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How heterogeneous are MSM from Brazilian cities? An analysis of sexual behavior and perceived risk and a description of trends in awareness and willingness to use PrEP

Thiago S Torres (thiago.torres@ini.fiocruz.br)
Instituto de Pesquisa Clinica Evandro Chagas https://orcid.org/0000-0002-2557-601X
Luana M. S. Marins
Fundacao Oswaldo Cruz
Valdilea G. Veloso
Fundacao Oswaldo Cruz
Beatriz Grinsztejn
Fundacao Oswaldo Cruz
Paula M. Luz
Fundacao Oswaldo Cruz

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Abstract

Background Brazil has the largest population of individuals living with HIV/AIDS in Latin America, with a disproportional prevalence of infection among gays, bisexuals and other men who have sex with men (MSM). Of relevance to prevention and treatment efforts, Brazilian MSM from different regions may differ in behaviors and risk perception related to HIV.

Methods We report on MSM living in 29 different cities: 26 Brazilian state capitals, the Federal District and two large cities in São Paulo state assessed in three web-based surveys (2016-2018) advertised on Grindr, Hornet and Facebook. Using logistic regression models, we assessed factors associated with high-risk behavior and high HIV perceived risk.

Results A total of 16,667 MSM completed the survey. Overall, MSM from the North and Northeast were younger, more black/mixed-black, of lower income and lower education compared to MSM from the South, Southeast and Central-west. Though 17% had never tested for HIV (with higher percentages in the North and Northeast), condomless receptive anal sex (previous 6 months) and high-risk behavior as per HIV Incidence Risk scale for MSM were observed for 41% and 64%, respectively. Sexual behaviors and HIV perceived risk had low variability by city. Younger age, being gay/homosexual, having a steady partner, binge drinking, report of STI and ever testing for HIV increased the odds of high-risk behavior. In contrast, younger age and having a steady partner decreased the odds of high HIV perceived risk, while report of STI most strongly increased the odds of high HIV perceived risk. All variables that serve as proxies for low socio-economic status (black/mixed-black race, low income and low education) were associated with increased odds of high HIV perceived risk. Awareness and willingness to use PrEP increased from 2016 to 2018 in most cities.

Conclusions Overall, MSM socio-demographic characteristics were heterogeneous among Brazilian cities, but similarities were noted among the cities from the same administrative region with a marked exception of the Federal District not following the patterns for the Central-West. The observed dissonance between sexual behavior and HIV perceived risk may be a barrier to effective PrEP implementation.

Background

Brazil is the largest country in Latin America and the fifth largest country by area and population, with more than 212 million inhabitants (1). Brazil is divided into five geographic regions: North (7 states), Northeast (9 states), Central-west (3 states and the Federal District), Southeast (4 states) and South (3 states). The Southeast, where São Paulo and Rio de Janeiro are located, is the most populous and industrialized region accounting for 42% of all Brazilians and almost 50% of the country's gross domestic product (GDP). Brazilian geographic regions have impressive disparities in terms of GDP per capita: the Northeast and North have the lowest values (USD 4,000–5,000) while GDP per capita in the Central-west, South and Southeast ranges from USD 9,000 to 10,000. Furthermore, disparities exist within regions and cities, as a result of the dramatic inequalities in wealth and health. In Rio de Janeiro city, for example, the human development index (HDI) varies from very high to low in two neighbor areas: Gávea (0.970) and Rocinha (0.732) (2).

Brazil has the largest population of individuals living with HIV/AIDS in Latin America, with a disproportional prevalence of infection among men who have sex with men (MSM) (3,4). A population-based study of HIV prevalence found that 18.4% of MSM in Brazil were living with HIV in 2016 (5), higher than the previous study conducted in 2009 (14.2%) (6). In 2017, approximately 60% of reported HIV infections among male were attributed to male-to-male sexual contact (7), even though a national survey has showed that approximately 3.5% (95% confidence interval [CI] 2.9%–4.3%) of the Brazilian men between 15–64 years old report sex with other men at the time of the survey (8). Unfortunately, new infections in this population continue to rise (9). To stop the HIV epidemic in Brazil, a continental, diverse and unequal country, it is necessary to understand and verify how heterogeneous are MSM from each region are in terms of sexual behavior and risk perception.

Since December 2017, pre-exposure prophylaxis (PrEP) with emtricitabine / tenofovir disoproxil fumarate (FTC/TDF) is offered free of charge through the Brazilian Public Health System (SUS) to populations at substantial risk for HIV infection including eligible MSM within the HIV prevention package (10). During 2018, the first year of PrEP provision in SUS, PrEP uptake among eligible MSM varied considerably from a maximum of 25% in Florianopolis (in the South) to a low of 1% in Belém (in the North) (4). One explanation for such a discrepancy could be a lack of perceived risk that differentially impacts PrEP uptake throughout the country. Data on sexual behavior, risk perception and willingness to use PrEP among MSM from each Brazilian region is essential to support the implementation and roll-out of the PrEP program.

This study provides an analysis of sexual behavior and perceived risk, as well as a description of socio-demographic characteristics and trends in awareness and willingness to use PrEP among MSM living in all Brazilian state capitals, the Federal District and two large cities from São Paulo state (Campinas and Santos).

Materials And Methods

Study design

We conducted three cross-sectional web-based studies targeting MSM in Brazil from 2016 to 2018, one per year. Individuals who met eligibility criteria (age ≥18 years, cisgender men, and HIV uninfected self-report) and who acknowledged reading the informed consent text were directed to the online questionnaire, which was programmed on SurveyGizmo®. The first study (2016 survey) was conducted in July 2016 in 10 Brazilian capitals, two from each Brazilian Geographical Region: Belém and Manaus (North); Salvador and Recife (Northeast); Brasília and Goiânia (Central-West); Florianópolis and Porto Alegre (South); and Rio de Janeiro and São Paulo (Southeast) (11). The second (2017 survey) (12) and third (2018 survey) (13) studies were conducted in July 2017 and March to April 2018, respectively, and were expanded to all Brazilian state capitals and two large urban centers in São Paulo State (Santos and Campinas). The 2016 and 2018 surveys were advertised on two geosocial networking (GSN) apps for sexual encounters among MSM: Hornet and Grindr. The 2018 survey

was also advertised on Facebook social media. The 2017 survey was advertised on Hornet only. No incentives were provided for answering the survey and, on average, participants took approximately ten minutes to complete it.

Survey instrument

The survey instrument was composed of five sections (25 questions) addressing: sociodemographic information, substance use, sexual behavior and history of sexually transmitted infections, HIV perceived risk and use of HIV testing as well as awareness and willingness to use PrEP. Though the instrument was not the same in the three surveys, the items used in this analysis were the present in all.

Variables

Socio-demographic

Age at the time of the survey was categorized in 4 brackets: 18 to 24; 25 to 29; 30 to 34 and ≥ 35 years; race was categorized in white/Asian, black and mix black/native; schooling was categorized in <10 years, 10–12 years, 13–16 years and >16 years. Family monthly income was grouped into the following strata: ≤ 1 >1–3, >3–10 and >10 minimum wages (Brazilian minimum wage was R$998 or US$268 in January 2019). Sexual orientation was dichotomized in gay or homosexual and other (bisexual, heterosexual or other). Steady partner (male or female) was dichotomized in yes/no. To infer the size of the MSM community in each city, we used the most recent nation-wide survey of sexual practices and behavior that estimated that 3.5% of men between 15–64 years had sex with other men (8).

Substance use

Binge drinking (14) was evaluated with the question “In the last 6 months, did you drink 5 or more drinks in a couple of hours?”. Use of stimulants (cocaine, poppers, crack, or amphetamines) during the previous 6 months was dichotomized in yes/no.

Sexual behavior and sexually transmitted diseases

Sexual behavior in the last six months was assessed with the following questions: number of partners, condomless receptive anal sex, sex with HIV+ partner and number of insertive anal intercourses with HIV+ partner. These questions (in addition to other questions regarding age and use of stimulants) compose the HIV Incidence Risk Index for MSM (HIRI-MSM), a 7-item questionnaire developed by Smith et al. (15) to predict HIV seroconversion among MSM that is recommended by the Centers for Disease Control and Prevention (CDC) to screen individuals who should be evaluated for PrEP use (16). Scores <10 and ≥10 were considered as “low risk” and “high risk”, respectively (15,16). Report of sexually transmitted infections (STI; syphilis, gonorrhea or rectal chlamydia) in the last six months were dichotomized in yes/no.

HIV Perceived risk and HIV testing

HIV perceived risk was assessed with the question “In your opinion, what is your risk of getting HIV in the next year?” with possible options grouped into “No risk”, “Low risk” and “High risk” which was a combination of the options “High risk/50%” and “Certain/100%”. This question included an “I don’t know or I don’t want to answer” option, which was considered as a missing value for the analysis. Individuals were asked about previous HIV tests (never or at least once in lifetime). Additionally, among those who reported never having tested, we accessed their reasons with the question “Why have you never tested for HIV?” with the following possible responses: “I am not at risk of getting infected”, “I don’t think it is practical to go to a health care center”, “I am ashamed”, “I am afraid of getting a positive result”, “I am too lazy” and “Other reasons”.

Awareness and willingness to use PrEP

PrEP awareness was assessed with the question "Have you ever heard of PrEP?" (yes/no). Willingness to use PrEP was defined as the “High interest" option on a four-point Likert scale with the question "What level of interest would you have in using PrEP?”. A brief explanation about PrEP was provided before these questions were asked. These questions have been previously used by our research team to describe PrEP awareness and willingness to use PrEP (11–13,17).

