JOURNAL OF BEHAVIORAL HEALTH, 2018
VOL 7, NO. 2, PAGE 78–90
10.5455/jbh.20170924070142

eJManager

ORIGINAL RESEARCH

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Sex without condom and HIV testing among men who have sex with men: A comparative study of two metropolitan statistical areas in Texas

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ABSTRACT

Background: Condomless anal sex (CAS) accounts for most HIV infections among men who have sex with men (MSM). Knowledge of one's HIV status through routine testing remains essential for reducing HIV transmission. We assessed the associations between demographic, behavioral, and prevention characteristics of MSM who engaged in CAS and HIV testing in the Dallas and Houston, Texas metropolitan statistical areas (MSA) in 2008 and 2014 and examined changes in CAS and HIV testing prevalence during this period.

Methods: Data from the National HIV Behavioral Surveillance for 2008 and 2014 MSM cycles in Dallas and Houston were used for this analysis. We compared proportions of self-reported CAS and HIV testing and determined the adjusted prevalence ratios (aPR) using generalized estimating equations.

Results: The overall adjusted prevalence of CAS among MSM in Dallas and Houston remained stable over time. MSM who had one sexual partner were 9 (aPR = 9.21, 95% confidence interval [CI] = 3.83–14.91, $P < 0.0001$) and 7 (aPR = 6.92, 95% CI = 2.29–20.92, $P = 0.001$) times more likely to engage in CAS in Dallas and Houston. CAS increased significantly by 36% (aPR = 1.36, 95% CI = 1.00–1.85, $P = 0.052$) among young MSM (18–29 years) in Houston. Overall, the prevalence of HIV testing in Dallas increased significantly by 63% from 2008 to 2014 (aPR = 1.63, 95% CI: 1.12–2.36, $^{P} = 0.010$) and across the subgroups. In Houston, HIV testing was generally stable, overall and across most subgroups, except for race/ethnicity, education al status and number of sexual partners.

Conclusion: The study highlights the need to tailor intervention efforts to each MSA unique circumstances and specific at-risk subpopulations as a mean to help reduce new HIV infection. In addition, the adoption of mutually-reinforcing HIV prevention interventions are recommended to overcome individual- and structural-level barriers to HIV testing especially in the MSM communities where testing are plateauing.

ARTICLE HISTORY

Received September 24, 2017
Accepted November 14, 2017
Published March 12, 2018

KEYWORDS

Condomless anal sex, HIV testing, men who have sex with men, Dallas and Houston, Texas

Introduction

In the United States (US), gay, bisexual, and other men who have sex with men (MSM) have an elevated HIV prevalence when compared to the general population [1]. In Texas, over 80,000 people were known to be living with HIV in 2014 with approximately 70% of new diagnoses occurring in gay or other MSM [2]. Sexual behaviors such as condomless anal sex (CAS) account for the majority of HIV infections among MSM and remain the greatest risk for HIV transmission among MSM [3,4]. From 2005 to 2014, CAS rose consistently among the US MSM population with or without HIV infection [5] Among MSM receiving medical care in Texas in 2013–2014, approximately 45% had CAS with a male partner in the past 12 months [2].

The Centers for Disease Control and Prevention (CDC) and other health authorities recommend condom usage to reduce the transmission of HIV and other sexually transmitted infections. However,

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adopting and maintaining consistent condom use remains a challenge that originates from individual preference, access, the willingness or capacity to negotiate its use, and contextual circumstances, such as sex and drug use [6,7]. In addition, relationship dynamics can play an important role in condom use among discordant couples [6,8]. For instance, there is considerable evidence that condom use among MSM varies depending on a person's own HIV status, their partner's status, whether the partner is a main or casual partner, and whether the individual engages in receptive sex, insertive sex, or both [7,9].

Previous studies involving MSM have indicated interconnections between health problems, such as the one between substance use and high-risk sex [10,11]. Stall et al. [10] noted that individuals with more psychosocial health problems are at greater risk for both participation in sexual risk behaviors and HIV infection. For instance, CAS has been associated with methamphetamine use in MSM [12,13]. Methamphetamine use has also been reported to increase sexual capacity and pleasure [14] and is widely used to facilitate socializing in the MSM communities [15]. Users of methamphetamines are much more likely to exhibit sexual behavior that puts them at high risk for contracting HIV [16,17]. In 2013, Texas street outreach workers identified young MSM as one of the population groups that use more crystal methamphetamine [18]. The combination of methamphetamine use and overlapping sexual networks increases the risk of HIV transmission among MSM [9]. Adding to these factors are differences in the age-related understanding and perception of HIV risk [19,20]. Among the younger MSM, awareness of HIV risks and engagement in protective behavior may differ from older MSM because their experience with HIV has been different [21]. Thus, young MSM may seek to downplay the severity of their risk level even at the expense of contracting HIV infection. Consequently, there is a strong need to bolster HIV prevention, education, and advocacy in MSM communities.

Persons unaware of their HIV infection contribute to nearly one-third of ongoing transmissions in the US [22]. In 2015, the US released the updated National HIV/AIDS Strategy, which lists one of its main goals as increasing the percentage of people living with HIV (PLWH) who are aware of their HIV serostatus [23]. CDC recommends HIV screening for persons aged 13–64 years as a normal part of medical practice to identify HIV infections and prevent ongoing transmission, and that sexually active MSM be tested for HIV at least once a year [24]. HIV diagnosis is an essential first step in the HIV care continuum, and persons who are aware of their infection status can also make behavioral changes to reduce transmission.

