antibody results for the DBS test compared to the antibody rapid test performed in Puerto Rico. All

Table 1
Sample characteristics (n=150)

Characteristics	N (%) / median
Age (median)	42(range 23-68)
Gender	
Male	133(88.7)
Female	17(11.3)
Municipality	
Caguas	62(41.3)
Cidra	38(25.3)
Other	50(33.3)
Past 12-month homelessness	67(44.7)
Income ≤10,000	140(93.3)
Education	
Did not complete High School	44 (29.3)
High School graduate or GED	59(39.3)
Some college/associate degree	37(24.7)
Bachelor's	10(6.7)
Marital Status	
Single	88(58.7)
Married or living together as married	20(13.3)
Separated	17(11.3)
Divorced or widowed	23(15.3)
Other	2(1.3)
Health Insurance Coverage	129(86.0)
Employment	
Employed	4(2.7)
Unemployed	66(44.0)
Odd jobs, Off the books	71(47.3)
Other	9(6.0)
Past 30-days drugs injected	
Heroin	49(32.7)
Cocaine	24(16.0)
Speedball	119(79.3)
Fentanyl	62(41.3)
Past 30-days frequency of injection*	
Number of days	
1-10	12(8.1)
11-20	6(4.1)
21-29	4(2.7)
30	126(85.1)
Number of times per day	
1-3	75(50.7)
4-6	36(24.3)
7-10	23(15.5)
11≥	14(9.5)
Past 12-month drug treatment utilization	56(37.3)
Methadone maintenance program	26(17.3)
Buprenorphine treatment	7(4.7)
Residential rehabilitation (28-day program)	13(8.7)
Faith based program	5(3.3)
Residential detoxification	7(4.7)
Long term residential program	4(2.7)
Past 90-days syringe service program utilization	102(68)
Self-reported HCV testing results prior study	
HCV antibody positive	65(43.3)
HCV antibody negative	54(36.0)
Did not receive results	7(4.7)

HCV=Hepatitis C, * 148

five were antibody positive by DBS and non-reactive by OraQuick HCV Rapid Test in Puerto Rico. Of these, three had detectable HCV RNA.

3.4. Estimation of HCV care cascade

Among study participants, the vast majority (126/150; 84%) had been screened for HCV prior to this study and 87% (109/126) were DBS antibody positive. Among those with a positive DBS antibody, 72% (79/109) were HCV-RNA positive. An estimated 48% (38/79) of participants were linked to care. Of the participants linked to care, 32% (12/38) initiated treatment; 58% (7/12) completed treatment; and 71% (5/7) achieved SVR (See Fig. 2 for the estimate of the HCV testing, care and treatment cascade among participants).

Table 2
Prior HCV testing and treatment among PWID

Category	*N* (%)
Year of last HCV test, n=150	
1985–2000	17 (11.3)
2001–2015	24 (16.0)
2016–2020	38 (25.3)
2021–2022	47 (31.3)
Never tested[1]	24 (16)
HCV testing locations[2], $n = 126$	
Prison	74 (58.7)
Drug treatment program	19 (15.1)
Public health clinics	33 (26.2)
HCV treatment location, PWID with treatment history[3], $n = 12$	
Prison	6 (50.0)
Doctor's office	3 (25.0)
Public health clinics	3 (25.0)
HCV medication, PWID initiated treatment[3], $n = 12$	
Interferon therapy	6 (50.0)
Direct-acting antivirals	3 (25.0)
Other*	3 (25.0)

[1] PWID without prior history of HCV testing.
[2] PWID with prior history of HCV testing.
[3] PWID with prior history of treatment initiation.
* PWID did not recall medication name.

3.5. Barriers to HCV care

Finally, Table 3 shows the most commonly perceived barriers among participants(n=150) to pursuing HCV treatment in Puerto Rico: lack of knowledge of a treatment center location (78.7%), lack of transportation (78%), and drug abstinence requirements (74.7%) were followed by feeling unwelcome at medical facilities (38.0%), insurance issues (29.3%), fear that others will know about their HCV status (29.3%), and medical distrust (8.7%). Participants who reported never being tested for HCV (n = 24) were asked the reasons for their lack of testing and identified testing barriers such as lack of knowledge of a testing location (70.8%), low perceived risk of infection (25.0%), and fear of receiving an HCV-positive test result (16.7%). The most commonly reported barriers to treatment among those who were linked to care (n = 38) included the following: lack of transportation (34.2%), fear of side effects (28.9%), and a long wait time for a first appointment with a HCV treatment provider (15.8%).