Statistical analysis

Socio-demographic characteristics and substance use, sexual and preventive behaviors of the participants were described according to their hometown for each Brazilian State capital, the Federal District, and two major cities in São Paulo. The results were organized according to 1) Brazilian geographical regions, from North to South, and, within each region, 2) by cities with the greatest number of participants: North (Manaus, Belém, Porto Velho, Palmas, Boa Vista, Rio Branco and Macapá), Northeast (Recife, Salvador, Fortaleza, Natal, João Pessoa, Aracaju, Teresina, Maceió and São Luís), Central-west (Brasília, Goiânia, Cuiabá and Campo Grande), Southeast (São Paulo, Rio de Janeiro, Belo Horizonte, Campinas, Vitória and Santos) and South (Porto Alegre, Curitiba and

Florianópolis). Reasons for never testing for HIV were presented according to the Brazilian geographical region. We tested the association between an individual's HIV perceived risk and their reported behavior as measured by: 1) the HIRI-MSM, 2) condomless receptive anal sex and 3) number of male partners. Two logistic regression models were used to explore factors associated with: 1) high risk behavior as per HIRI-MSM, and 2) high HIV perceived risk. The two models were developed for the whole country and for the two cities with the greatest number of participants within each region (except for the Southeast, with 3 cities): North (Manaus and Belém), Northeast (Recife and Salvador), Central-west (Brasília and Goiânia), Southeast (São Paulo, Rio de Janeiro and Belo Horizonte) and South (Porto Alegre and Curitiba). Finally, trends in PrEP awareness and willingness from 2016 to 2018 were graphically provided for the overall sample (Brazil) and the 10 state capitals included in the three surveys: Belém, Brasília, Florianópolis, Goiânia, Manaus, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo. Analyses were performed using Software R (The R project www.r-project.org).

Results

A total of 16,667 MSM completed the survey: 5065 (30.4%) in 2016, 2841 (17.0%) in 2017 and 8761 (52.6%) in 2018. Most participants were from the Southeast (10,418; 62.5%), followed by Northeast (2,320; 13.9%), Central-west (1,694; 10.2%), South (1,505; 9.0%) and North (730; 4.4%). The two largest Brazilian cities had the highest number of responders: São Paulo (34.6%) and Rio de Janeiro (19.0%) (Table 1). Considering the estimated MSM population of each city, Florianópolis was the city with the greatest proportion of responders (6.6%), followed by São Paulo (4.2%) and Rio de Janeiro (4.1%).

Overall, median age was 29 years (IQR: 24–36). The age distribution of the participants was shifted towards younger MSM (18–24 years) in most of cities in the North, Northeast and Central-west regions, representing almost half of responders from Manaus (46.5%) and Belém (43.1%), the two largest urban areas in the North. In large cities from the Southeast, South and Brasília the proportion of older MSM (35+ years) was higher (31% in São Paulo and Rio de Janeiro). Most responders from the North and Northeast self-declared mix black or native, and Salvador was the city with the greatest proportion of black MSM (30.7%). Conversely, more than half of responders from the Central-west, Southeast and South self-reported as white, except in Cuiabá (35.9%). Southern cities had the greatest proportion of white MSM (highest in Porto Alegre with 82.0%), followed by the cities from São Paulo State (68.1% in São Paulo city). Family monthly income was shifted towards lower income in cities in the North and Northeast with approximately 20% of responders earning one minimum wage in Manaus (19.2%), Rio Branco (21.7%), Aracaju (17.6%), and Teresina (20%). Most responders from the Central-west, Southeast and South regions had middle income (>3 to 10 minimum wages), and the greatest proportion of MSM with higher income (>10 minimum wages) was observed in Brasília (34.2%), São Paulo (20.9%) and Rio de Janeiro (18.7%). Having >12 years of schooling (equivalent to high school) was reported by more than half of the respondents in every city except for Manaus (45.8%). Brasilia was the city with the greatest proportion of MSM with >16 years of schooling (36.3%).

Most participants self-declared as gay or homosexual (89.9%) (Table 2). The proportion of MSM with a steady partner varied across the country, ranging in the largest urban areas from 19.5% in Belém to 28.2% in Brasília. Most MSM reported binge drinking (70.2%) with only slight variability by region and use of stimulants was more prevalent in the South and Southeast (~20%), the highest proportions were observed in the cities from São Paulo state (24.1% in São Paulo city), Brasília (23.1%) and Florianópolis (22.9%). Overall, 13.1% of participants reported an STI, Florianópolis (18.6%) had the highest proportion among the cities with >300 responders.

The proportion of MSM who reported never having tested for HIV was higher in the North and Northeast when compared to other regions: 26% in Manaus and Belém and 12% in Santos, Curitiba and Brasília. The main reason for never testing for HIV were, in order, "I am afraid of getting a positive result" (851; 32.4%), "I am ashamed" (559; 21.3%), "I am not at risk of getting infected" (459; 17.5%), "I am too lazy" (293; 11.2%), "I don't think it is practical to go to a health care center" (234; 8.9%) and others (227; 8.7%). This pattern was observed in all Brazilian regions except for the South where the response "I am not at risk of getting infected" was more frequent than "I am ashamed" (22% vs. 19%). In the North, more MSM reported "I am afraid of getting a positive result" (38%) in comparison to the other regions (Figure 1).

Figure 1. Distribution of responses to the question "Why have you never tested for HIV?" by Brazilian Geopolitical Region (n = 2,618).

Overall, the number of responders who reported sex with more than five men was lower in Northern and Northeastern cities compared to the other regions, around 35%. In contrast, this proportion was higher in Southeastern cities, São Paulo (46.2%), Rio de Janeiro (45.4%), Brasília (44.8%) and in the Southern cities, ranging from 43.5% in Curitiba to 45.5% in Porto Alegre. Condomless receptive anal sex was reported by 6,865 participants (41.4%) with little heterogeneity by city. Most participants met criteria for "high risk" according to the HIRI-MSM (64.3%), indicating that PrEP should be recommended. Conversely, only 28.0% of participants reported high HIV perceived risk, and this proportion was lower in Belém (23.5%) and Recife (24.9%).

Table 3 shows that irrespective of the definition of high-risk behavior, overall, less than a half of those with high-risk behavior (as measured by a score >10 in the HIRI-MSM, condomless receptive anal sex, or >5 partners in the prior six months) perceived themselves at high risk. Among those reporting low-risk behavior, around one-fifth perceived themselves at high-risk (13.9% as measured by the HIRI-MSM, 19.7% who report condomless anal sex and 18.8% who had ≤5 partners). High-risk behavior increased the odds of perceiving oneself at high HIV perceived risk, a pattern also present when stratified by city (Table 4 and Table 5).

Overall, the association of socio-demographic and behavioral characteristics with high-risk behavior as measured by the HIRI-MSM was consistent across the cities (Table 6). Younger age, being gay or homosexual, having a steady partner, binge drinking, STI diagnosis and ever testing for HIV increased the odds of high-risk behavior. As participants from São Paulo and Rio de Janeiro make up the majority of the study population, the results of Brazil as a whole greatly reflect those for these two cities. One notable exception was the association of having a steady partner increasing the odds of high-risk behavior which is most strongly observed in Goiania. Similarly, the association of binge drinking with high-risk behavior is more pronounced in the North, Central-west, and South, and not apparent in the Northeast.

In contrast to the model for high-risk behavior described above, all variables were significantly associated with high perceived risk for HIV (Table 7). Notably, younger age and having a steady partner were associated with lower odds of perceiving oneself as being at high-risk. Having an STI most strongly increased the odds of high perceived risk while the association of ever testing for HIV increasing the odds of high perceived risk was much more subtle and not consistent across cities. Though of small magnitude, all variables that serve as proxies for low socio-economic status (black/mixed-black race, low income and low education) were associated with increased odds of high HIV perceived risk. When we stratify the study population by risk behavior as measured by the HIRI-MSM, model results change somewhat. Among those with high-risk behavior, the association of younger age and steady partner decreasing the odds of high perceived risk was stronger. In contrast, among those with low-risk behavior, being black/mixed black or testing for HIV increased the odds of high perceived risk to a greater degree. Finally, in the two strata, having an STI increased the odds of high perceived risk consistently.

Overall, PrEP awareness increased overtime in Brazil from 58% in 2016 to 70% in 2018 (Figure 2). Among the 10 cities evaluated in all surveys, São Paulo had the highest proportion of awareness in 2016 (63%) and 2018 (74%), and Recife the lowest in 2018 (58%). Manaus had the greatest increase in PrEP awareness (from 40% in 2016 to 62% in 2018). Willingness to use PrEP also increased overtime in Brazil, from 52% in 2016 to 63% in 2018. The highest increase in willingness to use PrEP was in Manaus, from the lowest value in 2016 (50%) to the highest in 2018 (70%). A substantial increase in willingness to use PrEP was also observed for Porto Alegre (48% in 2016 to 67% in 2018) and Rio de Janeiro (55% in 2016 to 69% in 2019). Across the years, willingness to use PrEP was almost stable in Goiânia (58% in 2016 and 2018), Florianópolis (58% in 2016 and 61% in 2018) and Brasília (56% in 2016 to 62% in 2018) (Figure 2).

Figure 2. Awareness and willingness to use PrEP among MSM from 10 Brazilian State Capitals from 2016 to 2018.

Discussion

In the present, we described the socio-demographic characteristics as well as sexual behavior and HIV perceived risk by city across all regions of Brazil. We noted significant heterogeneity with respect to some factors (i.e. socio-demographic characteristics, stimulant use and never testing for HIV) and a homogeneous profile for others (binge drinking and sexual behavior). Moreover, our results highlight which factors were most associated with high-risk behavior and high HIV perceived risk, by city and in the country as a whole.

