


# HIV Prevalence, Knowledge, Attitudes, and Practices Among Polydrug Users in Brazil: A Biological Survey Using Respondent Driven Sampling

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**Abstract** Brazil has a concentrated HIV epidemic among key populations. In 2009, the Ministry of Health conducted a survey in 10 Brazilian cities aiming to estimate HIV prevalence, knowledge, and associated risk behaviors of polysubstance users (PSU). Using Respondent Driven Sampling (RDS), 3449 PSU were recruited, answered an Audio-Computer Self Assisted Interview (ACASI) and were tested for HIV and syphilis. Analyses were weighted by individual's social network size generated on RDSAT. Pooled HIV prevalence was 5.8% but varied across cities.

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Most PSU were male, non-white, without income, unemployed, with low levels of education. Overall, 12.0% used injectable drugs, 48.7% had sex with occasional partners and 46.4% engaged in commercial sex. A majority received free condoms (71.4%) but 76.7% exhibited inconsistent condom use. Findings can support policies aiming to improve health care and preventive interventions tailored to this population that remains at high risk of acquiring and transmitting HIV/STI in multiple scenarios.

**Resumen** Brasil tiene una epidemia concentrada de VIH en las poblaciones clave. En 2009, el Ministerio de Salud realizó una encuesta en 10 ciudades brasileñas con el objetivo de estimar la prevalencia del VIH y otros indicadores entre los consumidores de múltiples drogas (CMD). En la muestra Respondent-driven-sampling (RDS), 3,449 CMD contestaron una entrevista auto-asistida con Audio-Computer (A-CASI) y hicieron pruebas del VIH y sífilis. Las estimativas fueron ponderadas – pesos RDS. La prevalencia conjunta del VIH (5,8%) varió entre las ciudades. La mayoría eran hombres, no blancos, sin ingresos, desempleados, con bajos niveles de educación. Utilizó fármacos inyectables (12,0%), 48,7% tuvo relaciones sexuales con parejas ocasionales y 46,4% practicó sexo comercial. 71,4% recibió condones gratuitos pero 76,7% con uso inconsistente. Esos hallazgos pueden apoyar políticas destinadas a mejorar la atención y intervenciones preventivas adaptadas a los CMD que continúan en alto riesgo de adquirir y transmitir VIH/ITS en múltiples escenarios.

**Keywords** HIV · Syphilis · Drug users · Hard to reach population · Respondent driven sampling · Brazil

**Palabras-clave** VIH · Sífilis · Consumidores de drogas · Población de difícil alcance · Respondent-driven sampling · Brasil

## Introduction

In 2012 it was estimated that 5.2% (95% CI 3.5–7.0%) of the adult world's population aged 15–64 had used, at least once in the previous year, cannabis, opioids, cocaine or amphetamine-type stimulants [1]. Illicit drug use is considered a major social and public health problem [2, 3] and it is associated with transmission of blood-borne pathogens, particularly the human immunodeficiency virus (HIV), via shared contaminated syringes and needles (as well as several other materials, containers and liquids, such as vessels from which different users refill their syringes, cotton, filters etc.) and/or unprotected sex.

Among 12.7 million people (0.27%) who use drugs worldwide, it is estimated that an average of 13% are living with HIV and injection drug users have been associated with 30% of new infections outside of Sub-Saharan Africa in recent years [1]. However, non-injecting drugs are also relevant to the dissemination of HIV and other sexually transmitted infections (STI) in different settings, especially through the use of stimulants which may be associated with higher rates of unprotected sex [4], as well as the putative role of shared straws and other paraphernalia used by people who snort powder cocaine in the transmission of both HIV and Hepatitis C virus (HCV) [5].

The number of new HIV infections has been falling globally, whereas in Brazil, where 2% of the world's and 47% of Latin America's people living with HIV are located, an increase of 11% in the number of new HIV infections was recorded from 2005 to 2013 [6]. The number of HIV infections among non-injection drug users (non-IDUs) is high in Brazil [7] despite their decrease among IDUs. In both low/middle-income and high income countries, non-IDUs are receiving more attention and have been more frequently targeted by dedicated programs because data and researchers are suggesting that HIV prevalence in this population may be as high as among injection drug users in some contexts [8, 9].

A recent e-report [7] and several papers highlighted that the most frequently used illicit drugs in Brazil are cannabis, cocaine powder, crack-cocaine and related substances [10, 11]. Despite the low rate of drug injection in Brazil compared with rates of injection in USA and European countries [2], the country has reported a high prevalence of HIV among key populations, such as crack-cocaine users whose HIV prevalence was estimated to be eight times higher than that of the general population [7]. Although Brazil has strong HIV prevention and treatment programs, in some way hindered in the last years by the ongoing fiscal crisis [12], drug users have heterogeneous and complex patterns of drug use and may require different targeted interventions, tailored to specific subgroups of different

substances, such as ethnic and sexual minorities, women, minors, users of stimulants versus opiates [13].

Thus, behavioral surveillance surveys among drug user populations which are at increased risk of acquisition and/or transmission of STI are fundamental to curb STI spread among these populations, their families, partners and their communities at large. As such, the present paper estimated HIV prevalence, proportions of knowledge on HIV, risky attitudes and practices among polysubstance users (PSU) for each of the 10 Brazilian cities.

## Methods

### Study Design, Population, and Inclusion Criteria

A cross-sectional survey using Respondent Driven Sampling method (RDS) [14] was conducted with the key objectives of the main study were to assess sexual behaviors, attitudes, practices and HIV and syphilis prevalence among PSU, and to outline data for comparison with past and future surveillance surveys data.

Respondent driven sampling, a chain link sampling method that begins with a convenience sample of members of the target population called 'seeds' [14], was used [15] because other sampling methods not designed to assess hard-to-reach populations tend to be affected by three major caveats: (1) the absence of a priori sampling frame that could anchor classic sampling strategies; (b) the invisibility of some subgroups/hidden scenes, such as users of unrecorded alcohol, as previously demonstrated by a former study of our group [16]; (c) and last but not least the strong suspicion the targeted population maintains about interviewers, even those used to work as outreach workers, in case they belong to other communities/areas under the influence of specific criminal factions, which is especially relevant in a context of pervasive violence and mistrust [17].

A sample size was set at 2850 PSU by the Brazilian National Department of Surveillance, Prevention and Control of STIs, HIV/AIDS and Viral Hepatitis (DIAHV), distributed in 10 Brazilian cities, namely: Belo Horizonte, Brasília, Campo Grande, Curitiba, Itajaí, Manaus, Santos, Salvador, Recife, and Rio de Janeiro (Fig. 1).

