

HIV among MSM in a large middle-income country

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Objective: To conduct the first national biological and behavioral surveillance survey for HIV among MSM in Brazil.

Design: A cross-sectional surveillance study utilizing Respondent Driven Sampling (RDS) in 10 cities, following formative research. Planned sample: 350 MSM reporting sex with another man in the last 12 months, at least 18 years of age, and residing in the city of the study.

Methods: Conventional RDS recruitment. Results were calculated for each city using RDSAT 5.6. For the national estimate, a new individual weight using a novel method was calculated. The 10 cities were aggregated, treated as strata and analyzed using STATA11.0. Self-reported HIV status and logistic regression was used to impute missing values for serostatus, an important issue for RDSAT.

Results: A total of 3859 MSM were interviewed. Sample was diverse, most self-identified as mulatto or black, were social class C or below, and had relatively low levels of education. More than 80% reported more than one partner in the last 6 months. Only 49% had ever tested for HIV. HIV prevalence among MSM ranged from 5.2 to 23.7% in the 10 cities (3.7–16.5% without imputation) and was 14.2% for all cities combined with imputation. The overall prevalence was two and three times higher than that estimated for female sex workers and drug users, respectively, in Brazil. Half of those who tested HIV positive were not aware of their infection.

Conclusion: The AIDS epidemic in Brazil is disproportionately concentrated among MSM, as has been found in other countries. Renewed efforts to encourage testing, prevention and treatment are required.

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Introduction

Since the beginning of the AIDS epidemic in the early 1980s, MSM have been disproportionately affected by the

HIV [1]. The risk of infection remains high among MSM worldwide [2–6]. In Brazil, the HIV infection rates are substantially higher among MSM, drug users and female sex workers (FSW) [7,8]. Beginning in the 1990s, there

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was an increase of cases among heterosexual men. However, MSM still account for 29.2% of all AIDS cases reported in Brazil and about 40.0% of the cases among men 15–24 [9]. MSM in Brazil have an AIDS prevalence rate estimated 13 times higher than heterosexual men [10].

Lack of knowledge of HIV serostatus and perception of low risk may be reasons why MSM continue to engage in high-risk sex [11–13], including in Brazil [14]. A study of more than 5000 MSM in six US cities found that 77% did not know their serostatus; among African–Americans this percentage was 91% [15]. Among 6672 men of unknown serostatus approached for testing in the United States, MSM were 10 times more likely than non-MSM to have undiagnosed HIV infection [16].

This article presents the results of the first national study of HIV prevalence among MSM conducted in Brazil and is intended to serve as a baseline for monitoring the prevalence of HIV infection, knowledge and attitudes toward HIV and AIDS, and sexual practices among MSM.

Methodology

We conducted a cross-sectional study in 10 cities in Brazil in 2009. The cities were selected by the department of STD, HIV/AIDS and Viral Hepatitis (DN) of the Brazilian Ministry of Health. The cities were Manaus, Recife, Salvador, Campo Grande, Brasília, Curitiba, Itajaí, Santos, Belo Horizonte, and Rio de Janeiro (Fig. 1). The study was approved by the National Ethic Research Committee (CONEP # 14494).

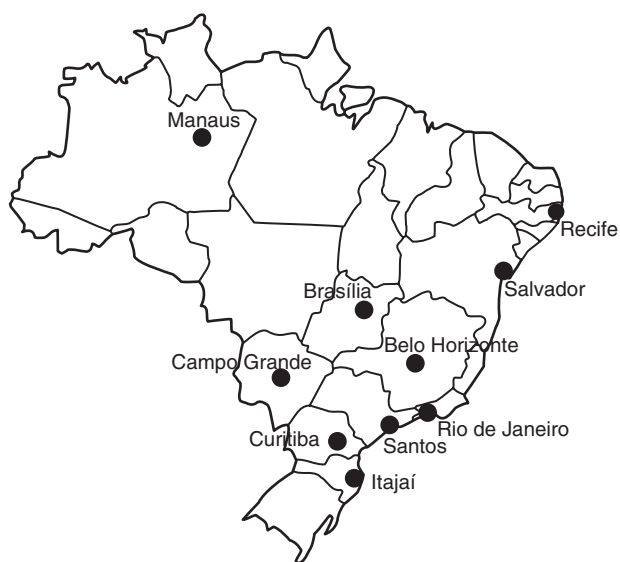


Fig. 1. Study sites for National HIV prevalence among MSM in Brazil, 2009.

Study population

Men were eligible if they were 18 years old or older, residents of the selected cities and had not previously participated in this study, had sex with a man or a transgendered person in the last 12 months, presented a valid coupon, did not identify as transgender, accepted conditions for the study, signed the consent form, and were not obviously under the influence of any drug. MSM who identified as transgendered are recognized as a distinctly different population in Brazil [17].

