## Title

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# Hepatitis C virus prevalence, determinants, and cascade of care among people who inject drugs in Iran

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## Abstract

**Background:** People who inject drugs (PWID) continue to experience the highest burden of hepatitis C virus (HCV). We aimed to characterize HCV antibody prevalence, determinants, and cascade of care among PWID in Iran.

**Methods:** Participants were recruited in 11 cities of Iran using respondent-driven sampling. PWID underwent a structural interview capturing measures on socio-demographics, behaviors, and HCV cascade of care. HCV and HIV were tested using antibody rapid tests. Multivariable logistic regression identified characteristics associated with HCV seropositivity.

**Results:** HCV antibody seroprevalence was 26.0% among 2,684 recruited PWID. Of 699 participants who were HCV antibody positive, 88 (12.6%) were aware of past infection. HCV antibody prevalence was associated with older age (adjusted odds ratio [aOR] 2.09; 95%CI 1.18, 3.71), lower education (aOR 1.31; 95%CI 1.02, 1.69), >10 year of injecting (aOR 6.03; 95%CI 4.10, 8.85), methamphetamine injection (aOR 1.46; 95%CI 1.07, 1.99), daily injection (aOR 1.26; 95%CI 1.01, 1.58), needle/syringe sharing (aOR 2.04; 95%CI 1.24, 3.34), recent incarceration (aOR 1.74; 95%CI 1.30, 2.32), and HIV seropositivity (aOR 7.93; 95%CI 4.12, 15.24). Additionally, 12.0% had ever tested for HCV, 4% had previously tested reactive for HCV

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antibody, and 3.7% had received an HCV diagnosis. Of diagnosed cases, 44.4% were linked to care, 15.2% received treatment, and 3.0% achieved sustained virologic response.

**Conclusion:** Our data show a high prevalence of HCV antibody and considerably low engagement in HCV care, underscoring an unmet need for HCV prevention, screening, and treatment among PWID in Iran. HCV prevention and treatment programs are needed to enhance harm reduction efforts and access to HCV care in Iran.

### Keywords

Hepatitis C Virus; HIV; Injection Drug Use; HCV Treatment; Iran

## 1. Introduction

Hepatitis C virus (HCV) disproportionately affects people who inject drugs (PWID) through its high transmissibility via unsafe injection (Falade-Nwulia et al., 2020). A global systematic review estimated that 52.3% (~8.2 million) of the 15.6 million PWID are HCV antibody positive indicating past or current infection (Degenhardt et al., 2017). Globally, the highest prevalence of HCV is reported in the Middle East and North Africa (MENA), accounting for approximately 20% of all people living with chronic HCV (World Health Organization, 2017a, b). PWID are also the most affected population by HCV in the region; the pooled HCV antibody prevalence among PWID was estimated at 49.3%, and 221,704 PWID were estimated to be living with chronic HCV infection, with the largest numbers estimated in Iran at 68,526 (Mahmud et al., 2020).

With the promising effectiveness of antivirals to treat infection and prevent transmission (Wedemeyer et al., 2015), the WHO declared the intention to eliminate viral hepatitis by 2030 (World Health Organization, 2016). Targets for elimination include an 80% decline in new HCV cases, 90% of infections being diagnosed, 80% of infections receiving treatment, and 65% reduction in HCV-related deaths. However, most people with HCV remain unaware of their status due to asymptomatic infection, low testing, and limited diagnosis and linkage to care (Solomon et al., 2015; Volk et al., 2009). Lack of accurate national HCV surveillance systems, particularly for key populations such as PWID, contributes to the challenge of HCV control and elimination (Bruggmann and Grebely, 2015). Evidence in MENA suggests that improving the detection of people living with HCV, particularly targeting of PWID for screening, may be the crucial step to HCV control in the region (Chemaitelly et al., 2019).

Characterizing the epidemiology of HCV among PWID is needed to advocated harm reduction services and target HCV screening and treatment initiatives (Mahmud et al., 2020). Moreover, understanding engagement across stages of the HCV cascade of care, which describes the continuum from diagnosis to treatment uptake and completion, is essential for developing interventions for elimination programs (Gibbs et al., 2021; Iversen et al., 2020). However, national studies examining HCV prevalence and its determinants among PWID in many countries, including Iran, remain limited. Data on the continuum of HCV care among PWID in Iran and the MENA region is especially limited. Given Iran's population size estimation of 280 per 100,000 persons injecting drugs (Nikfarjam et al., 2016) and Iran currently hosting the largest number of PWID with chronic HCV

infection in MENA (Mahmud et al., 2020), understanding the epidemiology of HCV among PWID in Iran is crucial to achieve HCV elimination in the region. Therefore, we aimed to characterize HCV antibody prevalence, individual and structural determinants of infection, and engagement in the HCV care cascade in a large cross-sectional sample of PWID from 11 major cities across Iran.

