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ORIGINAL PAPER

HIV Prevalence and Related Behaviors Among People Who Inject Drugs in Iran from 2010 to 2020

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Abstract

Injection drug use has been the leading route of HIV transmission in Iran. We assessed HIV prevalence, risk behaviors, and uptake of prevention services among people who inject drugs (PWID) in Iran between 2010 and 2020. We also examined the individual and environmental determinants of HIV among PWID. PWID were recruited in major cities across the country in three national bio-behavioral surveillance surveys in 2010, 2014, and 2020. Participants were tested for HIV and interviewed using a behavioral questionnaire. Between 2010 and 2020, the prevalence of HIV (15.1% to 3.5%), receptive needle sharing (25.2% to 3.9%) and unprotected sex (79.4% to 65.2%) decreased. Moreover, uptake of free needle/syringe increased (57.4% to 87.9%), while uptake of free condoms remained relatively stable across the surveys (34.3% to 32.6%). Multivariable analysis for the 2020 survey showed that a history of homelessness, incarceration, and a longer injection career significantly increased the odds of HIV seropositivity. During the past decade, HIV prevalence and drug- and sexual-related risk behaviors decreased among Iranian PWID. However, individual and structural determinants continue to drive HIV among this population. HIV prevention, diagnosis, and treatment among marginalized PWID with a history of homelessness or incarceration and those who inject drugs for a longer period, should be further prioritized in HIV care planning and resource allocation in Iran.

Keywords HIV · Homelessness · Injection drug use · Iran · Substance use

Introduction

People who inject drugs (PWID) are at an elevated risk of acquiring and transmitting HIV through needle/syringe sharing and unprotected sex [1, 2]. A global systematic review in 2017 estimated the population size of PWID as ~ 15.6 million, 17.8% of whom were living with HIV [3]. Another systematic review estimated that 23.9% of PWID had recently engaged in receptive needle/syringe sharing, with PWID in the Middle East and North Africa (MENA) ranking first (33.5%) globally [4]. In MENA, PWID, with an estimated population size of ~ 626,000, account for most HIV new infections in the region [5, 6]. HIV prevalence among PWID in MENA overall ranges from 10 to 15% [5].

Iran has an estimated 208,000 PWID who bear the highest prevalence of HIV among all its key populations at risk of HIV [7–9]. Although the proportion of sexual transmission of HIV has been increasing in recent years (e.g., around 37% of the identified HIV new cases have been infected through

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unprotected sex) [10, 11], injection drug use has remained the primary mode of HIV transmission in Iran during the past few decades [12]. A recent meta-analysis estimated the pooled HIV prevalence among PWID in Iran to be 14.3% before 2007 and 9.7% afterwards [13]. Despite PWID's relatively adequate knowledge about HIV prevention, high-risk sexual and injection behaviors are frequent [9, 14].

In response to concerns regarding prevalent high-risk behaviors and the spread of HIV, targeting key affected populations, including PWID, has been one of the main focuses of the HIV surveillance system in Iran. This surveillance system has contributed to assessing the burden of disease, developing, targeting, and evaluating interventions, as well as monitoring harm reduction efforts over time [15]. Since the rise of the HIV epidemic among PWID in the late 1990s, Iran's drug policy has shifted from a criminalization approach that criminalized any drug use to a more medicalized approach, and an extensive network of drug treatment and harm reduction services have been established [16]. Iran has also developed harm reduction programs tailored for PWID during the past ten years, including needle and syringe programs (NSP), opioid agonist therapy (OAT), educational programs, and HIV testing. These services are available through drop-in centers, voluntary counseling and testing centers, outreach care provision, and mobile harm reduction centers [17, 18]. Although evaluating changes in PWID's behaviors is of utmost importance, few small-scale studies have tried to examine HIV prevalence, HIV-related risk behaviors, and harm reduction uptake among PWID in Iran. Moreover, studies with sufficient statistical power and robust survey methodologies quantifying HIV-associated risk factors are lacking. In this study, we aimed to assess changes in HIV prevalence, risk behaviors, and harm reduction utilization of PWID in Iran using the extensive bio-behavioral data collected from 2010 to 2020. We also examined the individual and environmental determinants of HIV seropositivity in 2020 to help inform potential interventions and resource allocation activities.

Methods

Setting and Sampling

This study leveraged data from three national bio-behavioral surveillance surveys of Iranian PWID from 2010 to 2020. The surveys have been previously described [9, 19, 20]. In brief, the surveys were conducted in diverse cities representing different geographical regions across the country (Fig. 1). We recruited 2546 and 2399 PWID using a convenience sampling method from harm reduction facilities (e.g., drop-in centers, shelters, addiction treatment centers) catered towards PWID as well as through outreach efforts in both 2010 and 2014 surveys. In the 2020 survey (July 2019 to March 2020), 2684 PWID were recruited using a respondent-driven sampling (RDS) approach. RDS is a recruitment method based on long-chain peer referrals to identify and recruit a diverse representation of PWID [21]. The sampling method in 2020 was modified based on the feedback from the Ministry of Health and Medical Education (MoHME) and the need for improving the rigor and quality of HIV surveillance surveys in Iran.

The selection of the facilities in 2010 and 2014 was informed by the presumed level of HIV prevalence in PWID in the previous survey round in 2008, and input from the MoHME's HIV experts regarding the logistical and capacity constraints of the facilities. The recruitment of participants in 2020 was consistent with the RDS methodology and started with a non-random selection of seeds. Three referral coupons—valid for 3 weeks—were provided for each seed, and participants were trained to use them to recruit up to three peers. This process was repeated with succeeding recruits until the targeted sample size was reached.

Eligibility criteria in all studies were (i) $\geq$ 18 years of age at the time of the study; (ii) self-reporting illegal drug injection in the previous year; (iii) Iranian citizenship; (iv) residing in the surveyed cities, and (v) providing a valid referral coupon consistent with the study methodology in the 2020 survey. Participants received a monetary incentive for the interview and HIV test in all three surveys and additional incentives for every successful peer referral in the 2020 survey.

