


# Spatial heterogeneity of risk factors associated with HIV prevalence among men who inject drugs in India

## An analysis of the data from the integrated bio-behavioral surveillance, India

Santhakumar Aridoss, MSW, MPhil<sup>a</sup>, Joseph K. David, PhD<sup>b</sup>, Nagaraj Jaganathasamy, MSc<sup>a</sup>, Malathi Mathiyazhakan, PhD<sup>a</sup>, Ganesh Balasubramanian, PhD<sup>a</sup>, Manikandan Natesan, PhD<sup>a</sup>, Padmapriya V.M., MDS<sup>a</sup>, Pradeep Kumar, BHMS<sup>c</sup>, Shobini Rajan, MD<sup>c</sup>, Elangovan Arumugam, MSc, MTech<sup>a,\*</sup> 

### Abstract

People who inject drugs (PWID) are India's third-largest vulnerable population to human immunodeficiency virus (HIV) infection. PWID in India are confined to certain geographic locations and exhibit varying injecting and sexual risk behaviors, contributing considerably to increasing HIV trends in specific regions. Spatial heterogeneity in risk factors among vulnerable PWID influences HIV prevalence, transmission dynamics, and disease management. Stratified analysis of HIV prevalence based on risk behaviors and geographic locations of PWID will be instrumental in strategic interventions. To stratify the male PWID based on their risk behaviors in each state and determine the HIV prevalence for each stratum. The behavioral data and HIV prevalence of the national integrated biological and behavioural surveillance (IBBS), a nationwide cross-sectional community-based study conducted in 2014 to 2015, was analyzed. Data from 19,902 men who inject drugs across 53 domains in 29 states of India were included. Women who inject drugs were excluded at the time of IBBS, and hence PWID in this study refers to only men who inject drugs. PWID were categorized based on their risk profile, and the corresponding HIV prevalence for each state was determined. HIV prevalence was the highest (29.6%) in Uttar Pradesh, with a high prevalence of risk behaviors among PWID. High HIV prevalence ranging between 12.1% and 22.4% was observed in a few states in East and North-East India and most states in central and North India. Unsafe injecting and sexual practices were significantly ( $P < .05$ ) associated with higher HIV prevalence and more significantly in National Capital Territory of Delhi ( $P < .001$ ). Unsafe injecting practices among PWID were proportionally higher in Western and Central India, whereas unsafe sexual behaviors were widespread among most states. Unsafe sexual practices among male PWID were common. The high prevalence of unsafe injecting had significant HIV infection and transmission risks in Western and Central India. The results emphasize the need for stratified, region-specific interventions and combination approaches for harm reduction among PWID. Strengthening the measures that facilitate the reduction of high-risk behaviors, adoption of safe practices, and utilization of HIV services will positively impact HIV prevention measures among PWID.

**Abbreviations:** AIDS = acquired immuno-deficiency syndrome, ART = antiretroviral therapy, HCV = hepatitis C virus, HIV = human immunodeficiency virus, HRG = high risk groups, IBBS = integrated biological and behavioral surveillance, NCT = national capital territory, PWID = people who inject drugs, STI = sexually transmitted diseases.

**Keywords:** drug users, HIV prevalence, India, people who inject drugs, risk behavior, spatial behavior

The corresponding author received funding from the National AIDS Control Organization (NACO, Government of India) extramural research grants for conducting the National Integrated Biological and Behavioral surveillance as Regional Institute (RI) for the above research study. NACO Grant No. T-11020/36/09-NACO (Surveillance).

The authors have no consent to disclose.

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

All respondents were informed about the details of the survey and the voluntary nature of the participation. Written informed consent was obtained through an informed consent form (ICF). The Institutional Ethical Committee approved the study of ICMR – National Institute of Epidemiology, Chennai. The approval number is NIE/IHEC/20138/04.

An earlier version of this manuscript was previously posted to researchsquare.com and can be found at <https://www.researchsquare.com/article/rs-89506/v1>.

<sup>a</sup> Scientist-G, Division of Computing and Information Science, ICMR-National Institute of Epidemiology, Chennai, Tamil Nadu, India, <sup>b</sup> Procrea Fertility Centre,

Vaughan, Ontario, Canada, <sup>c</sup> National AIDS Control Organisation, Department of Health & Family Welfare, Government of India, New Delhi, India.

\* Correspondence: Elangovan Arumugam, Scientist-G, Division of Computing and Information Science, ICMR-National Institute of Epidemiology, R-127, 2nd Main Road, TNHB, Ayapakkam, Chennai 600 077, Tamil Nadu, India (e-mail: [elangovan@nie.gov.in](mailto:elangovan@nie.gov.in)).

Copyright © 2022 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial License 4.0 (CCBY-NC), where it is permissible to download, share, remix, transform, and build upon the work provided it is properly cited. The work cannot be used commercially without permission from the journal.

How to cite this article: Aridoss S, David JK, Jaganathasamy N, Mathiyazhakan M, Balasubramanian G, Natesan M, V.M. P, Kumar P, Rajan S, Arumugam E. Spatial heterogeneity of risk factors associated with HIV prevalence among men who inject drugs in India: An analysis of the data from the integrated bio-behavioral surveillance, India. *Medicine* 2022;101:48(e31688).

