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.

AIDS 2013, **27**:427–435

Keywords: condoms, MSM, respondent-driven sampling, seroprevalence, sexual behavior, surveillance

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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Received: 5 July 2012; revised: 10 September 2012; accepted: 27 September 2012.

DOI:10.1097/QAD.0b013e32835ad504

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, Brasilia, Curitiba, Itajaí, Santos, Belo Horizonte, and Rio de Janeiro (Fig. 1). The study was approved by the National Ethic Research Committee (CONEP # 14494).

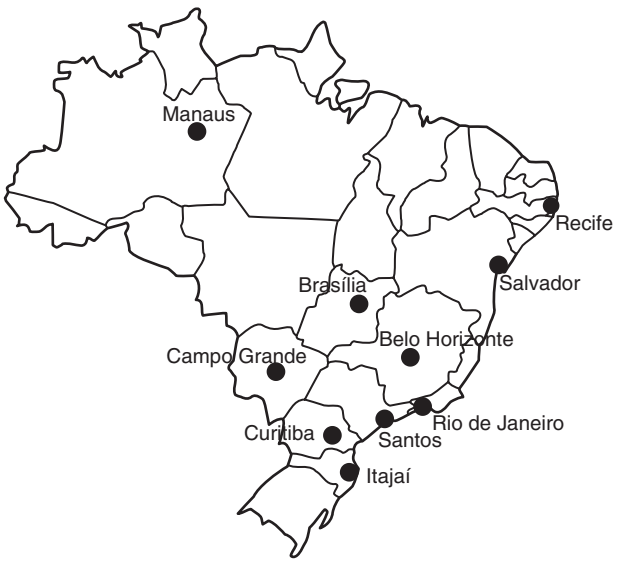

Fig. 1. Study sites for National HIV prevalence among MSM in Brazil, 2009.

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 (≈ US$ 10.00) and an incentive of R$ (Brazilian Real) 10.00 (≈ 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 ith participant of city 'j', $j = 1, 2, \ldots, 10$; '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%), Brasilia (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 (≥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	(35.2–53.3)	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.

[a]Using 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		Itajai	
	%	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 comercial 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	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	(85.6–95.1)
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/μl 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 %	Manaus (95% CI)	Recife %	Recife 95% CI	Salvador %	Salvador 95% CI	Brasília %	Brasília 95% CI	Campo Grande %	Campo Grande 95% CI	Belo Horizonte %	Belo Horizonte 95% CI	Rio de Janeiro %	Rio de Janeiro 95% CI	Santos %	Santos 95% CI	Curitiba %	Curitiba 95% CI	Itajaí[a] %	Itajaí[a] 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, .
[a]Not possible to impute with logistic regression.
[b]Not possible to estimate HIV serostatus for seven participants.
[c]not possible to estimate HIV serostatus for four participants.
[d]not possible to estimate HIV serostatus for eight participants.
[e]HIV positive = 1; HIV negative = 2; Did not test = 3.
[f]HIV 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.

Acknowledgements

We thank the National STD/AIDS and Hepatitis Department of the Ministry of Health (CSV 234/07) for funding the research; the Center for Global Health Equity of Tulane University for technical support, the Institute for Global Health of the University of San Francisco California where the project was conceived, and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for supporting L.R.F.S.K. postdoctorate fellowship at UCSF (# BEX 3495/06–0). We thank Dr Cristina Possas for her direction and enthusiastic support for HIV research in the National Program during her long tenure. We also thank Dr MárcioAntônio de Sá and Dr Gerson Pereira for coordinating the Project in the ten cities on behalf of the NSAHD; Dr Ana Roberta Pati Pascom (from NSAHD) and Dr Aristides Barbosa (from the Centers of Disease Control and Prevention/GAP Brazil) for their technical and implementation assistance in the RDS

methodology in Brazil. We thank the Joint United Nations Programme on HIV/AIDS (UNAIDS) for providing additional finding for Manaus. We also thank Dr Lisa Johnston for her contribution reviewing the paper and Sônia Batista in memoriam for coordinatingthe site in Rio de Janeiro. We are especially grateful to all the respondents who participated in the study.