4. Discussion

This study assesses the HCV cascade of care among PWID in Puerto Rico. Overall, our findings show that significant gaps exist in the HCV care cascade among PWID in Puerto Rico. Although the vast majority of participants reported prior HCV antibody testing, much of that testing was remote, and a significant drop-off was noted in screening, confirmation, treatment initiation, and cure. Our study also identified barriers to HCV care such as low awareness and accessibility to HCV testing and treatment, healthcare stigma, and drug abstinence requirements.

This research advances our current understanding of the HCV cascade of care. To the authors' knowledge, this is the first study to provide an assessment of the cascade of care for HCV among PWID in Puerto Rico. Additionally, this is the first assessment of HCV RNA positivity rates and barriers to HCV care among PWID. Importantly, we found steep discrepancies between participants' HCV antibodies and RNA self-reports and the results from our DBS study samples, showcasing gross underestimates of HCV vulnerabilities. Understanding the gaps and barriers to HCV care is crucial to eliminating HCV (Grebely et al., 2019). Our results indicate that to eliminate HCV, there is substantial work to be done to enhance PWID's access to and retention in the HCV care cascade in Puerto Rico. PWID-tailored HCV services in Puerto Rico are needed to overcome barriers and increase the level of engagement at each step of the cascade. Education regarding DAA

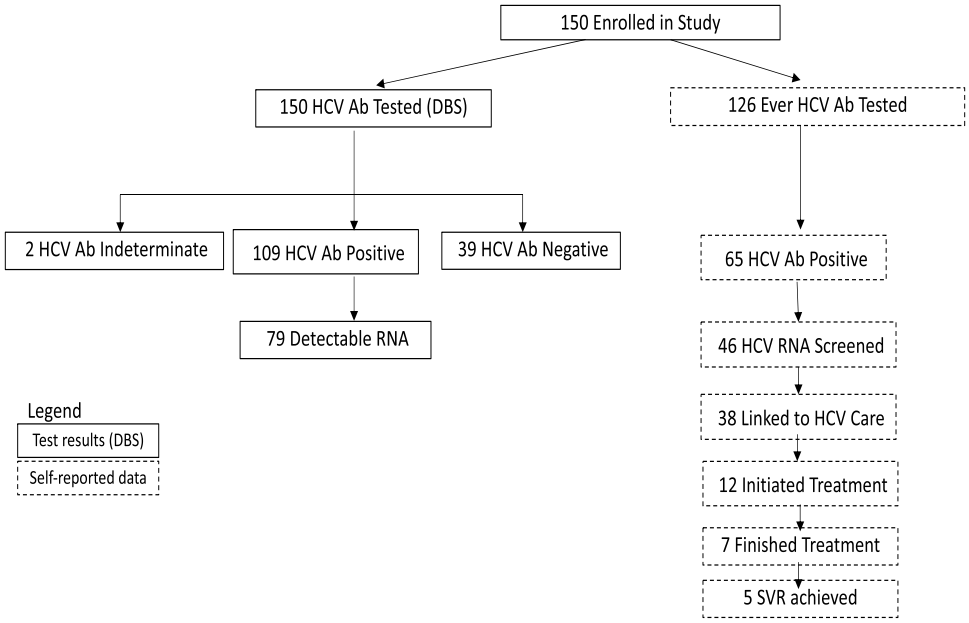

Fig. 1. Dried blood spot (DBS) testing result and self-reported HCV testing, care and treatement among PWID