We calculated a sample size of approximately 350 per city ($\alpha = 0.95$; power = 0.90; estimated prevalence 13.6% [18]) to provide independent estimates for each city. Participants were recruited through respondent-driven sampling (RDS) [19,20]. RDS is a chain link sampling method that begins with a convenience sample of members of the target population called ‘seeds’. Seeds recruit a prespecified number of recruits. These respondents recruit new participants. Assuming a stochastic Markov chain model, this method produces recruitment chains that, when long enough, are no longer dependent on the purposively selected seeds. The personal social network size of respondents is used to assign weight to correct for the influence of network size and differential recruitment. RDS is widely used as an HIV surveillance-sampling method [21] and has been recommended by the Centers for Disease Control and Prevention [22] and by DN [23] for hidden, hard-to-reach, and HIV high-risk populations.

This study was initiated with about six diverse seeds in each municipality. Each respondent received three coupons. This process was repeated until the study reached the desired sample size. Participants received a primary incentive of R\$ (Brazilian Real) 15.00 (\approx US\$ 10.00) and an incentive of R\$ (Brazilian Real) 10.00 (\approx US\$ 6.67) for each of their recruits who completed the survey. Anyone who visited the study site was offered educational materials and condoms.

Formative research

We carried out formative research to explore interest in participation, level and kind of incentives, potential seeds, health education materials, study site and logistics, and coupon design. We conducted semi-structured and in-depth interviews as well as focus group discussions. Although formative research suggested that the study sites should not be sited in health services, Brazilian law required test be conducted only in health services.

Data collection

Data on socioeconomic and demographic characteristics; HIV and Syphilis testing; sexual orientation and sexual identity; social network characteristics and size; sexual behavior; alcohol, illicit drugs and mental health; discrimination and violence; social integration and participation; sources of information about sexually

transmitted infections (STI) and condom access; healthcare and history of STI; and knowledge about HIV and other STIs were collected through face-to-face interviews. We used Brazilian criteria [24] to classify individuals into five economic classes: A, the highest, to E, the lowest.

Participants' personal social network sizes were measured by a cascade of questions that arrived at a number of MSM who were 18 or older, with whom they were familiar, met or talked to in the two previous months, and who they might invite to participate in this study.

All participants were offered a voluntary rapid test for HIV, and HIV infection was determined by using a finger stick rapid test kit. The study followed the national algorithm for rapid testing [25]: first the Rapid Check HIV-1 and 2 and Bio-Manguinhos HIV-1 and 2 were administered at the same time, followed by a third test, in case the previous two tests were discrepant. All participants who were tested also received pretest and posttest HIV counseling. Participants diagnosed with HIV infection were counseled. The unified health system in Brazil constitutionally guarantees free healthcare to all citizens. The National Program identified Reference Centers for HIV/AIDS in each site and each patient was referred to that Center, carrying a document from the study to assure rapid enrollment.

Analysis

Data from each city were first analyzed separately. RDS collected data requires analysis with RDS Analysis Tool (RDSAT), we used RDSAT 5.6. However, RDSAT treats missing values differently than many programs. RDSAT treats a missing value as the end of a chain, and the next person recruited by the individual with the missing value as a seed. Seeds are not considered part of the sample, and their values are ignored. This reduces sample size by two for each missing value.

In this study, the percentage of individuals who refused to test in the survey ranged from 2.3% in Campo Grande, to 50.3% in Itajaí. Thus, we decided to impute the missing values of the HIV test [26]. For those who self-reported seropositive, but who did not test in the study, we imputed a positive value. This procedure was based on the results of the study of self-reported reliability of HIV test among MSM population that showed 100% sensitivity and zero false positives for positive self-report [27].

Later, in addition to 'self-reported imputation', we used a nonweighted logistic regression to infer the most likely result for the HIV test for those whose characteristics were found to be highly associated with a given test result as in Lane *et al.* [28]. The independent variables (socioeconomic characteristics, sexual behavior, safe sex, drugs and alcohol use, violence and homophobia) for those included in the initial model were selected from those who tested for HIV and showed a significant

association with the HIV positive/HIV negative result ($<P=0.10$ Fisher's exact test). Nontesting participants with similar socioeconomic and behavioral values were assigned an HIV status according to the likelihood of being positive or negative.

With two ways to treat missing values in RDSAT, we used four methods to estimate the prevalence of HIV using RDSAT 5.6. First, we estimated the prevalence after setting missing values for the HIV test to a third integer, not the missing value code in RDSAT (HIV positive = '1'; HIV negative = '2'; Did not test = '3'). Second, HIV prevalence was calculated using the conventional RDSAT method (missing value = '9999'). Third, we estimated HIV prevalence using 'self-reported imputation' for missing values for the HIV test. Finally, HIV prevalence was calculated using a combination of 'self-reported imputation' and logistic regression.