L.R.F.S.K. (PI of the study, wrote proposal, supervised all phases of the study, wrote the paper), R.S.M. (analyzed all data, prepared tables, contributed to writing the paper), C.K. (assisted in writing the proposal, participated in all the phases of the activity, wrote the article with L.R.F.S.K.), A.P. (assisted in writing the proposal, organized the final datasets, helped analyze the data), M.B.M. (assisted in writing the proposal, contributed to writing the article), M.D.G. (Site coordinator, participant in all activities, helped write the article), I.D. (Site coordinator, participant in all activities, helped write the article), A.M.B. (Site coordinator, participant in all activities, helped write the article), A.S.B. (Site coordinator, participant in all activities, helped write the article), W.M. and G.W.R. (assisted in writing the proposal, contributed to article). The HIV/MSM Surveillance Group:F. ABREAU (Site coordinator, participant in all activities, helped write the article), L. OLIVEIRA(Site coordinator, participant in all activities, helped write the article), A. MORAES (Site coordinator, participant in all activities, helped write the article), E. HAMANN(Site coordinator, participant in all activities, helped write the article), G. FREITAS(Site coordinator, participant in all activities, helped write the article), E. MACIEL(Prepared the dataset and provide some analysis).

HIV/MSM Surveillance Group: Fabiano Abreau; Lisângela Oliveira; Adão de Souza Moraes; Edgar Hamann; Gisele Freitas; Elizabeth Maciel

Source of Funding: This work was carried out by the Federal University of Ceará with technical and financial support of the Ministry of Health/Secretariat of Health Surveillance/Department of STD, AIDS and Viral Hepatitis through the Project of International Technical Cooperation AD/BRA/03/H34 between the Brazilian Government and the United Nations Office on Drugs and Crime – UNODC.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. Department of HIV/AIDS. *Guidelines: prevention and treatment of HIV and other sexually transmitted infections among men who have sex with men and transgender people: recommendations for a public health approach*. Geneva, Switzerland: World Health Organization. 2011.
2. Baral S, Trapence G, Motimedi F, Umar E, Iipinge S, Dausab F, *et al*. **HIV prevalence, risks for HIV infection, and human rights among men who have sex with men (MSM) in Malawi, Namibia, and Botswana.** *PLoS One* 2009; **4**:e4997.
3. Bastos FI, Caceres C, Galvao J, Veras MA, Castilho EA. **AIDS in Latin America: assessing the current status of the epidemic and the ongoing response.** *Int J Epidemiol* 2008; **37**:729–737.
4. Beyrer C, Baral SD, Walker D, Wirtz AL, Johns B, Sifakis F. **The expanding epidemics of HIV type 1 among men who have sex with men in low- and middle-income countries: diversity and consistency.** *Epidemiol Rev* 2010; **32**:137–151.
5. Caceres CF, Konda K, Segura ER, Lyerla R. **Epidemiology of male same-sex behaviour and associated sexual health indicators in low- and middle-income countries: 2003–2007 estimates.** *Sex Transm Infect* 2008; **84 (Suppl 1)**:i49–i56.
6. Mumtaz G, Hilmi N, McFarland W, Kaplan RL, Akala FA, Semini I, *et al*. **Are hiv epidemics among men who have sex with men emerging in the middle east and north Africa?: a systematic review and data synthesis.** *PLoS Medicine* 2011; **8**:e1000444.