Behavioral Data Collection and HIV Testing

A group of trained staff collected the data using a standard behavioral questionnaire and through face-to-face interviews in a private room at each study site. The study questionnaire consisted of sections on demographic characteristics, drug use and injection-related behaviors, sexual practices, history of substance use treatment, and other utilization of harm reduction services. After providing verbal consent and completing the interview, participants received HIV pre-test counselling and consenting PWID were tested for HIV. As rapid HIV testing was unavailable during the 2010 and 2014 surveys, HIV serostatus was estimated using the dried blood spot (DBS) technique. DBS samples were assessed for HIV antibodies by ELISA using a bioMérieux Vironostika Uni-Form II Ag/Ab kit. All positive samples and 10% of the negative samples were rechecked by a Bio-Rad Genscreen Plus HIV Ag-Ab kit. In the 2020 survey, HIV testing was performed by SD-Bioline, South Korea rapid test, and if reactive, confirmed by Unigold HIV rapid test.

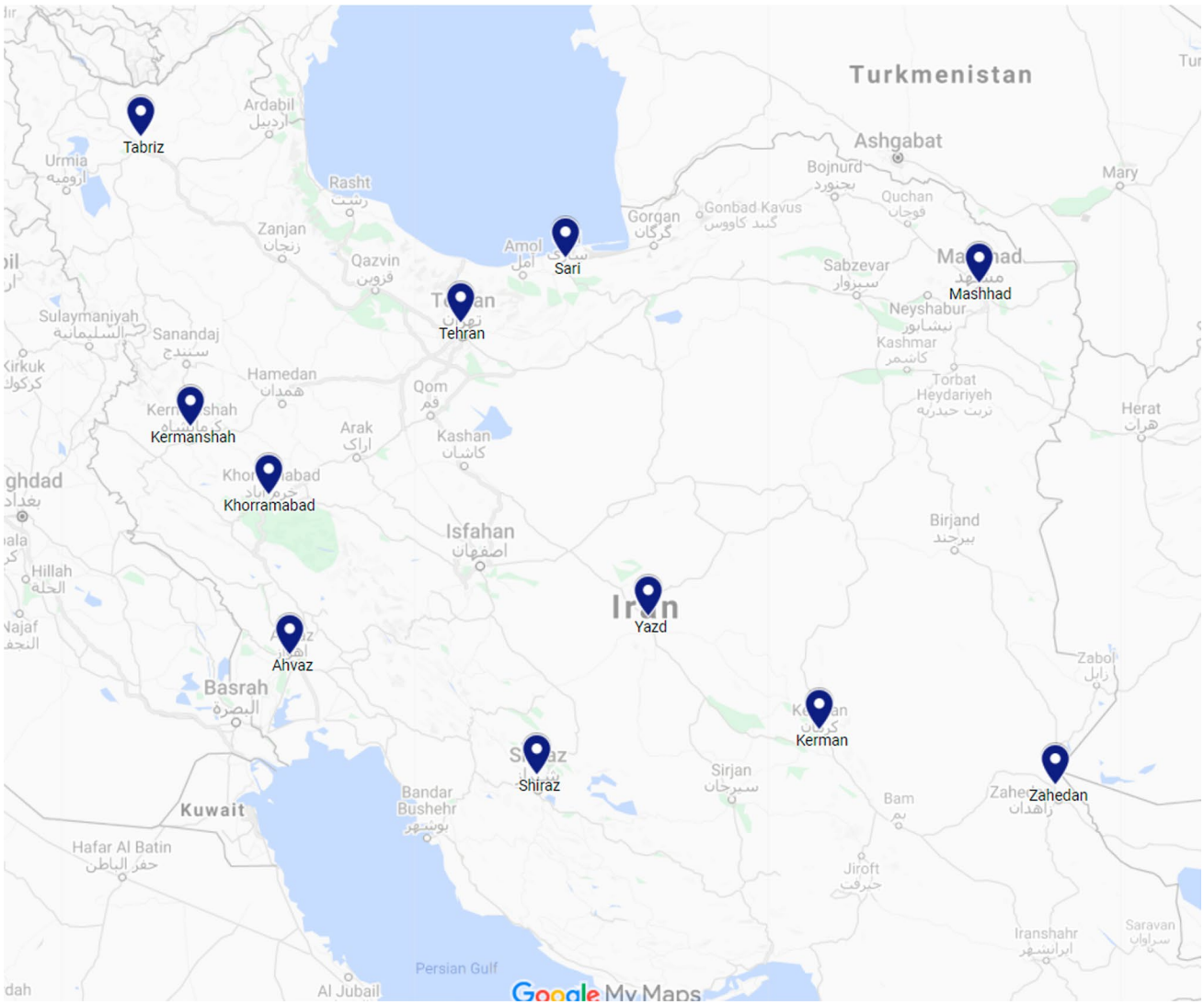

Fig. 1 Cities included in the fourth round of bio-behavioral surveillance survey of people who inject drugs in Iran, 2020

Variables

The primary outcome across all surveys was HIV seropositivity status (positive or negative). We examined correlates of HIV with socio-demographic, structural, and injection-related variables. Socio-demographic variables included age at interview (< 30, or ≥ 30 years old), sex (male or female), educational level (≤ high school or > high school), marital status (single, currently married or divorced/widowed), and employment (having a permanent job, having a temporary job or unemployed). Environmental and structural variables included homelessness (never, yes, before the last 12 months or yes, within the last 12 months) and incarceration history (never, yes, before the last 12 months or yes, within the last 12 months). Individual-related variables included age at first drug use (< 15, 15–19, 20–24 or ≥ 25 years old), length of injecting career (< 5, 5–10 or > 10 years), primary drug injected (opioids or stimulants), daily injection (yes or no), public injecting (yes or no), receptive needle/syringes sharing (yes or no), and unprotected sex (yes or no). Harm reduction service usage variables also included receipt of free needles/syringes (yes or no), free condoms (yes or no), and being on OAT (yes or no). All behavioral variables referred to activities in recent months unless otherwise specified. However, the definition of recent differed across the surveys for certain variables (i.e., daily injection, public injecting, and receptive needle/syringes sharing), varying from last month to the last 12 months.