The next step was to calculate an overall prevalence for the country using data from all 10 cities. First, we calculated a new individual weight using a variation of the method applied previously for RDS for FSW in Brazil [29]. The weight was defined by the following:

$$W_{ij} = D_{ij} m_j n$$

wherein, ' i ' is the i th participant of city ' j ', $j = 1, 2, \dots, 10$; ' D_{ij} ' is the weight for participant ' i ' generated by RDSAT when we estimated the HIV prevalence for city ' j ' using the fourth method described above; ' m_j ' is the proportion of MSM of the total men for city ' j ' between 18 and 64 years of age (total men estimated by the Department of Informatics of the Unified Health System [30]) estimated as 2.8% in Manaus, 2.5% in Recife and Salvador, 1.2% in Brasília and Campo Grande, 3.3% in Belo Horizonte and Santos, 3.9% in Curitiba and Itajaí (total MSM population for all the cities estimated at 377 802) [31]; and ' n ' is the total size of the MSM sample for the 10 cities ($n = 3859$). We then aggregated all the 10 datasets to create one single dataset weighted for each participant (W_{ij}). The 10-city dataset was then analyzed using the module for a complex sample wherein each city was treated as a stratum. This analysis was performed in STATA11.0 (Stata Corporation, College Station, Texas, USA).

Results

A total of 3859 MSM were interviewed in the 10 cities. Most participants were between 18 and 39 years old and identified themselves as mulatto or black (except in the cities located in the southeast and south). Belo Horizonte stood out with a high percentage of MSM (38.5%), with a high level of education (completed high school and above), whereas Manaus (2.0%), Brasília (4.2%), Santos (5.0%), and Rio de Janeiro (5.1%) had a small percentage of participants with advanced schooling. Classes A/B

(higher), had a low percentage in Rio de Janeiro (8.8%) and Santos (8.9%) and highest percentage in Belo Horizonte (60.1%). The highest percentage of participants belonging to classes D/E were found in Santos (56.8%), Rio de Janeiro (55.5%), Curitiba (45.1%), and Brasília (38.9%). In all municipalities, the majority was single, with around 10% married or living with a partner. Most respondents lived with their parents or friends/relatives, but cities such as Santos (47.1%) and Curitiba (43.5%) showed a higher proportion of participants living alone (Table 1).

With the exception of Campo Grande (88.6%), Rio de Janeiro (82.7%) and Santos (72.6%), 90% of MSM reported more than one sexual partner in the last 6 months. Most participants reported casual partners (30.8–66.1%) and many (6.3–42.4%) commercial sexual partners. The lowest and highest proportion of protected sex with all partners was reported in Manaus (30.1%) and in Santos (55.3%), respectively. Protected sex between casual partners was highest in Campo Grande (77.7%) and lowest in Curitiba (50.0%) while having sex with a condom with men and/or women at last intercourse ranged from 58.6% in Curitiba to 77.8% in Santos (Table 2).

Almost half (48.8%) reported having ever tested for HIV and, among those, 6.6% reported being HIV-infected. Most participants ($\geq 81.6\%$) agreed to test for HIV during the study, but in Itajaí and in Brasília 50.3 and 27.9%, respectively, refused to do so. Respondents in our study who did not test gave recent previous test as the single most mentioned reason for not testing [31%; 95% confidence interval (CI) 23.7–43.3%] constituting 52.6% of those that reported any reason for not testing.

Of the total sample, 475 refused to test. HIV prevalence varied widely among the studied cities. When we included those who self-reported being HIV-infected, the estimated prevalence tended to increase. Furthermore, prevalence increased in most cities after the logistic regression imputation and ranged from 5.2% (95% CI 2.7–8.2% in Recife) to 23.7% (95% CI 16.6–31.5% in Brasília) (Table 3). We did not impute values in Itajaí with logistic regression because so many respondents neither tested in the study nor reported their HIV status from previous tests. The overall prevalence of HIV in the total sample ranged from 11.1% (95% CI 9.1–13.6%) to 14.2% (95% CI 12.1–16.6%) depending on whether the imputation was through self-report or logistic regression (Table 4). Of those found to be HIV-positive testing in the study, 49.6% were not aware they were positive.

Discussion

This is the first nation-wide sample of MSM for HIV biological and behavioral surveillance conducted in

Brazil. The overall prevalence for MSM is three times higher than that estimated for FSW in Brazil [7] and over twice the 5.9% estimated for drug users [8]. Prevalence was heterogeneous, varying significantly among the studied cities. This study reinforces the finding that the AIDS epidemic in Brazil is disproportionately concentrated among MSM, as has been found in other countries [2,6,32–36].

The epidemic in this population demonstrated substantial diversity by city in indicators other than seroprevalence. The city samples differed in level of education and socioeconomic class. This finding has at least two plausible explanations. First, Brazil is not homogeneous with respect to development and infrastructure and that heterogeneity is reflected in these indicators. This was also an aim of the study to recruit participants from across the socioeconomic spectrum. Prevention and outcome indicators in many populations such as vertical transmission, condom use, late enrollment in therapy, survival and mortality do differ by region [37–39]. A second explanation may be associated with RDS. This method does not sample a population directly, but via a connected social network. Each network selected in the 10 cities may sample different sectors of the population category MSM. Not only RDS, but other methods for recruiting hard to reach populations may also generate diverse samples. Studies in the United States and Brazil have shown that different sampling methods may generate samples that appear to differ systematically [40,41]. Imputation of missing values increased HIV seroprevalence, meaning that men at high risk of transmission are refusing to test in surveillance activities. This has important implications for surveillance.