One strength of this study was the inclusion of a large number of MSM living in Brazilian state capitals, in the Federal District and in two large cities from São Paulo state. Considering the estimated population of MSM in each city, the highest proportions of MSM completing the questionnaire were from the South, Southeast and Central-west regions. Compared to the North and Northeast, these regions are more developed likely providing greater access to and use of mobile phones and cell phone data services and/or public Wi-Fi services on a daily basis (18), thus facilitating participation. On the other hand, it could be that MSM from all regions had the same level of access to the survey but that a relatively lower fraction of men from the North and Northeast proceeded with participation due to increased stigma and discrimination and/or a lack of community belonging. São Paulo, Rio de Janeiro and Florianópolis, for instance, have large LGBTQI communities suggesting lower stigma and greater likelihood of participation in a research study addressing sexual behavior related to HIV aimed to enhance health policies. Lastly, differential participation among cities could result from differential use of apps for sexual encounters by the MSM community of each city.

We observed similarities among MSM from 1) the South, Southeast and Brasilia versus those from 2) the North and Northeast. Different from group 1), for group 2) a greater proportion of MSM were young, non-white, of lower income and lower schooling, which are characteristics of the population most vulnerable to HIV infection in Brazil (9). These group differences could be a reflection of the socio-demographic characteristics of the population from these regions according to national data (19), suggesting that our samples were representative of the region, though not representative of MSM with no mobile or internet connection. Despite large inequalities, Brazil has a large number of internet users in all social strata: 58% of individuals receiving one minimum wage per month (~US$260.00) have access to internet (18). According to estimates, 84% of Brazilians have a mobile phone (20) and 96% have access to internet/apps via mobile phones (21). This supports the use of apps and social media to broadcast information on sexual education and HIV/STI treatment and prevention.

MSM reporting high-risk behavior measured by the HIRI-MSM, condomless receptive anal sex and number of partners were more likely to perceive themselves at higher risk, which is consistent with a web-based study conducted among 800 MSM from the United States (22). However, we also found that a high proportion of MSM reporting high-risk behavior do not perceive themselves at high-risk for HIV (~60%). This difference was also observed in other studies conducted in different settings (23–31) and could reflect a dissonance between sexual behavior and HIV transmission knowledge. Previous studies have shown a relationship between sexual behavior or low HIV perceived risk and mistaken beliefs about HIV transmission and epidemiology (32,33). A Brazilian study conducted in 2008/9 evaluated HIV knowledge among MSM from 10 Brazilian cities and found that 41% of the sample had lower than average knowledge with participants still reporting beliefs in incorrect modes of HIV transmission such as through the use of a public restroom (34). Nevertheless, we should consider a possible overestimation of high-risk behavior in our study, given the different estimates depending on the definition of high-risk behavior (sex with >5 men: 43%, condomless anal sex: 41% and the HIRI-MSM: 64%). Indeed, studies have suggested that HIV perceived risk might be a better predictor of actual risk than behavior indicators (30,31), as it is influenced by subjective factors, such as relationship agreements, trust, and perceived HIV infection seriousness (35). Importantly, low HIV perceived risk may be a barrier to PrEP uptake (36). HIV prevention services could benefit from acknowledging an individual's perceived risk rather than relying only on objective measures of risk behavior when offering combined prevention technologies, which includes PrEP. Health care providers could also provide or reinforce information on HIV transmission and prevention. This would empower MSM to make decisions and manage their risk safely.

We found that some factors associated with high-risk behavior were also associated with high HIV perceived risk. MSM who self-declared gay or homosexual compared to other sexual orientations (bisexual, heterosexual or other), had greater odds of high-risk behavior and of high HIV perceived risk. Moreover, when

stratifying by low vs high risk behavior, among those at high-risk, gay or homosexual sexual orientation had higher odds of high HIV perceived risk, while among those at low-risk, no association was found between sexual orientation and high HIV perceived risk. Although the proportion of non-gay MSM in the sample was low and includes self-declared bisexual MSM, one could speculate that those who self-declared gay may be more engaged in gay communities and more aware of their risks. This could also indicate a gap in the framing of health messages which might be inadvertently excluding non-gay MSM (37), leading to a low HIV risk perception and knowledge of prevention technologies.

MSM who reported binge drinking were also found at higher odds of high-risk behavior and of high HIV perceived risk. Indeed, the positive association between binge drinking and high HIV perceived risk remained when stratifying men by risk behavior. Binge drinking is known to increase high-risk behaviors among MSM (38–40) and the loss of consciousness or self-control while under alcohol may explain the high-risk perception. In our study, binge drinking was highly prevalent across the cities (~70%), while more MSM from the Central-west, South and Southeast regions (~20%) reported use of stimulants (compared to ~10% in the North and Northeast). Alcohol is widely used, accepted and easy to access in Brazil (41). Stimulants, in contrast, are expensive and illegal; access may be easier in larger urban areas, what may explain these disparities (42).

Contrasting with the findings reported above is the association of age with sexual behavior and risk perception. We found that younger age was associated with an increased odds of high-risk behavior but a decreased odds of high perceived risk for HIV. In fact, when stratified by risk behavior, younger age was associated with an even lower odds of high HIV perceived risk among MSM reporting high-risk behavior (aOR 0.70 [0.63–0.78] compared to 0.77 [0.70–0.84] in the non-stratified model). This dissonance between behavior and perceived risk is of great concern and might help explain the recent rise in HIV incidence among MSM aged 16–24 years in Brazil (9). A recent Thai study reported similar results among MSM attending a gay sauna, where young MSM were at higher-risk compared to older MSM due to their higher risk behaviors and false perception of low HIV risk (43). One explanation of this finding might be that younger individuals may be more fearless of HIV and/or optimistic of HIV treatment and prevention strategies (44–46). In a web-based survey conducted among MSM from the US, younger MSM had higher knowledge of HIV prevention compared to the older, but no differences regarding HIV perceived risk (47). However, in Brazil, sexual education at schools or within the families are still a taboo and may impact knowledge of HIV transmission risk and prevention strategies (34), which could also explain our findings. Young-friendly interventions to increase awareness of HIV risk behaviors and prevention technologies are urgent to stop new HIV infections among young MSM in Brazil.

Having a steady partner was also associated with an increased odds of high-risk behavior but decreased odds of high perceived risk for HIV. Risk perception decreases when feelings of trust grow in relationships (48). Accordingly, MSM may feel more comfortable to have condomless sex with a steady partner and may perceive no or low risk with this behavior (49). An open conversation between the couple or with the support of a health professional would be beneficial for risk management. PrEP could be an option in case of open or non-monogamic relationships as it does not depend on an agreement during sex (as condoms do). Moreover, when thinking specifically about serodiscordant couples, recent results from Opposites Attract suggest that PrEP might be useful in the initial months of a relationship or during the first months of ART initiation, after which ART-induced viral suppression is likely sufficient (50). Here, the need to disseminate the knowledge that U = U (undetectable = untransmissible) should be emphasized (51). As suggested in a recent review of HIV epidemiology in Latin America (4), U = U knowledge “empowers people living with HIV, improves adherence and decreases self-stigma” and it may also improve intimate relationships by decreasing fear of transmission.

Although there was no association of race, income or education with high-risk behavior (be it overall or by city except for 1 city), blacks/mixed-blacks, those with low income or low education had an increased odds of high HIV perceived risk. We interpret these findings as resulting from the persistent effects of stigma and discrimination, pervasive in our society (52), at the individual, interpersonal and structural levels that create a sense of self-stigma and low self-esteem (53). In addition, MSM populations may face different forms of stigma, including internalized, perceived, experienced and layered stigmas (54). This finding is even more pronounced for black/mixed-black race as even those with low-risk behavior had high-perceived risk for HIV (aOR 1.31 [1.12–1.54]). In a study conducted in Belo Horizonte, black individuals had over 50% higher odds of experiencing discrimination than whites, even after controlling for income, education, social status, and health problems (55). A systematic review showed a higher prevalence of mental health disorders in non-white Brazilians compared to their white counterparts (56), and this could be attributed to negative psychological stress response (57). According to Ribeiro, the place someone occupies in the society influences individual’s experiences and perspectives and the multiplicity of speeches should be promoted in order to break the authoritarian and unique voice (mostly male, white and of higher income) supposed to be universal (58). In this regard, the inclusion of black/mixed-black individuals in the concept and accomplishment of educational campaigns is necessary to increase representativeness and to better understand the needs of this population. Use of simple media messages could benefit those with lower income and education.

Finally, having an STI and ever testing for HIV were both associated with an increased odds of high-risk behavior and with a high HIV perceived risk. In fact, the association between having an STI with high-risk behavior and with high HIV perceived risk was the largest in magnitude when compared to all other factors. In Brazil, STI diagnosis still relies extensively on syndromic management (59) suggesting that these infections were symptomatic which might explain its strong effect on perceived risk: an individuals’ recognition of an STI could suggest his enhanced risk for other STIs, including HIV. Corroborating these findings are those diametrically opposite where asymptomatic MSM with a rectal STI in England reported low or no perceived risk prior to diagnosis (60). Furthermore, the interaction with health professionals at the time of STI diagnosis might have allowed for the provision of information on HIV risk thus increasing knowledge and awareness of one’s risk. This highlights the importance of health care provides as source of information and sexual education. On the association of perceived HIV risk and testing behavior among MSM (30,61), results are not consistent across studies and depends on how HIV testing frequency was measured. In this study, we were conservative and captured information on testing at least once in lifetime.