Received: 14 June 2022 / Received in final form: 14 October 2022 / Accepted: 14 October 2022

<http://dx.doi.org/10.1097/MD.00000000000031688>

## 1. Introduction

Human immunodeficiency virus (HIV) prevalence in India is highly heterogeneous the disease burden, vulnerabilities, and risk behaviors vary across different populations and geographies. Female sex workers, men having sex with men, people who inject drugs (PWID), and transgender are considered high-risk groups (HRG) for HIV infection. In India, the initial HIV epidemic was concentrated in the states of South and North-eastern India, with most of the transmission occurring through the heterosexual route.<sup>[1]</sup> While the HIV epidemic in the Southern states is considered to have matured, the North-eastern states have shown a considerable increase in annual new HIV infections and HIV incidence since 2015.<sup>[2-5]</sup> This is attributed to the widely prevalent injecting drug use in the region, given its proximity to Myanmar.<sup>[6]</sup>

The estimated size of PWID in India was about 0.39 millions in 2019,<sup>[7]</sup> and recent reports suggest a higher incidence rate among PWID in the North and North-eastern regions than other HRGs.<sup>[4]</sup> The HIV prevalence among PWID in 2015 was 9.9%, and Uttar Pradesh had the highest prevalence at 29%.<sup>[2]</sup> In 2017, HIV prevalence among PWID was 6.26 %, and Mizoram had the highest prevalence of 19.8%.<sup>[8]</sup> In 2020, the North-eastern states reported the highest estimated adult HIV prevalence, with Mizoram recording 2.37%, followed by Nagaland (1.44%) and Manipur (1.15%).<sup>[5]</sup> Recent district-level HIV estimates also indicate that all districts with an adult HIV prevalence of 1% or more were concentrated in the North-eastern states.<sup>[9]</sup> These reports suggest that injecting drug use contributes significantly to the increase in HIV prevalence, thus placing injecting drug users (PWID) among India's third-largest vulnerable HIV population.

The transmission might occur at a much higher rate among PWID with risk behaviors resulting in confined disease transmission and clusters of high prevalence. Lack of awareness or adequate knowledge of HIV/acquired immuno-deficiency syndrome (AIDS), sexually transmitted diseases (STI) symptoms, unsafe injecting behaviors, and inconsistent condom usage are commonly associated with higher infection risk.<sup>[10]</sup> Among PWID, the structure and extent of sexual and injecting risk behaviors vary, resulting in subpopulations such as PWID with risk behaviors and PWID with safe practices. Identifying the heterogeneity of risk behaviors based on the geographical regions will be insightful in understanding the transmission dynamics and the underlying disease confinement. Such profiling will pave the way for improvised decentralized targeted interventions with profound effects on interventional outcomes. The integrated biological and behavioral surveillance (IBBS) conducted among HRGs in 2014 to 2015 serves as a significant source of behavioral data for PWID to date. With its behavioral components, the IBBS presents the actuality of risk profile and disease confinement at different geographical locations within India that affects the dynamics of HIV prevalence and transmission among PWID. This study aims to stratify the PWID population based on their risk behaviors in each state and determine the HIV prevalence for each stratum.

## 2. Methods

### 2.1. Study Design

This study analyses the behavioral and HIV prevalence data of the National IBBS. IBBS is a cross-sectional study conducted in 2014 to 2015 among PWID across 53 domains in 29 states of India.<sup>[2]</sup> A domain was the basic study unit in IBBS for which the bio-behavioral estimates were generated. The domains were contiguous administrative geographical units, which were usually a single district (independent domain) or, at times, a group of districts (composite domain). The sample size was fixed at 400 for each domain. The respondents were recruited

based on probability-based cluster sampling; by employing conventional cluster sampling and time-location cluster sampling methods.

### 2.2. Participants

The inclusion criteria were men aged 15 years or more who had used any psychotropic (addictive/mind-altering) substance or drug for recreational or nonmedical reasons through injections at least once in the last 3 months. Women who inject drugs were not included in the study.

### 2.3. Data and Sample Collection

Informed consent was obtained from all participants, and a pre-validated standard questionnaire was used to collect the socio-demographic and behavioral data. For PWID, data on basic demographics, injecting and sexual behaviors, partner types, knowledge of STI, HIV, antiretroviral therapy (ART), and details on violence episodes were collected. Blood samples were collected from all consented respondents. IBBS followed the unlinked anonymous testing (UAT) approach and the standard 2-tests protocol for HIV testing. The detailed methodology for sample size calculation, data and sample collection is reported elsewhere.<sup>[2]</sup>

### 2.4. Issue of interest

The behavioral data considered for analysis were Self-reported symptoms of STIs; injecting practices such as sharing needles/syringes; condom usage with regular female partners; condom usage with sexual partners (other than regular female partners) such as paid or casual female partners or male or transgender partners and knowledge or misconceptions about HIV/AIDS.

Under each behavioral variable, PWID were grouped as those reporting risk behaviors and those who did not. The respondents who had self-reported having at least 1 of the following 3 STIs, genital ulcer/sore, urethral discharge or genital warts, in the last 12 months were considered to have STI symptoms. PWID were considered to have adequate awareness and knowledge of HIV/AIDS if they had given correct answers to all questions on awareness, mode of transmission and HIV preventive measures included in the survey. PWID were considered to follow unsafe injecting practices if he had shared needles or syringes in any injecting episodes in the last 3 months of the survey. PWID were considered to have consistent condom usage if he had consistently used condoms during the sex act in the last 12 months of the survey with his sexual partners.