Whatever the implications for generating a reliable and valid single prevalence figure for Brazil as a whole, the study here demonstrated real issues for prevention. MSM had multiple and diverse partners. They used condoms more frequently with their casual partners but consistent use with all partners, including casual and commercial, was low. Knowledge of serostatus is even more important for early treatment and prevention of transmission to partners. The benefits of HAART for the individual and the community are both higher if initiated early which may be a potential outcome of surveillance. Although it is gratifying that a majority of participants agreed to test in this study, it is alarming how few MSM had tested previously and that half of the men who tested positive in our study did not know they were infected.

In spite of an increase in reported ever testing from 20.2 to 33.6% in Brazil, we believe there are persistent barriers to testing. For example, men with low education and living in areas of lower socioeconomic development test less [42]. An important finding of this study is that almost one half of the sample had never had an HIV test, and many reported that their chance of being infected was

Table 1. Socioeconomic and demographic characteristics of MSM in 10 cities, Brazil, 2009.

	Manaus		Recife		Salvador		Brasília		Campo Grande		Belo Horizonte		Rio de Janeiro		Santos		Curitiba		Itajaí		
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	
Age (years)																					
18–24	71.8	(66.9–76.3)	0.5	(0.0–1.4)	63.2	(55.2–70.9)	34.5	(27.7–41.2)	52.5	(43.5–60.5)	53.6	(41.7–63.4)	23.6	(15.9–31.1)	25.0	(13.5–29.5)	31.5	(22.2–41.0)	50.9	(39.8–60.1)	
24–29	15.7	(12.6–19.5)	47.7	(40.3–56.7)	18.4	(13.2–24.3)	18.0	(12.5–24.1)	24.7	(18.9–32.5)	23.1	(16.8–31.3)	16.1	(9.6–19.9)	23.0	(15.7–33.0)	24.8	(17.7–32.6)	14.9	(10.3–20.6)	
30–39	10.2	(7.1–13.2)	18.6	(12.6–23.0)	16.0	(10.2–21.7)	28.1	(21.6–35.1)	17.7	(11.7–24.0)	15.4	(9.5–21.4)	33.8	(27.5–41.9)	29.2	(22.7–41.6)	26.4	(19.3–33.4)	24.5	(17.3–31.8)	
40–49	2.3	(1.2–3.5)	19.2	(14.3–24.2)	1.7	(0.4–3.7)	11.4	(6.6–16.9)	4.4	(1.8–7.0)	4.6	(1.5–9.1)	15.1	(11.7–20.8)	14.7	(8.7–23.4)	15.5	(9.3–23.5)	6.7	(3.0–11.8)	
50 or more	0.1	(0.0–0.2)	13.1	(7.9–19.9)	0.7	(0.0–2.2)	8.0	(4.2–12.3)	0.7	(0.1–1.6)	3.3	(0.0–9.3)	11.4	(6.6–17.7)	8.1	(1.7–14.6)	1.7	(0.4–3.5)	3.1	(0.6–7.2)	
Race																					
White	16.0	(12.5–19.4)	18.2	(13.4–22.9)	8.3	(5.1–12.3)	23.1	(17.3–29.8)	39.7	(31.9–48.4)	44.1	(36.9–53.3)	22.9	(16.2–30.1)	32.4	(24.4–42.2)	41.8	(33.5–49.1)	42.5	(34.9–49.4)	
Black/mulatto	82.3	(79.0–86.0)	77.1	(71.5–82.3)	90.0	(85.7–93.6)	74.9	(68.0–80.9)	57.4	(48.8–65.1)	52.5	(42.9–59.3)	74.3	(66.5–81.1)	65.7	(55.9–73.6)	55.9	(48.5–64.6)	52.5	(45.3–60.4)	
Asian/indigenous ^a	1.7	(0.7–2.6)	4.7	(2.4–7.9)	1.7	(0.5–3.1)	2.0	(0.3–4.7)	2.9	(1.3–4.7)	3.4	(1.0–7.6)	2.9	(0.8–6.1)	1.9	(0.3–4.2)	2.3	(0.6–4.3)	5.0	(1.6–9.1)	
Years of education																					
0–7 years	25.4	(21.1–29.6)	23.3	(16.2–31.3)	18.5	(12.2–25.3)	37.0	(29.3–45.7)	9.6	(5.3–14.4)	0.9	(0.0–2.0)	49.5	(39.8–55.9)	44.8	(33.4–54.3)	39.5	(29.5–46.9)	25.1	(17.2–34.2)	