7. Damacena GN, Szwarcwald CL, de Souza Junior PR, Dourado I. **Risk factors associated with HIV prevalence among female sex workers in 10 Brazilian cities.** *J Acquir Immune Defic Syndr* 2011; **57 (Suppl 3)**:S144–S152.
8. Brasil. Ministério da Saúde. Secretaria de Vigilância à Saúde. **Departamento de DST/AIDS e Hepatites Virais.** *Boletim Epidemiológico de DST/AIDS* [Epidemiological Bulletin of SDT/AIDS]. 2010; 7.
9. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. **Departamento de DST AeHV**. *Boletim Epidemiológico de AIDS/DST* [Epidemiological Bulletin of SDT/AIDS]. 2011; 8.
10. Barbosa Junior A, Szwarcwald CL, Pascom AR, Souza Junior PB. **Trends in the AIDS epidemic in groups at highest risk in Brazil, 1980–2004.** *Cad Saude Publica* 2009; **25**:727–737.
11. Jaffe HW, Valdiserri RO, De Cock KM. **The reemerging HIV/AIDS epidemic in men who have sex with men.** *JAMA* 2007; **298**:2412–2414.
12. MacKellar DA, Valleroy LA, Secura GM, Behel S, Bingham T, Celentano DD, *et al*. **Perceptions of lifetime risk and actual risk for acquiring HIV among young men who have sex with men.** *AIDS Behav* 2007; **11**:263–270.
13. Lo YC, Turabelidze G, Lin M, Friedberg Y. **Prevalence and determinants of recent HIV testing among sexually active men who have sex with men in the St. Louis metropolitan area, Missouri.** *Sex Transm Dis* 2012; **39**:306–311.
14. Gondim RC, Kerr LR, Werneck GL, Macena RH, Pontes MK, Kendall C. **Risky sexual practices among men who have sex with men in Northeast Brazil: results from four sequential surveys.** *Cad Saude Publica* 2009; **25**:1390–1398.
15. MacKellar DA, Valleroy LA, Secura GM, Behel S, Bingham T, Celentano DD, *et al*. **Unrecognized HIV infection, risk behaviors, and perceptions of risk among young men who have sex with men: opportunities for advancing HIV prevention in the third decade of HIV/AIDS.** *J Acquir Immune Defic Syndr* 2005; **38**:603–614.
16. Copeland B, Shah B, Wheatley M, Heilpern K, del Rio C, Houry D. **Diagnosing HIV in men who have sex with men: an emergency department's experience.** *AIDS Patient Care STDS* 2012; **26**:202–207.
17. Villela WV, Santos CG, Veloso JC. **Sobre transgeneros produzindo corpos e subjetividades** [About transgenders producing bodies and subjectivities]. *Saúde Coletiva* 2006; **11**: 73–78.
18. Malta M, Magnanini MM, Mello MB, Pascom AR, Linhares Y, Bastos FI. **HIV prevalence among female sex workers, drug users and men who have sex with men in Brazil: a systematic review and meta-analysis.** *BMC Public Health* 2010; **10**:317.
19. Heckathorn DD. **Respondent-driven sampling: a new approach to the study of hidden populations.** *Social Probl* 1997; **44**:174–199.
20. Heckathorn DD. **Extensions of Respondent Driven Sampling: Analyzing continuous variables and controlling for differential recruitment.** *Sociological Methodol* 2007; **37**:151–207.
21. Johnston LG, Malekinejad M, Kendall C, Iuppa IM, Rutherford GW. **Implementation challenges to using respondent-driven sampling methodology for HIV biological and behavioral surveillance: field experiences in international settings.** *AIDS Behav* 2008; **12**:S131–S141.