## 2. Methods

### 2.1. Study design and participants

Study participants were recruited in 11 major cities of Iran, including Tehran (central-north), Tabriz (north-west), Sari (north), Mashhad (north-east), Yazd (central), Kermanshah (west), Khorramabad (west), Ahvaz (south-west), Shiraz (south), Kerman (south-east) and Zahedan (south- east) as part of the fourth national HIV bio-behavioral surveillance survey (Khezri et al., 2022). The cities were selected by study investigators following consultations received from the Ministry of Health to represent different regions across the country. Inclusion criteria for enrollment were: i) being ≥ 18 years of age at the time of the interview; ii) self-reporting illicit drug injection in the previous year; iii) residing in the surveyed cities, and iv) providing a valid referral coupon.

Recruitment began in July 2019 and ended in March 2020, conducted through respondent-driven sampling (RDS), a chain-referral recruitment strategy utilized in HIV surveillance and research to identify and recruit marginalized populations, including PWID (Solomon et al., 2017). Seeds from various subgroups of PWID with expansive social networks were recruited to initiate recruitment. We provided three coupons to each seed to distribute to social network peers with an expiration date of three weeks. All participants received monetary incentives in compensation for the interview and HIV/HCV rapid test (~1.5 USD) and an additional incentive (~1 USD) for successful peer referrals to the study.

All study protocols were reviewed and approved by the Kerman University of Medical Sciences ethics committee (Ethics Codes: IR.KMU.REC.1397.573(. Participation was anonymous. All participants provided verbal informed consent for biological and behavioral data collection prior to study enrollment. Behavioral data were collected through the face-to-face interviews using a standard behavioral questionnaire, which captured information on demographics, social network characteristics, drug use behaviors, and drug treatment. Participants also provided blood samples for HCV and HIV testing with pre-test and post-test counseling. HCV testing was performed with HCV antibody rapid test (SD-Bioline, South Korea). We also performed HIV testing by SD-Bioline, South Korea rapid test, and if reactive, was followed by confirmatory Unigold HIV rapid test. Test results were linked to survey responses using a unique code; no personal identifying information was asked for or collected.

### 2.2. Outcomes

The primary outcome of interest was HCV seroprevalence. HCV seroprevalence was measured by the detection of HCV antibodies. The awareness of HCV positive status was determined based on self-reported knowledge of a prior reactive result on an HCV

test. Secondary outcomes were the proportion of participants involved at each step of the HCV care cascade. Self-reported information was collected to evaluate HCV cascade of care stages, and the following outcomes based on the following survey questions were considered: a) *ever tested for HCV*: "have you ever been tested for HCV?", with yes and no response options; b) *tested positive for HCV antibody*: "what was the result of your previous HCV test?, with positive, negative, uninterpretable, did not get the test result, and do not know response options; c) *diagnosed with HCV*: "has a doctor, nurse or other health care provider ever told you that you had HCV infection?", with yes and no response options; d) *linkage to care*: "In the last time you were told you had HCV infection, have you been referred to a care center to see a doctor or other health care provider for your HCV infection care management? with yes and no response options; e) *initiation of HCV treatment*: "have you ever taken medicine to treat your HCV infection?", with yes and no response options; f) *tested to check sustained virologic response (SVR)*: "have you been tested for HCV to find out what the result of the treatment was?", with yes and no response options; and h) *achieved SVR*: "If you were tested again after completing the HCV treatment, do you know what the result was?, with positive, negative, uninterpretable, and do not know response options".

### 2.3. Covariates

Individual and structural determinants of HCV were examined. These included demographic characteristics, HIV status, and related risk behaviors, such as age (< 30, ≥ 30), gender (women, men), education (high school or more, less than high school), marital status (single, currently married, divorced/widowed), employment status (having a permanent job, having a temporary job, unemployed), HIV sero-status (negative, positive), knowledge of HCV transmission through sharing needle/syringe (no, yes), length of injection (< 5, 5–10, > 10 years), heroin injection in the last 12 months (no, yes), opium injection in the last 12 months (no, yes), methamphetamine injection in the last 12 months (no, yes), cocaine injection in the last 12 months (no, yes), public injecting in the last 12 months (no, yes), daily injection in the last three months (no, yes), and receptive needle/syringe sharing in the last three months (no, yes). Treatment and service engagement covariates included needle and syringe program use in the last year (no, yes), and currently on opioid agonist treatment (OAT) (no, yes). Structural-level risks were experiencing stigma within healthcare settings (no, yes), homelessness history (never, yes, before the last 12 months, yes, within the last 12 months), and incarceration history (never, yes, before the last 12 months, yes, within the last 12 months).