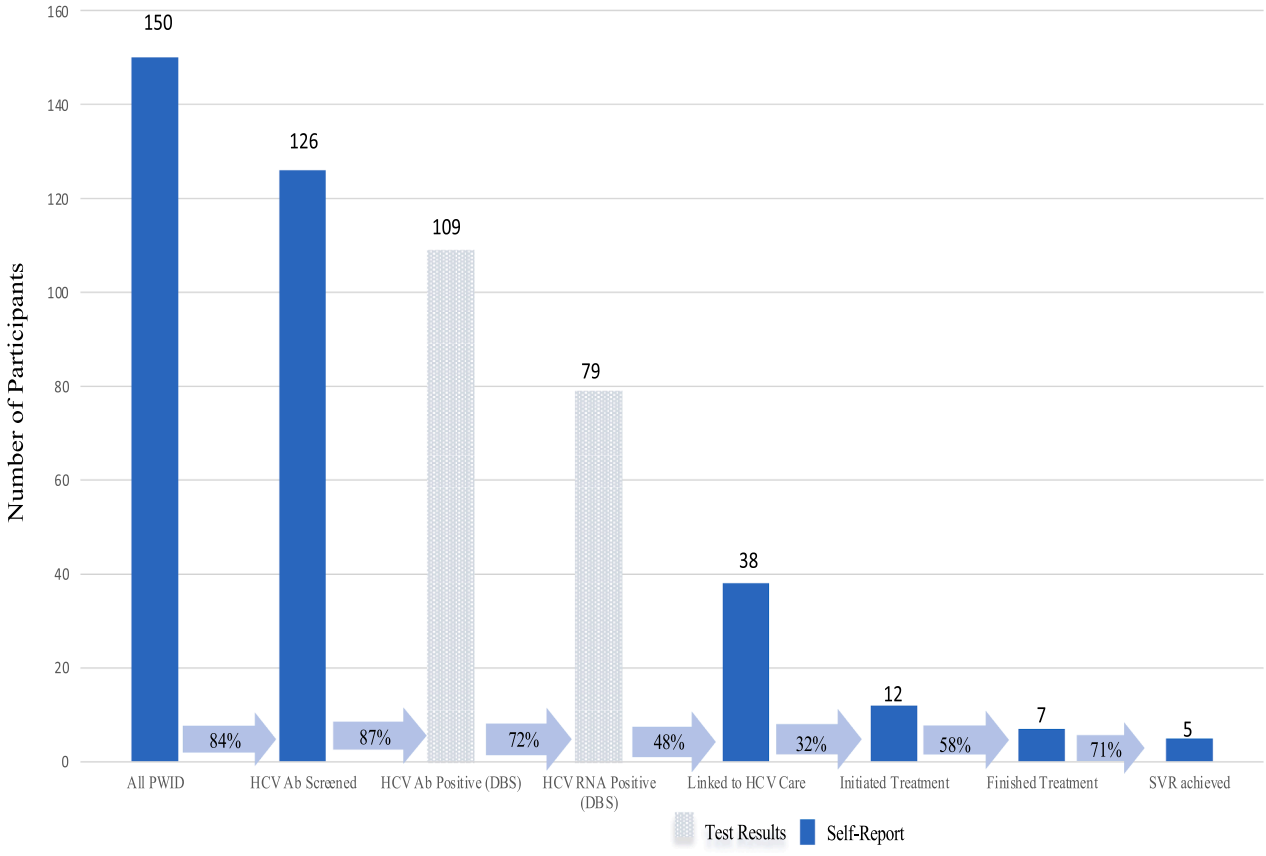

Fig. 2. Estimate HCV Care Cascade among PWID in Puerto Rico

treatment and the development of mobile and community-based models of care is needed to improve the HCV care cascade. Treatment as prevention (identification, linkage, and treatment) is a major component of combating HCV (Vickerman et al., 2013) and has not yet been implemented in Puerto Rico. Major efforts to scale up HCV testing and treatment and sustain access to syringe exchange services within the PWID population are critical to reaching the WHO elimination targets (Grebely et al., 2017) in Puerto Rico. In addition, drug-related stigma interventions in healthcare settings may be particularly needed to improve PWIDs' engagement in HCV care.