### 2.5. Statistical Analysis

HIV prevalence among PWID with and without risk behaviors was determined and compared based on the state weight under each category. A Chi-square test was done to establish an association between the risk behaviors and HIV prevalence in each state. Missing data on risk behaviors were not included in the analysis. The spatial mapping was done using Q-GIS software (Version 3.12). All statistical analysis was done using SPSS software (Version 26.0 Armonk, NY, IBM Corp. 2019).

### 2.6. Ethical Review

All respondents were informed about the details of the survey and the voluntary nature of the participation. Written informed consent was obtained through an informed consent form (ICF). The institutional ethical committee approved the study of ICMR - National Institute of Epidemiology, Chennai. The approval number is NIE/IHEC/20138/04.

### 3. Results

All valid samples of consented PWID were included in the analysis, accounting for 19,902 respondents with a median age of 30. The highest HIV prevalence was recorded in Uttar Pradesh (29.6%), followed by national capital territory (NCT) of Delhi (22.4%), Madhya Pradesh (15.7%), Uttarakhand (13.2%) and Manipur (12.1%). Chandigarh, West Bengal, and Mizoram recorded a prevalence of over 10%, while it ranged between 7% and 10% in Punjab, Haryana, and Chhattisgarh (Table 1, Fig. 1A).

About 1-fourth to 2-fifths of PWID reported the presence of 1 or more STI symptoms, the highest in Uttarakhand, followed by Gujarat, NCT of Delhi, Haryana, Jammu & Kashmir, and Punjab. (Fig. 1B). Accordingly, in most high prevalence states, a positive association was significantly established between the presence of STI symptoms and HIV prevalence. A reverse association was significant in Chandigarh and Chhattisgarh, whereas, irrespective of the presence or absence of STI symptoms, HIV prevalence was invariably high among PWID in Uttar Pradesh (Table 2).

While the overall awareness of HIV among PWID in India was around 96%, nearly 10% of the PWID in Uttar Pradesh and Delhi were unaware of HIV. Nearly 1 to third or more

PWID lacked adequate awareness of HIV/AIDS across India, with the highest proportions in Goa and Gujarat (Table 1). Higher the rate of unawareness higher was the rate of unsafe injecting practices in most states. HIV prevalence was predominantly higher among PWID with inadequate knowledge of HIV/AIDS, which was significant in Delhi, Haryana, Chandigarh, Punjab, West Bengal, Chhattisgarh, and Andhra Pradesh (Fig. 1C).

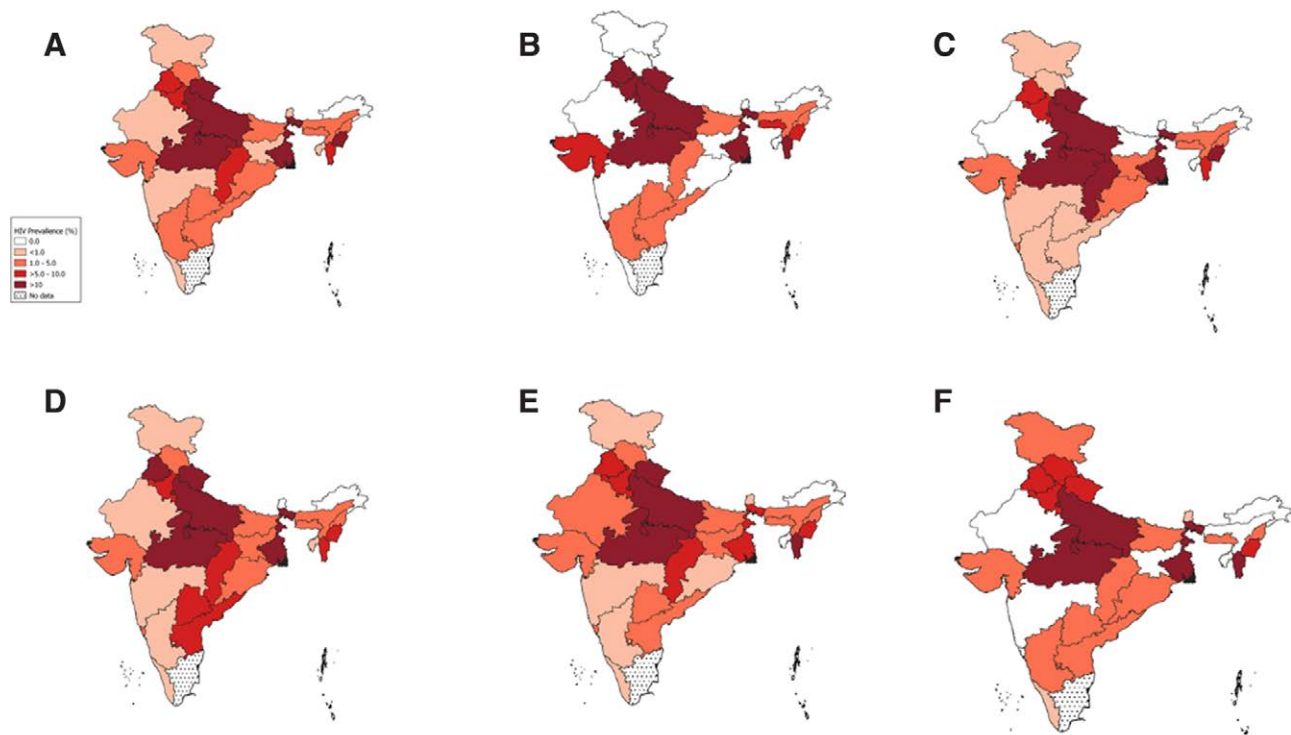
Nearly 1 to third or more respondents reported unsafe injecting practices in Gujarat, Goa, Himachal Pradesh, Karnataka, Maharashtra, Uttar Pradesh, Mizoram, Haryana, Punjab, and Madhya Pradesh (Table 1). In most states, HIV prevalence was higher among PWID with unsafe injecting practices than those with safe injecting practices in most states (Table 2, Fig. 1D). The unsafe injecting practice was significantly associated with higher HIV prevalence in Uttar Pradesh, NCT of Delhi, West Bengal, Chhattisgarh, and Kerala. In contrast, a reverse association was observed in Punjab and Himachal Pradesh (Table 2).