### 2.4. Data analysis

We report proportions with 95% confidence intervals (CI) for HCV antibody prevalence, overall and in each city, as well as HCV care cascade steps. Bivariable and multivariable logistic regression models characterized factors associated with HCV seropositivity. Crude odds ratios (OR) and adjusted ORs (aOR) along with their 95% CIs are reported. Variables with a P value < 0.2 in bivariable analysis were entered into a full multivariable regression model. A final model was selected through a backward elimination approach with significance set at P value < 0.05. All unweighted analysis was done in Stata v.16 (StataCorp, College Station, Texas, USA). We also calculated and reported RDS-adjusted

estimates for HCV antibody prevalence, overall and in each city, and HCV care cascade steps, which considered network size and homophily within networks. RDS-adjusted estimates were calculated in RDS-Analyst version 1.8.

## 3. Results

Among 2,684 PWID surveyed, the mean age was 40.2 (SD 9.2) years, and 90 (3.4%) were women (Table 1). Over two-thirds (69.1%) had less than high school education; 25.0% were married; and 17.9% had a permanent job. A plurality injected heroin (41.4%), 4.8% injected opium, 14.7% injected methamphetamine, and 3.5% injected cocaine in the last 12 months. More than two thirds (69.6%) reported public injecting in the previous 12 months. Over half (50.5%) reported daily injection in the previous three months. Only 3.4% reported receptive needle/syringe sharing in the previous three months. Homelessness and incarceration in the last year were reported by 43.2% and 11.2%, respectively. Overall prevalence of HIV was 3.5%.

HCV antibodies were detected in 699 PWID, yielding a prevalence of 26.0% (95% CI: 24.4, 27.7). Of 699 participants who were HCV antibody positive, 88 (12.6%; 95% CI: 10.3, 15.3) were aware of their HCV antibody positive status. HCV antibody prevalence was significantly higher among PWID who were older than 30 years (28.8% vs. 6.8%; $P < 0.001$), were men (26.7% vs. 16.7%; $P = 0.037$), had less than high school education (29.3% vs. 18.9%; $P < 0.001$), were divorced/widowed (30.7% vs. 23.6% for single; $P < 0.001$), and had a temporary compared to permanent job (27.2% vs. 20.4%; $P = 0.006$). A higher prevalence of HCV antibody was also reported among PWID with 10 or more years history of injecting (39.6% vs. 7.5% for < 5 years; $P < 0.001$), did not inject heroin in the last 12 months (27.8% vs. 23.3%; $P = 0.009$), injected methamphetamine in the previous year (37.5% vs. 24.0%; $P < 0.001$), primary injected in public settings in the previous year (27.1% vs. 22.8%; $P = 0.027$), reported daily injection in the last three months (28.4% vs. 24.5%; $P = 0.025$), and reported receptive needle/syringe sharing in the last three months (43.5% vs. 22.3%; $P < 0.001$). HCV prevalence was also higher among those who experienced stigma within healthcare settings (30.1% vs. 23.1%; $P < 0.001$), had experienced homelessness in the previous year (29.0% vs. 22.2% for never experienced homelessness; $P < 0.001$), had incarcerated in the previous year (36.2% vs. 12.6% for never incarcerated; $P < 0.001$), reported current OAT (30.6% vs. 24.8%; $P = 0.004$) and were living with HIV (70.5% vs. 24.4%; $P < 0.001$).

Multivariable logistic regression analysis showed that being reactive for HCV antibody was significantly and independently associated with age over 30 years (aOR 2.09; 95% CI 1.18, 3.71), less than high school education (aOR 1.31; 95% CI 1.02, 1.69), longer injecting history (aOR for over 10 years 6.03; 95% CI 4.10, 8.85), methamphetamine injection (aOR 1.46; 95% CI 1.07, 1.99), daily injection (aOR 1.26; 95% CI 1.01, 1.58), receptive needle/syringe sharing (aOR 2.04; 95% CI 1.24, 3.34), incarceration (aOR 1.74; 95% CI 1.30, 2.32), and HIV seropositivity (aOR 7.93; 95% CI 4.12, 15.24).

HCV antibody prevalence varied by geographical location (Figure1). PWID in Yazd (52.8%), Mashhad (44.3%), Shiraz (31.9%), Ahvaz (30.3%), and Kerman (27.5%) had the

highest HCV antibody prevalence. There was also city-level variability in awareness of HCV seropositive status among PWID who are living with HCV, which was ranged from 0 in Khorramabad and Shiraz to 43.3% in Yazd. Low levels were generally reported, with only 12.6% of PWID who were HCV seropositive being aware of prior HCV infection. RDS-adjusted estimates are also presented in Supplementary Table 1.