Overall, almost 17% of the surveyed MSM reported never having tested for HIV (median age 29 years), which can be considered quite high as the CDC recommends that everyone aged 13–64 years should be tested at least once and that sexually active gay and bisexual men benefit from more frequent testing (e.g. every 3 to 6 months) (62). This proportion was even higher in the North and the Northeast. This may be related to limited access to health services in these regions, though only 7–10% of those who never tested reported that it was not practical to go to a health care center. The main reasons for not testing (“I

am afraid of getting a positive result" and "I am ashamed") reflects the persistent HIV stigma in Brazil with fear of HIV stigma hindering HIV testing. In a study conducted in New York City, MSM and transgender women afraid of HIV stigma were less likely to get tested (63,64). In addition, some MSM already face stigma for being gay and a possible HIV diagnosis would represent a new stigma to bear. HIV testing is a key technology within the HIV prevention package, it is the necessary step to linkage to care and treatment for those with HIV infection and to prevention services for those with a negative result. Information on the benefits of early HIV diagnosis and antiretroviral therapy initiation to decrease comorbidities related and not related to AIDS (65) and to decrease HIV transmission (50,66) are essential to decrease stigma, increase HIV testing and, as consequence, decrease new cases of HIV. HIV self-testing, which is available commercially in Brazil, can play in an important role in increasing testing, although awareness of this technology is still low in the country (12,13,67). A previous analysis verified that MSM willing to use PrEP were also willing to use HIV self-testing, indicating that both technologies could be offered in the same platform, which could be web-based (67). In this regard, it is encouraging that awareness and willingness to use PrEP increased overtime in Brazil though it varied according to the evaluated cities. This is likely the result of the expansion of PrEP demonstration projects to other cities (e.g. inclusion of Manaus and Porto Alegre to PrEP Brasil study) (68), the initiation of ImPrEP demonstration study in 12 Brazilian cities (http://imprep.org/) and the campaigns to increase PrEP knowledge among key populations in websites (e.g. http://prepbrasil.com.br), social media (e.g. http://facebook.com/prepbrasil) and apps for sexual encounters. Acknowledging the heterogeneity in PrEP awareness is important as PrEP is being offered at no cost to high-risk populations in the Brazilian Public Health System. Increased efforts and resources in particular cities or regions are paramount to increase awareness and create demand for PrEP.

This study has limitations. First, web-based studies are not probabilistic sampling strategies, precluding the generalization of the findings to all Brazilian MSM. Given the cross-sectional nature of the data, causality and the direction of association may not be inferred. All collected data were self-reported by participants and may be subject to bias. However, individuals tend to be more open and honest through web-based surveys, thereby reducing the possibility of social desirability bias (69). Our data are subject to recall bias due to 6-month or 12-month recall periods. There is also a concern about participants taking the survey multiple times. To mitigate this bias, the first question of the survey was, "Are you answering this survey for the first time?". On the definition of our high-risk behavior outcomes, we used three different definitions that have been consistently used in other studies as well as in guidelines to define populations at substantial risk of HIV infection (15–17,70–72). The use of the HIRI-MSM as the outcome in the regression model precluded the evaluation of stimulants use as a covariate as it is already included in the scale. Instead, we focused on the effect of alcohol use as measured by binge drinking.

Conclusions

Overall, MSM socio-demographic characteristics were heterogeneous among Brazilian cities, but similarities were noted among the cities from the same administrative region with a marked exception of the Federal District not following the patterns for the Central-West. Some behaviors were more homogeneous across the country, including high-risk sexual behavior, though never testing for HIV was notably higher in the least developed cities. Discordance between sexual behavior and HIV perceived risk may be a barrier to effective PrEP implementation, and prevention programs could evaluate the added role of assessing HIV risk perception.

List Of Abbreviations

AIDS: acquired immunodeficiency syndrome

CDC: Centers for Disease Control and Prevention

CI: confidence interval

FTC/TDF: emtricitabine / tenofovir disoproxil fumarate

GDP: gross domestic product

GSN: geosocial networking

HDI: human development index

HIRI-MSM: HIV Incidence Risk Index for MSM

HIV: human immunodeficiency virus

IQR: interquartile range

LGBTQI: lesbian, gay, bisexual, transgender, queer and intersex

OR: odds ratio

MSM: gays, bisexuals and other men who have sex with men

MW: minimum wage

PrEP: pre-exposure prophylaxis

STI: sexually transmitted infections

SUS: Brazilian Public Health System

Declarations

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Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Author contributions

TST and PML conceived this study and did the literature search. TST analyzed the data and generated the tables and figures. TST and PML interpreted the data and draft the manuscript. All authors critically revised the manuscript for important intellectual content and approved the final version of the manuscript.

Ethics, consent and permissions

INI Evandro Chagas-FIOCRUZ institutional review board approved this study (#CAAE 51595815.7.0000.5262 and 82021918.0.0000.5262) in accordance with all applicable regulations and all study participants digitally signed an informed consent form. No form of identification of participants was collected.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. Characteristics of MSM who completed the online surveys in each Brazilian city. 2016-2018