Inconsistent condom usage with regular female partners was associated with slightly higher HIV prevalence in most states, which was significant in the NCT of Delhi (Fig. 1E). In contrast, a significant reverse association between consistent condom usage with regular female partners and HIV prevalence

**Table 1**  
State-wise distribution and proportion of PWID based on risk characteristics.

State	n	Age median (IQR)	HIV prevalence (%)	Have any STI symptoms (%)	Inadequate HIV knowledge (%)	Unsafe injecting (%)	Inconsistent condom usage RFP (%)	Inconsistent condom usage OP (%)
Andhra Pradesh	768	30 (26-34)	3.1	17.7	32.4	18.0	86.8	48.3
Arunachal Pradesh	397	25 (22-28)	0.0	4.7	72.8	23.9	82.7	65.4
Assam	805	28 (24-31)	2.3	4.4	64.3	22.2	90.1	52.1
Bihar	288	28 (23-34)	2.2	19.1	72.6	18.8	92.7	70.1
Chandigarh	401	30 (28-36)	11.8	17.0	33.7	13.7	84.7	52.2
Chhattisgarh	764	26 (23-31)	7.4	19.4	54.8	18.6	76.5	38.3
Goa	380	28 (23-33)	1.4	19.0	84.5	60.3	52.1	65.5
Gujarat	394	35 (29-40)	2.7	39.4	85.3	65.0	53.8	30.1
Haryana	1437	29 (25-35)	8.0	27.3	73.3	34.8	84.8	60.4
Himachal Pradesh	403	27 (23-34)	3.8	14.7	71.2	54.3	82.5	71.8
Jammu Kashmir	359	30 (26-38)	0.4	27.3	72.1	32.6	91.5	76.5
Jharkhand	393	28 (23-35)	0.7	2.5	70.7	8.9	82.6	41.5
Karnataka	364	27 (22-33)	1.1	17.2	49.5	50.0	90.0	70.5
Kerala	1113	31 (26-40)	0.2	10.0	41.8	23.5	96.1	70.7
Madhya Pradesh	1175	28 (24-35)	15.7	15.4	58.1	33.6	72.0	63.4
Maharashtra	383	31 (28-36)	0.6	8.4	77.5	49.1	83.5	72.5
Manipur	1594	32 (27-37)	12.1	11.3	38.0	25.6	83.0	53.4
Meghalaya	396	26 (23-29)	3.2	2.7	77.0	33.1	77.2	68.7
Mizoram	1084	25 (23-30)	10	7.2	39.8	37.7	89.7	74.9
Nagaland	1198	33 (28-40)	3.2	18.5	66.6	21.6	80.4	63.4
NCT Of Delhi	790	30 (25-35)	22.4	34.9	48.7	20.5	76.6	67.3
Orissa	391	27 (24-33)	1.4	12.8	47.3	16.4	74.6	54.5
Punjab	1087	26 (23-31)	9.6	23.1	65.8	34.5	79.6	54.4
Rajasthan	273	34 (28-40)	1	15.1	72.9	19.4	97.3	62.8
Sikkim	385	24 (21-28)	0.2	15.9	47.8	30.9	93.8	83.5
Tripura	286	28 (25-33)	0.6	6.1	68.2	15.0	88.5	57.7
Uttar Pradesh	1587	35 (28-40)	29.6	14.0	76.8	48.7	93.9	83.9
Uttarakhand	411	30 (26-35)	13.2	40.7	60.3	23.8	96.8	73.1
West Bengal	596	30 (24-37)	10.8	13.7	66.9	22.8	89.7	67.8

HIV = human immunodeficiency virus, NCT = national capital territory, OP = other partners including paid or casual female partners, male or transgender partners, PWID = people who inject drugs, RFP = regular female partners, STI = sexually transmitted infections.



**Figure 1.** State-wise HIV prevalence of PWID (A), state-wise HIV prevalence of PWID based on risk characteristics; having at least one STI symptom (B), having inadequate knowledge of HIV knowledge (C), having unsafe injection practice (D), inconsistent condom usage with regular female partners (E) and inconsistent condom usage with other sexual partners (F). HIV = human immunodeficiency virus, PWID = people who inject drugs, STI = sexually transmitted diseases.

was found in Meghalaya, Manipur, Punjab, West Bengal, Uttar Pradesh, and Uttarakhand (Table 2). Similarly, a reverse association was established between consistent condom usage with casual or paid sexual female partners and HIV prevalence in most states, which was significant in Haryana. Nevertheless, inconsistent condom usage with casual or paid partners was significantly associated with higher HIV prevalence in Delhi, Mizoram, and Nagaland (Table 2, Fig. 1F).