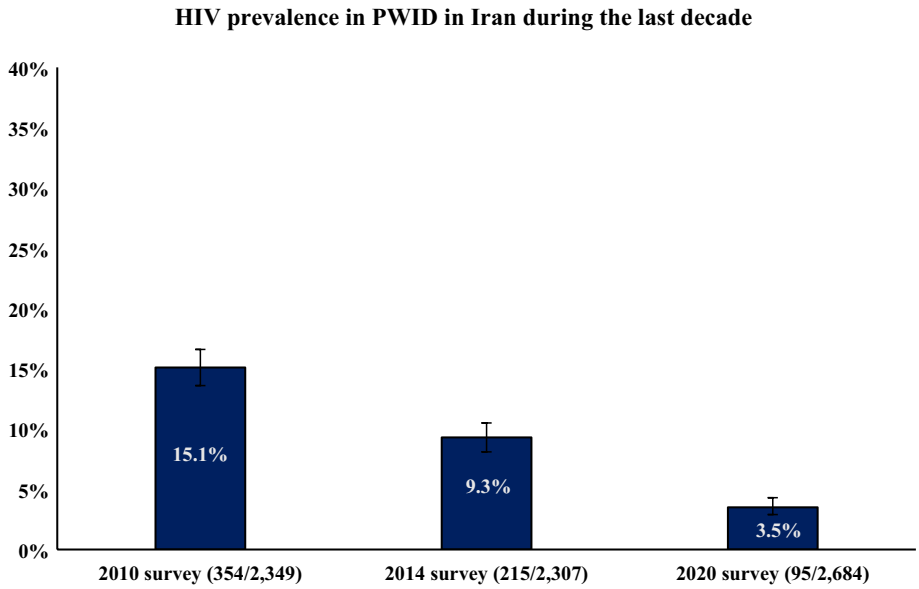

Fig. 2 HIV prevalence among people who inject drugs in Iran recruited in 2010, 2014, and 2020 bio-behavioral surveillance surveys. Values in the bar charts indicate prevalence, values in the labels indicate (n/N), which is (People living with HIV/total population)

Statistical Analysis

We calculated and reported descriptive statistics and frequencies along with 95% confidence intervals (CI) for HIV prevalence, socio-demographic characteristics, risk behaviors, and harm reduction service utilization in all three surveys. HIV prevalence was compared across subgroups of independent variables using the χ^2 test. Bivariable and multivariable logistic regression models were built to identify the significant correlates of HIV seropositivity among PWID for the survey in 2020. The inclusion of individual and environmental risk factors for HIV in the multivariable analysis was guided by the HIV risk environment framework [22, 23]. We constructed the multivariable regression model in four stages [20, 24]. The first multivariable model was performed for socio-demographic variables. The second model included environmental variables, including homelessness and incarceration history. In the third model, we conducted a multivariable model for individual risk factors. Variables with a significant p-value in each model were included in the final multivariable regression model. Stata v.15 (StataCorp, College Station, Texas, USA) was used to analyze the data, and p-values < 0.05 were considered statistically significant throughout. Given the lack of consensus on the validity of weighted regression models, unweighted regression models were performed to avoid error rate, have better coverage, increase accuracy, and avoid biased results arising from the RDS weighted analyses [25]. The RDS unweighted regression has been supported by the growing body of literature [26, 27]. Despite this, we also reported RDS-adjusted estimates for HIV prevalence, overall and in subgroups of PWID recruited in the 2020 survey, which considered network size and homophily within networks. RDS-adjusted estimates for HIV prevalence were calculated in RDS-Analyst.

Ethical Considerations

Ethical issues included the guarantee of the participants' confidentiality using anonymous questionnaires and obtaining verbal informed consent for both biological and behavioral data collection procedures. Participants' refusal to take part in the study did not affect their access to healthcare services in any manner. The survey protocols were reviewed and approved by the Kerman University of Medical Sciences ethics committee (Ethics Codes: IR.KMU.REC.597, IR.KMU.REC.93.205, and IR.KMU.REC.1397.573; IR.NIMAD.REC.1398.029).

Results

HIV Prevalence

After removal of missing data on the outcome measure, the analytic sample included 2,349 participants in 2010, 2,307 in 2014, and 2,684 in 2020. Overall, HIV prevalence was 15.1% (95% CI 13.6, 16.6) in 2010, 9.3% (95% CI 8.1, 10.5) in 2014, and 3.5% (95% CI 2.9, 4.3) in 2020 (Fig. 2).

Participants Characteristics and Risk Behaviors Over Time

Participants in the 2010 survey were younger than those in the 2014 and 2020 surveys (mean age = 34.5, 36.8, and 40.2, respectively). While most PWID were male across surveys,

the proportion of female participants slightly increased (2.2%, 2.5%, and 3.3%). The proportion of participants with divorced/widowed marital status (21.8%, 24.7%, and 38.3%), and a permanent job (2.2%, 14.8%, and 17.8%) also increased. The prevalence of 10+ years of injecting career (30.4%, 45.6%; and 49.4%), injecting opioids as the primary drug (74.2% and 77.9%), daily injection (26.3% and 50.5%), and public injecting (32.6%, 26.9%, and 69.6%) increased. However, the proportion of participants who reported receptive needle/syringe sharing (25.2%, 10.4%, and 3.9%), unprotected sex (79.4%, 67.9%, and 65.2%), and a history of incarceration decreased (78.2%, 76.5%, and 66.1%). While an increase was observed in the uptake of free needles/syringes (68.8%, 57.4%, and 87.9%), uptake of free condoms remained stable across the surveys (34.3%, 36.1%, and 32.6%), and a downward trend was observed for PWID who reported being on OAT (35.6%, 37.6%, and 25.0%) (Table 1).