	N (%)	Male pop. (≥18 years)[a]	Estimated MSM pop. (≥18 years)[b]	% resp.[c]	Age (years)					Race			Income (minimum wage)				Schooling (years)			
					Median (IQR)	18-24	25-29	30-34	35+	White/ Asian	Black	Mix black/ Native	≤1	>1-3	>3-10	>10	<10	10-12	13-16	>
North																				
Manaus	297 (1.8)	569,834	19,944	1.5	25 (22-30)	138 (46.5)	78 (26.3)	37 (12.5)	44 (14.8)	98 (33.8)	30 (10.3)	162 (55.9)	57 (19.2)	126 (42.4)	85 (28.6)	29 (9.8)	14 (4.8)	145 (49.5)	67 (22.9)	6 (22
Belém	290 (1.7)	457,322	16,006	1.8	26 (22-32)	125 (43.1)	64 (22.1)	51 (17.6)	50 (17.2)	112 (39.0)	43 (15.0)	132 (46.0)	35 (12.1)	103 (35.5)	111 (38.3)	41 (14.1)	7 (2.4)	116 (40.3)	101 (35.1)	6 (22
rto Velho	37 (0.2)	146,727	5,135	0.7	25 (22-30)	17 (45.9)	10 (27.0)	7 (18.9)	3 (8.1)	16 (43.2)	3 (8.1)	18 (48.6)	4 (10.8)	12 (32.4)	18 (48.6)	3 (8.1)	1 (2.7)	13 (37.1)	13 (37.1)	(22
Palmas	34 (0.2)	75,543	2,644	1.3	27.5 (24-32.7)	11 (32.4)	9 (26.5)	6 (17.6)	8 (23.5)	15 (44.1)	5 (14.7)	14 (41.2)	4 (11.8)	9 (26.5)	18 (52.9)	3 (8.8)	0 (0.0)	12 (35.3)	11 (32.4)	1 (32
oa Vista	31 (0.2)	89,030	3,116	1.0	30 (24.5-37.5)	8 (25.8)	6 (19.4)	8 (25.8)	9 (29.0)	5 (16.1)	2 (6.5)	24 (77.4)	3 (9.7)	12 (38.7)	12 (38.7)	4 (12.9)	0 (0.0)	8 (25.8)	13 (41.9)	1 (32
o Branco	23 (0.1)	103,808	3,633	0.6	28 (24.5-32)	6 (26.1)	9 (39.1)	5 (21.7)	3 (13.0)	7 (30.4)	2 (8.7)	14 (60.9)	5 (21.7)	6 (26.1)	9 (39.1)	3 (13.0)	0 (0.0)	8 (34.8)	9 (39.1)	(26
Macapá	18 (0.1)	120,180	4,206	0.4	27 (22.5-30.7)	7 (38.9)	5 (27.8)	3 (16.7)	3 (16.7)	9 (50.0)	3 (16.7)	6 (33.3)	3 (16.7)	8 (44.4)	4 (22.2)	3 (16.7)	1 (5.6)	4 (23.5)	8 (47.1)	(23
ortheast																				
Recife	636 (3.8)	508,405	17,794	3.6	29 (24-36)	183 (28.8)	160 (25.2)	113 (17.8)	180 (28.3)	283 (45.4)	87 (13.9)	254 (40.7)	82 (12.9)	239 (37.6)	223 (35.1)	92 (14.5)	17 (2.7)	232 (36.7)	207 (32.8)	1 (27
alvador	628 (3.8)	904,397	31,654	2.0	29 (24-35)	168 (26.8)	162 (25.8)	120 (19.1)	178 (28.3)	182 (29.4)	190 (30.7)	247 (39.9)	83 (13.2)	224 (35.7)	216 (34.4)	105 (16.7)	16 (2.6)	213 (34.0)	230 (36.7)	1 (26
ortaleza	418 (2.5)	800,792	28,028	1.5	28 (23-34)	131 (31.3)	115 (27.5)	80 (19.1)	92 (22.0)	157 (38.2)	55 (13.4)	199 (48.4)	69 (16.5)	160 (38.3)	145 (34.7)	44 (10.5)	7 (1.7)	170 (41.6)	139 (34.0)	9 (22
Natal	171 (1.0)	268,193	9,387	1.8	28 (24-34)	48 (28.1)	51 (29.8)	31 (18.1)	41 (24.0)	91 (53.5)	22 (12.9)	57 (33.5)	13 (7.6)	68 (39.8)	62 (36.3)	28 (16.4)	6 (3.5)	61 (35.9)	55 (32.4)	4 (28
o Pessoa	115 (0.7)	237,865	8,325	1.4	29 (24-34)	31 (27.0)	27 (23.5)	29 (25.2)	28 (24.3)	44 (38.3)	12 (10.4)	59 (51.3)	18 (15.7)	47 (40.9)	37 (32.2)	13 (11.3)	4 (3.5)	35 (30.4)	52 (45.2)	2 (20
Aracaju	108 (0.6)	185,953	6,508	1.7	25 (21-29)	46 (42.6)	36 (33.3)	10 (9.3)	16 (14.8)	48 (45.7)	17 (16.2)	40 (38.1)	19 (17.6)	53 (49.1)	26 (24.1)	10 (9.3)	1 (0.9)	51 (47.2)	34 (31.5)	2 (20
eresina	100 (0.6)	262,763	9,197	1.1	27 (22-31.2)	39 (39.0)	25 (25.0)	18 (18.0)	18 (18.0)	27 (27.3)	18 (18.2)	54 (54.5)	20 (20.0)	37 (37.0)	38 (38.0)	5 (5.0)	2 (2.0)	34 (35.4)	33 (34.4)	2 (28
Maceió	91 (0.5)	292,718	10,245	0.9	27 (23-33)	37 (40.7)	20 (22.0)	15 (16.5)	19 (20.9)	33 (36.7)	17 (18.9)	40 (44.4)	14 (15.4)	28 (30.8)	36 (39.6)	13 (14.3)	1 (1.1)	35 (38.9)	29 (32.2)	2 (27
ão Luís	53 (0.3)	326,863	11,440	0.5	25 (23-30)	26 (49.1)	10 (18.9)	7 (13.2)	10 (18.9)	20 (37.7)	11 (20.8)	22 (41.5)	5 (9.4)	28 (52.8)	17 (32.1)	3 (5.7)	1 (1.9)	24 (45.3)	17 (32.1)	1 (20
ıtral-west																				
Brasília	890 (5.3)	855,306	29,936	3.0	30 (25-38)	219 (24.6)	209 (23.5)	170 (19.1)	292 (32.8)	460 (52.8)	88 (10.1)	324 (37.2)	46 (5.2)	199 (22.4)	341 (38.3)	304 (34.2)	12 (1.4)	261 (29.4)	293 (33.0)	3 (36
Goiânia	570 (3.4)	450,221	15,758	3.6	28 (23-33)	169 (29.6)	174 (30.5)	113 (19.8)	114 (20.0)	287 (51.0)	61 (10.8)	215 (38.2)	64 (11.2)	201 (35.3)	227 (39.8)	78 (13.7)	32 (5.7)	222 (39.2)	167 (29.5)	1 (25
Cuiabá	119 (0.7)	190,291	6,660	1.8	27 (23-33)	43 (36.1)	34 (28.6)	20 (16.8)	22 (18.5)	42 (35.9)	30 (25.6)	45 (38.5)	9 (7.6)	46 (38.7)	48 (40.3)	16 (13.4)	4 (3.4)	39 (33.6)	44 (37.9)	2 (25
Campo Grande	115 (0.7)	270,346	9,462	1.2	28 (23-33)	42 (36.5)	28 (24.3)	24 (20.9)	21 (18.3)	58 (50.9)	19 (16.7)	37 (32.5)	8 (7.0)	41 (35.7)	50 (43.5)	16 (13.9)	4 (3.5)	45 (39.5)	36 (31.6)	2 (25
outheast																				
ão Paulo	5764 (34.6)	3,889,290	136,125	4.2	30 (25-36)	1393 (24.2)	1382 (24.0)	1187 (20.6)	1801 (31.3)	3885 (68.1)	476 (8.3)	1342 (23.5)	396 (6.9)	1596 (27.7)	2566 (44.5)	1206 (20.9)	214 (3.7)	1966 (34.2)	2147 (37.4)	14 (24
Rio de aneiro	3166 (19.0)	2,198,018	76,931	4.1	30 (24-37)	803 (25.4)	757 (23.9)	602 (19.0)	1004 (31.7)	1791 (57.1)	415 (13.2)	931 (29.7)	293 (9.3)	996 (31.5)	1285 (40.6)	592 (18.7)	150 (4.8)	1293 (41.0)	878 (27.8)	8 (26
Belo orizonte	967 (5.8)	831,360	29,098	3.3	29 (24-35)	260 (26.9)	262 (27.1)	176 (18.2)	269 (27.8)	468 (48.8)	138 (14.4)	353 (36.8)	97 (10.0)	328 (33.9)	429 (44.4)	113 (11.7)	42 (4.4)	361 (37.6)	309 (32.2)	2 (25
ampinas	260 (1.6)	389,948	13,648	1.9	29 (25-38)	60 (23.1)	72 (27.7)	48 (18.5)	80 (30.8)	165 (63.7)	25 (9.7)	69 (26.6)	19 (7.3)	82 (31.5)	129 (49.6)	30 (11.5)	16 (6.2)	99 (38.1)	75 (28.8)	7 (26
Vitória	160 (1.0)	114,835	4,019	4.0	29 (24.7-34)	40 (25.0)	43 (26.9)	43 (26.9)	34 (21.3)	76 (48.1)	20 (12.7)	62 (39.2)	18 (11.3)	67 (41.9)	64 (40.0)	11 (6.9)	4 (2.6)	60 (37.7)	55 (34.6)	4 (25
Santos	101 (0.6)	148,026	5,181	1.9	31 (26-40)	16 (15.8)	26 (25.7)	24 (23.8)	35 (34.7)	68 (67.3)	7 (6.9)	26 (25.7)	7 (6.9)	29 (28.7)	50 (49.5)	15 (14.9)	2 (2.0)	27 (26.7)	46 (45.5)	2 (25
South																				
to Alegre	648 (3.9)	489,677	17,139	3.8	30 (25-37)	150 (23.1)	149 (23.0)	134 (20.7)	215 (33.2)	526 (82.0)	30 (4.7)	85 (13.3)	29 (4.5)	196 (30.2)	303 (46.3)	120 (18.5)	20 (3.1)	242 (37.5)	203 (31.4)	1 (28
Curitiba	499	615,841	21,554	2.3	30	122	118	115	144	347	32	114	28	147	248	76	16	169	161	1

	(3.0)				(25-36)	(24.4)	(23.6)	(23.0)	(28.9)	(70.4)	(6.5)	(23.1)	(5.6)	(29.5)	(49.7)	(15.2)	(3.2)	(34.0)	(32.4)	(3(
rianópolis	358	155,364	5,438	6.6	29	88	100	85	85	259	26	69	15	132	153	58	18	147	107	8
	(2.1)				(25-34)	(24.6)	(27.9)	(23.7)	(23.7)	(73.2)	(7.3)	(19.5)	(4.2)	(36.9)	(42.7)	(16.2)	(5.0)	(41.1)	(29.9)	(2
Total	16,667	15,948,916	558,212	3.0	29	4426	4141	3281	4818	9579	1884	5014	1463	5220	6950	3034	612	6092	5539	43
	(100.0)				(24-36)	(26.6)	(24.8)	(19.7)	(28.9)	(58.1)	(11.4)	(30.4)	(8.7)	(31.3)	(41.7)	(18.2)	(3.7)	(36.7)	(33.4)	(2(

Missing (participant did not want to answer or did not know): age=1; race=190; schooling=75; sexual orientation=86; steady partner=76; test lifetime=51.
a According to Brazilian CENSO 2010 (https://sidra.ibge.gov.br/tabela/1209); b Considering the proportion of MSM among Brazilian male population between 15-64 years (3.5%) (http://www.aids.gov.br/pt-br/pub/2016/pesquisa-de-conhecimentos-atitudes-e-praticas-na-populacao-brasileira-pcap-2013); c Proportion of MSM who completed the web-based surveys in relation to estimated MSM population.

Table 2. Sexual orientation, steady partner and behaviors of MSM who completed the online surveys in each Brazilian city. 2016-2018