#### 4. Discussion

The regions of higher HIV prevalence among PWID were confined to north and central India and a few states of East and North-East India. Accordingly, Uttar Pradesh, Delhi, Punjab, Manipur, and Nagaland have the highest estimated PWID.<sup>[7]</sup> The analysis shows that unsafe injecting practices were more prevalent in Western and Central India, whereas unsafe sexual behaviors were widespread among most states. PWID with unsafe injecting practices and sexual practices had a significantly higher prevalence. Higher HIV prevalence was also significantly associated with inadequate knowledge or misconceptions about HIV/AIDS. These behaviors cannot be generalized to all regions in India, and region-specific indicators need to be identified and addressed.

Awareness and adequate knowledge of HIV/AIDS are essential to HIV prevention and management.<sup>[11–13]</sup> PWID with inadequate knowledge or misconceptions about HIV/AIDS are more likely to be involved in high-risk behaviors. In India, 26.1% of the PWID had misconceptions about the transmission routes or HIV preventive measures, and 42.6% lacked comprehensive knowledge of HIV/AIDS. Information education and communication activities aim to create awareness of HIV/AIDS among all PWID in India, which is of utmost importance to prevent disease transmission. However, in India, only 58.2% of the PWID had received information education and communication services, representing a knowledge gap to

be addressed for effective HIV management.<sup>[14,15]</sup> While educating the PWID on HIV prevention and management is essential, it is necessary not to foster unintended, false assumptions. For instance, evidence suggests that ART awareness led to misconceptions about considering HIV as a non-communicable or curable disease.<sup>[16]</sup>

Safe injecting practices prevent HIV transmission among PWID,<sup>[17,18]</sup> which, however, is compromised by various social-structural contextual factors such as social networks, peer pressure, fear of harassment, and inaccessibility to sterile needles or syringes.<sup>[19,20]</sup> Reports show that HIV-positive PWID follow specific strategies to reduce transmission risks, such as “being the last receiver,” sharing with HIV-positive PWID and washing the needles/syringes before sharing. These practices, however, increase their risk of acquiring other STIs, such as hepatitis C virus (HCV) and hepatitis B virus.<sup>[19,21]</sup>

Reports show that the HIV prevention interventions among PWID focus on propagating safer injection practices and emphasizing condom use with high-risk partners such as paid.<sup>[22]</sup> Among all HRGs, more than 50% of the participants have reported having consistent condom usage among all partner types other than regular partners, except PWID. Nationwide, the proportion of PWID with female partners is 80.2%, of which 15.9%, 29.2%, and 50.0% had consistent condom usage with regular, casual, and paid partners. While 37.4% of them had male/transgender partners, only 35.9% reported consistent condom usage.<sup>[2]</sup> A significant positive association between HIV prevalence and inconsistent condom usage in high prevalence states such as Delhi and Mizoram suggests the need to emphasize safe sexual practices in PWID interventions. Several studies have documented the unsafe sexual behaviors of PWID and transmission risk from PWID to their non-injecting partners, specifically the regular partners.<sup>[23,24]</sup>

Various factors affect condom usage with sexual partners of PWID, such as non-disclosure of risk behaviors due to fear of rejection, social stigma, or discrimination. In some cases,