Of 2,684 recruited PWID, 321 (12.0%) had previously been tested for HCV, 106 (4%) had tested HCV antibody positive, and 99 (3.7%) had received an HCV diagnosis (Figure 2). Of those diagnosed, 44 (44.4%) had been linked to care, 15 (15.2%) had taken HCV treatment, 6 (6.1%) had tested for SVR, and 3 (3.0%) had achieved SVR. RDS-adjusted estimates for HCV cascade of care showed similar results (Supplementary Table 2).

## 4. Discussion

Our study shows a high prevalence of HCV antibody in a national, community-recruited sample of PWID in Iran. HCV seropositivity was significantly associated with older age, lower education, longer injection history, methamphetamine injection, daily injection, receptive needle/syringe sharing, incarceration, and HIV seropositivity. Additionally, HCV testing and engagement in care were low. Only one in ten of those with a positive HCV antibody test were aware of their HCV seropositive status. Of those who were previously diagnosed with HCV, less than half had been linked to care, and only one in 15 had initiated HCV treatment.

HCV antibody seroprevalence was high among PWID in Iran with more than one in four testing HCV antibody positive. Our national estimate of HCV antibody prevalence was lower than the estimate of recent systematic reviews among PWID in MENA (49.3%) (Mahmud et al., 2020) and in Iran (46.5%) (Rajabi et al., 2021). However, the majority of included studies in these reviews were limited to small sample size or used convenience sampling methods that recruited PWID from drop-in-centers, hospitals, healthcare centers, or prisons. Our study is the first of its kind to examine the prevalence and determinants of HCV among PWID using a community-based sampling approach that achieved both high statistical power and robust inclusion of PWID outside of facilities in the context of MENA that have the highest prevalence of HCV globally. Our estimate of HCV antibody prevalence falls within the range of studies in other low- and middle-income settings such as Tanzania (16.2%) (Leyna et al., 2019) and India (37.2%) (Solomon et al., 2015). Unfortunately, the HCV status awareness and engagement in HCV care among Iranian PWID were substantially lower than that in high-income countries. For example, among PWID in Germany, 59% of those living with HCV were aware of their positive status (Enkelmann et al., 2020). In the USA, 88% of PWID had previously been tested for HCV, and 42% of those diagnosed with HCV had received treatment (Mirzazadeh et al., 2021). Of PWID diagnosed with HCV in Australia, 76% reported initiating treatment, and 78% completed the treatment (Gibbs et al., 2021). These findings indicate that substantial efforts to promote HCV prevention, testing, awareness, and treatment of PWID in Iran are urgently needed.

Although HCV assessment and treatment services should be provided in a range of settings such as hospitals, health centers, primary care clinics, prisons, and homelessness shelters (Grebely et al., 2017), there is no publicly funded HCV program in Iran, and HCV services are limited to referrals to tertiary healthcare centers (Alavi et al., 2019). The existing health insurance providers have inadequate coverage, particularly for marginalized populations such as PWID (Mousavi and Sadeghifar, 2016). Among these marginalized populations, evidence suggests that community-based HCV services have the potential to promote engagement in HCV care. For example, San Francisco Community Health Clinics in 2016 were able to diagnose and engage in care 578 individuals living with HCV from marginalized populations using community-based services (Facente et al., 2018; Mirzazadeh et al., 2021). Another approach is co-locating HCV services with other services (e.g., substance use, harm reduction, HIV care) to improve linkage to HCV care (Bajis et al., 2017). For example, the integration of HCV care into existing substance use services has been strongly suggested to improve HCV prevention and treatment (Bruggmann and Litwin, 2013; Socías et al., 2019). Iran has a highly functional harm reduction infrastructure (Ekhtiari et al., 2020) that could be utilized to integrate HCV interventions. Evidence of community-based HCV interventions within drop-in-centers, substance use treatment clinics, and homeless reception centers in Iran also showed promising results. In Kerman, 91.7% of PWID who were eligible initiated treatment, and 91.0% achieved SVR at an on-site community-based drop-in-center for harm reduction and HIV services (Mirzazadeh et al., 2022). A study in Tehran also showed that locating services within drug treatment and homeless centers, HCV testing and treatment uptake was substantial (e.g., 84.% initiated and almost 100% completed treatment) (Alavi et al., 2019).