The targeted population was PSU residing in one of the ten cities and inclusion criteria were as follows: people  $\geq 18$  years old in 2009, who had ever reported injecting substances including cocaine, crack, amphetamine, heroin or hallucinogens at least once in the past 6 months, and/or who had reported using any other non-injecting illicit substances for at least 25 times in the 6 months preceding the survey. These criteria were defined after Pan American Health Organization's (PAHO's) CODAR ("Consumidores

**Fig. 1** Study sites, Brazil, 2009

de Drogas con Alto Riesgo or High Risk Drug Users” [Spanish original and respective English versions]) manual and related materials [18].

The study protocol was approved by the Ethical Council of the Sergio Arouca National School of Public Health (CEP/ENSP n°. 90/2008).

### Recruitment and Data Collection

At project’s inception, a preliminary formative research was carried out comprising focus group discussion with members of the targeted population and in-depth interviews. Interviewees were probed in terms of their interest in

participation, their social connections, and potential study sites, considering accessibility and interviewees’ privacy.

Considering the formative results, study sites in each city was defined and at least three seeds, diverse in age, sex, drug use type, and socioeconomic characteristics, were intentionally selected to start recruitment. Each seed received three coupons to be handled to potential participants who in turn recruited new putative participants.

Once launched the recruitment process, a peer-recruited participant who reached the study site, a public health center located in each city, with a uniquely coded valid coupon connected to the recruiter’s coupon in the coupon manager software and who were not under the acute influence of drugs was screened for eligibility. Coded

coupons, coupon manager software, as well as individual characteristics were used to minimize duplications.

After free and informed consenting, eligible participants were invited to answer the main interview based on validated questionnaire delivered as an *Audio Computer-Assisted Self Interview* (ACASI), which has been used with very high acceptability and good performance among this population in the Brazilian context [19]. The questionnaire included questions on socio-demographic factors, lifetime and current (past 12 months and 30 past days, respectively) drug use and sexual behavior, healthcare services usage, and knowledge of STIs.

After completing research procedures and the main interview, eligible participants received a participation incentive of R\$(Brazilian Real) 40.00 (~US\$20.00 in 2009) as well as three coupons to invite their peers. Then, a recruitment incentive of R\$40.00 was given for each of their three recruits who reached the study site and participated in the survey.

Field workers were previously trained on RDS, on data collection, and on guiding peers on recruitment strategies. All participants signed a free and informed consent form in order to participate and received pretest and post-test counseling for STI. Blood specimens were drawn for voluntary finger stick rapid tests: rapid plasma reaction (RPR) *Bioline Syphilis*<sup>TM</sup> and *Rapid Check HIV 1/2* and Bio-Manguinhos HIV 1/2, following the national algorithm established by the Brazilian Ministry of Health [20, 21]. We referred to specialized care those who tested positive for one of the rapid tests.

## Measures

Participants' personal social network size were assessed through the question as follows: “Among the drug users you know by name and have encountered in the last month, how many of them would you invite to participate in this study?”. Recruiter-recruitee relationship was further explored by asking: “What is your relationship with the person who referred you to this study, i.e., with the person who gave you the coupon?”.

The frequency of condom use in the last 12 months before the interview was categorized as ‘Never’, ‘Rarely/Sometimes’—both classified as “Inconsistent use”—and ‘Always’ classified as “Consistent use”. Other variables were: age (taking mean as the cut point), gender, race/skin color, income, a minimum wage in 2009 (taking R\$(Brazilian Real) 400 (~USD \$210) as cutting point), condom use at first sexual intercourse, self-perceived risk of HIV infection, engaging in commercial sex (sex in exchange of money or drugs), number of commercial sexual partners, marital status, years of education, income, access

to condoms, to have received counselling and educational materials on preventing STIs in the last 12 months.

## Data Analysis

In this paper, we present descriptive statistics on HIV prevalence, proportions of knowledge on HIV, risky attitudes and practices among PSU for each of the 10 Brazilian cities, with a 95% confidence interval. Pooled and study site estimates were weighted by the inverse of the individual's probability selection considering the individual's social network size reported by each respondent (degree) and the measure of “homophily” (degree of similarity between recruiter and recruitee in relation to HIV and syphilis infection).

For adjusting the parameter's estimation procedure in order to adjust for recruitment biases [14], individual RDS sampling weights were calculated with the RDS Analysis Tool (RDSAT 7.1; available at [www.respondentdrivensampling.org](http://www.respondentdrivensampling.org)). Individuals weights were then exported to Stata 10.0 [22] to proceed the statistical analysis. This analysis included seeds and subsequent recruits data.

Although adjusted findings do no longer correspond to actual interviewees since they do refer to weighted estimates, we kept the original term “interviewees”/“respondents” for the sake of conciseness and to help the potential readers (most of them not sampling statisticians) to better understand findings.

## Results

### Study Population and Recruitment Characteristics

Data collection occurred between March and November 2009 in all study sites. Recruitment duration varied greatly from six weeks in Santos to 28 weeks in Rio de Janeiro, and recruitment waves varied from seven in Santos to 16 in Brasília. At least three seeds were included to start recruitment in each study site. In total, 60 seeds started the recruitment in whole cities, while varied between three seeds in Itajaí and nine seeds in Campo Grande and Salvador. For this survey, a total of 3784 PSU was achieved in the ten cities under study, fluctuating between 679 in Rio de Janeiro and 218 in Campo Grande. 3449 participants were eligible and included in the study and analysis, while pretended sample was 2850 participants (Table 1). After excluding cases with missing information in key variables, the following analysis consider a sample size of 3449 PSU. Patterns of recruitment in each city are presented in Fig. 2.

**Table 1** Recruitment description and characteristics of sample of PSU at baseline in ten Brazilian cities, 2009

Study site	Seeds at start	Aded seeds	Recruits/coupons by seed	Number of waves	Weeks of recruitment	Pretended sample	Examined for eligibility	Eligible <sup>a</sup>
Belo Horizonte	4	1	3	10	12	300	376	342
Brasília	4	3	3	16	14	300	358	322
Campo Grande	5	4	3	11	11	200	218	199
Curitiba	5	0	3	9	12	250	316	303
Itajaí	2	1	3	9	11	200	322	300
Manaus	6	0	3	13	10	250	328	296
Recife	5	1	3	15	12	250	428	358
Rio de Janeiro	4	2	3	11	28	600	679	597
Salvador	5	4	3	10	12	300	432	423
Santos	4	0	3	7	6	200	327	309
Total	44	16				2850	3784	3449

<sup>a</sup> Examined for eligibility, confirmed eligibility, included in the study and analysis

### Sociodemographic and Behavioral Characteristics

A summary of proportions weighted baseline characteristics of PSU in each city is presented in Table 2. The mean age was 30.6 years old (range 18–73), and varied from 18 to 56 years old in Curitiba and from 18 to 73 years old in Brasília (data not presented); and 56.2% were 30 or more years old. Most of the overall sample (73.7%) consisted of males, varying from 53.6% in Manaus to 90.8% in Campo Grande, and 78.0% identified themselves as non-white, ranging from 34.3% in Itajaí to 90.7% in Salvador.