**Table 2****Stratified HIV prevalence among PWID subgroups based on risk profile.**

High risk behaviors	HIV prevalence (%)									
	Presence of any STI symptoms		Injecting practice		Aware of HIV transmission		Consistent condom usage (RFP)		Consistent condom usage (OP)	
	Yes	No	Safe	Unsafe	Yes	No	Yes	No	Yes	No
Andhra Pradesh	1.5	3.3	3.7	0.7	2.1	5.2	5.3	2.1	3.5	2.4
Arunachal Pradesh	0	0	0	0	0	0	0	0	0	0
Assam	2.8	2.3	2.4	2.2	2.4	2.3	2.8	1.5	0	0
Bihar	1.8	2.1	2.6	0	3.8	1.4	6.7	2.6	2.2	1.9
Chandigarh	<b>2.9</b>	<b>13.5*</b>	11.8	10.9	<b>9</b>	<b>17.0*</b>	4.3	7.1	3.9	6
Chhattisgarh	<b>2.7</b>	<b>8.5*</b>	<b>3.9</b>	<b>22.5***</b>	<b>4.1</b>	<b>10.0**</b>	4.2	8.9	3.3	3.5
Goa	<b>5.5</b>	<b>0.6**</b>	0.7	1.7	0	1.6	3.6	5	0	0
Gujarat	<b>5.2</b>	<b>0.8*</b>	1.4	3.5	3.4	2.7	6.6	1.4	3.8	2.9
Haryana	<b>12.8</b>	<b>6.1***</b>	6.9	9.8	9.1	7.5	8.4	9.3	<b>15.6</b>	<b>8.7**</b>
Himachal Pradesh	0	4.4	<b>7.1</b>	<b>0.9***</b>	1.7	4.5	0	1.1	1.4	5.3
Jammu & Kashmir	0	0.4	0	0.9	0	0.4	0	0.6	0	1.3
Jharkhand	0	0.8	0.6	2.9	0	1.1	0	1.2	0	0
Karnataka	1.6	1	2.2	0.5	2.2	0.6	0	0.7	2.6	1.1
Kerala	0	0.2	<b>0</b>	<b>0.8*</b>	0	0.4	0	0.2	0	0.4
Madhya Pradesh	13.3	16.2	15	17	14.6	16.5	10.3	14.9	13.9	11.7
Maharashtra	0	0.6	0.5	0.5	0	0.7	0	0.4	1.5	0
Manipur	8.3	12.6	11.8	13.2	<b>13.8</b>	<b>9.4*</b>	<b>16.7</b>	<b>7.7**</b>	8.2	10
Meghalaya	9.1	3.1	2.6	3.8	2.2	3.6	11.5	1.1*	7.3	2.2
Mizoram	<b>31.6</b>	<b>8.3***</b>	10.5	9.3	<b>11.5</b>	<b>7.7*</b>	6	10.3	<b>5.6</b>	<b>15.0*</b>
Nagaland	4.5	2.9	3.1	3.9	<b>5.3</b>	<b>2.1**</b>	2.3	3.1	<b>1.2</b>	<b>4.7*</b>
NCT Of Delhi	<b>30.1</b>	<b>18.3***</b>	<b>19.6</b>	<b>32.7***</b>	<b>11.6</b>	<b>33.6***</b>	<b>6.7</b>	<b>21.4***</b>	<b>8.1</b>	<b>30.9***</b>
Orissa	0	1.5	1.2	1.6	1.5	1.1	0	1	1	2.6
Punjab	<b>15.9</b>	<b>7.8***</b>	11	7.2*	<b>6.7</b>	<b>11.1**</b>	<b>17.3</b>	<b>6.3***</b>	4.9	7.1
Rajasthan	0	1.3	1.4	0	2.7	0.5	0	1.1	4.8	0
Sikkim	0	0.3	0.4	0	0.5	0	0	0.6	0	0.6
Tripura	0	0.7	0.8	0	0	1	0	0	0	0
Uttar Pradesh	34.8	28.8	<b>25.3</b>	<b>34.2***</b>	30.4	29.4	<b>40</b>	<b>24.9*</b>	27.1	27.8
Uttarakhand	15.5	11.5	12.1	16.3	12.9	13.3	<b>44.4</b>	<b>10.2**</b>	10.2	9
West Bengal	<b>25.6</b>	<b>8.4***</b>	<b>7</b>	<b>23.5***</b>	<b>6.6</b>	<b>13.0*</b>	<b>21.9</b>	<b>6.5**</b>	7.8	11.1

HIV = human immunodeficiency virus, NCT = national capital territory, OP = other partners including paid or casual female partners, male or transgender partners, PWID = people who inject drugs, RFP = regular female partners, STI = sexually transmitted diseases.

\* Significantly differed at 5% level ( $P < .05$ ).

\*\* Significantly differed at 0.5% level ( $P < .005$ ).

\*\*\* Significantly differed at 0.1% level ( $P < .001$ ).

HIV sero-concordant and concordant HIV-negative relationships may significantly affect the consistent use of condoms. Nevertheless, condom usage reduces transmission risks as well as resistance to ART.<sup>[25,26]</sup> Drug intake during or before sex is often associated with unsafe sexual behavior due to the physiological impact the drug has on the drug user. Negotiating condom usage under the alcohol influence is difficult, posing a much higher risk of disease transmission. Hence, advocating consistent condom usage among PWID with all sexual partners and providing necessary psychological support and counseling ensures safe sexual practices in PWID.<sup>[22]</sup>

Untreated STIs increase HIV and other infection risks; therefore, HIV interventions in India include regular screening and treatment for STIs, despite which only 76.1% of PWID have heard of STIs against 96% of HIV/AIDs. A predominantly significant association between the presence of self-reported STI symptoms and high HIV prevalence calls for appropriate interventions. Recent studies emphasize the risk of HIV and HCV coinfection among PWID in India, as needle sharing is a predominant risk factor for HCV.<sup>[27,28]</sup> However, a cross-sectional study indicated that most HIV and HCV-infected PWID were unaware of their infection status and underlined the urgent need to rapidly identify and treat HIV and HCV-infected PWID in India.<sup>[27]</sup> Besides common factors such as personal hygiene, drug abuse and sexual encounters, studies also report an association between accessibility to interventions like needle syringe exchange programme and HCV prevalence.<sup>[29]</sup>

The criminalization of drug use in India is considered to be a major barrier to accessing HIV interventions.<sup>[28]</sup> Identifying and addressing such programmatic gaps is crucial for successful harm reduction and drug reform efforts in high-burden states.

While a significant positive association between risk behaviors and higher HIV prevalence has been observed in a few states, a significant reverse association could also be observed in most states, as discussed above. In a cross-sectional study design, the temporality or causality between the prevalence and associated risk behaviors cannot be established. Several behavioral studies have reported such reverse association, which could be explained by a former association, i.e. an infected person becomes more aware of HIV and opts for behavioral changes.

A systematic review of HIV among PWID in India indicated that needle sharing, injection frequency, early drug use, inconsistent condom use and having multiple partners are associated with HIV among PWID.<sup>[28]</sup> Studies also report various other individual and socio-structural contextual factors that influence the behavior and service utilization of PWID, namely the age, age at initiation of the drug use or duration of PWID behavior, stigma, violence victimization, and inaccessibility to interventional services.<sup>[30,31]</sup> The researchers highlight the need for high coverage and combined approaches for HIV prevention and recommend social and structural changes for effective outcomes.<sup>[32]</sup> Stratified, region-specific interventions based on geographic risk structure and combination approaches are recommended to prevent HIV transmission among PWID.