Our multivariable analysis also provides insights to target and improve HCV prevention and treatment programs for PWID in Iran. The high HIV and HCV co-infection prevalence supported the integration of HCV-related services into HIV services, a strategy supported by WHO (World Health Organization, 2014). The high co-infection prevalence also underscores that HCV treatment should be prioritized among people living with HIV. The association of HCV with high-risk injection practices such as frequent injection, needle/syringe sharing, and longer injecting history suggests the need to improve harm reduction interventions overall. Such interventions are considered insufficient to effectively prevent HIV and HCV transmission in many countries, including Iran (Larney et al., 2017). While Iran has an extensive network of addiction treatment services and a high rate of OAT uptake (Farhoudian and Radfar, 2022), OAT uptake was low among our PWID sample, underscoring several barriers that continue to undermine PWID's access to OAT in Iran that need to be addressed. Ideally, OAT programs should have slots available to all PWID and needle and syringe programs should cover all PWID (Grebely et al., 2017). Studies indicate that a combination of OAT programs and high-coverage needle and syringe programs could decrease HCV incidence by up to 80% (MacArthur et al., 2014; Platt et al., 2016). Given the risk of onward transmission and re-infection and the potential for HCV treatment to prevent onward transmission of infection, treatment scale-up among people with high risk injection practices are indeed essential. Supervised injection facilities have been also suggested for reducing high-risk injection practices and providing HCV-related services (Belackova et al., 2018; Kennedy et al., 2017). Iranian PWID have also reported a high willingness to use such

facilities (Khezri et al., 2021). The correlation of HCV with lower education level, coupled with poor HCV knowledge in our sample, underscore that educational interventions need to be provided (Solomon et al., 2015). While little is known about methamphetamine-related liver toxicity (Karch et al., 1999; Robaeys et al., 2013), the association of methamphetamine injection and HCV suggests that PWID should be informed about the potential impact of substance use on the liver (Robaeys et al., 2013). Peer support of social network members through peer education and transportation to appointments are also warranted to promote HCV programs (Falade-Nwulia et al., 2020). Association of incarceration and HCV highlights prisons as pivotal settings for HCV prevention and treatment. In addition to enhanced coverage of harm reduction services in prisons, HCV screening and treatment should be offered in prisons that have been shown to be feasible and effective in prison settings in Iran (Grebely et al., 2015; Hariri et al., 2020).

### 4.1. Limitations

This study has several limitations that should be acknowledged and considered when interpreting findings. First, the cross-sectional nature of the survey limits our ability to conclude causal and temporal relationships between HCV and determinants of interest. Second, the small sample of those previously diagnosed or initiated treatment was underpowered to identify factors associated with engagement in care at each stage of the HCV cascade of care. Third, the sensitive and illegal nature of drug use makes self-reported data subject to social-desirability bias. Moreover, recall bias may be present given PWID were asked to report risk behaviors and harm reduction service usage from three to 12 months in the past. Fourth, we did not assess the presence of HCV RNA, which prevents the ability to precisely estimate the proportion of PWID with current infection, who needs treatment, and the proportion that are virus-free. Fifth, limiting recruitment to 11 cities makes the findings less generalizable to all areas of the country, particularly small towns and rural areas. Finally, participants enrolled may not be representative of the target populations even within the cities included in our study. RDS purports to produce representative samples when properly implemented and analyzed with survey weights. However, several assumptions need to be met. These assumptions are difficult to verify, including random recruitment from social networks, accurate reporting of network size, and that the target population forms a single network within several degrees of separation.