The majority of all participants was non-single or was living with partner (66.8%), ranging from 50.2% in Itajaí to 76.7% in Manaus. More than 1/3 (40.3%) of the participants had a monthly income over R\$(Brazilian Real) 400.00 (~US\$ 210 in 2009), and 36.3% had no income. In total, unemployment among PSU was quite high (48.9%), varying from 35.7% in Campo Grande to 56.3% in Rio de Janeiro. A low level of education (less than ten years of formal education) was reported by 71.0% of the pooled interviewees, ranging from 54.6% in Manaus to 83.9% in Santos, while 21.4% reported no formal education, 11.3% in Campo Grande and 41.7% in Manaus. Just one quarter of participants (26.6%) stated that their sexual debut took place with condom use, 14.0% in Santos and 33.9% in Manaus.

### HIV Prevalence by Study Site, Sex and Injection Status

HIV prevalence varied substantially in the 10 cities. Table 3 presents estimates of HIV prevalence according to sex and injection status by study site. The weighted pooled estimate was 5.8% (95% CI 5.0–6.6%), and ranged from 1.9% (95% CI 0.3–3.5) in Manaus to 11.2% (95% CI 7.6–14.7) in Itajaí. Weighted pooled estimates of HIV by

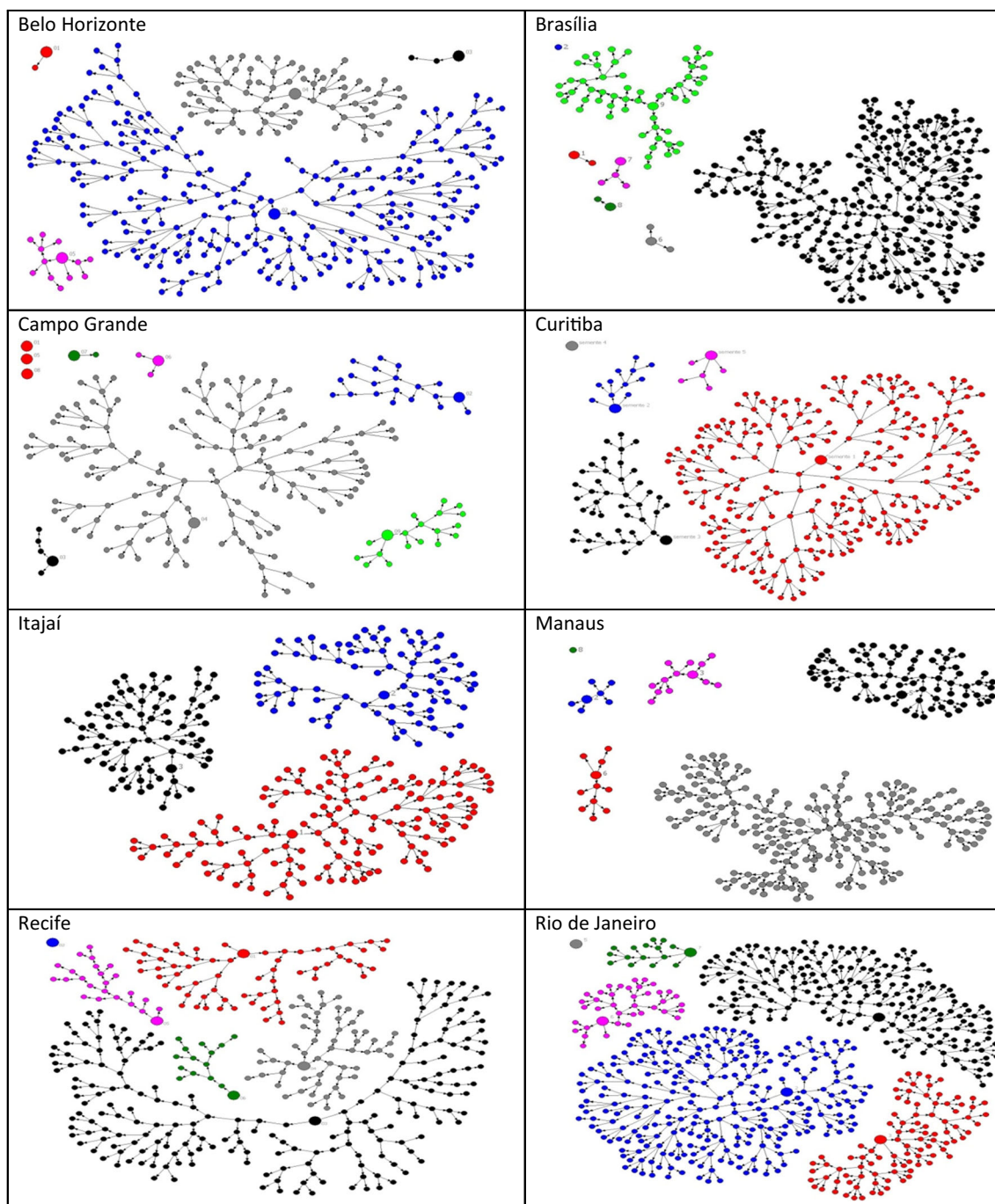
sex were 7.4% (95% CI 5.7–9.1) for females and 5.2% (95% CI 4.3–6.1) for males. The prevalence of HIV by sex varied greatly from 0.7% (95% CI –0.8 to 2.3) among females in Brasília to 18.9% (95% CI –0.4 to 41.9) among females in Santos, and to 18.8% (95% CI 8.7–28.9) among females in Curitiba. For males, the prevalence of HIV varied from 1.4% (95% CI –0.03 to 3.3) among males in Manaus to 12.2% (95% CI –0.2 to 26.5) among males in Itajaí.

Weighted pooled estimates of HIV according to injection status were 8.2% (95% CI 5.5–10.8) for those who injected drugs in the last 12 months before the interviews and 5.5% (95% CI 4.6–6.3) among those who did not inject drugs in the last 12 months before the interviews. Among injectors in the last 12 months before the interviews, HIV prevalence varied greatly from 1.3% (95% CI –0.0 to 4.8) in Brasília to 19.5% (95% CI –1.1 to 49.8) in Campo Grande (Table 3).