8–10 years	35.0	(30.7–39.7)	25.4	(19.5–31.6)	28.5	(21.4–35.7)	30.7	(23.3–37.9)	23.8	(17.1–31.1)	7.7	(3.0–12.5)	27.8	(20.9–34.5)	33.1	(23.3–40.7)	24.3	(17.9–32.2)	25.0	(18.2–32.3)	
11–14 years	37.6	(33.3–42.1)	39.5	(32.5–47.0)	41.6	(33.8–49.2)	28.1	(21.7–34.9)	40.8	(33.3–48.7)	53.0	(42.7–63.5)	17.6	(13.8–25.0)	17.1	(10.9–28.9)	23.8	(17.3–32.1)	40.2	(31.3–47.9)	
≥15 years	2.0	(0.9–3.1)	11.8	(7.0–16.8)	11.4	(7.6–16.2)	4.2	(1.8–6.8)	25.8	(17.9–33.9)	38.5	(28.4–49.8)	5.1	(2.5–8.8)	5.0	(1.3–10.2)	12.4	(7.5–18.5)	9.8	(5.6–15.7)	
Economic class																					
A/B (higher)	12.5	(9.9–15.6)	20.7	(15.0–27.7)	16.5	(12.3–21.5)	16.8	(12.1–22.5)	41.2	(33.4–48.4)	60.1	(51.3–69.5)	8.8	(5.2–14.0)	8.9	(5.0–15.2)	20.6	(13.3–28.7)	37.0	(27.9–45.3)	
C (middle)	71.4	(67.2–75.4)	54.6	(47.9–61.1)	58.6	(52.0–65.2)	44.2	(37.0–52.1)	51.2	(43.5–59.0)	36.5	(27.4–44.9)	35.8	(28.7–43.4)	34.3	(24.7–41.7)	34.3	(26.9–42.6)	36.0	(28.9–44.6)	
D/E (lower)	16.1	(12.6–19.5)	24.7	(17.4–31.8)	24.9	(18.4–31.1)	38.9	(31.1–45.9)	7.6	(4.2–12.4)	3.5	(0.3–7.4)	55.5	(46.7–62.9)	56.8	(47.4–67.3)	45.1	(35.1–54.9)	27.0	(18.3–36.2)	
Marital status																					
Married/living with partner	5.1	(3.0–7.1)	7.8	(4.3–12.2)	8.1	(4.1–11.5)	9.5	(5.1–14.8)	4.5	(2.1–7.4)	1.9	(0.1–4.6)	9.5	(4.0–17.1)	4.8	(0.8–10.9)	5.7	(2.4–9.6)	11.2	(5.3–18.7)	
Single/living with partner	94.6	(92.5–96.7)	88.4	(83.0–92.8)	89.9	(87.1–94.7)	83.8	(78.1–88.7)	92.4	(88.0–96.0)	96.1	(92.0–99.0)	77.4	(68.5–84.1)	87.2	(78.2–92.6)	84.5	(78.1–90.0)	75.8	(65.7–84.1)	
Widowed/separated/divorced	0.3	(0.0–0.9)	3.8	(1.6–6.3)	2.0	(0.2–2.9)	6.7	(4.1–9.6)	3.1	(0.5–6.8)	2.0	(0.0–5.4)	13.1	(8.7–18.8)	8.0	(3.9–15.0)	9.8	(5.2–15.7)	13.0	(7.2–20.0)	
Monthly income [MW = 465 reais (US\$ 290)]																					
<1 MW	66.4	(61.8–70.7)	70.7	(62.3–77.7)	67.4	(60.6–74.0)	56.0	(48.2–64.7)	34.1	(26.4–42.3)	16.0	(10.7–22.1)	63.7	(55.3–70.6)	46.4	(38.0–56.6)	48.4	(40.1–56.9)	20.2	(14.6–27.5)	
1–2 MW	27.4	(23.4–31.8)	21.2	(15.4–27.7)	24.5	(19.0–30.1)	32.5	(24.6–40.2)	42.7	(34.7–51.1)	33.4	(25.2–44.2)	28.4	(22.3–35.7)	43.6	(34.0–52.2)	35.3	(28.0–42.9)	51.3	(43.1–58.6)	
≥2 MW	6.2	(4.1–8.3)	8.1	(4.0–13.5)	8.0	(4.8–11.9)	11.5	(7.8–15.0)	23.1	(16.4–30.3)	50.6	(39.2–59.3)	7.9	(4.7–12.3)	10.0	(4.9–15.4)	16.3	(10.4–22.5)	28.5	(21.3–35.9)	
With whom do you live?																					
Live alone	5.7	(3.8–7.9)	17.1	(11.9–22.2)	11.6	(7.4–16.2)	28.3	(20.2–35.7)	23.3	(16.1–30.4)	15.6	(10.1–22.1)	23.4	(15.2–31.2)	47.1	(31.5–55.6)	43.5	(33.5–52.7)	21.6	(14.0–28.6)	
Partner (a)	9.6	(6.9–12.4)	20.0	(14.2–26.8)	12.3	(7.8–16.9)	14.5	(9.5–21.2)	16.4	(10.8–22.9)	11.8	(5.8–19.0)	17.2	(11.3–26.6)	19.3	(11.8–29.9)	9.8	(5.3–16.9)	23.1	(15.3–31.7)	
Friends (s)/relatives (not parent)	16.2	(13.0–19.6)	12.8	(8.0–17.3)	19.9	(14.3–26.4)	27.8	(20.6–34.3)	10.6	(6.7–15.5)	27.3	(18.5–35.0)	31.5	(22.5–40.2)	14.2	(8.4–19.2)	21.1	(13.6–28.2)	17.3	(11.6–24.2)	
Mother and/or father	65.7	(61.4–70.2)	49.9	(41.8–59.1)	53.0	(45.2–60.9)	28.1	(21.6–36.4)	48.1	(40.0–56.2)	43.5	(35.9–53.3)	24.5	(16.2–32.0)	18.7	(9.2–35.7)	18.0	(11.8–25.4)	34.1	(26.6–42.6)	
Other	2.7	(1.2–4.6)	0.1	(0.0–0.2)	3.2	(1.3–6.0)	1.3	(0.3–2.9)	1.6	(0.5–3.1)	1.8	(0.0–4.3)	3.5	(1.1–7.6)	0.8	(0.5–2.7)	7.6	(3.4–12.4)	3.9	(1.4–7.0)	