The HCV epidemic in Puerto Rico, as in other countries such as the United States, Russia, and Vietnam, is driven by injected drug use

Table 3
Barriers for hepatitis C (HCV) testing and care among people who inject drugs

Category	N(%)
Perceived barriers to HCV testing[1], (n=24)	
Lack of knowledge of a testing location	17(70.8)
Low HCV risk perception	6(25)
Fear of HCV positive result	4(16.7)
Lack of transportation	3(12.5)
Lack of health insurance	3(12.5)
Perceived barriers to HCV care [2], (n=150)	
Lack of knowledge of a treatment location	118(78.7)
Lack of transportation	117(78)
Drug abstinence requirement	112(74.7)
Feeling unwelcome at medical facilities	57(38)
Insurance problems	44(29.3)
Fear of HCV disclosure to others	43(28.7)
Medical distrust	13(8.7)
Perceived barriers among PWID linked to HCV care[3],**(n=38)**	
Lack of transportation	13(34.2)
Fear of side effects	11(28.9)
Wait time for first appointment with HCV provider	6(15.8)
Did not want treatment	4(10.5)
Did not have health insurance	4(10.5)
Using too many drugs or alcohol	6(15.8)
Inconvenient location or office hours	5(13.2)

[1] The question inquiring about barriers to testing was asked only to participants who reported never being tested.
[2] The question inquiring about barriers to care utilization was asked to all participants.
[3] The question inquiring about barriers to treatment was asked only to participants who reported being linked to HCV care.

(Isakov & Nikityuk, 2022; Pérez et al., 2007; Rapoud et al., 2020; Tsui et al., 2016). Historically, PWID in Puerto Rico have been disproportionally affected by HCV. Given the extremely poor access to HCV-related services in Puerto Rico, it is not surprising to find such high rates of HCV infection. Previous studies conducted among Puerto Rican PWID have shown how risk factors such as sharing injection equipment, high injection frequency, and polysubstance use are prevalent among Puerto Rican PWID, triggering negative health outcomes (Abadie et al., 2016; Gelpí-Acosta et al., 2019; Hernandez et al., 2017; Pérez et al., 2015; Reyes et al., 2006). These injection risks unfold in a context of poor access to HCV testing and services for people who use drugs, including syringe services and opioid agonist programs. Arguably, the ongoing financial crisis combined with natural disasters (e.g., hurricane María) have further weakened Puerto Rico's public health infrastructure (Hernandez et al., 2017). However, these crises are relatively new, and our findings suggest that access to HCV care for PWID was not in place before these natural phenomena unfolded. In fact, decades of literature support the notion of permanently weak and almost nonexistent access to HCV care infrastructure for PWID in Puerto Rico (Abadie et al., 2016; Colón et al., 2006; Deren et al., 2007; Deren et al., 2014; Mino et al., 2006; Pérez et al., 2015; Reyes-Pulliza et al., 2006; Robles et al., 2003; Zerden et al., 2010).

Findings from this study are consistent with other HCV cascades of care in the United States and other countries (Carmody et al., 2023; Folch et al., 2021; Kapadia et al., 2021; Grebely et al, 2019; Tsui et al., 2019; Morris et al., 2019; Jordan et.al 2017). Previous studies conducted among PWID have also identified gaps along the cascade of care, with considerable drop-off between HCV antibody and confirmatory RNA testing and linkage to care and treatment initiation (Carmody et al., 2023; Folch et al., 2021; Kapadia et al., 2021; Grebely et al., 2019; Tsui et al., 2019; Morris et al., 2019; Jordan et.al 2017). Linkage to care has been identified as one of the biggest gaps in the HCV cascade of care among PWID in the United States (Jordan et.al 2017). The low rates of HCV RNA testing and treatment among PWID reported in this study align with findings from previous studies among PWID in the United States that have shown insufficient confirmatory testing and poor rates of linkage to care and antiviral treatment after HCV diagnosis among PWID (Blake et al., 2021; Blackburn et al., 2016; Chhatwal and Sussman, 2019; Morris et al., 2019; Tsui et al., 2019; Jordan et.al 2017; Yehia et al., 2014).This lack of HCV confirmatory testing and treatment is in part due to health insurance restrictions and medical providers' concerns regarding treatment compliance among people who use drugs (Blake et al., 2021; Grebely et al, 2019; Royal 2017 et al., 2017; Stephens et al., 2017). Although PWID are a key population in the HCV epidemic, very often medical providers believe that PWID will fail to complete treatment, despite findings from multiple studies that show high levels of treatment adherence (Eckhardt et al., 2021, Grebely et al., 2018, Sivakumar et al., 2022; Solomon et al., 2020). While treatment among PWID with DAA has shown high SVR rates, the perception of poor adherence to treatment remains a barrier (Dore et al., 2016; Eckhardt et al., 2021; Grebely et al., 2018; Janjua et al., 2019; Macías et al., 2019; Rosenthal et al., 2020). Even after the loosening of the substance use restrictions in Puerto Rico as an eligibility criterion to access HCV treatment (Center for Health Law and Policy Innovation, 2020), HCV treatment among PWID remains low.