In Texas, as with the rest of the US, while the estimated overall incidence of HIV has remained stable in recent years, MSM has continued to experience an increasing trend in the annual HIV case rate [2]. A variety of HIV prevention and testing initiatives designed to reach populations disproportionately affected by HIV have been developed by CDC and its partners at both national and local levels [25]. These efforts are believed to be responsible for the general decline in new HIV infections. Previous analyses have examined differences in testing among various subpopulations of MSM [24,26-28]. Despite the fact that MSM have the highest rate of HIV infections and at risk for HIV transmission [1-4], there is no known report that assesses the progress made over time on HIV prevention and testing initiatives in Dallas and Houston, TX.

The objectives of the current study were to assess the associations between demographic, behavioral, and prevention characteristics of MSM who engaged in CAS and HIV testing in the Dallas and Houston metropolitan areas in 2008 and 2014 and to assess changes in CAS and HIV testing prevalence during this period.

METHODS

Study sites

The study used data collected from two National HIV Behavioral Surveillance System (NHBS) project sites in Texas: The Dallas-Fort Worth-Arlington, including Plano-Irving Division and the Houston-Sugar Land-Baytown metropolitan statistical area (MSA), referred to as "Dallas" and "Houston" hereafter. These two urban areas house nearly 40% of the entire Texas population and also have the highest numbers of PLWH and the MSM population in the state [2]. The NHBS is a comprehensive survey system established and funded by the CDC to monitor HIV related behaviors and prevention services among groups at high risk for HIV infection in selected MSAs [29]. NHBS targets MSM as one of the population groups at high risk for HIV infection. We used data from the MSM cycles in 2008 and 2014 to estimate change over time based on demographic characteristics, self-reported behaviors, and prevention services received by survey participants in the two MSAs.

Sampling, eligibility, and data collection

NHBS participants in the MSM cycle are selected through venue-based sampling (VBS). This method is used for hard-to-reach populations where traditional probabilistic sampling methods may not be suitable and have been thoroughly discussed in previous publications [29,30]. Variations in venue attendance, as well as the likelihood of being recruited, are part of how the VBS recruitment method is structured, but in this analysis, VBS sampling weights were not available to account for this complex recruitment method. To be included in the study, MSM participants must have reported having sex with men in the past 12 months, of age ≥18 years old and residing in the MSAs. Eligible participants were required to provide answers to standardized questions regarding sociodemographic characteristics, sexual risk behaviors, prevention characteristics, and history of HIV testing. There were 444 NHBS participants from Dallas who met these criteria in the 2008 cycle and 368 in the 2014 cycle. The corresponding figures for the Houston participants were 355 in the 2008 cycle and 408 in the 2014 cycle.

Measures

Dependent variables

The analysis had two main outcome measures reported by participants as having occurred within the 12 months before becoming an NHBS survey participant: CAS with one or more male partners and HIV testing. We examined these two outcomes as dichotomous variables ("yes" or "no") by subsets of the MSM population in Dallas and Houston in relation to the demographic, behavioral, and prevention characteristics.

Independent variables—Demographic, behavioral, and prevention

Independent variables used in the analysis comprised demographic, behavioral, and prevention characteristics. Demographic variables were classified as follows: Age group (18–29 years, ≥30 years), race and ethnicity (White, Black/African American, Hispanic/Latino, and other/multiracial; other races included Asian, Hawaiian, or Pacific Islanders), and level of education completed (high school or less, some college, and college graduate or higher). Behavioral variables included measures of HIV risk represented by the number of sex partners (one, two to three, and four or more), use of non-injection methamphetamine, visit to a healthcare provider, participating in an HIV behavioral intervention or organized sessions to discuss ways to prevent HIV including distribution, and receipt of free condoms. The latter variables were defined as dichotomous ("yes" or "no").

Data analyses

First, descriptive analyses were performed to determine the distribution patterns of demographic, behavioral, and prevention characteristics of study participants by CAS and HIV testing in Dallas and Houston in 2008 and 2014. Following these, we conducted tests of homogeneity and independence for the associated measures using Pearson Chi-square statistics. The test of homogeneity assessed the null hypothesis that the two populations have the same proportions of the selected independent characteristics (H_0: $p_1 = p_2 = \ldots = p_n$, i.e., the proportion of X is the same in the populations studied; Ha: At least one proportion of X is not the same). The test of independence assessed the null hypothesis that there is no association between the selected characteristics and outcome variables (CAS and HIV testing) in a given population (H_0: X and Y are independent; H_a: X and Y are dependent).

We also fitted two multivariate regression models using generalized estimating equations (GEE) with Poisson distribution and log link functions to determine the existence of temporal changes in the prevalence of CAS and HIV testing in Dallas and Houston over the time period (2008 and 2014) using 2008 as the baseline. The model for the mean is $g(\mu_{ij}) = x_{ij}'\beta$, where β is a vector of regression parameters estimated. The GEE provides a semi-parametric approach to longitudinal analyses of repeated categorical responses that are correlated and clustered (i.e., cases are not independent), where $Y = (Y_{ij})$ is the response for each subject i, measured at 2 time points, j = 1, 2 (2008 and 2014). $X = (X_1, X_2, \ldots, X_k)$ or X_i is a $n_i \times k$ matrix of covariates, which is the set of explanatory variables that includes demographic, behavioral, and prevention characteristics. In addition, the model does not include homogeneity of variance as an assumption and uses quasi-likelihood estimation rather than maximum likelihood estimation or ordinary least squares to estimate the parameters. Modeling decisions for GEE were guided by quasi-likelihood under the Independence Model Criterion goodness of fit statistics [31]. The GEE produced each unique pair of responses within clusters, and all clusters were parameterized identically, generating mean estimates of adjusted

prevalence ratios (aPR) for CAS and HIV testing and 95% confidence intervals (CI) of aPR, robust empirical standard errors (eSE) with 95% CI of eSE, and P values for overall and each level of the demographic, behavioral, and prevention characteristics. All tests performed used a probability value of 0.05 as the statistical significance level. Data management and statistical analyses were conducted using SAS Statistical Software Version 9.4 (SAS Institute, Cary, NC, USA).