Factor Associated with HIV

In 2010, HIV prevalence was significantly higher among PWID who were ≥ 30 years (17.5% vs. 10.1%; $\chi^2 = 22.770$, $p = 0.023$), had ≤ high school education (15.6% vs. 4.5%; $\chi^2 = 9.724$, $p = 0.013$), been ever incarcerated (16.5% vs. 9.3%; $\chi^2 = 16.272$, $p = 0.014$), injected drugs for 10+ years (21.7% vs. 10.3% for < 5 years; $\chi^2 = 39.622$, $p = 0.011$), not engaged in unprotected sex in the last year (20.8% vs. 11.1%; $\chi^2 = 17.755$, $p = 0.005$), and received free condoms (17.8% vs. 13.6%; $\chi^2 = 7.295$, $p = 0.030$). In 2014, HIV prevalence was significantly higher among PWID who were older than 30 years (10.5% vs. 4.7%; $\chi^2 = 15.164$, $p < 0.001$), were female compared to males (24.1% vs. 8.9%; $\chi^2 = 15.459$, $p < 0.001$), were single compared to married (13.9% vs. 4.3%; $\chi^2 = 53.713$, $p < 0.001$), had a temporary job compared to permanent job (10.8% vs. 3.8%; $\chi^2 = 15.275$, $p < 0.001$), been ever incarcerated (10.1% vs. 6.6%; $\chi^2 = 5.989$, $p = 0.014$), initiated drug use between 15 to 19 years old (11.0% vs. 5.5% for ≥ 25 years; $\chi^2 = 9.563$, $p = 0.023$), injected drugs for 10+ years (14.4% vs. 2.2% for < 5 years; $\chi^2 = 65.593$, $p < 0.001$), primarily injected opiates in the last month (10.2% vs. 5.5%; $\chi^2 = 8.802$, $p = 0.003$), reported daily injection in the last month (14.1% vs. 7.7%; $\chi^2 = 21.482$, $p < 0.001$), reported receptive needle/syringe sharing in the last month (18.1% vs. 8.4%; $\chi^2 = 23.394$, $p < 0.001$), received free needles/syringes in the last year (10.1% vs. 7.3%; $\chi^2 = 5.433$, $p = 0.020$), and were on OAT (11.3% vs. 8.1%; $\chi^2 = 6.379$, $p = 0.012$) (Table 2).

In 2020, HIV prevalence was significantly higher among PWID who were older than 30 years (3.9% vs. 1.0%; $\chi^2 = 6.258$, $p = 0.012$), experienced homelessness (5.7% vs. 2.2% for never experienced homelessness; $\chi^2 = 12.160$, $p = 0.002$), been incarcerated before the previous year (4.7% vs. 1.3% for never incarcerated; $\chi^2 = 18.844$, $p < 0.001$), injected for 10+ years (5.6% vs. 1.2% for < 5 years; $\chi^2 = 34.773$, $p < 0.001$), and not engaged in unprotected sex in the last 3 months (4.8% vs. 2.6%; $\chi^2 = 6.222$, $p = 0.013$) (Table 3). The final multivariable logistic regression model for the 2020 survey showed that HIV seropositivity was significantly associated with homelessness (AOR 2.10, 95% CI 1.11, 3.95; $p = 0.021$), incarceration (AOR 2.66, 95% CI 1.33, 5.32; $p = 0.006$), and having a longer injecting career (AOR 3.27, 95% CI 1.50, 7.14; $p = 0.003$) (Table 4).

Discussion

Our results suggest that the prevalence of HIV has declined among PWID recruited in the three consecutive bio-behavioral surveillance surveys in Iran. A decline was also observed in the prevalence of receptive needle/syringe sharing and unprotected sex. There was also an increase in uptake of free needles/syringes. However, the proportion of those who reported daily injection and public injecting has increased. Our final multivariable analysis based on the 2020 survey showed that homelessness, incarceration, and longer injecting careers were significantly associated with HIV seropositivity.

The decline in HIV prevalence could be associated with several factors and should be interpreted with caution. While we employed comparable eligibility criteria and recruited participants from the same harm reduction facilities across the surveys, PWID were recruited using a convenience sampling method in 2010 and 2014 and RDS in 2020, leading to potentially heterogeneous populations being recruited in different rounds. Although a decline in HIV prevalence may suggest a decrease in HIV incidence among PWID in Iran [28], it could also be partly associated with the high mortality rate among people living with HIV in Iran. Indeed, data from the National HIV/AIDS Case Registry System suggests that the survival rate of people living with HIV was 67% for 10 years, and by June 2016, 25.1% of registered people living with HIV had died due to AIDS-related diseases [29]. While the availability of antiretroviral therapy has increased in recent years, its coverage is insufficient (e.g., only 25% of people living with HIV in Iran had received antiretroviral therapy by the end of 2019) [30].