Participants perceived that barriers to care pose further challenges to overcoming the HCV epidemic among PWID in Puerto Rico. These findings are similar to those from research among PWID globally (Amoako et al., 2021). Multiple studies have shown that PWID face multiple barriers to HCV care, including drug abstinence requirements by health insurance providers, prior authorization requirements for HCV treatment, lack of knowledge regarding treatment, and prescriber restrictions (National Hepatitis Viral Roundtable 2023, Amoako et al., 2021; Grebely et al., 2017; Lo Re et al., 2016; Do et al., 2015; Edlin et al., 2005). Stigma in healthcare settings has also been recognized as a major barrier to linkage and engagement in healthcare, including HCV care among PWID (Austin et al., 2022; Biancarelli et al., 2019). Very often, PWID are reluctant to seek services for fear of stigmatization. Additionally, transportation issues are well-known predictors of lower healthcare utilization and poorer healthcare outcomes (Borda et al., 2022). Transportation challenges to HCV care have also been reported as a major barrier to PWID access to services, especially among rural communities in the United States (Gordon, 2018). In Puerto Rico, lack of transportation has been previously reported as a main impediment to substance abuse treatment initiation and retention (Abadie et al., 2021). Mitigating the identified barriers along the HCV cascade of care will increase engagement in life-saving testing and treatment and reduce HCV-related mortality (Grebely et al., 2017).

This study has several limitations. First, the HCV cascade of care is based on self-reported data on testing history, treatment uptake, and linkage to care which lacks the accuracy that medical records provide. The timeframe for the analysis of the HCV cascade of care was lifetime, so the self-reported data is limited by the participants' memory of HCV-related services they may have undergone a long time ago. Second, the study sample might not be fully representative of PWID in Puerto Rico. The research sites were located in two municipalities, and we recruited PWID residing in 11 municipalities. Puerto Rico has 78 municipalities, which limit generalizability potentially affecting our assessments of the cascade of care and treatment uptake. Third, the use of RDS, a non-random recruitment methodology, may introduced bias into the sample.

5. Conclusion

This study identified gaps and barriers along the cascade of HCV care, including lack of testing; linkage to care, knowledge-related treatment, and testing sites; as well as the participants' perception that PWID are not allowed to receive HCV services due to ongoing drug use. Scaled-up HCV testing and integration of harm-reduction programs within HCV treatment delivery are needed to eliminate HCV as a public health threat and achieve HCV elimination among PWID in Puerto Rico.

Authors' contributions

YAM, PMG, and BE were involved in the study design, data analysis, and conceptualization of the manuscript. YAM drafted the initial manuscript. CF led and conducted the statistical analysis. AP helped with data analysis. WTM and EMR collected the data. All the authors reviewed, revised, and approved the submitted manuscript.

Ethics approval

The authors declare that they have obtained ethics approval from an appropriately constituted ethics committee/institutional review board where the research entailed animal or human participation.

All participants provided written consent for participation in the survey and collection of blood samples. This study received IRB approval from the CUNY Graduate School of Public Health and Health Policy (approval number 20212008PHHP).

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Dr. Nancy Agront discloses employment by Abbvie Corp

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