22. Lansky A, Abdul-Quader AS, Cribbin M, Hall T, Finlayson TJ, Garfein RS, *et al*. **Developing an HIV behavioral surveillance system for injecting drug users: the National HIV Behavioral Surveillance System.** *Public Health Rep* 2007; **122 (Suppl 1)**: 48–55.
23. Barbosa Junior A, Pascom AR, Szwarcwald CL, Kendall C, McFarland W. **Transfer of sampling methods for studies on most-at-risk populations (MARPs) in Brazil.** *Cad Saude Publica* 2011; **27 (Suppl 1)**:S36–S44.
24. ABEP. *Criterio Economico Brasil*. [Brazilian Economic Criteria] http://www.gerp.com.br/Criterio.htm [Accessed 29 July 2007].
25. Brasil. Ministério da Saúde. Secretaria de Vigilância à Saúde. Portaria n°. 34 [Rule No. 34]. 2005. http://bvsms.saude.gov.br/bvs/saudelegis/svs/2005/prt0034_28_07_2005.html [Accessed June 2012].
26. Floyd S, Molesworth A, Dube A, Crampin AC, Houben R, Chihana M, *et al.* **Underestimation of HIV prevalence in surveys when some people already know their status, and ways to reduce the bias.** *AIDS* 2012. http://www.ncbi.nlm.nih.gov/pubmed/22842993 [Accessed 17 October 2012]
27. Salani Mota RM, Sansigolo Kerr LR, Kendall C, Pinho A, de Mello MB, Dourado I, *et al*. **Reliability of self-report of HIV status among men who have sex with men in Brazil.** *J Acquir Immune Defic Syndr* 2011; **57 (Suppl 3)**:S153–S156.
28. Lane T, Raymond HF, Dladla S, Rasethe J, Struthers H, McFarland W, *et al*. **High HIV prevalence among men who have sex with men in Soweto, South Africa: results from the Soweto Men's Study.** *AIDS Behav* 2011; **15**:626–634.
29. Lorway R, Reza-Paul S, Pasha A. **On becoming a male sex worker in Mysore: sexual subjectivity, ''empowerment,'' and community-based HIV prevention research.** *Med Anthropol Q* 2009; **23**:142–160.
30. DATASUS. *Estimativas populacionais para 2009 ajustadas por 2007* [Population estimation for 2009 adjusted from 2007]. 2009. http://www2.datasus.gov.br/DATASUS/index.php?area=0206 [Accessed 18 April 2012].
31. Barbosa Junior A. *Challenges for monitoring of the HIV /AIDS among the population groups at highest risk in Brazil*. Brazil: Oswaldo Cruz Foundation; 2008.
32. Sullivan PS, Hamouda O, Delpech V, Geduld JE, Prejean J, Semaille C, *et al*. **Reemergence of the HIV epidemic among men who have sex with men in North America, Western Europe, and Australia, 1996–2005.** *Ann Epidemiol* 2009; **19**:423–431.
33. Malekinejad M, McFarland W, Vaudrey J, Raymond HF. **Accessing a diverse sample of injection drug users in San Francisco through respondent-driven sampling.** *Drug Alcohol Depend* 2011; **118**:83–91.
34. Fan S, Lu H, Ma X, Sun Y, He X, Li C, *et al*. **Behavioral and serologic survey of men who have sex with men in Beijing, China: implication for HIV intervention.** *AIDS Patient Care STDS* 2012; **26**:148–155.
35. van Griensven F. **Men who have sex with men and their HIV epidemics in Africa.** *AIDS* 2007; **21**:1361–1362.
36. Vanden Berghe W, Nostlinger C, Buve A, Beelaert G, Fransen K, Laga M. **A venue-based HIV prevalence and behavioural study among men who have sex with men in Antwerp and Ghent, Flanders, Belgium, October 2009 to March 2010.** *Euro Surveill* 2011; **16** http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19914 [Accessed Oct 2012].
37. Kerr LR, Cavalcante Mdo S, Kendall C, Machado MM, Dourado MI, Galvao M. **Disparities in mother-to-child transmission in Northeast Brazil: regional failures within successful country programs.** *AIDS Care* 2011; **23**:771–774.
38. Pascom ARPBJ A, Szwarcwald CL. **Diferenças regionais nas práticas sexuais e comportamentos relacionados à transmissão do HIV** [Regional differences in sexual practices and knowledge related to HIV transmission]. In: *Pesquisa de conhecimento, atitudes e práticas na população brasileira* [Research on knowledge, attitudes and practices among the Brazilian population]. Brasília: Brasil: Ministério da Saúde; 2006. pp. 18.
39. Grangeiro A, Escuder MM, Menezes PR, Alencar R, Ayres de Castilho E. **Late entry into HIV care: estimated impact on AIDS mortality rates in Brazil, 2003–2006.** *PLoS One* 2011; **6**:e14585.
40. Kendall C, Kerr LR, Gondim RC, Werneck GL, Macena RH, Pontes MK, *et al*. **An empirical comparison of respondent-driven sampling, time location sampling, and snowball sampling for behavioral surveillance in men who have sex with men, Fortaleza, Brazil.** *AIDS Behav* 2008; **12(4 Suppl)**:S97–S104..
41. Wei C, McFarland W, Fuqua V, Raymond HF. **reaching black men who have sex with men: a comparison between respondent-drive sampling and time-location sampling.** *Sex Transm Infect* (in press).
42. Franca Junior I, Calazans G, Zucchi EM. **Changes in HIV testing in Brazil between 1998 and 2005.** *Rev Saúde Pública* 2008; **42 (Suppl 1)**:84–97.
43. Attia S, Egger M, Muller M, Zwahlen M, Low N. **Sexual transmission of HIV according to viral load and antiretroviral therapy: systematic review and meta-analysis.** *AIDS* 2009; **23**:1397–1404.
44. Donnell D, Baeten JM, Kiarie J, Thomas KK, Stevens W, Cohen CR, *et al*. **Heterosexual HIV-1 transmission after initiation of antiretroviral therapy: a prospective cohort analysis.** *Lancet* 2010; **375**:2092–2098.
45. Granich RM, Gilks CF, Dye C, De Cock KM, Williams BG. **Universal voluntary HIV testing with immediate antiretroviral therapy as a strategy for elimination of HIV transmission: a mathematical model.** *Lancet* 2009; **373**:48–57.