The decline in HIV prevalence could also be partly related to the expansion of HIV-related harm reduction programs across the country. During the last 10 years, Iran has implemented diverse harm reduction programs for PWID, and the coverage of prevention programs has expanded over time. These harm reduction programs include NSP, OAT, behavioral counseling for PWID and their sexual partners,

Table 1 Socio-demographic characteristics, risk behaviors, and harm reduction services utilization of people who inject drugs surveyed in Iran, 2010–2020

Variables	2010 survey % (95% CI)	2014 survey % (95% CI)	2020 survey % (95% CI)
Total number of participants	2349	2307	2684
Socio-demographics			
Mean [SD] age, year	34.5 (8.9)	36.8 (8.9)	40.2 (9.2)
Age group			
< 30	33.2 (29.3, 37.2)	21.2 (19.5, 22.8)	11.2 (10.0, 12.4)
≥ 30	66.8 (62.6, 70.5)	78.8 (77.1, 80.4)	88.8 (87.5, 89.9)
Sex			
Male	97.8 (96.2, 98.7)	97.5 (96.7, 98.0)	96.7 (95.8, 97.2)
Female	2.2 (1.2, 3.7)	2.5 (1.9, 3.2)	3.3 (2.7 4.1)
Education			
≤ High school	95.4 (93.2, 96.8)	95.5 (94.5, 96.2)	94.9 (93.9, 95.6)
> High school	4.6 (3.0, 6.6)	4.5 (3.7, 5.4)	5.1 (4.3, 6.0)
Current marital status			
Single	45.8 (41.8, 49.8)	48.1 (46.0, 50.1)	36.6 (34.7, 38.5)
Married	32.4 (28.3, 36.7)	27.2 (25.4, 29.0)	25.0 (23.3, 26.7)
Divorced/widowed	21.8 (18.8, 25.0)	24.7 (22.9, 26.5)	38.3 (36.4, 40.2)
Current employment			
Having a permanent job	2.2 (1.4, 3.4)	14.8 (13.3, 16.3)	17.8 (16.3, 19.5)
Having a temporary job	68.4 (62.0, 74.2)	55.4 (53.3, 57.4)	79.6 (77.8, 81.2)
Unemployed	29.3 (23.5, 35.7)	29.8 (27.9, 31.6)	2.5 (1.9, 3.2)
Incarceration history			
Never	21.8 (18.3, 25.8)	23.5 (21.7, 25.2)	33.9 (32.1, 35.7)
Ever	78.2 (74.2, 81.7)	76.5 (74.7, 78.2)	66.1 (64.2, 67.8)
Risk behaviors			
Age at first drug use, years			
< 15	18.7 (15.5, 22.4)	17.5 (16.0, 19.1)	10.2 (9.0 11.4)
15–19	45.7 (41.8, 49.6)	47.0 (44.9, 49.0)	48.5 (46.5, 50.4)
20–24	23.3 (19.9, 27.1)	22.7 (20.9, 24.4)	27.1 (25.4, 28.9)
≥ 25	12.3 (9.7, 15.3)	12.8 (11.4, 14.1)	14.2 (12.8, 15.6)
Length of injecting career, years			
< 5	36.8 (32.4, 41.4)	22.4 (20.7, 24.2)	25.7 (24.0, 27.4)
5–10	32.8 (29.8, 35.9)	32.0 (30.0, 33.9)	24.9 (23.2, 26.6)
> 10	30.4 (26.5, 34.6)	45.6 (43.5, 47.6)	49.4 (47.4, 51.3)
Primary drug injected[a]			
Opioids	–	74.2 (72.0, 76.2)	77.9 (75.9, 79.7)
Stimulants		25.8 (23.7, 27.9)	22.1 (20.2, 24.0)
Daily injection[a]			
No	–	73.7 (71.8, 75.5)	49.5 (47.5, 51.4)
Yes		26.3 (24.4, 28.1)	50.5 (48.5, 52.4)
Public injecting[b]			
No	67.4 (59.9, 74.2)	73.1 (37.2, 43.3)	30.4 (28.5, 32.2)
Yes	32.6 (25.8, 40.1)	26.9 (25.0, 28.7)	69.6 (67.7, 71.4)
Receptive needle/syringe sharing[c]			
No	74.8 (67.3, 81.1)	89.6 (88.2, 90.8)	96.1 (95.2, 96.8)
Yes	25.2 (18.9, 32.7)	10.4 (9.1, 11.7)	3.9 (3.1, 4.7)
Unprotected sex[c]			
No	20.6 (16.5, 25.4)	32.1 (30.0, 34.2)	34.8 (32.6, 36.9)
Yes	79.4 (74.6, 83.5)	67.9 (65.7, 69.9)	65.2 (63.0, 67.3)
Harm reduction service utilization			
Received free needles/syringes[d]			

Table 1 (continued)

Variables	2010 survey % (95% CI)	2014 survey % (95% CI)	2020 survey % (95% CI)
No	31.2 (23.6, 39.9)	42.6 (40.5, 44.6)	12.1 (10.7, 13.6)
Yes	68.8 (60.0, 76.3)	57.4 (55.3, 59.4)	87.9 (86.3, 89.3)
Received free condoms[d]			
No	65.7 (60.3, 70.7)	63.9 (61.8, 65.8)	67.4 (65.1, 69.5)
Yes	34.3 (29.3, 39.7)	36.1 (34.1, 38.1)	32.6 (30.4, 34.8)
Currently on opioid agonist therapy			
No	64.4 (53.9, 74.0)	62.4 (60.3, 64.3)	75.0 (73.2, 76.6)
Yes	35.6 (26.4, 46.1)	37.6 (35.6, 39.6)	25.0 (23.3, 26.7)

[a]Last month in 2014, last 3 months in 2020

[b]Last month in 2010 and 2014, last 12 months in 2020

[c]Last month in 2010, and 2014, last 3 months in 2020

[d]Last 12 months in all survey rounds

and HIV testing and counseling [17, 31]. Our results showed that while receptive needle/syringe sharing has decreased over time, uptake of free-of-charge needles/syringes has increased from 57% to 87%. Reduction in the prevalence of HIV and risk behaviors which is coincident with increased harm reduction services utilization, have also been reported in other international settings [32, 33]. However, adequate availability of harm reduction services is only part of the wider risk environment framework that helps reduce HIV acquisition risk and lower HIV new infections [23, 24].