CI, confidence interval; MW, minimum wage.
^aUsing official Brazilian government classification. Indigenous was not treated separately due to extremely small numbers.

Table 2. Sexual behavior of MSM in 10 cities, Brazil, 2009.

	Manaus		Recife		Salvador		Brasília		Campo Grande		Belo Horizonte		Rio de Janeiro		Santos		Curitiba		Itajaí		
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	
Reported sexual partner in the last 6 months																					
No	4.4	(2.7–6.4)	2.6	(0.6–4.2)	6.9	(3.4–10.8)	5.3	(2.4–8.8)	11.4	(6.0–17.4)	3.8	(0.8–7.6)	17.3	(10.6–23.4)	27.4	(17.8–34.5)	7.3	(3.4–12.1)	2.3	(0.6–4.6)	
Yes	95.6	(93.6–97.3)	97.4	(95.8–99.4)	93.1	(89.2–96.6)	94.7	(91.2–97.6)	88.6	(82.6–94.0)	96.2	(92.4–99.2)	82.7	(76.6–89.4)	72.6	(65.5–82.2)	92.7	(87.9–96.6)	97.7	(95.4–99.4)	
Type of sexual partner in the last 6 months																					
No partner	4.4	(2.7–6.5)	2.8	(0.7–4.7)	6.6	(3.1–10.2)	5.2	(2.3–8.8)	11.9	(6.2–17.4)	3.4	(0.6–7.6)	17.5	(11.1–23.8)	29.6	(20.3–37.3)	7.4	(3.2–11.6)	2.6	(0.6–4.6)	
Only stable partner	16.8	(13.3–20.7)	23.0	(17.5–28.4)	16.9	(11.6–21.8)	18.8	(12.8–25.1)	26.3	(19.7–33.9)	24.2	(17.4–33.2)	12.4	(7.5–17.5)	12.0	(7.1–20.5)	9.5	(4.8–15.8)	20.4	(14.0–26.3)	
Casual and but no commercial partners	36.4	(31.9–40.5)	51.5	(45.5–59.5)	54.7	(48.0–61.9)	46.5	(38.3–54.3)	41.2	(34.3–47.8)	66.1	(55.6–74.8)	30.8	(23.8–38.0)	37.3	(28.0–46.8)	42.6	(33.7–52.1)	61.8	(55.9–69.9)	
Commercial partner	42.4	(37.7–47.2)	22.6	(15.7–29.1)	21.8	(15.4–29.7)	29.6	(22.1–37.0)	20.6	(14.9–27.6)	6.3	(1.6–12.4)	39.3	(32.1–47.7)	21.1	(13.7–28.9)	40.5	(31.2–49.8)	15.2	(9.3–20.9)	
Partner																					
Transgender	8.0	(5.5–11.2)	6.8	(3.1–11.7)	8.7	(4.3–14.9)	9.7	(4.8–15.6)	5.6	(1.9–10.4)	0	-	27.7	(20.2–37.4)	22.6	(12.4–32.8)	20.7	(14.6–29.5)	9.1	(4.1–15.7)	
Women	44.6	(38.4–50.0)	25.6	(17.6–30.0)	36.6	(28.1–46.9)	35.3	(26.5–43.4)	23.1	(15.5–32.4)	6.4	(2.1–9.9)	38.3	(28.4–46.6)	27.3	(14.6–39.0)	43.1	(35.4–53.5)	45.9	(34.9–57.2)	
Men	93.1	(90.2–95.8)	95.5	(92.1–98.2)	91.2	(84.7–95.2)	90.7	(85.4–94.9)	97.4	(95.6–99.4)	97.1	(95.1–100.0)	88.7	(81.4–93.8)	91.4	(83.9–97.8)	85.4	(78.6–91.4)	90.8	(85.6–95.2)	
Condom use with all partners																					
No	69.9	(65.4–74.5)	60.9	(54.7–68.4)	62.3	(55.6–69.4)	45.9	(38.3–55.1)	49.3	(42.1–57.0)	54.3	(44.3–61.1)	61.2	(53.2–68.3)	44.7	(37.3–55.1)	62.6	(55.2–69.9)	48.5	(41.7–57.5)	
Yes	30.1	(25.5–34.6)	39.1	(31.6–45.3)	37.7	(30.6–44.4)	54.1	(44.9–61.7)	50.7	(43.0–57.9)	45.7	(38.9–55.7)	38.8	(31.7–46.8)	55.3	(44.9–62.7)	37.4	(30.1–44.8)	51.5	(42.5–58.3)	
Condom use with casual or commercial partner in the last 6 months																					
No	49.9	(45.0–55.2)	28.4	(22.0–35.5)	37.4	(30.6–45.0)	22.4	(16.7–29.3)	22.3	(16.6–28.5)	19.9	(12.9–26.6)	48.6	(40.3–55.3)	27.4	(20.5–37.2)	50.0	(40.9–58.5)	29.4	(21.8–38.0)	
Yes	50.1	(44.8–55.0)	71.6	(64.5–78.0)	62.6	(55.0–69.4)	77.6	(70.7–83.3)	77.7	(71.5–83.4)	80.1	(73.4–87.0)	51.4	(44.7–59.7)	72.6	(62.8–79.5)	50.0	(41.5–59.1)	70.6	(62.0–78.2)	
Condom use in the last sexual relationship with man or woman																					
No	36.8	(32.2–41.7)	27.7	(21.4–34.9)	30.9	(24.4–37.7)	23.3	(16.9–30.9)	29.4	(22.3–37.0)	27.8	(19.7–35.1)	40.7	(31.8–48.4)	22.2	(15.5–31.6)	41.4	(33.1–49.4)	32.3	(24.8–41.5)	
Yes	63.2	(58.3–67.8)	72.3	(65.1–78.6)	69.1	(62.3–75.6)	76.7	(69.1–83.1)	70.6	(63.0–77.7)	72.2	(64.9–80.3)	59.3	(51.6–68.2)	77.8	(68.5–84.5)	58.6	(50.6–66.9)	67.7	(58.5–75.2)	