## 5. Conclusion

Ensuring adherence to safe injecting and safe sexual practices under the influence of drugs by PWID is a significant challenge for HIV prevention and control measures. Addressing this situation through intensified, decentralized, region-specific strategies with high coverage and outreach are recommended for optimal and effective program response.

## 6. Limitations

IBBS does not include any female PWID; hence the data analyzed in this paper are limited to male PWID alone. The variables selected for this analysis were chosen to identify the behavioral risk structure; therefore, the underlying socio-demographic factors, such as age, education, age at initiation of drug use or occupation, and violence victimization, were not considered. Further, owing to the cross-sectional study design, the temporality of the risk behaviors and HIV infection could not be established.

## Acknowledgments

The authors wish to thank the project directors of state AIDS control societies for their support in completing the surveillance activities on time. The authors also thank the concerned referral laboratories, state surveillance team members, and sentinel site personnel. Our special thanks to Dr Sanjay Madhav Mehendale, Former Director, and Dr Manoj Murhekar, Director of ICMR—National Institute of Epidemiology, Chennai, for their immense contribution and technical inputs towards the successful completion of the HIV surveillance.

## Author contributions

**Conceptualization:** Santhakumar Aridoss, Elangovan Arumugam.

**Data curation:** Santhakumar Aridoss, Joseph K. David.

**Data Analysis and Spatial mapping:** Nagaraj Jaganathasamy.

**Formal analysis:** Nagaraj Jaganathasamy.

**Funding acquisition:** Elangovan Arumugam.

**Investigation:** Santhakumar Aridoss, Joseph K. David, Nagaraj Jaganathasamy, Ganesh Balasubramanian, Shobini Rajan, Elangovan Arumugam.

**Methodology:** Santhakumar Aridoss, Pradeep Kumar, Elangovan Arumugam.

**Project administration:** Santhakumar Aridoss, Pradeep Kumar, Shobini Rajan, Elangovan Arumugam.

**Resources:** Santhakumar Aridoss, Manikandan Natesan, Elangovan Arumugam.

**Software:** Shobini Rajan.

**Supervision:** Santhakumar Aridoss, Joseph K. David, Ganesh Kumar, Shobini Rajan, Manikandan Natesan, Pradeep Kumar, Shobini Rajan, Elangovan Arumugam.

**Validation:** Santhakumar Aridoss, Nagaraj Jaganathasamy.

**Visualization:** Nagaraj Jaganathasamy, Padmapriya V.M.

**Writing – original draft:** Malathi Mathiyazhakan, Elangovan Arumugam.

**Writing – review & editing:** Santhakumar Aridoss, Pradeep Kumar, Shobini Rajan, Ganesh Balasubramanian, Manikandan Natesan, Padmapriya V.M., Elangovan Arumugam.