Ethical considerations

NHBS activities have been approved by local Institutional Review Boards (IRBs) in the Dallas and Houston project areas. Because the CDC has determined NHBS to be public health surveillance, it is considered a non-research activity used for disease control program or policy purposes [32,33]. Given the non-research determination, NHBS is not subject to human subjects' regulations including IRB review at the federal level. Participants were assured of the anonymous nature of the survey, and all participants provided verbal informed consent to take part in the interview. As required by local IRB protocols, verbal consent was documented electronically and on hard copy by interviewers.

RESULTS

Demographic, behavioral, and prevention characteristics of participants

The demographic, behavioral, and prevention characteristics of MSM in Dallas (n = 812) and Houston (n = 763) who participated in NHBS in 2008 and 2014 are shown in Table 1. The proportion of young MSM (aged 18–29 years) decreased by 14% (52% vs. 38%) in Dallas, and increased by 7% in Houston (39% vs. 46%) between 2008 and 2014. The racial/ethnic composition of participants in both cities changed between 2008 and 2014. In 2008, participants in Dallas were predominantly Black/African American (45%, n = 194) but that number decreased in 2014 by 15–30% (n = 111), making White MSM the predominant participants (38%, n = 141). In Houston, White MSM made up the majority of participants in 2008 (55%, n = 189) and remained so in 2014 with a 17% reduction to 38% (n = 155). The number of MSM participants of Hispanic/Latino origin in Dallas and Houston increased by 7% during the study period (Table 1).

MSM in Dallas had similar distribution patterns for levels of education in both sampling years. However, a greater proportion of participants in Houston reported college level or higher education in 2014 than in 2008 (39%, n = 160 vs. 27%, n = 94). By 2014, there was a 7% increase among participants in Dallas reporting increase four or more sexual partners in the past 12 months. In Houston, the number of participants with only one sex partner in the past 12 months increased from 23% in 2008 to 25% in 2014, while the number of participants reporting four or more sexual partner decreased by 1% (45% vs. 44%) during the same period. The proportion of non-injection methamphetamine users in Dallas almost doubled from 9% in 2008 to 16% in 2014; while a 4% (10% vs. 6%) decrease was reported in Houston during the same period. Indicators of contact with a healthcare provider during the survey period were similar in Dallas and Houston (Dallas: 65% vs. 72%; Houston: 69% vs. 74%). MSM interactions with outreach workers and participation in organized prevention activities were relatively low in both cities but increased by 7% in Dallas and 4% in Houston from the 2008 baseline. Although there were proportional increases in the receipt of free condoms between 2008 and 2014, condoms were generally more accessible to participants in Houston (69% vs. 72%) than those in Dallas (43% vs. 57%).

Characteristics associated with MSM engaged in CAS

Table 2 summarizes a comparison of MSM in Dallas and Houston who engaged in CAS with male partners by selected characteristics and year (2008 and 2014). Although CAS remained fairly stable in both cities (P = 0.362), there were significant variations among subgroups. For instance, we noted significant changes in the racial/ethnic compositions in Dallas (P < 0.0001) and Houston (P = 0.033). CAS decreased significantly by 16% and 8% among Black/African American MSM in Dallas and Houston from 2008 to 2014. Similarly, slight decreases were recorded among Whites in both Dallas and Houston MSAs. In Houston, CAS was significantly (P = 0.002) associated with the level of education. We noted a 13% decrease and increase in CAS among MSM with high school education or less and college level or higher degree by 2014, respectively. The proportion of MSM of age ≥30 years who engaged in CAS in Dallas increased significantly (P = 0.001) from 45% in 2008 to 59% in 2014, while participants in the younger age group (18–29 years) decreased from 55% (2008) to 41% (2014). Although non-injection methamphetamine use among MSM increased

Table 1. Characteristics of MSM—National HIV Behavioral Surveillance System, Dallas and Houston, TX, 2008 and 2014.