### Knowledge, Attitudes, and Practices

The pooled rate of injection drugs in the last 12 months before the interview was 12.0% (95% CI 10.9–13.1), varying from 3.1% (95% CI 1.0–5.2) in Recife to 24.6% (95% CI 20.5–28.8) in Belo Horizonte, while specific injection of powder cocaine was 4.9% (95% CI 4.0–5.7) and varied between 0.4% (95% CI –0.01 to 1.6) in Recife and 10.5% (95% CI 6.7–14.2) in Belo Horizonte (Table 4).

Regarding risky behavioral, most respondents (64.1%) reported having ever used alcohol/drugs and in consequence of it did not use condoms during sexual intercourse. Sex with occasional partner in the last 12 months before the interview was reported by 48.7%, varying from 41.6% in Curitiba to 64.9% in Santos, with 65.0% reporting condom use with occasional partners, 54.5% in Curitiba and 77.1% in Salvador. Ever been engaged in commercial



**Fig. 2** RDS Recruitment tree of PSU in 10 Brazilian cities, 2009

sex (giving or receiving money or drugs for sex) was reported by 46.4% of the participants and varied from 34.8% in Brasília to 58.2% in Recife. The number of partners with whom participants were engaged in commercial sex was reported as ‘one’ by 32.3%, ‘2 to 5’ by 38.1%, and ‘6 or more’ by 29.6% of the whole interviewees. The highest (89.9%) and lowest (13.3%) proportions of engagement in commercial sex with ‘6 or more’ partners were reported in Santos and Manaus, respectively.

Engagement in sexual violence (as victim or perpetrator) was reported by 22.7% of the whole sample, and was found to be highest (28.8%) in Rio de Janeiro and lowest (14.2%) in Santos.

The frequency of condom use in the last 12 months before the interviews was reported as ‘rarely/sometimes’ by 56.0% and as ‘never’ by 20.7% of participants. Highest and lowest rates of consistent condom use (‘always’) were reported in Itajaí (34.0%) and Rio de Janeiro (18.8%),

**Table 2** Numbers and weighted proportions for selected baseline characteristics of PSU in ten Brazilian cities, 2009

Characteristics	Whole sample <sup>a</sup> (%)		Belo Horizonte		Brasília		Campo Grande		Curitiba		Itajaí	
<b>Sex</b>												
Male	2682 (73.7)		301	88.0	230	73.0	184	90.8	265	81.6	248	79.0
Female	767 (26.3)		41	12.0	92	27.0	15	9.2	38	18.4	52	21.0
<b>Age</b>												
<30 years old	1448 (43.8)		170	48.5	122	42.5	87	41.7	121	45.1	123	46.2
≥30 years old	2001 (56.2)		172	51.5	200	57.5	112	58.3	182	54.9	177	53.8
<b>Skin color</b>												
None-white	2545 (78.0)		276	83.7	258	80.3	138	65.5	186	61.0	111	34.3
White	904 (22.0)		66	16.3	64	19.7	61	34.5	117	39.0	189	65.7
<b>Conjugal status</b>												
Single	2118 (33.2)		109	28.2	121	34.2	69	32.7	89	35.8	151	49.8
Non-single/living with partner	1261 (66.8)		233	71.8	201	65.8	130	67.3	214	64.2	149	50.2
<b>Education</b>												
Without formal schooling	198 (21.4)		97	22.6	47	13.2	46	11.3	104	27.9	92	27.2
<10 years of schooling	2347 (71.0)		235	74.2	242	73.2	144	84.2	181	64.2	190	62.8
≥10 years of schooling	904 (7.6)		10	3.2	33	13.6	9	4.5	18	7.9	18	10.0
<b>Monthly income</b>												
≤R\$400 (~USD \$210)	987 (23.3)		110	32.3	95	30.1	69	31.8	91	19.8	132	38.6
>R\$400 (~USD \$210)	1334 (40.3)		138	37.1	154	48.9	69	39.3	103	47.0	81	26.9
Without income	1128 (36.3)		94	30.6	73	20.9	61	28.8	109	33.2	87	34.5
<b>Working status</b>												
Employed	1858 (51.1)		196	54.5	195	63.9	123	64.3	128	44.0	170	59.5
Unemployed	1591 (48.9)		146	45.5	127	36.1	76	35.7	175	56.0	130	40.5
<b>Ever been arrested</b>												
Yes	1769 (46.6)		188	52.9	183	53.0	134	67.0	202	65.9	166	53.5
<b>Used condom at first sexual intercourse</b>												
Yes	798 (26.6)		66	22.2	81	29.6	35	32.3	79	26.6	88	29.5
Characteristics	Manaus		Recife		Rio de Janeiro		Salvador		Santos			
<b>Sex</b>												
Male	179	53.6	274	73.8	437	69.4	309	71.9	255	82.0		
Female	117	46.4	84	26.2	160	30.6	114	28.1	54	18.0		
<b>Age</b>												
<30 years old	60	23.7	123	33.7	304	53.2	135	35.0	202	67.8		
≥30 years old	236	76.3	235	66.3	293	46.8	289	65.0	107	32.2		
<b>Skin color</b>												
None-white	211	70.6	290	78.7	484	79.1	388	90.7	203	67.4		
White	85	29.4	68	21.3	113	20.9	35	9.3	106	32.6		
<b>Conjugal status</b>												
Single	74	23.3	153	45.3	229	34.0	145	31.0	121	37.2		
Non-single/living with partner	222	76.7	205	54.7	368	66.0	278	69.0	188	62.8		
<b>Education</b>												
Without formal schooling	159	41.7	68	15.2	121	19.2	107	22.8	63	14.8		
<10 years of schooling	126	54.6	267	76.7	426	71.2	296	71.9	240	83.9		
≥10 years of schooling	11	3.7	23	8.1	50	9.5	20	5.3	6	1.3		
<b>Monthly income</b>												
≤R\$400 (~USD \$210)	108	29.5	60	14.7	112	15.1	128	26.8	82	24.9		
>R\$400 (~USD \$210)	79	32.0	171	46.0	216	34.0	189	46.3	134	43.4		

**Table 2** continued

Characteristics	Manaus		Recife		Rio de Janeiro		Salvador		Santos	
Without income	109	38.5	127	39.3	269	50.9	106	26.9	93	31.7
Working status										
Employed	136	44.7	184	51.4	294	43.7	230	54.4	202	63.8
Unemployed	160	55.3	174	48.6	303	56.3	193	45.6	107	36.2
Ever been arrested										
Yes	107	33.7	142	40.7	265	36.4	216	48.3	166	52.4
Used condom at first sexual intercourse										
Yes	107	33.9	74	23.7	101	20.7	122	35.6	45	14.0

<sup>a</sup> Proportions weighted by the inverse of the individual's social network size and homophily degrees