	Total	Sexual Orientation (Gay or homosexual)	Steady partner	Binge drinking[a]	Use of Stimulants [a, b]	STI[a, c]	HIV testing (never)	Sex with >5 men[a]	Condomless receptive anal sex[a]	The HIV Incidence Risk Index for MSM (HIRI-MSM)[d]		HIV perceived risk[e]		
										Low Risk	High risk	No risk	Low risk	High risk
North														
Manaus	297	242 (83.2)	72 (24.2)	191 (64.3)	30 (10.1)	32 (10.9)	75 (25.5)	114 (38.4)	118 (39.9)	120 (40.4)	177 (59.6)	59 (21.5)	134 (48.9)	81 (29.6)
Belém	290	240 (83.9)	56 (19.5)	203 (70.0)	31 (10.7)	32 (11.1)	76 (26.5)	105 (36.2)	122 (42.2)	116 (40.0)	174 (60.0)	64 (23.5)	144 (52.9)	64 (23.5)
Porto Velho	37	31 (83.8)	6 (16.7)	28 (75.7)	5 (13.5)	4 (10.8)	7 (19.4)	13 (35.1)	19 (52.8)	9 (24.3)	28 (75.7)	3 (8.6)	19 (54.3)	13 (37.1)
Palmas	34	29 (85.3)	9 (26.5)	25 (73.5)	3 (8.8)	6 (17.6)	5 (15.2)	9 (26.5)	17 (50.0)	11 (32.4)	23 (67.6)	4 (11.8)	16 (47.1)	14 (41.2)
Boa Vista	31	27 (87.1)	10 (32.3)	22 (71.0)	6 (19.4)	6 (19.4)	1 (3.2)	12 (38.7)	13 (41.9)	12 (38.7)	19 (61.3)	7 (22.6)	18 (58.1)	6 (19.4)
Rio Branco	23	23 (100.0)	7 (31.8)	18 (78.3)	3 (13.0)	7 (30.4)	3 (13.0)	11 (47.8)	10 (43.5)	8 (34.8)	15 (65.2)	3 (13.0)	15 (65.2)	5 (21.7)
Macapá	18	13 (72.2)	6 (33.3)	10 (55.6)	3 (16.7)	3 (17.6)	3 (16.7)	7 (38.9)	9 (50.0)	7 (38.9)	11 (61.1)	3 (16.7)	6 (33.3)	9 (50.0)
Northeast														
Recife	636	550 (87.0)	173 (27.3)	437 (68.8)	81 (12.7)	64 (10.2)	130 (20.4)	251 (39.5)	255 (40.3)	253 (39.8)	383 (60.2)	121 (20.2)	329 (54.9)	149 (24.9)
Salvador	628	555 (88.8)	147 (23.6)	451 (71.8)	113 (18.0)	73 (11.8)	106 (17.0)	277 (44.1)	251 (40.2)	241 (38.4)	387 (61.6)	119 (20.2)	312 (53.1)	157 (26.7)
Fortaleza	418	391 (93.8)	94 (22.7)	288 (68.9)	56 (13.4)	46 (11.2)	103 (25.0)	151 (36.1)	158 (38.3)	173 (41.4)	245 (58.6)	70 (17.6)	214 (53.8)	114 (28.6)
Natal	171	155 (91.2)	33 (19.5)	118 (69.0)	19 (11.1)	23 (13.5)	43 (25.3)	66 (38.6)	76 (45.0)	67 (39.2)	104 (60.8)	22 (13.2)	96 (57.5)	49 (29.3)
Joao Pessoa	115	106 (93.0)	30 (26.1)	75 (65.2)	17 (14.8)	14 (12.3)	18 (15.8)	52 (45.2)	44 (38.3)	46 (40.0)	69 (60.0)	16 (14.7)	55 (50.5)	38 (34.9)
Aracaju	108	93 (86.1)	20 (18.7)	77 (71.3)	12 (11.1)	10 (9.3)	36 (33.6)	34 (31.5)	39 (36.4)	49 (45.4)	59 (54.6)	24 (23.3)	53 (51.5)	26 (25.2)
Teresina	100	84 (85.7)	25 (26.0)	63 (63.0)	6 (6.0)	9 (9.4)	26 (27.1)	35 (35.0)	37 (37.4)	43 (43.0)	57 (57.0)	18 (18.9)	42 (44.2)	35 (36.8)
Maceió	91	79 (86.8)	26 (29.2)	65 (71.4)	11 (12.1)	6 (6.9)	20 (22.2)	33 (36.3)	35 (38.5)	35 (38.5)	56 (61.5)	15 (17.9)	54 (64.3)	15 (17.9)
São Luís	53	50 (94.3)	10 (18.9)	33 (62.3)	5 (9.4)	9 (17.0)	18 (34.0)	21 (39.6)	22 (41.5)	21 (39.6)	32 (60.4)	9 (19.1)	22 (46.8)	16 (34.0)
Central-west														
Brasília	890	795 (89.6)	250 (28.2)	632 (71.1)	206 (23.1)	110 (12.5)	113 (12.7)	399 (44.8)	359 (40.5)	322 (36.2)	568 (63.8)	133 (15.8)	481 (57)	230 (27.3)
Goiânia	570	509 (89.9)	123 (21.7)	405 (71.3)	103 (18.1)	89 (16.1)	126 (22.1)	230 (40.4)	227 (40.0)	213 (37.4)	357 (62.6)	104 (19.7)	267 (50.7)	156 (29.6)
Cuiabá	119	102 (86.4)	22 (18.6)	84 (70.6)	19 (16.0)	19 (16.4)	22 (18.6)	52 (43.7)	53 (45.3)	36 (30.3)	83 (69.7)	15 (13.5)	56 (50.5)	40 (36.0)
Campo Grande	115	98 (85.2)	19 (16.5)	80 (69.6)	25 (21.7)	20 (17.9)	22 (19.1)	44 (38.3)	50 (44.2)	40 (34.8)	75 (65.2)	16 (14.3)	60 (53.6)	36 (32.1)
Southeast														
São Paulo	5764	5201 (90.6)	1341 (23.3)	4005 (69.6)	1421 (24.7)	763 (13.4)	790 (13.7)	2664 (46.2)	2375 (41.4)	1951 (33.8)	3813 (66.2)	911 (16.8)	3033 (55.9)	1484 (27.3)
Rio de Janeiro	3166	2820 (89.6)	775 (24.6)	2287 (72.3)	624 (19.8)	398 (12.7)	541 (17.1)	1438 (45.4)	1331 (42.1)	1104 (34.9)	2062 (65.1)	499 (16.9)	1640 (55.6)	810 (27.5)
Belo Horizonte	967	881 (91.3)	227 (23.6)	693 (71.7)	180 (18.6)	123 (13.0)	177 (18.3)	386 (39.9)	392 (40.9)	362 (37.4)	605 (62.6)	134 (14.5)	504 (54.7)	283 (30.7)
Campinas	260	235 (91.1)	56 (21.6)	173 (66.5)	59 (22.7)	31 (12.1)	47 (18.1)	97 (37.3)	115 (45.3)	102 (39.2)	158 (60.8)	35 (14.2)	137 (55.5)	75 (30.4)
Vitória	160	148 (94.9)	34 (21.5)	115 (71.9)	36 (22.5)	21 (13.4)	22 (13.8)	58 (36.2)	72 (46.2)	44 (27.5)	116 (72.5)	22 (14.9)	83 (56.1)	43 (29.1)
Santos	101	92 (91.1)	28 (27.7)	68 (67.3)	14 (13.9)	16 (16.0)	12 (11.9)	38 (37.6)	39 (39.0)	41 (40.6)	60 (59.4)	21 (22.1)	46 (48.4)	28 (29.5)
South														
Porto Alegre	648	555 (88.8)	167 (25.9)	441 (68.2)	129 (20.0)	77 (12.1)	93 (14.4)	295 (45.5)	274 (42.3)	238 (36.7)	410 (63.3)	89 (14.6)	361 (59.2)	160 (26.2)
Curitiba	499	455 (91.5)	110 (22.2)	335 (67.1)	102 (20.4)	68 (13.9)	63 (12.7)	217 (43.5)	197 (39.6)	170 (34.1)	329 (65.9)	70 (14.8)	255 (53.9)	148 (31.3)
Florianópolis	358	324 (90.8)	79 (22.1)	262 (73.2)	82 (22.9)	66 (18.6)	56 (15.7)	160 (44.7)	156 (43.7)	111 (31.0)	247 (69.0)	59 (17.4)	177 (52.2)	103 (30.4)
Total	16667	14909 (89.9)	3955	11684	3401	2145	2754	7269	6865 (41.4)	5945	10722	2665	8629	4387

	(23.8)	(70.2)	(20.4)	(13.1)	(16.6)	(43.6)		(35.7)	(64.3)	(17.0)	(55.0) (28.0)

uring the previous 6 months; [b] Cocaine, poppers, crack, or amphetamines; [c] Syphilis, gonorrhea, or rectal chlamydia; [d] The HIRI-MSM was calculated based on sexual havior in the previous six months (number of partners, condomless receptive anal intercourse, sex with HIV-positive partner), age and use of stimulants, being stratified ir v risk (< 10 points) and high risk (≥10 points; PrEP is recommended). "Unknown" answers scored 0 points on the HIRI-MSM; [e] In the next 12 months.

Table 3. Association between HIV risk behavior and HIV perceived risk among MSM who completed the online surveys in Brazil.

	HIV Perceived risk[a]		High HIV perceived risk OR (95%CI)
	Low	High	
The HIV Incidence Risk Index for MSM[b]			
Low	4860 (86.1)	784 (13.9)	Ref.
High	6434 (64.1)	3603 (35.9)	3.47 (3.19-3.78)
Condomless receptive anal sex[c]			
No	7400 (80.3)	1811 (19.7)	Ref.
Yes	3847 (60.1)	2552 (39.9)	2.71 (2.52-2.91)
Number of male partners[c]			
≤5	7213 (81.2)	1671 (18.8)	Ref.
>5	4081 (60.0)	2716 (40.0)	2.87 (2.67-3.09)

[a] In the next 12 months; [b]The HIRI-MSM was calculated based on sexual behavior in the previous six months (number of partners, condomless receptive anal intercourse, sex with HIV-positive partner), age and use of stimulants, being stratified in low risk (< 10 points) and high risk (≥10 points; PrEP is recommended)."Unknown" answers scored 0 points on the HIRI-MSM; [c] During the previous 6 months.

Table 4: HIV risk behavior vs. HIV perceived risk among MSM from 11 cities in Brazil.

	HIV risk behavior[a]	HIV perceived risk [b]	
		Low	High
North			
Manaus	Low	99(85.3)	17(14.7)
	High	94(59.5)	64(40.5)
Belém	Low	102(89.5)	12(10.5)
	High	106(67.1)	52(32.9)
Northeast			
Recife	Low	203(84.9)	36(15.1)
	High	247(68.6)	113(31.4)
Salvador	Low	198(85.3)	34(14.7)
	High	233(65.4)	123(34.6)
Central-west			
Brasília	Low	268(86.7)	41(13.3)
	High	346(64.7)	189(35.3)
Goiânia	Low	166(83.4)	33(16.6)
	High	205(62.5)	123(37.5)
Southeast			
São Paulo	Low	1604(86.9)	241(13.1)
	High	2340(65.3)	1243(34.7)
Rio de Janeiro	Low	910(87.8)	126(12.2)
	High	1229(64.2)	684(35.8)
Belo Horizonte	Low	287(83.2)	58(16.8)
	High	351(60.9)	225(39.1)
South			
Porto Alegre	Low	198(87.2)	29(12.8)
	High	252(65.8)	131(34.2)
Curitiba	Low	137(84.0)	26(16.0)
	High	188(60.6)	122(39.4)
Brazil	Low	4860 (86.1)	784 (13.9)
	High	6434 (64.1)	3603 (35.9)

[a] measured by the HIRI-MSM, which was calculated based on sexual behavior in the previous six months (number of partners, condomless receptive anal intercourse, sex with HIV-positive partner), age and use of stimulants, being stratified in low risk (< 10 points) and high risk (≥10 points; PrEP is recommended); [b] HIV perceived risk (in the next 12 months) was dichotomized in low (no/low) and high risk.