Characteristics	Dallas, n (%)		Houston, n (%)	
	2008	2014	2008	2014
Demographic				
Age group (years)				
18–29	231 (52.0)	140 (38.0)	140 (39.4)	189 (46.3)
≥30	213 (48.0)	228 (62.0)	215 (60.6)	219 (53.7)
Race/Ethnicity				
White	151 (35.2)	141 (38.3)	189 (54.6)	155 (38.0)
Black/African American	194 (45.2)	111 (30.2)	93 (26.9)	138 (33.8)
Hispanic/Latino	72 (16.8)	86 (23.4)	53 (15.3)	90 (22.1)
Other/Multiracial	12 (2.8)	30 (8.2)	11 (3.2)	25 (6.1)
Education al status				
High School or less	183 (41.2)	147 (40.0)	128 (36.1)	128 (36.1)
Some college	159 (35.8)	136 (37.0)	133 (37.5)	140 (34.3)
College grad or higher	102 (23.0)	85 (23.1)	94 (26.5)	160 (39.2)
Number of sex partners				
One	117 (26.4)	83 (22.6)	82 (23.1)	102 (25.0)
Two to three	145 (32.7)	110 (29.9)	113 (31.8)	127 (31.1)
Four or more	182 (41.0)	175 (47.6)	160 (45.1)	179 (43.9)
Non-injection methamphetamine				
No	405 (91.2)	310 (84.2)	321 (90.4)	382 (93.6)
Yes	39 (8.8)	58 (15.8)	34 (9.6)	26 (6.4)
Visit health-care provider				
No	155 (34.9)	102 (27.7)	111 (31.3)	106 (26.0)
Yes	289 (65.1)	266 (72.3)	244 (68.7)	302 (74.0)
Prevention activities				
No	402 (90.5)	309 (84.0)	287 (80.9)	315 (77.2)
Yes	42 (9.5)	59 (16.0)	68 (19.2)	93 (22.8)
Free condoms				
No	253 (57.0)	159 (43.2)	112 (31.6)	116 (28.4)
Yes	191 (43.0)	209 (56.8)	243 (68.5)	292 (71.6)
Total	444	368	355	355

Within characteristic, the total percentages may not add up to a 100 due to rounding up. MSM = men who have sex with men.

slightly (P = 0.031) in Dallas from 11 % (2008) to 18% (2014), it remained stable in Houston during the same period. There were no significant (P > 0.05) associations between visits to health-care provider, involvement in prevention activities, and receipt of free condoms and study years in Dallas and Houston. However, a comparison of the two MSAs revealed that MSM who engaged in CAS in Houston participated in more prevention activities and received more free condoms than those in Dallas (Table 2).

Characteristics associated with HIV testing among MSM

Table 3 summarizes the comparison of HIV testing among MSM by demographic, behavioral, and prevention characteristics within and between Dallas and Houston. Overall, within Dallas, HIV testing among MSM remained stable in Dallas between 2008 and 2014 (P = 0.384) but increased significantly in Houston during the same period (42% vs. 58%, P < 0.001). However, there were significant subgroup variations in Dallas; the highest proportions of HIV testing occurred among MSM aged >30 years (58%, P < 0.0001), white (43%, P < 0.0001), and MSM with four or more sexual partners (54%, P = 0.045), and those who received free condoms (65%, P < 0.0001). In Houston, variations were generally non-significant (P > 0.05) across subgroups except for race/ethnicity (P = 0.001) and educational level (P < 0.0001), where less HIV testing occurred among Whites (53% vs. 37%) and more HIV testing occurred among MSM who had a college level or higher degree (25% vs. 43%) by 2014 (Table 3). A comparison of the two cities (Dallas vs. Houston) indicated that there were significant (P < 0.0001) proportional increases from the baseline (2008) in preventive activities (18% vs. 27%) and distribution of free condoms (65% vs. 75%) among MSM who tested for HIV in the 12 months before the interview. Similarly, our study noted a significant variation (P < 0.0001) in the level of education of MSM who received an HIV test in 2014; the majority in Dallas had some college education

Table 2. Comparison of MSM who engaged in CAS with male partners in the 12 months before interview by selected characteristics within and between Dallas and Houston, TX in 2008 and 2014—National HIV Behavioral Surveillance System.

Characteristics	Dallas				Houston				Dallas versus Houston		
	n (%)		Test statistics		*n* (%)		Test statistics		χ^2 *P* value		
	2008	2014	χ^2	*P* value	2008	2014	χ^2	*P* value	2008	2014	Overall
Overall	259 (53.3)	227 (46.7)	2.1	0.147	215 (46.9)	243 (53.1)	1.7	0.191	4.1 **0.043**	0.5 0.461	0.8 0.362
Demographic											
Age group (years)											
18–29	143 (55.2)	93 (41.0)	9.8	**0.001**	93 (43.3)	122 (50.2)	2.2	0.136	6.7 **0.010**	4.0 **0.045**	0.2 0.619
≥30	116 (44.8)	134 (59.0)			122 (56.7)	121 (49.8)					
Race/ethnicity											
White	89 (35.7)	89 (39.2)	23.3	**<0.0001**	109 (52.2)	108 (44.4)	8.7	**0.033**	14.2 **0.003**	4.1 0.247	13.8 **0.003**
Black/African American	105 (42.2)	60 (26.4)			58 (27.8)	57 (23.5)					
Hispanic/Latino	49 (19.7)	54 (23.8)			36 (17.2)	63 (25.9)					
Other/Multiracial	6 (2.4)	24 (10.6)			6 (2.9)	15 (6.2)					
Educational Status											
High school or less	99 (38.2)	91 (40.1)	0.9	0.610	80 (37.2)	59 (24.3)	12.3	0.002	0.4 0.829	15.7 **<0.0001**	10.9 **0.004**
Some college	100 (38.6)	78 (34.4)			80 (37.2)	90 (37.0)					
College grad or higher	60 (23.2)	58 (25.6)			55 (25.6)	94 (38.7)					
Behavioral and prevention											
Number of sex partners											
One	53 (20.5)	32 (14.1)	5.4	0.066	45 (20.9)	48 (19.8)	0.4	0.824	0.0 0.984	3.6 0.164	1.7 0.421
Two to three	75 (29.0)	58 (25.6)			63 (29.3)	67 (27.6)					
Four or more	131 (50.6)	137 (60.4)			107 (49.8)	128 (52.7)					
Non-injection methamphetamine											
No	231 (89.2)	187 (82.4)	4.7	**0.031**	198 (92.1)	224 (92.2)	0.1	0.972	1.2 0.283	10.3 **0.001**	9.0 **0.003**
Yes	28 (10.8)	40 (17.6)			17 (7.9)	19 (7.8)					
Visit to health-care provider											
No	86 (33.2)	64 (28.2)	1.4	0.232	70 (32.6)	65 (26.8)	1.8	0.173	0.0 0.882	0.1 0.726	0.2 0.642
Yes	173 (66.8)	163 (71.8)			145 (67.4)	178 (73.3)					
Prevention activities											
No	227 (87.6)	196 (86.3)	0.2	0.670	174 (80.9)	182 (74.9)	2.4	0.121	4.1 **0.044**	9.8 **0.002**	14.2 **<0.0001**
Yes	32 (12.4)	31 (13.7)			41 (19.1)	61 (25.1)					
Free condoms											
No	136 (52.5)	102 (44.9)	2.8	0.095	70 (32.6)	65 (26.8)	1.9	0.173	19.0 **0.0001**	16.9 **<0.0001**	37.5 **<0.0001**
Yes	123 (47.5)	125 (55.1)			145 (67.4)	178 (73.3)					