## 5. Conclusion

Our data indicate high HCV antibody prevalence among PWID in Iran with minimum engagement in HCV care. HCV interventions prioritized for PWID do not exist and current programs have not attained adequate coverage to affect the HCV epidemic among PWID in Iran. Achieving public health goals such as HCV elimination by 2030 will be impossible without robust surveillance through regular testing and linkage to care. HCV harm reduction and treatment services should be expanded throughout the country, and innovative strategies for community-based programs must be developed, implemented, and evaluated. Future research within Iran and the MENA region is urgently needed to design and implement interventions to offer other opportunities for HCV transmission prevention, early diagnosis, treatment linkage, and retention in care.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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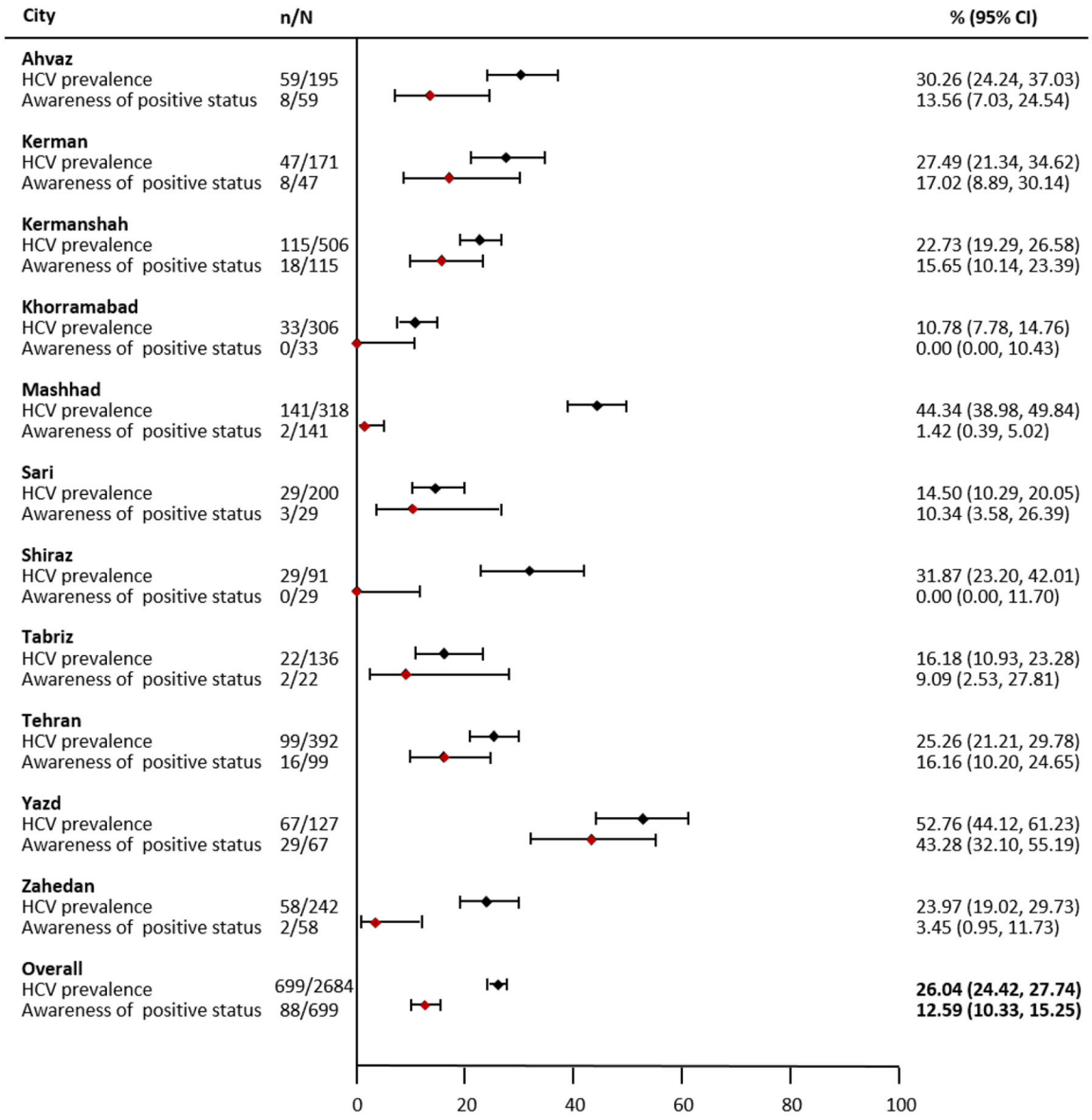


**Figure 1.**

Hepatitis C virus (HCV) antibody prevalence, and awareness of HCV antibody positive status among people who inject drugs in 11 cities in Iran, 2020. Denominators for HCV antibody prevalence are the total samples; denominators for awareness of HCV antibody positive status are participants testing reactive for HCV. HCV antibody prevalence was assessed using HCV-antibody rapid test (SD-Bioline, South Korea).