Table 5: Condomless receptive anal sex vs. HIV perceived risk among MSM from 11 cities in Brazil.

	Condomless receptive anal sex [a]	HIV perceived risk [b]	
		Low	High
North			
Manaus	No	133(79.6)	34(20.4)
	Yes	60(56.6)	46(43.4)
Belém	No	137(85.6)	23(14.4)
	Yes	71(64.0)	40(36.0)
Northeast			
Recife	No	295(82.4)	63(17.6)
	Yes	153(64.3)	85(35.7)
Salvador	No	292(81.3)	67(18.7)
	Yes	138(60.8)	89(39.2)
Central-west			
Brasília	No	400(79.4)	104(20.6)
	Yes	212(62.9)	125(37.1)
Goiânia	No	247(77.9)	70(22.1)
	Yes	123(59.1)	85(40.9)
Southeast			
São Paulo	No	2592(81.5)	590(18.5)
	Yes	1334(60.0)	889(40.0)
Rio de Janeiro	No	1397(81.6)	314(18.4)
	Yes	741(60.0)	494(40.0)
Belo Horizonte	No	414(76.4)	128(23.6)
	Yes	218(58.6)	154(41.4)
South			
Porto Alegre	No	290(81.5)	66(18.5)
	Yes	160(63.2)	93(36.8)
Curitiba	No	221(76.5)	68(23.5)
	Yes	103(56.3)	80(43.7)
Brazil	No	7400 (80.3)	1811 (19.7)
	Yes	3847 (60.1)	2552 (39.9)

[a] During the previous 6 months; [b] HIV perceived risk (in the next 12 months) was dichotomized in low (no/low) and high risk.

Table 6. Association, measured by the adjusted odds ratios (aOR, 95% confidence interval) between MSM characteristics and high-risk behavior as measured by the HIV Incidence Risk Index for MSM (HIRI-MSM), by city, 2016-2018.

	Total	Young age: 18-24 years (ref: >24 years	Black/mixed-black (ref: white/Asian)	≤ 3 MW income (ref: >3 MW)	≤ 12 years of Schooling (ref: >12 years)	Gay or homosexual (ref: Other than gay)	Steady partner (ref: no)	Binge drinking[a] (ref: no)	STI[a, c] (ref: no)	Ever HIV testing (ref: never)
North										
Manaus	297	1.20(0.67-2.18)	1.48(0.86-2.55)	0.78(0.44-1.37)	1.13(0.65-2.00)	0.95(0.47-1.89)	1.54(0.84-2.88)	**2.15(1.27-3.64)**	1.48(0.63-3.69)	**2.44(1.36-4.42)**
Belém	290	1.65(0.91-3.03)	1.32(0.77-2.28)	0.62(0.35-1.09)	1.11(0.60-2.02)	1.42(0.69-2.92)	0.71(0.37-1.39)	**2.76(1.58-4.90)**	**5.35(1.93-19.12)**	0.62(0.33-1.16)
Northeast										
Recife	636	**1.71(1.12-2.62)**	0.81(0.57-1.13)	0.73(0.51-1.05)	1.15(0.78-1.71)	**1.67(1.03-2.72)**	1.19(0.82-1.73)	1.18(0.82-1.68)	1.32(0.76-2.35)	1.14(0.74-1.75)
Salvador	628	1.12(0.72-1.73)	0.83(0.56-1.22)	0.95(0.65-1.39)	1.40(0.90-2.17)	**2.59(1.52-4.51)**	1.11(0.74-1.67)	1.33(0.92-1.94)	**3.82(2.01-7.93)**	1.61(1.00-2.59)
Central-west										
Brasília	890	1.29(0.87-1.91)	1.05(0.78-1.42)	0.86(0.60-1.24)	0.83(0.58-1.21)	**2.46(1.55-3.93)**	1.20(0.86-1.67)	**1.84(1.34-2.53)**	**3.28(1.96-5.80)**	1.09(0.69-1.72)
Goiânia	570	1.39(0.88-2.21)	0.93(0.64-1.35)	0.98(0.65-1.46)	**1.55(1.02-2.38)**	1.28(0.70-2.31)	**1.72(1.10-2.74)**	**2.00(1.34-3.00)**	**2.37(1.38-4.23)**	1.34(0.84-2.14)
Southeast										
São Paulo	5764	**1.46(1.25-1.71)**	1.04(0.92-1.18)	0.90(0.79-1.03)	0.96(0.84-1.11)	**2.05(1.70-2.48)**	1.04(0.90-1.19)	**2.08(1.84-2.34)**	**2.48(2.04-3.04)**	**1.42(2.04-3.04)**
Rio de Janeiro	3166	**1.40(1.14-1.72)**	0.94(0.80-1.10)	1.09(0.92-1.30)	0.97(0.81-1.16)	**1.73(1.36-2.20)**	1.16(0.97-1.39)	**1.69(1.43-2.00)**	**2.60(1.98-3.46)**	**1.75(1.42-2.16)**
Belo Horizonte	967	0.93(0.67-1.31)	1.00(0.75-1.32)	1.18(0.88-1.59)	0.93(0.68-1.28)	**2.17(1.35-3.51)**	1.02(0.74-1.42)	**1.74(1.29-2.34)**	**1.58(1.04-2.46)**	1.09(0.76-1.57)
South										
Porto Alegre	648	1.27(0.80-2.04)	0.79(0.51-1.23)	1.11(0.76-1.63)	0.94(0.63-1.40)	**2.01(1.16-3.51)**	1.05(0.71-1.57)	**2.09(1.46-2.99)**	**2.49(1.39-4.74)**	1.21(0.73-1.98)
Curitiba	499	1.09(0.65-1.84)	1.28(0.82-2.03)	0.90(0.58-1.42)	0.86(0.54-1.37)	**2.09(1.02-4.31)**	1.16(0.71-1.91)	**2.12(1.40-3.21)**	**2.00(1.07-4.00)**	1.65(0.89-3.02)
Brazil	16667	**1.34(1.23-1.46)**	0.97(0.91-1.04)	0.96(0.89-1.04)	1.00(0.93-1.09)	**1.91(1.71-2.13)**	**1.13(1.04-1.22)**	**1.88(1.75-2.02)**	**2.30(2.06-2.59)**	**1.45(1.32-1.59)**

MW = minimum wage

The HIRI-MSM was calculated based on sexual behavior in the previous six months (number of partners, condomless receptive anal intercourse, sex with HIV-positive partner), age and use of stimulants, being stratified in low risk (< 10 points) and high risk (≥10 points; PrEP is recommended). “Unknown” answers scored 0 points on The HIRI-MSM; [a] During the previous 6 months; [b] Cocaine, poppers, crack, or amphetamines; [c] Syphilis, gonorrhea, or rectal chlamydia.

Table 7. Association, measured by the adjusted odds ratios (aOR, 95% confidence interval) between MSM characteristics and high HIV perceived risk, by city, 2016-2018.

	Total	Young age: 18-24 years (ref: >24 years)	Black/mixed-black (ref: white/Asian)	≤ 3 MW income (ref: >3 MW)	≤ 12 years of Schooling (ref: >12 years)	Gay or homosexual (ref: Other than gay)	Steady partner (ref: no)	Binge drinking[a] (ref: no)	STI[a, c] (ref: no)	Ever HIV testing (ref: never)
North										
Manaus	297	0.94(0.49-1.80)	**1.93(1.03-3.75)**	1.37(0.73-2.60)	0.94(0.50-1.76)	1.56(0.72-3.63)	1.17(0.60-2.25)	1.77(0.98-3.30)	**3.22(1.30-8.05)**	0.88(0.45-1.74)
Belém	290	1.13(0.56-2.27)	1.61(0.84-3.16)	1.55(0.79-3.05)	1.28(0.63-2.60)	**3.31(1.19-11.30)**	0.59(0.23-1.38)	**2.93(1.39-6.67)**	**6.67(2.68-17.49)**	1.58(0.72-3.68)
Northeast										
Recife	636	0.66(0.40-1.07)	1.30(0.87-1.94)	0.88(0.57-1.34)	1.39(0.88-2.19)	**2.07(1.08-4.33)**	0.94(0.60-1.46)	1.22(0.80-1.89)	**2.44(1.37-4.31)**	0.81(0.49-1.35)
Salvador	628	0.74(0.45-1.22)	1.07(0.69-1.67)	1.07(0.69-1.65)	0.94(0.57-1.53)	1.66(0.87-3.40)	1.06(0.67-1.64)	1.17(0.76-1.82)	**3.36(1.98-5.72)**	0.65(0.38-1.13)
Central-west										
Brasília	890	**0.47(0.30-0.75)**	1.14(0.82-1.60)	1.12(0.74-1.69)	1.22(0.80-1.84)	1.25(0.71-2.28)	0.72(0.49-1.05)	**1.69(1.16-2.49)**	**4.42(2.86-6.88)**	1.13(0.66-2.03)
Goiânia	570	1.17(0.71-1.92)	0.82(0.54-1.24)	0.94(0.60-1.46)	0.94(0.59-1.50)	1.84(0.87-4.39)	0.72(0.43-1.20)	1.38(0.87-2.22)	**2.55(1.53-4.27)**	1.23(0.72-2.16)
Southeast										
São Paulo	5764	**0.81(0.68-0.96)**	**1.29(1.13-1.48)**	0.93(0.80-1.08)	**1.20(1.03-1.40)**	**1.64(1.29-2.11)**	**0.78(0.67-0.91)**	**1.22(1.06-1.40)**	**2.77(2.35-3.27)**	**1.24(1.01-1.52)**
Rio de Janeiro	3166	0.82(0.65-1.02)	1.04(0.87-1.24)	1.20(0.99-1.45)	1.19(0.97-1.45)	**1.75(1.28-2.42)**	0.93(0.77-1.14)	**1.28(1.05-1.56)**	**2.59(2.06-3.26)**	1.12(0.88-1.44)
Belo Horizonte	967	**0.62(0.43-0.90)**	1.00(0.74-1.34)	1.18(0.86-1.62)	1.06(0.76-1.48)	1.27(0.74-2.25)	**0.70(0.49-1.00)**	1.18(0.85-1.64)	**1.87(1.23-2.82)**	1.25(0.83-1.92)
South										
Porto Alegre	648	0.82(0.49-1.35)	1.02(0.61-1.66)	1.21(0.79-1.83)	1.31(0.85-2.00)	0.65(0.35-1.22)	1.16(0.75-1.78)	**2.14(1.38-3.38)**	**2.13(1.24-3.62)**	1.09(0.62-1.97)
Curitiba	499	**0.46(0.26-0.79)**	1.39(0.88-2.16)	1.41(0.88-2.24)	1.16(0.72-1.87)	0.95(0.42-2.28)	0.75(0.44-1.26)	1.39(0.89-2.20)	**1.97(1.11-3.49)**	0.78(0.40-1.53)
Brazil	16667	**0.77(0.70-0.84)**	**1.17(1.08-1.26)**	**1.11(1.02-1.20)**	**1.14(1.05-1.24)**	**1.48(1.30-1.70)**	**0.83(0.76-0.91)**	**1.31(1.21-1.43)**	**2.65(2.40-2.92)**	**1.14(1.02-1.27)**
Risk behavior [d]										
Low	5644	**0.78(0.62-0.97)**	**1.31(1.12-1.54)**	1.17(0.98-1.40)	0.88(0.73-1.06)	1.14(0.90-1.45)	0.96(0.79-1.15)	**1.17(1.00-1.38)**	**2.06(1.60-2.62)**	**1.31(1.04-1.64)**
High	10037	**0.70(0.63-0.78)**	**1.15(1.05-1.26)**	**1.11(1.01-1.23)**	**1.24(1.12-1.36)**	**1.35(1.14-1.60)**	**0.76(0.69-0.84)**	**1.12(1.02-1.24)**	**2.38(2.13-2.66)**	0.96(0.85-1.09)