Within characteristic, the total percentages may not add up to a 100 due to rounding up; χ^2 = Chi-square; Bold represents significant *P* values. CAS = condomless anal sex, MSM = men who have sex with men.

(40%, *n* = 100) while the majority in Houston had a college level or higher degree (43%, *n* = 128).

Prevalence of CAS and HIV testing among MSM

Table 4 summarizes the aPRs of MSM who engaged in CAS with male partners in the 12 months before the interviews in 2008 and 2014 by the demographic, behavioral, and prevention characteristics in Dallas and Houston. Following adjustments, significant aPRs were recorded for race/ethnicity and sexual partner subgroups in Dallas and Houston. CAS increased significantly by 36% (aPR = 1.36, 95% confidence

Table 3. Comparison of MSM who tested for HIV in the 12 months before interview by selected characteristics within and between Dallas and Houston, TX in 2008 and 2014—National HIV Behavioral Surveillance System.

Characteristics	Dallas				Houston				Dallas versus Houston		
	n (%)		Test statistics		*n* (%)		Test statistics		χ^2 *P* value		
	2008	2014	χ^2	*P* value	2008	2014	χ^2	*P* value	2008	2014	Overall
Overall	229 (48.0)	248 (52.0)	0.8	0.384	221 (42.4)	300 (57.6)	12.0	**0.001**	0.1	4.9	1.9
									0.706	**0.026**	0.164
Demographic											
Age group (years)											
18–29	135 (59.0)	105 (42.3)	13.1	**<0.0001**	91 (41.2)	143 (47.7)	2.2	0.141	14.2	0.6	2.9
									<0.0001	0.212	0.088
≥30	94 (41.1)	143 (57.7)			130 (58.8)	157 (52.3)					
Race/ethnicity											
White	83 (37.6)	107 (43.2)	32.4	**<0.0001**	114 (52.8)	110 (36.7)	16.8	0.001	14.3	6.0	1.4
									0.003	0.110	0.707
Black/African American	106 (48.0)	67 (27.0)			67 (31.0)	108 (36.0)					
Hispanic/Latino	30 (13.6)	53 (21.4)			31 (14.4)	64 (21.3)					
Other/Multiracial	2 (0.9)	21 (8.5)			4 (1.9)	18 (6.0)					
Educational Status											
High school or less	78 (34.1)	84 (33.9)	0.7	0.700	80 (36.0)	68 (22.7)	20.3	**<0.0001**	0.9	18.3	7.7
									0.641	**0.001**	**0.021**
Some college	85 (37.1)	100 (40.3)			86 (38.9)	104 (34.7)					
College grad or higher	66 (28.8)	64 (25.8)			55 (24.9)	128 (42.7)					
Behavioral and prevention											
Number of sex partners											
One	59 (25.8)	48 (19.4)	6.2	**0.045**	46 (20.8)	71 (23.7)	0.7	0.711	1.7	2.9	0.3
									0.420	0.235	0.868
Two to three	71 (31.0)	65 (26.2)			69 (31.2)	87 (29.0)					
Four or more	99 (43.2)	135 (54.4)			106 (48.0)	142 (47.3)					
Non-injection methamphetamine											
No	210 (91.7)	212 (85.5)	4.5	**0.003**	198 (89.6)	281 (93.7)	2.8	0.091	0.6	10.1	3.4
Yes	19 (8.3)	36 (14.5)			23 (10.4)	19 (6.3)			0.442	**0.002**	0.065
Visit to health-care provider											
No	49 (21.4)	60 (24.2)	0.5	0.467	55 (24.9)	66 (22.0)	0.6	0.441	0.8	0.4	0.0
Yes	180 (78.6)	188 (75.8)			166 (75.1)	234 (78.0)			0.380	0.544	0.889
Prevention activities											
No	198 (86.5)	204 (82.3)	1.6	0.208	168 (76.0)	220 (73.3)	0.5	0.487	8.1	6.2	14.5
Yes	31 (13.5)	44 (17.7)							**0.005**	**0.013**	**<0.0001**
Free condoms											
No	120 (52.4)	87 (35.1)	14.5	**<0.0001**	56 (25.3)	74 (24.7)	0.0	0.861	34.6	7.1	37.9
Yes	109 (47.6)	161 (64.9)			165 (74.7)	226 (75.3)			**<0.0001**	**0.008**	**<0.0001**