## References

- [1] Paranjape RS, Challacombe SJ. HIV/AIDS in India: an overview of the Indian epidemic. *Oral Dis.* 2016;22:10–4.
- [2] National AIDS Control Organisation, NACO. National integrated biological and behavioural surveillance (IBBS) 2014-15. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2015. Available at: <http://naco.gov.in/sites/default/files/IBBS%20Report%202014-15.pdf> [access date December 14, 2021].
- [3] National AIDS Control Organisation, NACO. India HIV Estimations 2017. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2017. Available at: [http://naco.gov.in/sites/default/files/HIV%20Estimations%202017%20Report\\_1.pdf](http://naco.gov.in/sites/default/files/HIV%20Estimations%202017%20Report_1.pdf) [access date December 14, 2021].
- [4] National AIDS Control Organization & ICMR-National Institute of Medical Statistics. India HIV Estimates 2019: Report. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2020. Available at: <http://naco.gov.in/sites/default/files/INDIA%20HIV%20ESTIMATES.pdf> [access date December 14, 2021].
- [5] National AIDS Control Organisation & ICMR-National Institute of Medical Statistics. India HIV Estimates 2020: Technical Brief. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India. 2021; Available at: [http://naco.gov.in/sites/default/files/India%20HIV%20Estimates%202020\\_Web\\_Version.pdf](http://naco.gov.in/sites/default/files/India%20HIV%20Estimates%202020_Web_Version.pdf) [access date December 14, 2021].
- [6] Ganju D, Ramesh S, Saggurti N. Factors associated with HIV testing among male injecting drug users: findings from a cross-sectional behavioural and biological survey in Manipur and Nagaland, India. *Harm Reduction J.* 2016;13:21.
- [7] Arumugam E, Kangusamy B, Sahu D, et al. Size Estimation of high-risk groups for HIV infection in India based on data from national integrated bio-behavioral surveillance and targeted interventions. *Indian J Public Health.* 2020;64:39–45.
- [8] National AIDS Control Organization. HIV Sentinel Surveillance: Technical Brief, India 2016-17. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2017. Available at: [http://naco.gov.in/sites/default/files/HIV%20SENTINEL%20SURVEILLANCE\\_06\\_12\\_2017\\_0.pdf](http://naco.gov.in/sites/default/files/HIV%20SENTINEL%20SURVEILLANCE_06_12_2017_0.pdf) [access date December 14, 2021].
- [9] National AIDS Control Organisation & ICMR-National Institute of Medical Statistics. District-Level HIV Estimates and Prioritization in India 2019: Technical Brief. New Delhi: NACO, Ministry of Health and Family Welfare, Government of India; 2021. Available at: <file:///F:/Documents/Articles/HSS%20Reference%20Articles/District-Level%20HIV%20Estimates%20and%20Prioritization%20in%20India.pdf> [access date December 14, 2021].
- [10] Ganesh B, Mosoniro K, Vasna J, et al. Factors associated with human immunodeficiency virus infection and self-assessed risk to human immunodeficiency virus among injecting drug users in Manipur, India. *Indian J Public Health.* 2020;64:61–6.
- [11] De Souza NJ, Kolipaka RP, Kumar J, et al. Knowledge, attitude, and practice toward human immunodeficiency virus/acquired immune deficiency syndrome: a questionnaire study among students, teachers, and parents in Mangalore, India. *J Indian Assoc Public Health Dent.* 2019;17:70–5.
- [12] Dokubo EK, Shiraishi RW, Young PW, et al. Awareness of HIV status, prevention knowledge and condom use among people living with HIV in Mozambique. *PLoS One.* 2014;9:e106760.
- [13] Nketiah-Amponsah E, Afful-Mensah G. A review of HIV/AIDS awareness and knowledge of preventive methods in Ghana. *Afr J Reprod Health.* 2013;17:69–82.
- [14] Zaman FA. Impact assessment of IEC intervention on knowledge attitude and practice (KAP) of HIV/AIDS in Assam. *Ann Trop Med Public Health.* 2013;6:644–8.
- [15] Imran M, Madhusudan M. Role of IEC in improvement of knowledge and attitude about HIV/AIDS among college students. *Indian J Public Health Res Develop.* 2014;5:221–6.
- [16] Lange Joep MA, Perriens J, Kuritzkes D, et al. What policymakers should know about drug resistance and adherence in the context of scaling-up treatment of HIV infection. *AIDS.* 2004;18:S69–74.
- [17] Noroozi M, Noroozi A, Mirzazadeh A, et al. impact of needle and syringe program coverage on HIV incidence in people who inject drugs. *Int J High Risk Behav Addict.* 2017;6:e28929.
- [18] Wodak A, McLeod L. The role of harm reduction in controlling HIV among injecting drug users. *AIDS.* 2008;22:S81.
- [19] Chakrapani V, Newman PA, Shunmugam M, et al. Social-structural contexts of needle and syringe sharing behaviours of HIV-positive injecting drug users in Manipur, India: a mixed methods investigation. *Harm Reduction J.* 2011;8:9.
- [20] De P, Cox J, Boivin JF, et al. The importance of social networks in their association to drug equipment sharing among injection drug users: a review. *Addiction.* 2007;102:1730–9.

- [21] Latkin CA, Buchanan AS, Metsch LR, et al. Predictors of sharing injection equipment by HIV-seropositive injection drug users. *J Acquired Immune Deficiency Syndromes* (1999). 2008;49:447–50.
- [22] Sharma V, Tun W, Sarna A, et al. Prevalence and determinants of unprotected sex in intimate partnerships of men who inject drugs: findings from a prospective intervention study. *Int J STD & AIDS*. 2019;30:386–95.
- [23] Pisani E, Suahya PK, Kamil O, et al. Sexual behavior among injection drug users in 3 Indonesian cities carries a high potential for HIV spread to noninjectors. *JAIDS J Acquir Immune Defic Syndr*. 2003;34:403–6.
- [24] Panda S, Kumar MS, Saravanamurthy PS, et al. Sexually transmitted infections and sexual practices in injection drug users and their regular sex partners in Chennai, India. *Sex Transm Dis*. 2007;34:250–3.
- [25] Eaton LA, West TV, Kenny DA, et al. HIV transmission risk among HIV seroconcordant and serodiscordant couples: dyadic processes of partner selection. *AIDS Behav*. 2009;13:185–95.
- [26] Jones D, Kashy D, Villar-Loubet O, et al. Enhancing acceptability and use of sexual barrier products among HIV concordant and discordant couples. *AIDS Behav*. 2013;17:2185–93.
- [27] Solomon SS, McFall AM, Lucas GM, et al. Respondent-driven sampling for identification of HIV-and HCV-infected people who inject drugs and men who have sex with men in India: a cross-sectional, community-based analysis. *PLoS Med*. 2017;14:e1002460.
- [28] Pachua LN, Tannous C, Dharmi MV, et al. HIV among people who inject drugs in India: a systematic review. *BMC Public Health*. 2022;22:1–7.
- [29] Sogarwal R, Madge V, Bishi P, et al. Predisposing, enabling, and need factors associated with utilization of HCV testing services among PWID in two settings in India. *Hepatol Med Pol*. 2016;1:1.
- [30] Armstrong G, Nuken A, Medhi GK, et al. Injecting drug use in Manipur and Nagaland, Northeast India: injecting and sexual risk behaviours across age groups. *Harm Reduction J*. 2014;11:271–0.
- [31] Panda S, Kumar MS. Injecting drug use in India and the need for policy and program change. *Int J Drug Policy*. 2016;37:115–6.
- [32] Degenhardt L, Mathers B, Vickerman P, et al. Prevention of HIV infection for people who inject drugs: why individual, structural, and combination approaches are needed. *Lancet*. 2010;376:285–301.