Despite the expansion of harm reduction interventions across Iran and increased uptake of services among PWID in the past decade, several limitations exist and need to be addressed. First, despite the increasing number of female PWID, they are disproportionately under-represented in harm reduction service provision in Iran. Studies suggest that while women include almost 10% of people who use drugs in Iran, the proportion of female and male individuals who use the addiction treatment services in Iran is 1 in 17 [17, 34]. The high level of stigma and male-dominant treatment services have been proposed as potential contributors to the lower representation of females in these treatment services [35, 36]. While women-only drug treatment and harm reduction services have been developed to address women's specific needs, these centers are primarily located in Tehran, the country's capital, and women face multiple barriers to entering treatment and using these services [37, 38]. The expansion and development of these services is required to address female PWID's specific needs and implement other strategies to effectively reach and engage women in HIV prevention and drug treatment programs. Second, the increasing prevalence of public injecting in the past decade calls for novel and innovative interventions (e.g., supervised injection facilities) to be introduced to care provision to help reduce high-risk injection practices [39]. The integration of this service into Iran's harm reduction programs is indeed supported by a high willingness of Iranian PWID to use the service and could help reduce harms among PWID [20].

Our multivariable analysis showed that the length of injecting career and environmental adversities, such as incarceration and homelessness experienced by PWID increased the odds of HIV seropositivity. The link between the duration of injecting and increased odds of HIV indicates how cumulative exposures to high-risk practices or exposures makes PWID more vulnerable to HIV acquisition [40, 41]. The association of HIV with incarceration and homelessness has also been supported by a body of international evidence. For example, a global systematic review associated incarceration with an 81% greater risk of HIV acquisition among PWID and highlighted the importance of decriminalizing drugs [42]. Additionally, it is estimated that in comparison to PWID with stable housing, homeless or unstably housed PWID are 1.5 times more likely to acquire HIV [43]. Indeed, PWID experiencing homelessness experience multiple adversities [43–45], such as unemployment, food insecurity, and incarceration. They are also more likely to be involved in high-risk injection and sexual behaviors, and therefore, less likely to access and utilize harm reduction services [43, 46]. Addressing homelessness among PWID is a complex issue requiring context-specific multi-layered social and political interventions. However, programs such as Housing First, have shown promise in improving health, well-being, social integrations, reduction in drug use, and encounter with the criminal justice system among marginalized PWID in high-income settings and could also be a viable option for low- and middle-income countries, including Iran [47, 48].

Limitations

We acknowledge the limitations of this study. First, behavioral data were collected through face-to-face

Table 2 HIV prevalence overall and in subgroups of people who inject drugs and were recruited in the three rounds of the bio-behavioral surveys in Iran, 2010–2020

Variables	2010			2014			2020			
	Total N	HIV prevalence % (95% CI)	χ^2, p-value	Total N	HIV prevalence % (95% CI)	χ^2, p-value	Total N	HIV prevalence		χ^2, p-value
								% (95% CI)	RDS-adjusted % (95% CI)	
Overall	2349	15.1 (13.6, 16.6)	–	2307	9.3 (8.1, 10.5)	–	2684	3.5 (2.9, 4.3)	3.1 (1.8, 4.4)	–
Age group			22.770, 0.023			15.164, < 0.001				6.258, 0.012
< 30	783	10.1 (5.7, 17.1)		484	4.7 (3.1, 7.0)		294	1.0 (0.2, 2.9)	0.3 (0.1, 0.7)	
≥ 30	1560	17.5 (10.9, 27.0)		1821	10.5 (9.2, 12.0)		2337	3.9 (3.1, 4.7)	3.5 (2.0, 4.9)	
Sex			0.245, 0.716			15.459, < 0.001				0.474, 0.491
Male	2290	15.2 (9.7, 23.1)		2249	8.9 (7.8, 10.1)		2564	3.6 (2.9, 4.4)	3.5 (2.1, 4.9)	
Female	59	10.2 (3.8, 27.7)		58	24.1 (14.6, 37.1)		89	2.2 (0.2, 7.8)	1.0 (0.1, 2.1)	
Education			9.724, 0.013			0.868, 0.351				0.353, 0.552
≤ High school	2251	15.6 (9.8, 23.7)		2201	9.4 (8.2, 10.7)		2503	3.5 (2.7, 4.2)	2.8 (1.7, 3.9)	
> High school	96	4.5 (1.4, 13.6)		104	6.7 (3.2, 13.6)		135	4.4 (1.6, 9.4)	2.7 (0.1, 5.3)	
Marital status			4.615, 0.330			53.713, < 0.001				5.217, 0.074
Single	1110	15.5 (9.9, 23.2)		1107	13.9 (11.9, 16.0)		936	3.0 (1.9, 4.2)	3.1 (0.6, 5.5)	
Currently married	737	13.0 (7.0, 22.8)		627	4.3 (2.9 6.2)		640	2.2 (1.2, 3.6)	1.6 (0.2, 2.9)	
Divorced/widowed	502	17.3 (10.8, 26.5)		569	6.0 (4.2, 8.2)		980	4.2 (3.0, 5.6)	3.1 (1.2, 4.9)	
Employment			6.706, 0.190			15.275, < 0.001				3.223, 0.200
Permanent job	45	6.4 (1.4, 24.3)		339	3.8 (2.2, 6.5)		392	1.7 (0.7, 3.6)	0.9 (0.2, 2.1)	
Temporary job	1601	14.3 (9.0, 21.9)		1270	10.8 (9.1, 12.6)		1744	3.5 (2.7, 4.5)	3.0 (1.6, 4.2)	
Unemployed	693	17.4 (10.4, 27.8)		628	9.4 (7.4, 11.8)		55	3.6 (0.4, 12.5)	2.0 (1.2, 5.2)	
Incarceration history			16.272, 0.014			5.989, 0.014				18.556, < 0.001
Never	499	9.3 (4.4, 18.4)		541	6.6 (4.8, 9.0)		889	1.3 (0.6, 2.3)	0.9 (0.1, 1.6)	
Ever	1841	16.5 (10.7, 24.7)		1763	10.1 (8.8, 11.6)		1731	4.6 (3.6, 5.7)	4.0 (2.2, 5.8)	
Age at first drug use			9.783, 0.313			9.563, 0.023				2.162, 0.539
< 15	398	15.4 (9.6, 23.6)		402	8.0 (5.6, 11.0)		250	4.4 (2.2, 7.7)	7.9 (0.3, 15.9)	
15–19	1103	13.0 (8.6, 19.0)		1077	11.0 (9.2, 12.9)		1191	3.4 (2.4, 4.6)	2.0 (1.0, 3.1)	
20–24	533	18.8 (10.4, 31.6)		519	8.9 (6.6, 11.6)		666	3.1 (1.9, 4.7)	2.4 (0.8, 3.9)	
≥ 25	287	13.9 (6.2, 27.8)		292	5.5 (3.3, 8.7)		348	2.3 (0.9, 4.4)	1.6 (0.3, 2.9)	
Length of injecting career			39.622, 0.011			65.593, < 0.001				34.773, < 0.001
< 5	856	10.3 (6.0, 17.2)		510	2.2 (1.1, 3.8)		655	1.2 (0.5, 2.3)	0.4 (0.1, 0.6)	
5–10	737	13.6 (8.2, 21.7)		727	7.3 (5.6, 9.4)		635	1.4 (0.6, 2.6)	1.4 (0.2, 2.6)	
> 10	680	21.7 (13.1, 33.7)		1036	14.4 (12.3, 16.6)		1260	5.6 (4.3, 6.9)	5.3 (2.7, 7.9)	
Primary drug injected						8.802, 0.003				2.058, 0.151
Opioids	–	–		1257	10.2 (8.6, 11.9)		1410	4.0 (3.0, 5.2)	3.6 (1.8, 5.4)	
Stimulants	–	–		438	5.5 (3.6, 8.0)		399	2.5 (1.2, 4.5)	1.3 (0.5, 2.1)	
Daily injection						21.482, < 0.001				3.268, 0.071
No	–	–		1685	7.7 (6.5, 9.0)		1259	2.9 (2.0, 4.0)	2.1 (0.8, 3.5)	