Within characteristic, the total percentages may not add up to a 100 due to rounding up; χ^2 = Chi-square; Bold represents significant *P* values. CAS = condomless anal sex, MSM = men who have sex with men.

interval [CI] = 1.00–1.85, *P* = 0.052) among young MSM (18–29 years) in Houston. MSM who had one sexual partner were 9 times (aPR = 9.21, 95% CI = 3.83–14.91, *P* < 0.0001) and 7 times (aPR = 6.92, 95% CI = 2.29–20.92, *P* = 0.001) more likely to engage in CAS in Dallas and Houston. Although we recorded significant reduction in the aPR of CAS among White and Black/African American MSM in the two MSAs, this practice tended to increase by 44% (aPR = 1.44, 95% CI = 1.07–1.93, *P* = 0.016) among other races/multiracial MSM in Houston (Table 4).

The prevalence of HIV testing among MSM after adjusting for demographic, behavioral, and prevention characteristics in Dallas and Houston is shown in Table 5. Overall, the prevalence of HIV testing in Dallas increased significantly by 63% from 2008 to 2014 (aPR = 1.63, 95% CI: 1.12–2.36, *P* = 0.010) and across the subgroups. Prevalence of HIV testing increased by 71%, 76%, and 87% for MSM had

Table 4. Prevalence ratios for MSM who engaged in CAS with male partners in the 12 months before interview by selected characteristics—National HIV Behavioral Surveillance System, Dallas and Houston, TX, 2008 and 2014.

Characteristics	Dallas				Houston			
	n	aPR[a]	95% CI	*P* value	*n*	aPR[a]	95% CI	*P* value
Overall	812	0.93	0.72–1.22	0.613	763	1.23	0.91–1.66	0.180
Demographic								
Age group (years)								
18–29	371	0.97	0.73–1.29	0.818	329	1.36	1.00–1.85	**0.052**
≥30	441	0.90	0.69–1.18	0.446	434	1.11	0.81–1.52	0.513
Race/ethnicity								
White	292	0.06	0.00–0.44	**0.038**	344	0.62	0.33–1.64	**<0.001**
Black/African American	305	0.22	0.06–0.88	**0.032**	231	0.03	0.00–0.16	**<0.001**
Hispanic/Latino	158	0.81	0.60–1.08	0.156	143	0.84	0.59–1.19	0.320
Other/Multiracial	42	0.88	0.67–1.17	0.391	36	1.44	1.07–1.93	**0.016**
Educational Status								
High school or less	330	1.53	0.41–5.66	0.426	236	1.04	0.32–3.35	0.954
Some college	295	0.98	0.72–1.34	0.905	273	1.21	0.87–1.68	0.260
College grad or higher	187	0.86	0.65–1.14	0.293	254	1.34	0.97–1.84	0.073
Behavioral and prevention								
Number of sex partners								
One	200	9.21	3.83–14.91	**<0.0001**	184	6.92	2.29–20.92	**0.001**
Two to three	255	1.36	1.05–1.75	**0.018**	240	1.46	1.07–1.99	**0.017**
Four or more	357	0.91	0.68–1.22	0.522	339	1.18	0.85–1.63	0.318
Non-injection methamphetamine								
No	715	0.90	0.70–1.16	0.427	703	1.15	0.87–1.52	0.323
Yes	97	0.97	0.70–1.16	0.831	60	1.31	0.91–1.90	0.151
Visit to health-care provider								
No	257	0.96	0.72–1.28	0.777	217	1.30	0.91–1.79	0.109
Yes	555	0.91	0.70–1.19	0.489	546	1.16	0.85–1.58	0.340
Prevention activities								
No	711	1.01	0.79–1.30	0.907	602	1.12	0.83–1.51	0.451
Yes	101	0.86	0.62–1.20	0.372	161	1.35	0.97–1.87	0.076
Free condoms								
No	412	0.87	0.66–1.15	0.334	228	1.26	0.94–1.70	0.122
Yes	400	1.00	0.76–1.32	0.993	535	1.20	0.86–1.66	0.291

[a]aPR = adjusted prevalence ratio, 95% CI = 95% confidence interval, CAS = condomless anal sex, MSM = Men who have sex with men. Bold represents significant *P* values.

a college level or higher degree (aPR = 1.71, 95% CI: 1.18–2.49, *P* = 0.005), MSM who were younger (ages 18–29) (aPR = 1.76, 95% CI: 1.20–2.56, *P* = 0.003), and those that belonged to other races/multiracial group (aPR = 1.87, 95% CI: 1.28–2.71, *P* = 0.001). The aPR of HIV testing for most behavioral and prevention characteristics in Dallas were almost doubled by 2014, except for MSM who had one sexual partner, where prevalence ratio increased approximately 6 times (aPR = 5.71, 95% CI: 2.10–15.51, *P* = 0.001) during the period. HIV testing increased significantly among participants who used non-injection methamphetamine (aPR = 1.53, 95% CI: 1.02–2.31, *P* = 0.041), visited health-care provider (aPR = 1.72, 95% CI: 1.19–2.49, *P* = 0.004), participated in prevention activities (aPR = 1.68, 95% CI: 1.14–2.47, *P* = 0.008), and those who had not received free condoms as part of prevention outreach efforts (aPR = 1.87, 95% CI: 1.29–2.70, *P* = 0.001). In Houston, we recorded no significant changes in HIV testing, overall and across most subgroups except for race/ethnicity, educational level and number of sexual partners. HIV testing tripled among Black/African American MSM (aPR = 3.03, 95% CI: 1.08–8.50, *P* = 0.035) and MSM who had one sexual partner (aPR = 3.11, 95% CI: 1.33–7.29, *P* = 0.009), and quadrupled among MSM who had high school or less education (aPR = 3.62, 95% CI: 1.60–8.21, *P* = 0.002) by 2014 (Table 5).