**Table 3** Weighted HIV prevalence among PSU by study site and according to sex and injection status, Brazil, 2009

Study site	HIV prevalence (95% CI <sup>a</sup> )	HIV prevalence by sex		HIV prevalence by injection status	
		Female	Male	Yes	No
Belo Horizonte	4.7 (2.4–6.9)	17.6 (6.9–28.3)	2.9 (1.2–4.6)	7.0 (2.0–11.9)	3.9 (1.7–6.0)
Brasília	6.7 (3.9–9.4)	0.7 (–0.8 to 2.3)	8.9 (5.7–12.0)	1.3 (–0.0 to 4.8)	7.3 (4.7–9.8)
Campo Grande	5.4 (2.2–8.6)	5.3 (–0.1 to 18.8)	5.4 (1.2–9.6)	19.5 (–1.1 to 49.8)	4.5 (0.7–8.3)
Curitiba	7.6 (4.6–10.6)	18.8 (8.7–28.9)	5.1 (2.4–7.7)	17.1 (3.0–31.1)	6.7 (3.8–3.6)
Itajaí	11.2 (7.6–14.7)	7.2 (–1.6 to 30.5)	12.2 (–0.2 to 26.5)	8.2 (–2.9 to 46.0)	11.5 (–0.1 to 24.6)
Manaus	1.9 (0.3–3.5)	2.6 (–0.0 to 5.3)	1.4 (–0.0 to 3.3)	–	2.1 (0.3–3.9)
Recife	5.0 (2.7–7.2)	12.4 (4.5–20.2)	2.3 (0.2–4.5)	–	5.1 (2.4–7.8)
Rio de Janeiro	7.4 (5.3–9.5)	8.8 (5.6–11.9)	6.8 (4.9–8.6)	10.5 (5.7–15.2)	6.8 (5.1–8.5)
Salvador	3.5 (1.7–5.3)	2.9 (0.2–5.7)	3.7 (1.8–5.7)	8.5 (–0.2 to 19.4)	3.2 (1.7–4.8)
Santos	9.0 (5.8–12.2)	18.9 (–0.4 to 41.9)	6.8 (0.1–13.5)	4.8 (–0.9 to 18.3)	9.8 (1.9–17.6)
Total	5.8 (5.0–6.6)	7.4 (5.7–9.1)	5.2 (4.3–6.1)	8.2 (5.5–10.8)	5.5 (4.6–6.3)

<sup>a</sup> Proportions weighted by the inverse of the individual's social network size and homophily degrees, – No cases

respectively; with an overall rate of 23.3%, as is presented in Table 4.

Around two-fifths (45.1%) reported receiving educational materials on STI in the last 12 months before the interview, with the highest frequency observed in Itajaí (54.0%) and the lowest in Brasília (37.1%). Nearly half (48.7%) reported receiving counseling on STI in the same period, many in Curitiba (59.6%) and few in Recife (40.5%). Furthermore, participants who received free condoms was 71.4%, with highest rates reported in Salvador (90.3%), followed by Santos (89.6%), and lowest in Rio de Janeiro (60.5%).

Table 4 shows that around half (44.3%) of the interviewees had not been previously tested for HIV in lifetime. Previous HIV testing was lowest (33.1%) in Campo Grande, followed by Manaus (36.1%) and Recife (37.0%), whereas the highest proportion (64.5%) was reported in Santos.

Regarding self-perception of HIV risk acquisition, roughly half of the whole sample (50.8%) considered their

risk of becoming infected with HIV as 'none/low' (42.3% in Campo Grande and 65.8% in Salvador), while 39.3% did not answer or did not know how to classify their own risk, varying from 24.5% in Salvador to 47.1% in Rio de Janeiro. Only 10.0% ranked themselves as in a 'high-risk situation' to acquire HIV infection, the lowest rate (9.7%) in Salvador and the highest rate (16.1%) in Belo Horizonte. Meanwhile, the vast majority (92.0%) perceived syringe and needle sharing as putatively associated with HIV transmission (ranging from 84.0% in Brasília to 98.0% in Santos). PSU who have ever been enrolled in treatment programs were 30.9% (pooled estimated point prevalence), ranging from 13.5% in Manaus to 62.7% in Curitiba.

## Discussion

This was the first study conducted among people who misuse substances in Brazil using RDS to amass, integrate and define a pool of data from different study sites. Results



**Table 4** Weighted<sup>a</sup> proportions (95% Confidence Interval) of knowledge, attitudes and practices related to HIV/AIDS among PSU in ten Brazilian cities, 2009