Table 2 (continued)

Variables	2010			2014			2020			
	Total N	HIV prevalence % (95% CI)	χ^2, p-value	Total N	HIV prevalence % (95% CI)	χ^2, p-value	Total N	HIV prevalence		χ^2, p-value
								% (95% CI)	RDS-adjusted % (95% CI)	
Yes	–	–		601	14.1 (11.5, 17.1)		1286	4.3 (3.2, 5.5)	3.9 (1.9, 5.9)	
Public injecting			18.408, 0.072			1.109, 0.292				0.436, 0.509
No	1533	12.9 (8.6, 18.9)		1674	9.0 (7.6, 10.4)		725	3.6 (2.3, 5.2)	1.5 (0.9, 2.1)	
Yes	810	19.7 (10.7, 33.5)		615	10.4 (8.2, 13.0)		1663	3.1 (2.2, 4.0)	2.7 (1.3, 4.1)	
Receptive needle/syringe sharing			4.880, 0.171			23.394, < 0.001				0.079, 0.778
No	1732	14.1 (9.0, 21.5)		2048	8.4 (7.2, 9.6)		2277	2.8 (2.1, 3.5)	2.5 (1.3, 3.6)	
Yes	606	17.9 (10.3, 29.3)		238	18.1 (13.6, 23.5)		92	3.3 (0.6, 9.2)	1.3 (0.1, 2.5)	
Unprotected sex			17.755, 0.005			1.686, 0.194				6.222, 0.013
No	275	20.8 (11.1, 35.5)		620	7.4 (5.5, 9.7)		662	4.8 (3.3, 6.7)	4.3 (1.5, 7.1)	
Yes	1031	11.1 (7.0, 17.1)		1311	5.9 (4.7, 7.2)		1243	2.6 (1.8, 3.7)	1.5 (0.7, 2.2)	
Received free-needles/syringes			17.081, 0.170			5.433, 0.020				3.979, 0.046
No	704	10.6 (5.9, 17.9)		959	7.3 (5.8, 9.1)		240	1.7 (0.4, 4.2)	3.7 (1.7, 9.0)	
Yes	1629	17.2 (10.0, 27.8)		1293	10.1 (8.5, 11.9)		1738	4.4 (3.4, 5.4)	4.0 (2.3, 5.6)	
Received free condoms			7.295, 0.030			0.000, 0.982				0.002, 0.960
No	1554	13.6 (8.8, 20.5)		1452	9.3 (7.9, 10.9)		1203	4.1 (3.0, 5.3)	3.9 (0.7, 7.1)	
Yes	782	17.8 (10.5, 28.5)		820	9.3 (7.4, 11.4)		582	4.1 (2.6, 6.0)	4.1 (2.0, 6.2)	
Currently on opioids agonist therapy			24.870, 0.231			6.379, 0.012				0.092, 0.760
No	1626	12.3 (8.2, 17.9)		1435	8.1 (6.8, 9.6)		1941	3.7 (2.8, 4.5)	2.8 (1.6, 4.0)	
Yes	701	20.0 (8.8, 39.0)		866	11.3 (9.3, 13.6)		647	3.4 (2.1, 5.1)	3.2 (0.1, 6.4)	

Table 3 Adjusted and unadjusted ORs for environmental and individual factors associated with HIV infection among people who inject drugs in 2020 national bio-behavioral survey in Iran