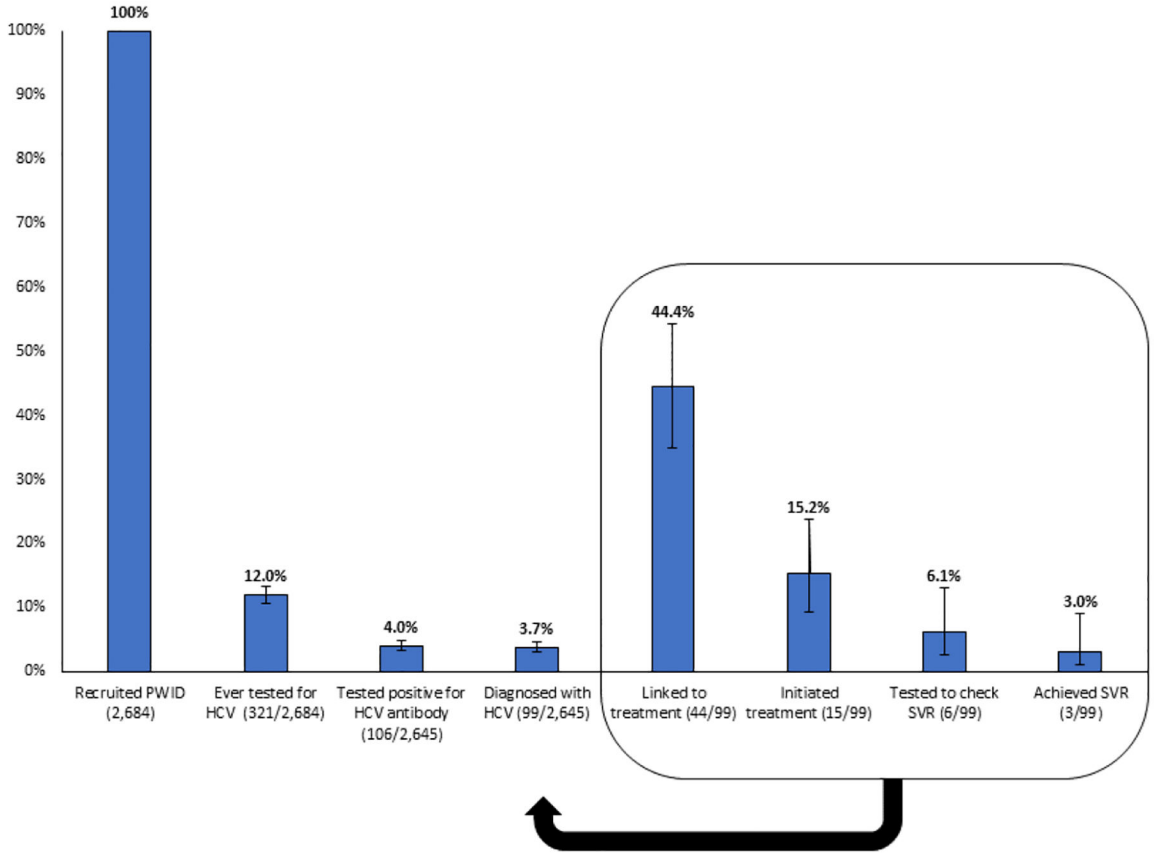


**Figure 2.**

Hepatitis C virus (HCV) cascade of care among people who inject drugs in Iran in 2020. Denominators for percent who were linked to treatment, initiated treatment, tested for sustained virologic response (SVR), and achieved SVR are participants previously diagnosed with HCV. Self-reported information was used to evaluate HCV cascade of care stages.

**Table 1.**

Unadjusted and adjusted ORs for factors associated with hepatitis C virus antibody prevalence among people who inject drugs in 2020 national HIV bio-behavioral survey in Iran.

| Variables | Total sample N (column %) | HCV infection n (row %) | OR | P value | aOR[a] | P value |
|---|---|---|---|---|---|---|
| **Total, N** | 2,684 | 699 (26.0) | | | | |
| **Age group** | | | | | | |
| < 30 | 294 (11.2) | 20 (6.8) | Ref | | Ref | |
| ≥ 30 | 2,337 (88.8) | 673 (28.8) | 5.54 (3.48, 8.80) | < 0.001 | 2.09 (1.18, 3.71) | 0.011 |
| **Gender** | | | | | | |
| Women | 90 (3.4) | 15 (16.7) | Ref | | | |
| Men | 2,564 (96.6) | 684 (26.7) | 1.81 (1.03, 3.18) | 0.037 | | - |
| **Education** | | | | | | |
| High school or more | 814 (30.9) | 154 (18.9) | Ref | | Ref | |
| Less than high school | 1,824 (69.1) | 535 (29.3) | 1.77 (1.45, 2.17) | < 0.001 | 1.31 (1.02, 1.69) | 0.034 |
| **Marital status** | | | | | | |
| Single | 936 (36.6) | 221 (23.6) | Ref | | | |
| Currently married | 640 (25.0) | 139 (21.7) | 0.89 (0.70, 1.14) | 0.380 | | - |
| Divorced/widowed | 980 (38.4) | 301 (30.7) | 1.43 (1.17, 1.75) | < 0.001 | | |
| **Current employment** | | | | | | |
| Having a permanent job | 392 (17.9) | 80 (20.4) | Ref | | | |
| Having a temporary job | 1,744 (79.6) | 475 (27.2) | 1.45 (1.11, 1.90) | 0.006 | | - |
| Unemployed | 55 (2.5) | 14 (25.4) | 1.33 (0.69, 2.56) | 0.391 | | |
| **Knowledge of HCV transmission through sharing needle/syringe** | | | | | | |
| No | 1,940 (72.3) | 486 (25.1) | Ref | | | |
| Yes | 744 (27.7) | 213 (28.6) | 1.20 (0.99, 1.45) | 0.059 | | - |
| **Length of injecting** | | | | | | |
| < 5 | 655 (25.7) | 49 (7.5) | Ref | | Ref | |
| 5–10 | 635 (24.9) | 132 (20.8) | 3.24 (2.29, 4.59) | < 0.001 | 2.86 (1.87, 4.36) | < 0.001 |
| > 10 | 1,260 (49.4) | 499 (39.6) | 8.10 (5.93, 11.08) | < 0.001 | 6.03 (4.10, 8.85) | < 0.001 |
| **Heroin injection, last 12 months** | | | | | | |
| No | 1,498 (58.6) | 417 (27.8) | Ref | 0.009 | | - |