Characteristics	Belo Horizonte	Brasília	Campo Grande	Curitiba	Itajaí	Manaus
<i>Attitudes and practices</i>						
Injected drugs in the last 12 months	24.6 (20.5–28.8)	9.7 (7.0–12.5)	6.0 (1.9–10.2)	9.0 (5.9–12.1)	11.0 (0.00–22.5)	8.6 (5.4–11.9)
Used cocaine in the last 12 months						
Injected	10.5 (6.7–14.2)	4.3 (2.0–6.6)	5.7 (0.0–11.7)	6.6 (2.9–10.3)	4.0 (–0.6 to 13.7)	0.9 (–0.0 to 2.1)
Snorted	79.2 (74.3–84.2)	73.7 (68.8–78.6)	70.4 (58.5–82.3)	65.4 (58.3–72.5)	83.1 (64.6–101.5)	69.4 (63.4–75.4)
Smoked	8.0 (4.7–11.3)	18.1 (13.8–22.3)	15.7 (6.2–25.2)	21.4 (15.2–27.5)	9.6 (–0.5 to 24.1)	27.9 (22.1–33.8)
Other	2.3 (0.4–4.1)	3.9 (1.7–6.1)	8.2 (1.0–15.4)	6.6 (2.9–10.3)	3.3 (–0.5 to 12.2)	1.8 (0.0–3.5)
Ever used drugs and forget to use condom	64.5 (59.8–69.1)	57.0 (52.3–61.7)	59.5 (50.8–68.2)	70.2 (65.0–75.3)	55.8 (37.4–74.1)	61.76 (56.0–67.4)
Ever been discriminated because use drugs	68.3 (63.8–73.0)	56.7 (52.0–61.5)	77.4 (70.0–84.8)	74.3 (69.4–79.2)	63.4 (45.7–81.2)	53.3 (47.5–59.2)
Ever been in drug treatment program	36.8 (32.1–41.3)	32.7 (28.3–37.1)	35.0 (26.7–43.3)	62.7 (57.4–68.0)	44.2 (25.9–62.5)	13.5 (9.5–17.4)
Sex with occasional partner—last 12 months	45.3 (40.4–50.2)	46.4 (41.6–51.1)	48.0 (39.2–56.9)	41.6 (36.1–47.2)	55.2 (36.8–73.6)	42.6 (36.8–48.4)
Condom use with occasional partner—last sex	63.2 (55.3–71.2)	63.9 (56.3–71.4)	65.0 (50.3–79.7)	54.5 (43.4–65.6)	71.3 (41.4–98.2)	66.6 (57.1–76.1)
Used condom with regular partner—last sex	60.3 (50.5–70.0)	77.6 (70.8–84.4)	47.4 (30.9–63.8)	51.3 (40.7–62.0)	68.1 (34.4–100.0)	58.6 (49.7–67.4)
Commercial sex—last 12 months	46.5 (41.7–51.4)	34.8 (30.3–39.4)	50.7 (41.8–59.5)	49.0 (43.4–54.6)	42.6 (24.4–60.9)	36.1 (30.5–41.7)
Number of commercial sexual partners among those who exchanged sex—last 12 months						
One	29.9 (23.3–36.5)	37.8 (30.0–45.6)	31.3 (19.7–42.8)	36.5 (28.7–44.2)	38.2 (10.0–66.3)	44.0 (34.2–53.7)
2–5	41.4 (34.3–48.4)	35.7 (28.0–43.4)	46.7 (34.2–59.1)	43.3 (35.4–51.3)	34.9 (7.3–62.5)	42.7 (33.1–53.7)
6 or more	28.8 (22.2–35.3)	26.5 (19.4–33.6)	22.1 (11.7–32.4)	20.2 (13.7–26.6)	26.9 (1.2–52.6)	13.3 (6.6–19.9)
Engaged in sexual violence in lifetime (victim/perpetrator)	24.4 (20.2–28.7)	20.2 (16.4–24.0)	15.6 (9.2–22.0)	18.2 (13.9–22.5)	14.9 (1.8–28.0)	21.2 (16.4–26.0)
Received educational materials on STIs—last 12 months	50.2 (45.4–55.0)	37.1 (32.6–41.6)	47.2 (38.5–56.0)	49.6 (44.1–55.1)	54.0 (35.6–72.4)	47.2 (41.4–53.1)
Received counseling on STIs—last 12 months	45.4 (40.6–50.2)	45.5 (40.8–50.2)	40.9 (32.3–49.5)	59.6 (54.3–65.0)	53.2 (34.8–71.6)	58.0 (52.2–63.8)
Received condoms—last 12 months	74.4 (70.1–78.6)	70.5 (66.2–74.8)	76.0 (68.5–83.5)	67.3 (62.0–72.5)	81.3 (66.9–95.7)	66.1 (60.6–71.7)
Frequency of condom use—last 12 months						
Always	25.7 (21.5–29.9)	29.1 (24.8–33.3)	27.2 (19.4–35.0)	20.0 (15.7–24.4)	34.0 (16.5–51.4)	23.8 (18.8–28.8)
Rarely/sometimes	52.1 (47.3–56.9)	53.1 (48.4–57.8)	57.3 (48.6–65.9)	53.3 (47.9–58.8)	45.1 (26.8–63.4)	58.0 (52.2–63.7)
Never	22.1 (18.1–26.1)	17.8 (14.1–21.1)	15.5 (9.2–21.8)	26.6 (21.8–31.4)	20.9 (5.9–35.9)	18.2 (13.7–22.7)

**Table 4** continued

Characteristics	Belo Horizonte	Brasília	Campo Grande	Curitiba	Itajaí	Manaus
Previous HIV testing	43.9 (39.1–48.8)	54.7 (50.0–59.4)	33.1 (24.8–41.4)	58.3 (52.7–63.8)	60.5 (42.5–78.5)	36.1 (30.5–41.8)
<i>Knowledge and other</i>						
Syringes sharing can transmit HIV	92.8 (90.3–95.3)	84.0 (80.5–87.5)	91.8 (87.0–96.7)	92.2 (89.2–95.2)	96.5 (89.7–103.3)	95.0 (92.4–97.5)
Self-perceived risk of HIV infection						
High	16.1 (12.5–19.7)	10.2 (7.3–13.0)	15.2 (8.8–21.5)	7.0 (4.1–9.8)	12.4 (0.3–24.6)	3.7 (1.5–5.9)
None/low	57.5 (52.2–62.3)	44.6 (39.9–49.3)	42.3 (33.6–51.0)	48.4 (42.8–54.0)	58.9 (40.8–77.1)	52.5 (46.6–58.3)
No answer/don't know	26.5 (22.1–30.7)	45.2 (40.5–50.0)	42.5 (33.8–51.3)	44.6 (39.0–50.1)	28.6 (11.9–45.2)	43.8 (38.0–49.6)
Lifetime syphilis exposure (antibody+)	8.9 (6.1–11.7)	12.9 (9.7–16.1)	11.7 (6.0–17.3)	10.9 (7.4–14.3)	4.4 (0.0–12.0)	2.3 (0.5–4.0)
Characteristics	Recife	Rio de Janeiro	Salvador	Santos	Total (95% CI)	
<i>Attitudes and practices</i>						
Injected drugs in the last 12 months	3.1 (1.0–5.2)	15.9 (13.7–18.1)	5.1 (3.2–7.0)	16.0 (7.3–24.7)	12.0 (10.9–13.1)	
Used cocaine in the last 12 months						
Injected	0.4 (–0.1 to 1.6)	6.3 (4.7–8.0)	1.4 (0.2–2.5)	2.1 (–0.2 to 6.2)	4.9 (4.0–5.7)	
Snorted	83.9 (76.9–90.8)	69.9 (65.8–72.0)	95.8 (93.8–97.8)	95.8 (89.9–101.6)	76.0 (74.3–77.7)	
Smoked	14.2 (7.6–20.8)	19.0 (16.4–21.7)	2.4 (0.9–3.9)	2.1 (–0.2 to 6.3)	15.4 (14.0–16.8)	
Other	1.5 (–0.1 to 3.7)	5.7 (4.2–7.3)	0.4 (–0.0 to 1.0)	–	3.7 (3.0–4.5)	
Ever used drugs and forget to use condom	66.2 (60.5–71.9)	69.1 (66.3–72.0)	59.0 (54.7–63.3)	58.3 (46.6–70.0)	64.1 (62.5–65.7)	
Ever been discriminated because use drugs	82.4 (77.8–87.0)	62.1 (59.1–65.1)	71.9 (67.9–75.8)	74.5 (64.2–84.8)	66.4 (64.8–68.0)	
Ever been in drug treatment program	24.8 (19.6–30.0)	29.5 (26.7–32.2)	19.5 (16.1–23.0)	26.3 (16.0–36.8)	30.9 (29.4–32.5)	
Sex with occasional partner—last 12 months	50.9 (44.8–57.0)	50.6 (47.5–53.7)	53.4 (49.0–57.7)	64.9 (53.6–76.2)	48.7 (47.0–50.3)	
Condom use with occasional partner—last sex	74.2 (65.6–82.8)	58.9 (53.7–64.1)	77.1 (71.4–82.8)	55.9 (40.5–71.3)	65.0 (62.3–67.6)	
Used condom with regular partner—last sex	60.6 (49.5–71.7)	63.6 (57.6–69.7)	72.8 (66.2–74.4)	66.7 (40.2–93.3)	64.5 (61.6–67.5)	
Commercial sex—last 12 months	58.2 (52.2–64.1)	55.1 (52.0–58.1)	35.8 (31.6–40.0)	47.8 (35.9–59.6)	46.4 (44.8–48.1)	
Number of commercial sexual partners among those who exchanged sex—last 12 months						
One	33.4 (25.9–40.9)	32.3 (28.4–36.2)	24.0 (17.7–30.2)	4.5 (00.0–11.7)	32.3 (30.0–34.6)	
2–5	35.7 (28.1–43.3)	36.9 (32.9–40.9)	38.9 (31.7–46.0)	5.5 (00.0–13.5)	38.1 (35.7–40.5)	