CI, confidence interval.

zero or very low. MSM in our study were concerned about confidentiality, stigma and discrimination related to testing and test results, resulting in changes in test sites in Santos and Itajaí and lower levels of testing overall. These factors may explain why so many infected individuals in Brazil arrive late to diagnosis and treatment [39]. These findings argue for more MSM friendly testing sites, such as nongovernmental organizations (NGOs), more support for campaigns to address stigma and discrimination, and to test, as well as a broad array of testing options perhaps including self-testing, and internet assisted testing.

Late diagnosis contributes to incidence and risk of death from AIDS, especially in the first year of treatment, and adds to health system costs and reduction in the effectiveness of antiretrovirals [43–45]. A recently completed study of cases of AIDS in individuals 15 years of age and older showed that 97.5% of deaths were among those who first presented at the clinic with advanced AIDS. The risk of death in the first 12 months of treatment associated with late diagnosis was 49.5% (45.1–54.2) higher than those diagnosed earlier in the course of their infection (350 cells/ μ l or above). It is estimated that 39.5% of registered deaths from AIDS between 2003 and 2006 could have been avoided [39].

Limitations

Among the principal limitations of the study that need to be considered are claims that RDS generates a probabilistic sample. Interpretation of RDS data remains controversial, but it does improve on snowball sampling through generating longer chains, and can be operationally systematic and rigorous. Wherein venue-based sampling is impossible or inappropriate, RDS may be the only available method. Here, when used to generate a national-level sample, a further limitation is that 10 independent samples are drawn. Aggregating the independent networks to generate a single sample violates an assumption of RDS that a sample forms one complete network component [20]. A related limitation is that the 10 cities selected may not represent MSM in Brazil.

In Brazil, at the time of the study, the government required that all HIV testing take place in government clinics. Although MSM in most sites felt comfortable using these clinics, in Santos and Itajaí, more conservative cities with substantial homophobia, MSM were not comfortable using the health clinics. In Santos, following feedback from MSM, we changed the original site and worked extensively with clinic staff addressing MSM concerns. Still, this resulted in only 50% of the sample agreeing to be tested. In Itajaí a new private site needed to be identified.

Conclusion

MSM in Brazil have higher HIV prevalence than other vulnerable populations in Brazil. These findings argue for

Table 3. HIV Prevalence among MSM estimated by different methods, Brazil, 2009.