Variables	2020						
	Total N	HIV prevalence %	χ^2, p-value	Crude OR	p-value	Adjusted OR[a]	p-value
Overall	2684	3.5					
Model 1: Socio-demographics							
Age group			6.258, 0.012				
< 30	294	1.0		Ref		Ref	
≥ 30	2337	3.9		3.93 (1.23, 12.49)	0.020	3.34 (1.02, 10.90)	0.045
Marital status			5.217, 0.074				
Single	936	3.0		Ref		Ref	
Currently married	640	2.2		0.72 (0.37, 1.38)	0.332	0.62 (0.32, 1.21)	0.166
Divorced/widowed	980	4.2		1.41 (0.86, 2.30)	0.163	1.21 (0.73, 1.99)	0.447
Model 2: Environmental factors							
Homelessness			12.160, 0.002				
Never	1143	2.2		Ref		Ref	
Yes, before the last 12 months	352	5.7		2.69 (1.47, 4.91)	0.001	2.18 (1.18, 4.04)	0.013
Yes, within the last 12 months	1137	4.1		1.92 (1.17, 3.15)	0.009	1.67 (1.01, 2.77)	0.046
Incarceration history			18.844, < 0.001				
Never	889	1.3		Ref		Ref	
Yes, before the last 12 months	1438	4.7		3.62 (1.95, 6.73)	< 0.001	3.40 (1.77, 6.52)	< 0.001
Yes, within the last 12 months	293	4.1		3.12 (1.38, 7.02)	0.006	2.97 (1.28, 6.86)	0.011
Model 3: Individual factors							
Length of injecting career			34.773, < 0.001				
< 5	655	1.2		Ref		Ref	
5–10	635	1.4		1.16 (0.44, 3.03)	0.758	1.71 (0.40, 7.24)	0.466
> 10	1260	5.6		4.75 (2.27, 9.94)	< 0.001	6.74 (2.04, 22.20)	0.002
Primary drug injected			2.058, 0.151				
Opioids	1410	4.0		1.63 (0.82, 3.23)	0.155	2.33 (0.98, 5.46)	0.054
Stimulants	399	2.5		Ref		Ref	
Daily injection			3.268, 0.071				
No	1259	2.9		Ref		Ref	
Yes	1286	4.3		1.47 (0.96, 2.25)	0.072	1.37 (0.67, 2.78)	0.378
Unprotected sex			6.222, 0.013				
No	622	4.8		Ref		Ref	
Yes	1243	2.6		0.53 (0.32, 0.88)	0.014	0.58 (0.31, 1.09)	0.091

[a]Using multivariable logistic regression, variables with a p-value < 0.2 in the bivariable analysis were entered into three separate multivariable analyses for socio-demographic, environmental, and individual factors

interviews, which may be subject to social desirability and under-reporting biases. We employed gender-matched experienced interviewers and trained them to help address this concern. Second, participants were not followed up over time, and they were recruited with different sampling strategies; therefore, variation between the studies' findings could be partly due to divergent selection of PWID subgroups. Third, differences across studies measuring recent timeframe for some behavioral variables could have introduced bias to the findings. Harmonizing the surveillance survey methodologies and using comparable sampling design and questionnaire is recommended. Fourth, although efforts were made to enroll PWID from diverse geographical areas, these samples may not represent PWID in all areas of the country as participants

Table 4 Factor associated with HIV seropositivity among people who inject drugs recruited in 2020 national bio-behavioral surveillance survey in Iran

Variables	Final model[a]		
	Adjusted OR	95% CI	p-value
Age group			
< 30	Ref		
≥ 30	1.20	0.35, 4.15	0.763
Homelessness			
Never	Ref		
Yes, before the last 12 months	2.10	1.11, 3.95	0.021
Yes, within the last 12 months	1.50	0.89, 2.54	0.123
Incarceration history			
Never	Ref		
Yes, before the last 12 months	2.66	1.33, 5.32	0.006
Yes, within the last 12 months	2.16	0.89, 5.25	0.087
Length of injecting career			
< 5 years	Ref		
5–10 years	0.92	0.35, 2.43	0.875
> 10 years	3.27	1.50, 7.14	0.003

[a] Variables with P-value < 0.05 from Models 1–3 were included in the final regression model

were recruited from the major cities of the most populated provinces. Lastly, the study's design was cross-sectional, reducing the ability to infer causality from the observed associations.

Conclusion

HIV prevalence and related risk behaviors have declined among PWID in Iran during the past decade. Although the decrease in HIV prevalence and risk behaviors is promising, HIV prevalence remained considerably high among specific subgroups of PWID. There is still plenty of room for improvement to achieve public health goals, such as moving towards no new cases of HIV. Indeed, future HIV outbreaks among PWID in Iran are highly likely and continuous surveillance and investments in HIV prevention and harm reduction programs are warranted. Moreover, since structural factors appear to significantly contribute to HIV acquisition among PWID in Iran, developing upstream interventions aimed at tackling these inequities are strongly recommended.

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Author Contributions HSH, MKH, MSH, AM, MK, and AAH conceptualized the study and developed the study conception and design. Material preparation and data collection were performed by HSH, AAH, PAK, NG, FT, GM, SM, and MKH. HSH and MK supervised the study implementation and data collection. MKH performed the data analysis and drafted the manuscript. All authors reviewed and revised the initial draft and approved the final version of the manuscript.

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Data Availability Data are owned by the MoHME of Iran and are available from the HIV/STI office located at Iran's MoHME (E-mail: aids@behdasht.gov.ir; Tel: +98-21-81455055) for researchers who meet the criteria for access to confidential data. The authors of this research were the implementers of the survey and had access to the data with permission obtained from the MoHME's HIV/STI office.

Declarations

Conflict of interest PAK was the head of HIV/STI office at Iran's MoHME during the last round of the bio-behavioural surveillance survey. Other authors confirm they have no potential conflicts of interest to declare.

Ethical Approval Ethical issues included the guarantee of the participants' confidentiality using anonymous questionnaires tools and obtaining verbal informed consent for both biological and behavioral data collection procedures. Participants' refusal to take part in the study did not affect their access to healthcare services in any manner. The survey protocols were reviewed and approved by the Kerman University of Medical Sciences ethics committee (Ethics Codes: IR.KMU.REC.597, IR.KMU.REC.93.205, and IR.KMU.REC.1397.573; IR.NIMAD.REC.1398.029).

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