**Table 4** continued

Characteristics	Recife	Rio de Janeiro	Salvador	Santos	Total (95% CI)
6 or more	30.9 (23.5–38.2)	30.7 (26.9–34.6)	37.1 (30.1–44.2)	89.9 (74.5–100.0)	29.6 (27.3–31.8)
Engaged in sexual violence in lifetime (victim/perpetrator)	21.3 (16.4–26.3)	28.8 (26.0–31.6)	19.0 (15.6–22.5)	14.2 (5.9–22.5)	22.7 (21.3–24.1)
Received educational materials on STIs—last 12 months	39.6 (33.7–45.5)	44.2 (41.2–47.2)	48.2 (43.9–52.5)	39.1 (27.5–50.7)	45.1 (43.5–46.8)
Received counseling on STIs—last 12 months	40.5 (34.6–46.4)	45.3 (42.2–48.3)	55.0 (50.7–59.3)	46.4 (34.5–58.2)	48.7 (47.0–50.3)
Received condoms—last 12 months	77.0 (72.0–82.1)	60.5 (57.5–63.5)	90.3 (87.7–92.9)	89.6 (82.4–96.8)	71.4 (69.9–72.9)
Frequency of condom use—last 12 months					
Always	23.1 (18.1–28.2)	18.8 (16.4–21.2)	25.0 (21.3–28.8)	27.6 (17.0–38.2)	23.3 (21.9–24.7)
Rarely/sometimes	51.8 (45.8–57.8)	59.6 (56.6–62.6)	57.2 (52.9–61.5)	56.0 (44.2–67.8)	56.0 (54.3–57.6)
Never	25.0 (19.8–30.3)	21.6 (19.1–24.1)	17.7 (14.4–21.0)	16.4 (7.6–25.2)	20.7 (19.4–22.1)
Previous HIV testing	37.0 (31.2–42.8)	43.2 (40.1–46.2)	37.2 (33.0–41.4)	64.5 (53.2–75.9)	44.3 (42.7–46.0)
<i>Knowledge and other</i>					
Syringes sharing can transmit HIV	94.7 (92.1–97.4)	90.8 (89.0–92.5)	96.4 (94.8–98.1)	98.0 (94.6–101.3)	92.0 (91.1–92.9)
Self-perceived risk of HIV infection					
High	6.8 (3.8–9.8)	10.0 (8.1–11.8)	9.7 (7.1–12.3)	11.6 (4.0–19.2)	10.0 (8.9–10.9)
None/low	55.8 (49.8–61.8)	42.9 (39.9–46.0)	65.8 (61.6–69.9)	52.9 (41.0–64.7)	50.8 (49.1–52.6)
No answer/don't know	37.4 (31.6–43.1)	47.1 (44.0–50.2)	24.5 (20.7–28.2)	35.5 (24.2–46.9)	39.3 (37.7–40.9)
Lifetime syphilis exposure (antibody+)	8.3 (5.0–11.6)	16.5 (14.2–18.8)	5.0 (3.17–6.9)	8.0 (1.6–14.4)	10.7 (9.7–11.8)

<sup>a</sup> Proportions weighted by the inverse of the individual's social network size and homophily degrees

indicate a high (5.8%; 95% CI 5.0–6.6) prevalence of HIV infection among our sample of PSU compared to the general Brazilian population (0.6%) [23]. Despite diverse recruitment methodologies, drug using patterns and large differences in socioeconomic characteristics between and within countries, the literature, notwithstanding, highlights key similarities characterizing the drug use phenomenon across countries worldwide. Studies conducted in the Americas, Eastern Europe, and African and Asian countries, found rates of HIV among PSU (of both injectable and non-injectable substances) similar to ours and some of them even higher than our estimates [8, 24–29].

Although differential HIV risk acquisition rates between injecting and non-injectable are not fully understood [30],

HIV infection rates as high as 10.9 and 42.0% were reported among injecting drug users in Yerevan, Armenia [24] and Dar es Salaam, Tanzania [31], respectively, countries where rates of injection are low, as have been observed in recent years in Brazil. On the other hand, HIV infection rates ranged from 3.0 to 69.0% in a pool of eight Russian cities [32], where injection rates are very high compared to Brazil.

A high proportion of engagement in occasional sex was found in this study, with 65.0% (95% CI 62.3–67.6) of the interviewees reporting condom use at their last sexual encounter prior to the interview. The proportion is similar to 40.0% found among injecting drug users in Yerevan, Armenia [24] and to 36.2% among frequent drug users in a study summarizing data from Chinese HIV sentinel

surveillance sites [33]. In India, a country with high rates of injection and HIV [34], compared to Brazil, in the states of Nagaland and Manipur 60.0 and 72.0% of drug users, respectively, reported to have had unprotected sex with occasional paid/unpaid partners in the last 12 months before the interview [35]. Most (77.0%) interviewees from our sample reported inconsistent condom use, which is the most important risk factor for HIV acquisition and transmission in the Brazilian scenario, even considering the pronounced heterogeneity of general characteristics and the overall low rates of injection in the ten study sites. Despite diverse recruitment methodologies and drug using patterns, similar rates of inconsistent condom use among PSU were reported by all studies conducted in Brazil and several other middle-income countries, such as Colombia, India, and Iran [31, 35–39].

Many participants reported sex with multiple sexual partners. High frequencies of multiple sexual intercourse and engagement in commercial sex have been reported in the most different settings, worldwide, such as in surveys targeting injecting and non-injecting drug users in China [33, 39] and in Lebanon [40].