Discussion

Nearly, 40% of the Texas population and 61% of persons living with HIV in Texas live in Houston and Dallas [2]. The 6-year interval between the

Table 5. Prevalence ratios for MSM who tested for HIV within the 12 months before interview by selected characteristics—National HIV Behavioral Surveillance System, Dallas and Houston, TX, 2008 and 2014.

Characteristics	Dallas				Houston			
	n	aPR[a]	95% CI	*P* value	*n*	aPR[a]	95% CI	*P* value
Overall	812	1.63	1.12–2.36	**0.010**	763	1.22	0.91–1.64	0.192
Demographic								
Age group (years)								
18–29	371	1.76	1.20–2.56	**0.003**	329	1.24	0.92–1.69	0.161
≥30	441	1.51	1.04–2.19	**0.032**	434	1.19	0.88–1.61	0.248
Race/ethnicity								
White	292	0.08	0.02–1.04	0.469	344	0.61	0.42–2.96	0.073
Black/African American	305	0.96	0.25–3.73	0.948	231	3.03	1.08–8.50	**0.035**
Hispanic/Latino	158	1.54	1.04–2.29	**0.030**	143	1.33	0.99–1.81	0.061
Other/Multiracial	42	1.87	1.28–2.71	**0.001**	36	1.15	0.84–1.56	0.382
Educational Status								
High school or less	330	2.15	0.70–6.58	0.178	236	3.62	1.60–8.21	**0.002**
Some college	295	1.67	1.13–2.48	**0.011**	273	1.36	1.00–1.84	**0.048**
College grad or higher	187	1.71	1.18–2.49	**0.005**	254	1.24	0.91–1.69	0.166
Behavioral and prevention								
Number of sex partners								
One	200	5.71	2.10–15.51	**0.001**	184	3.11	1.33–7.29	**0.009**
Two to three	255	1.85	1.27–2.67	**0.001**	240	1.34	0.99–1.81	0.058
Four or more	357	1.55	1.05–2.29	**0.027**	339	1.15	0.84–1.56	0.385
Non-injection methamphetamine								
No	715	1.73	1.21–2.48	**0.003**	703	1.20	0.91–1.58	0.197
Yes	97	1.53	1.02–2.31	**0.041**	60	1.24	0.86–1.78	0.245
Visit to health-care provider								
No	257	1.54	1.04–2.27	**0.031**	217	1.22	0.82–1.55	0.475
Yes	555	1.72	1.19–2.49	**0.004**	546	1.32	0.98–1.77	0.064
Prevention activities								
No	711	1.58	1.09–2.29	**0.016**	602	1.14	0.85–1.53	0.389
Yes	101	1.68	1.14–2.47	**0.008**	161	1.30	0.96–1.77	0.092
Free condoms								
No	412	1.87	1.29–2.70	**0.001**	228	1.31	0.97–1.75	0.075
Yes	400	1.42	0.96–2.09	0.078	535	1.14	0.83–1.56	0.429

[a]aPR = adjusted prevalence ratio, 95% CI = 95% confidence interval, CAS = condomless anal sex, MSM = men who have sex with men. Bold represents significant *P* values.

two sampling years in our study was a transition period for public health initiatives in these metropolitan areas that included prioritized HIV testing programs in non-clinical settings targeting MSM, specifically Black MSM, as well as targeted prevention efforts, and the expansion of mobilization efforts within the Black MSM community. In Dallas, a 13-year ban on condom distribution was lifted in 2009 [34], whereas Houston never had such a ban. Dallas County was the only public health agency in Texas to ban condom distribution in education and prevention programs.

Overall, there were no significant changes in the prevalence ratios of CAS among MSM during the study period in Dallas and Houston MSAs. The variety of HIV prevention education campaigns and testing initiatives designed to reach populations disproportionately affected by HIV at the local levels [25,35] may be responsible for the stability of prevalence. However, the significant decrease in CAS recorded among White and Black/African American MSM in Dallas and Houston, when taken in the light of HIV diagnoses decline among White and stabilized rate among Black/African American MSM [36], might suggest that targeted HIV testing and prevention education in these subpopulations could be having a significant impact.

Although there was no significant change in the prevalence of free condoms, research has shown that increased availability of condoms is associated with significant reductions in HIV risk [37]. However, MSM may employ some other HIV risk reduction strategies not addressed in this analysis such as serosorting, strategic positioning, or pre-exposure prophylaxis [38,39]. These strategies are sometimes used along with condoms and

may render the distinction between risk behavior and the adoption of risk reduction practices less clear. While the progress made among Black/African American MSM must be sustained, there is also an urgent need to address the upward trend in CAS noted among the other/multiracial group in Houston.

On the other hand, the significant increase in the prevalence of CAS among MSM who had one or two-three sexual partners in Dallas and Houston, respectively, call for continuous and targeted prevention education and HIV testing and counseling in this subgroup. The need for this effort is further amplified by the recent CDC report indicating that 29% of MSM who are HIV positive and not aware of their HIV infection have discordant CAS [39].