| Variables | Total sample N (column %) | HCV infection n (row %) | OR | P value | aOR[a] | P value |
|---|---|---|---|---|---|---|
| Yes | 1,058 (41.4) | 246 (23.3) | 0.78 (0.65, 0.94) | | | |
| **Opium injection, last 12 months** | | | | | | |
| No | 2,493 (95.2) | 645 (25.9) | Ref | | | |
| Yes | 126 (4.8) | 42 (33.3) | 1.43 (0.97, 2.09) | 0.064 | | - |
| **Methamphetamine injection, last 12 months** | | | | | | |
| No | 2,121 (85.3) | 509 (24.0) | Ref | | Ref | |
| Yes | 365 (14.7) | 137 (37.5) | 1.90 (1.50, 2.40) | <0.001 | 1.46 (1.07, 1.99) | 0.014 |
| **Cocaine injection, last 12 months** | | | | | | |
| No | 2,387 (96.5) | 616 (25.8) | Ref | | | |
| Yes | 87 (3.5) | 27 (31.0) | 1.29 (0.81, 2.05) | 0.276 | | - |
| **Public injecting, last 12 months** | | | | | | |
| No | 725 (30.4) | 165 (22.8) | Ref | | | |
| Yes | 1,663 (69.6) | 450 (27.1) | 1.25 (1.02, 1.54) | 0.027 | | - |
| **Daily injection, last 3 months** | | | | | | |
| No | 1,259 (49.5) | 308 (24.5) | Ref | | Ref | |
| Yes | 1,286 (50.5) | 365 (28.4) | 1.22 (1.02, 1.46) | 0.025 | 1.26 (1.01, 1.58) | 0.041 |
| **Receptive needle/syringe sharing, last 3 months** | | | | | | |
| No | 2,277 (96.1) | 507 (22.3) | Ref | | Ref | |
| Yes | 92 (3.4) | 40 (43.5) | 2.68 (1.75, 4.10) | < 0.001 | 2.04 (1.24, 3.34) | 0.005 |
| **Experience of stigma within healthcare settings** | | | | | | |
| No | 1,360 (53.4) | 314 (23.1) | Ref | | | |
| Yes | 1,186 (46.6) | 357 (30.1) | 1.43 (1.20, 1.71) | < 0.001 | | - |
| **Needle exchange, last 12 months** | | | | | | |
| No | 240 (12.1) | 60 (25.0) | Ref | | | |
| Yes | 1,738 (87.9) | 530 (30.5) | 1.31 (0.96, 1.79) | 0.082 | | - |
| **Opioid agonist treatment, current** | | | | | | |
| No | 1,941 (75.0) | 482 (24.8) | Ref | | | |
| Yes | 647 (25.0) | 198 (30.6) | 1.33 (1.09, 1.62) | 0.004 | | - |
| **Homelessness history** | | | | | | |
| Never | 1,143 (43.4) | 254 (22.2) | Ref | | | |

| Variables | Total sample N (column %) | HCV infection n (row %) | OR | P value | aOR[a] | P value |
|---|---|---|---|---|---|---|
| Yes, before the last 12 months | 352 (13.4) | 105 (29.8) | 1.48 (1.13, 1.94) | 0.004 | | - |
| Yes, within the last 12 months | 1,137 (43.2) | 330 (29.0) | 1.43 (1.18, 1.72) | < 0.001 | | |
| **Incarceration history** | | | | | | |
| Never | 889 (33.9) | 112 (12.6) | Ref | | Ref | |
| Yes, before the last 12 months | 1,438 (54.9) | 466 (32.4) | 3.32 (2.65, 4.17) | < 0.001 | 2.23 (1.51, 3.29) | < 0.001 |
| Yes, within the last 12 months | 293 (11.2) | 106 (36.2) | 3.93 (2.88, 5.36) | < 0.001 | 1.74 (1.30, 2.32) | < 0.001 |
| **HIV sero-status** | | | | | | |
| Negative | 2,589 (96.5) | 632 (24.4) | Ref | | Ref | |
| Positive | 95 (3.5) | 67 (70.5) | 7.40 (4.72, 11.62) | < 0.001 | 7.93 (4.12, 15.24) | < 0.001 |

[a]Using multivariable logistic regression, variables with a P value < 0.2 in the bivariable analysis were entered into the multivariable analysis. The final model was selected through a backward elimination approach with significance was set at P value < 0.05.