MW = minimum wage

HIV perceived risk (in the next 12 months) was dichotomized in low (no/low) and high risk;.[a] During the previous 6 months; [b] Cocaine, poppers, crack, or amphetamines; [c] Syphilis, gonorrhea, or rectal chlamydia; [d] Measured by the HIRI-MSM, which was calculated based on sexual behavior in the previous six months (number of partners, condomless receptive anal intercourse, sex with HIV-positive partner), age and use of stimulants, being stratified in low risk (< 10 points) and high risk (≥10 points; PrEP is recommended). “Unknown” answers scored 0 points on the HIRI-MSM.

Figures

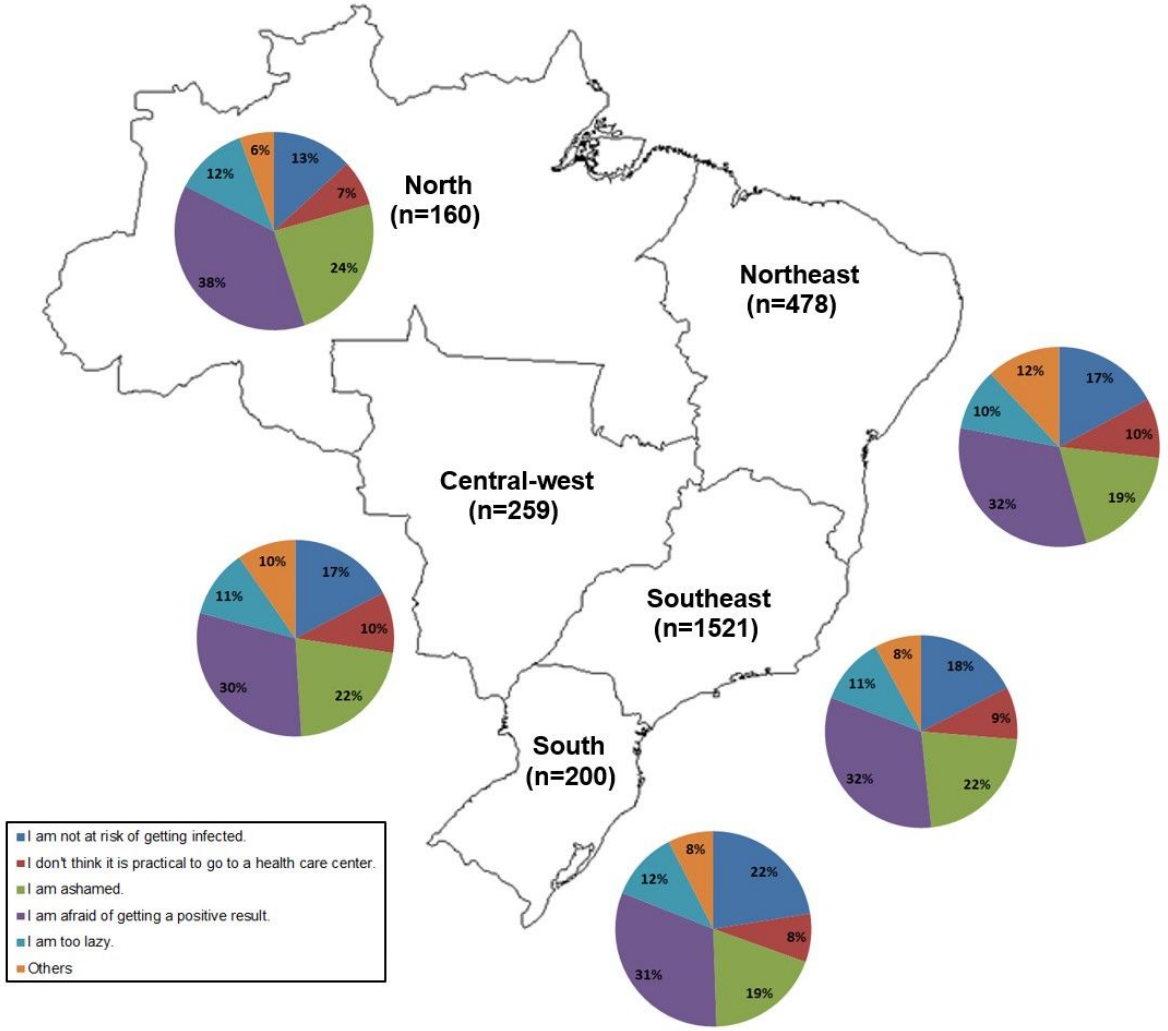

Figure 1

Distribution of responses to the question “Why have you never tested for HIV?” by Brazilian Geopolitical Region (n=2,618).

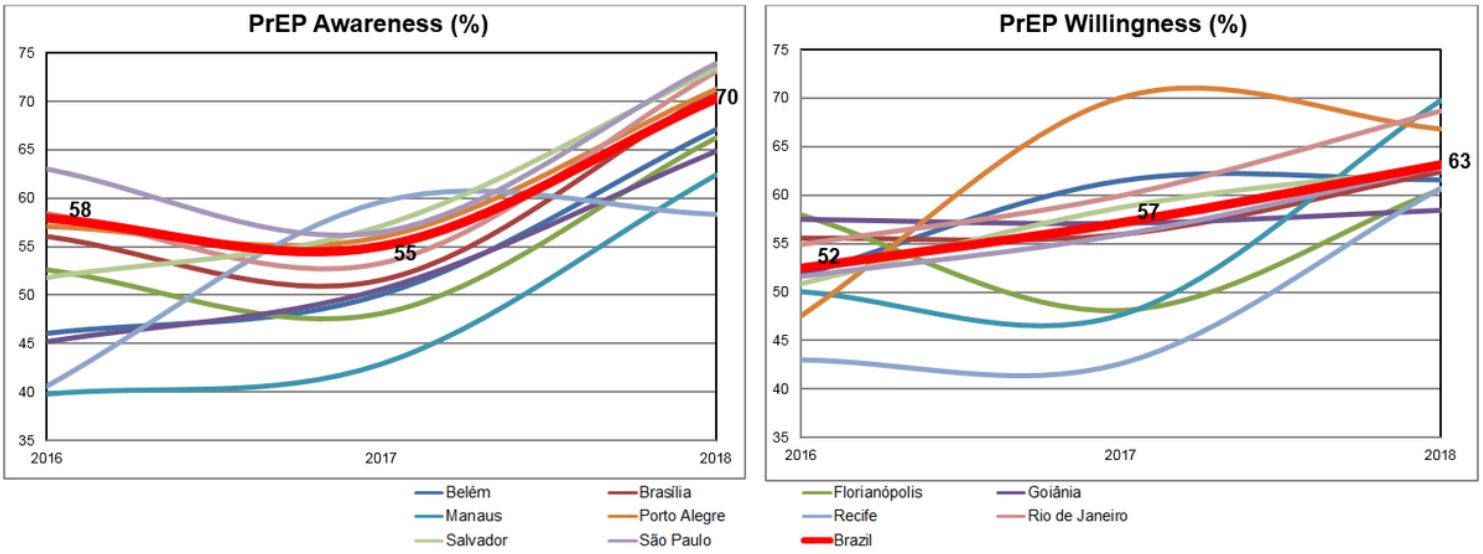

Figure 2

Awareness and willingness to use PrEP among MSM from 10 Brazilian State Capitals from 2016 to 2018.