HIV prevalence	Manaus		Recife		Salvador		Brasília		Campo Grande		Belo Horizonte		Rio de Janeiro		Santos		Curitiba		Itajaí ^a		
	%	(95% CI)	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	
Using RDSAT without missing values algorithm ^e																					
Negative	89.7	86.7-92.2	92.9	89.4-96.0	90.8	87.2-94.3	60.0	52.5-67.3	92.4	88.3-95.8	85.4	79.5-93.2	79.8	72.7-87.3	79.5	72.9-85.3	76.2	68.5-82.9	43.8	35.5-52.3	
Positive	6.7	4.7-9.3	3.7	1.6-6.2	6.3	3.4-9.5	10.2	5.9-15.6	4.6	2.4-7.3	9.0	3.6-15.2	16.5	9.3-22.8	1.7	0.3-3.6	6.9	3.6-11.2	6.2	2.8-10.4	
Did not take the test																					
	3.6	2.1-5.4	3.4	1.2-6.2	2.9	1.2-4.9	29.8	22.7-36.9	3.0	0.7-6.4	5.6	0.8-9.1	3.7	1.5-7.5	18.8	13.2-25.5	16.9	10.9-23.6	50.0	41.5-58.6	
Using RDSAT with missing values algorithm ^f																					
Negative	93.1	90.2-95.1	96.1	93.4-98.3	93.5	90.5-96.8	83.3	72.0-90.2	95.2	92.4-97.6	89.9	83.7-96.0	82.4	75.1-90.2	97.4	94.3-99.5	92.7	87.0-96.7	91.0	82.4-97.7	
Positive	6.9	4.9-9.8	3.9	1.7-6.6	6.5	3.2-9.5	16.7	9.8-28.0	4.8	2.4-7.6	10.1	4.0-16.3	17.6	9.8-24.9	2.6	0.5-5.7	7.3	3.3-13.0	9.0	2.3-17.6	
Imputed HIV positive from self-report																					
Negative	93.0	90.2-95.0	95.9	93.3-98.1	93.5	90.6-96.7	77.1	65.0-86.4	95.0	92.1-97.4	89.9	83.8-96.0	82.4	75.2-90.2	96.2	92.5-98.9	88.7	80.9-94.0	87.7	78.9-94.7	
Positive	7.0	5.0-9.8	4.1	1.9-6.7	6.5	3.3-9.4	22.9	13.6-35.0	5.0	2.6-7.9	10.1	4.0-16.2	17.6	9.8-24.9	3.8	1.1-7.5	11.3	6.0-19.1	12.3	5.3-21.1	
Imputed HIV positive from self-report and logistic regression																					
Negative	91.7	89.1-94.0	94.8	91.8-97.3	91.1	87.3-94.5	76.3	68.5-83.4	93.3	89.3-96.5	89.4	83.9-95.8	81.4	74.6-88.9	91.0	86.5-94.8	81.1	74.1-87.4	-	-	
Positive	8.3	6.0-10.9	5.2	2.7-8.2	8.9	5.5-12.7	23.7 ^b	16.6-31.5	6.7	3.5-10.7	10.6	4.2-16.1	18.3 ^c	10.9-24.9	9.0 ^d	5.2-13.5	18.9	12.6-25.9	-	-	

CI, confidence interval; RDSAT, .
^aNot possible to impute with logistic regression.
^bNot possible to estimate HIV serostatus for seven participants.
^cNot possible to estimate HIV serostatus for four participants.
^dNot possible to estimate HIV serostatus for eight participants.
^eHIV positive = 1; HIV negative = 2; Did not test = 3.
^fHIV positive = 1; HIV negative = 2; Did not test = '9999' (missing value for RDSAT).

Table 4. HIV prevalence among MSM estimated with different methods for the 10 cities, Brazil, 2009.

	%	95% CI
Self-report of HIV status prior to survey		
Negative	39.5	36.4-42.6
Positive	6.6	5.0-8.7
Inconclusive/do not know	5.1	3.7-7.0
Did not test previously	48.8	45.5-52.0
Tested in the survey		
No	7.7	6.4-9.2
Yes	92.3	90.8-93.6
HIV prevalence among those who tested in the survey		
Negative	88.9	86.4-90.9
Positive	11.1	9.1-13.6
HIV prevalence imputed with self-report of HIV-positive status		
Negative	87.9	85.5-90.0
Positive	12.1	10.0-14.5
HIV prevalence imputed with self-report of HIV-positive status and the probability obtained with logistic regression		
Negative	85.8	83.4-87.9
Positive	14.2	12.1-16.6

CI, confidence interval.

a heightened focus on MSM in all aspects of the Brazilian national response to AIDS: continued focus on MSM-targeted education and promotion of safer sex; continued support for MSM friendly services and community building, especially with HIV/AIDS and MSM focused NGOs addressing homophobia and discrimination; and increased promotion of testing and enhanced surveillance involving testing. This enhanced response also has to be sensitive to regional differences and therefore direct resources to the poorest and least developed areas of the country. Although stabilizing incidence rates in some developed countries, the success of current treatment, and the promise of prophylactic therapy appears to have prompted an effort to 'normalize' the prevention and treatment of HIV, a very real emergency exists among MSM in Brazil.

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Conflicts of interest

There are no conflicts of interest.

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