Findings documenting low condom use and a sizeable proportion of respondents who perceive themselves at none/low risk of HIV infection may increase the risk of acquiring and eventually transmitting HIV, in case self-perception of risks translates into a diminished perception of other people's risk. Fortunately, as repeatedly shown by the literature, a high proportion of our sample answered correctly that sharing syringes/needles can transmit HIV [41]. Surveys worldwide have reported high rates of drug users with a sound knowledge on HIV transmission ways [27, 42, 43], but it is of great importance to note that a sound knowledge about most risks of acquiring and transmitting HIV may not be comprehensive or coherent [41], and might not be translated into the consistent adoption of safer practices [6].

A small proportion of PSU reported to have been attended treatment programs. Notably, according to UNAIDS only one in six drug users access drug treatment services each year and, on average, each drug user access 90 needles per year, whereas the actual demand was estimated at 200 per year per drug user [6]. The proportion of PSU who have ever been tested for HIV in our study may be defined as a mid-range proportion according to UNAIDS criteria. Although our data are not perfectly comparable to other countries' published data due to differences in the drug user population's characteristics (especially the type of substances most frequently consumed), as well as biases associated with each specific method and respective procedures, international surveys have highlighted both similar and different results. For

example, higher rates as 75.7 and 97.4% of drug users have been ever documented for HIV in San Francisco [44] and in methadone clinics located in Southern China [45], respectively. On the other hand, much lower rates have been reported in several countries of Sub-Saharan Africa where different cultural characteristics, less than optimal access, as well as long-distances and high transportation costs (especially relevant in cities located far from major urban centers) have compromised testing strategies in real world conditions [46].

Almost half of the sample reported to have received counseling and educational materials on STI, with the majority stating they have received free condoms. In a study conducted in New York City [47], the proportion of people who received counseling was 13.0%, whereas the proportion who received free condoms was 62.9%. The number of commercial sex partners in our sample was similar to that found in Sidney, Australia [48], and it is known that to have unprotected sexual intercourse with many commercial sexual partners could increase the risk of HIV acquisition.

In general, our findings suggest that female (7.4%, 95% CI 5.7–9.1) PSU have higher overall HIV prevalence than their male (5.2%, 95% CI 4.3–6.1) counterparts, instead of local variations. A recent pooled prevalence analysis issued by the UNAIDS estimated as 13% and 9% the point prevalence of HIV for women and for men drug users worldwide, respectively [6]. Additional literature on HIV differential infection rates between male and female who inject drugs strengthens our findings that female PSU tend to have higher HIV prevalence than males [9], as was observed in this study in Belo Horizonte, Curitiba, Recife and Santos. Yet, HIV prevalence was higher among female drug users than among their male counterparts in Tijuana, Mexico [49]. Notably, we should emphasize that female PSU seem to be at higher risk of HIV infection in the ten study sites through a combination of overlapping risks: high levels of unprotected sexual intercourse, partner/gender based violence, and more frequent unsafe injection habits, as reported in several studies [43, 50–53].

The relatively high HIV prevalence (*vis-à-vis* much lower infection rates among Brazil's general population) made evident in this study seem to be secondary to a combination of repeated risky interactions within social networks with high background prevalences [54], as well as in consequence of less than optimal preventive campaigns, which have been fell short of reaching key populations with the necessary broadness and comprehensiveness, as has been suggested by researchers in Mexico [55]. Such specific risk factors tend to be aggravated by structural problems secondary to interpersonal violence, scarcity of health and

social facilities, as well as dire poverty with the consequent lack of basic resources, such as free condoms and sterile syringes as well as food insecurity [56].

### Study Limitations

Although our findings highlighted some important points regarding HIV infection rates and attitudes, practices and knowledge related to HIV among PSU in ten Brazilian cities, certain limitations should be considered here. Since recruiting chains are driven by the respondents themselves, they are prone to selection bias because recruiters are more likely to recruit peers with characteristics similar to their own, with consequent overrepresentation of such specific segments and specific branches of broader social networks [14]. Cross-sectional studies are also influenced by recall bias, i.e., participants might not remember certain aspects of the past and/or might select some information, which is, consciously or unconsciously, associated with other relevant events, taking place over a whole lifetime. Questions regarding both past 12 months and 30 past days were used to minimize recall bias. Yet, findings may be affected as well by social desirability bias, thus favoring under-report of socially unacceptable behaviors. Last but not least, cross-sectional studies are invariably plagued by the difficulty or impossibility to discern the directionality of observed associations.

Finally, we should mention Brazil is a particularly vast, densely populated and heterogeneous country. In this sense, any study sampling data from 10 municipalities in a universe of over 5500 municipalities spread over a continental-size country should be not viewed as representing the country as such.

Moving from the macro to the micro level, one must keep in mind that pooled estimates of individual networks, tend to mix-up the underlying structure of each local network. Since putative biases are strongly context-dependent, no algorithmic procedure can fix such inaccuracies. Nonetheless, RDS may produce quasi-probabilistic estimates according to its basic assumptions of reaching (after a given number of waves) a situation of actual equilibrium of local networks as the chain-referral process progress over time and across the chain of successive referrals [14]. Importantly, we pooled ten independent networks in order to obtain a large sample as opposed to much smaller [57] single networks, generating a more suitable data for the purpose of surveillance among PSU and multivariable analyses that may be precluded by lack of statistical power. To conclude, other sampling methods not designed to assess hard-to-reach populations might generate biased samples as well, although the magnitude and directionality of these biases are far from straightforward, as demonstrated by cross-comparisons between multimethod studies using RDS and Time-Location Sampling (TLS) [44, 58, 59].

### Conclusion

The prevalence of HIV varied across the study site, but remains, notwithstanding, substantially higher than rates observed in the general population. These findings should inform policies and targeted interventions to improve health care and preventive interventions among PSU. The most needed HIV prevention calls for structural interventions that can help to alleviate health inequity and insure the protection (and ideally the promotion of) human rights.

These findings are critical in light of a considerably high level of free condom distribution, as reported by the interviewees of our study. Our results suggest that several obstacles for HIV prevention remain and messages disseminated by mass campaigns are not successfully reaching especially vulnerable groups and/or have not been tailored to them. It is urgent to redesign campaigns strategies, to integrate them with targeted interventions, taking in consideration that sound knowledge of HIV prevention and access to broad campaigns do not necessarily translate into concrete behavioral change and prevention practices. Future studies using RDS must go beyond addressing relationships between HIV infection and risk factors by examining the broader social context where people are inserted and interact with each other.

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### Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol was approved by the Ethical Council of the Sergio Arouca National School of Public Health (CEP/ENSP n°. 90/2008).

**Informed Consent** Informed consent was obtained from all participants included in the study.

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