Although CAS has long been recognized as the primary mode of sexual transmission of HIV in gay and other MSM [3,4], it has also been associated with methamphetamine users among MSM [12,13]. In this analysis, the prevalence of CAS among methamphetamine users was generally stable between the survey years in both Dallas and Houston and did not seem to reflect the increasing trend in non-injection methamphetamine use reported in Texas [18]. However, evidence from previous studies [10-13,16-17] indicates that methamphetamine use may lead to riskier sexual behavior. It is important to note that the prevalence of HIV testing among young MSM who used non-injection methamphetamine in Dallas increased significantly by 53% during the study period. This may indicate that young MSM awareness of the health risks associated with methamphetamine use has improved and suggests the need for an integrated public health response that includes risk elimination and prevention strategies.

Achieving awareness of HIV infection through testing is an essential first step to linking HIV-positive individuals to medical care and services. The CDC currently recommends that all sexually active MSM get tested for HIV at least once per year [24]. In 2014, HIV testing among MSM in Dallas during the 12 months before the survey increased by 63%. This statistic is lower than the one obtained at the national level where HIV testing among MSM showed an increasing trend from 62% in 2008 to 66% in 2011, and 71% in 2014 [39]. The significant increases in HIV testing noted across the subgroups in Dallas may reflect aggressive testing initiatives focused on areas of high HIV risk, and defined by zip codes with high HIV rates, and those disproportionately affected by HIV, especially MSM [34,40,41]. Following these efforts, in 2010 Dallas recorded a 5-year high rate of 37.3 new HIV infections per 100,000 population, with MSM accounting for 70% of the new cases [42]. In addition to prioritized HIV testing programs targeting MSM, specifically Black/African American MSM, prevention plans have also included the distribution of free condoms, education, and counseling [40,41]. The higher prevalence of HIV testing among young MSM of age 18–29 years, who had not received free condoms, who had visited a health-care provider, and participated in prevention activities in Dallas suggests that exposure to prevention activities may have occurred both inside and outside of clinic settings. In addition, it is critical to provide HIV prevention information to protect individuals at greatest risk of transmitting or acquiring HIV [43]. Although the CDC's recommendations have not been fully met, increased access to health-care coverage, and preventive services through the Affordable Care Act may have contributed to the general increase in HIV testing [44].

There was no significant increase in the prevalence of HIV testing across most subgroups in Houston. However, the 3–4 fold increase in HIV testing among Black/African American MSM, MSM with some college education or less education and those who had one sexual partner, respectively, may be associated to some extent to the annual event tagged "*Hip Hop for HIV*" [35]. This event is an innovative model that utilize the exchange of an HIV test for a hip-hop concert ticket and targets younger population [35]. Overall, the stable prevalence of HIV testing in Houston may well be a balancing act between the broad-based community mobilization efforts through rapid HIV testing in traditional (e.g., clinic-based) and non-traditional (e.g., community-based, mobile units) settings [45], and the large population gain (12.4% increase) in Houston since the 2010 census [46].

Study limitations

The study findings are limited by the design and implementation process of the NHBS survey. First, the survey used the VBS method that excludes MSM who did not frequent venues such as bars or dance clubs. Second, the survey was only conducted in metropolitan areas, where the prevalence of and resources for addressing HIV are higher compared to the surrounding areas. Third, data on risk and protective behaviors and HIV status were obtained through participant self-report and thus, may have been impacted by social desirability bias, leading to

underreporting of socially stigmatizing behaviors such as CAS or HIV diagnosis and over-reporting of socially valued behaviors such as HIV testing. Fourth, our study data were not weighted to account for the complex sampling methodology used to recruit MSM, and therefore, our samples may not be representative of the entire MSM population in either Dallas or Houston MSA. Therefore, our point estimates may be biased by over- or under-representation of subgroups of the MSM population. Fifth, due to the small number of eligible cases, it was not possible to determine any associated risk of HIV acquisition through the examination of CAS by HIV status and sexual positioning. Finally, this study was cross-sectional and cannot be linked to any particular HIV testing initiatives such as the CDC's Expanded Testing Initiative, and thus, causality cannot be established.

Conclusions

Our findings suggest that while progress has been made in communicating the importance of HIV testing and awareness of one's serostatus, sharing the message about the importance of condom use remains a challenge for HIV prevention in the MSM subpopulation. The outcomes differences noted between the two MSAs are possibly linked to differences in policy and may reflect sociocultural differences between localized groups and structural factors within the health care and financing systems. The uptake of HIV testing in Dallas is encouraging and should be strengthened since knowledge of one's HIV status would help reduce the risk of acquisition, transmission, and new HIV infections. The plateauing of HIV testing in Houston is an indication of the need to adopt mutually reinforcing HIV prevention interventions to overcome individual- and structural-level barriers to HIV testing in the MSM communities. While HIV testing and counseling in the MSM population alone may not be enough to control the HIV epidemic, behavioral interventions for those at high risk for acquiring HIV and for people aware they are infected are strongly recommended. Those interventions have been reported to help reduce sexual risk behavior by as much as 30%–40% [47-49]. Future research should examine the potential of utilizing the unique social and sexual networks of MSM to reduce risk behavior such as CAS and to promote and increase HIV testing in the Dallas and Houston MSAs.

ACKNOWLEDGMENTS

The authors would like to thank all the NHBS 2008 and 2014 participants, the NHBS staff from Dallas and Houston project areas, the Texas Department of State Health Services, the Houston Health Department and the Centers for Disease Control and Prevention (CDC) for the various levels of support received during the data collection period. The findings and conclusions in this article are those of the authors and do not represent the official position of the Texas Department of State Health Service, Houston Health Department, or the CDC.

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