Trends in HIV Risk, Testing, and Treatment among MSM in Chicago 2004–2014: Implications for HIV Elimination Planning

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Abstract Men who have sex with men (MSM) in the USA continue to have high rates of HIV infection. Increasingly, in addition to behavioral factors, biomedical interventions have been found to play important roles in HIV prevention. In this analysis, we used four waves of cross-sectional data (2004, 2008, 2011, and 2014) from the National HIV Behavioral Surveillance

System (NHBS) to examine trends in key behaviors and biomedical interventions among MSM in Chicago ($N = 3298$). Logistic regression was used to determine changes in behaviors and use of biomedical interventions. Condomless sex increased significantly in waves 3 and 4, compared to wave 1: wave 3 (AOR = 2.07; 95% CI 1.53, 2.78) and wave 4 (AOR = 2.19; 95% CI 1.62, 2.96). Compared to those aged 18–24, older participants were significantly less likely to be routinely tested for HIV: 30–39 (AOR = 0.63; 95% CI 0.48, 0.83), 40–49 (AOR = 0.40; 95% CI 0.29, 0.55), and >50 (AOR = 0.28; 95% CI 0.18, 0.43). Awareness of both post-exposure prophylaxis (PEP) (AOR = 3.13; 95% CI 1.22, 8.03) and pre-exposure prophylaxis (PrEP) (AOR = 10.02; 95% CI 2.95, 34.01) increased significantly in wave 4, compared to wave 3. These results suggest a potential increase in HIV rates among men with main and casual partners and should be monitored closely as PrEP becomes more widespread among MSM of all races and ethnicities in Chicago. This study also suggests that further analyses of the barriers to PEP and PrEP uptake among high-risk populations are necessary.

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Introduction

Men who have sex with men (MSM) in the USA continue to have high rates of HIV infection [1]. Though

only estimated to be between 3 and 7% of the population, MSM accounted for 83% of new infections in 2014 [2, 3]. In addition, there are marked racial disparities within urban epicenters such as Chicago [4] with blacks having disproportionately high rates of infection compared to whites and Hispanics [5–7]. In Chicago, a decline has been observed among all risk categories, except MSM, who have experienced a 5% increase in new HIV diagnoses since 2009 [5]. The National HIV/AIDS Strategy (NHAS) has called for a renewed focus on MSM communities with particular efforts to increase the percentage aware of their HIV status to at least 90%, to reduce the number of new diagnoses by at least 25%, and to reduce the percentage who have engaged in HIV risk behaviors by at least 10% [8].

In addition to behavioral factors and the HIV continuum of care, biomedical interventions have been found to increasingly play important roles in HIV prevention [8]. These approaches include HIV testing [9], treatment as prevention (TaSP) [10], and antiretroviral-based prevention including post-exposure prophylaxis (PEP) and pre-exposure prophylaxis (PrEP) [11, 12]. These interventions are conceptualized within the context of behavioral risk reduction [13] including reducing the number of sex partners, decreasing condomless sex, decreasing alcohol and other substance use, and improving mental health [14–16]. As HIV prevention implementation scientists work to better target and adapt interventions, an improved understanding of local epidemics and the behaviors associated with them is required, particularly in the context of newer biomedical prevention approaches. Further, as NHAS is implemented, community service agencies and health departments could further focus and refine their prevention efforts if they had a better understanding of current trends in HIV testing and engagement in treatment. Understanding trends in behaviors associated with the acquisition of HIV could help implementation scientists (1) determine whether an intervention is effective and (2) identify changes in behavior that could be a consequence of emerging risk such as increased methamphetamine use in a subpopulation of MSM [4, 17, 18]. Examining current behavioral trends in subpopulations is also important in the context of biomedical interventions including access to and use of antiretroviral therapy (ART), PrEP, and PEP [19]. Monitoring the emergence of

risk behaviors through systematic sampling from representative samples could give intervention planners an early start in confronting emerging drivers of HIV transmission.

In this analysis, we use Chicago data from the National HIV Behavioral Surveillance System [20] (NHBS) to examine 10-year trends in key behaviors (regular HIV testing, number of sexual partners, condomless sex, and drug or alcohol use during sex) and biomedical interventions (PrEP/PEP awareness and ART use) that impact HIV care and prevention continuums for MSM. We also explore demographic and provider-level factors that might be related to the biomedical and behavioral outcomes of interest.

Study Design

The National HIV Behavioral Surveillance System is an ongoing Centers for Disease Control and Prevention (CDC)-funded project that collects cross-sectional data on HIV/STI risk behaviors, HIV testing behaviors, and HIV prevention behaviors in populations at risk for HIV infection among MSM, persons who inject drugs (PWIDs), and high-risk heterosexuals [20]. Surveys for each at-risk population are repeated in 3-year cycles. The Chicago Department of Public Health (CDPH), in collaboration with the University of Illinois at Chicago (UIC), conducted four NHBS surveys of MSM occurring in 2004, 2008, 2011, and 2014 [21]. In order to address the needs of the survey, eligibility criteria changed over time. For the purposes of this study, the eligibility criteria include (1) participants who were 18 years of age or older, (2) residents of Chicago's metropolitan statistical area, (3) born male, and (4) reported oral or anal intercourse with a male in their lifetime.

Venue-based, time-location sampling (VBS) was used to select participants from places where MSM congregate in Chicago. VBS is a three-stage process [22–24]. First, formative research is conducted to garner community buy-in, to identify potential venues for sampling, and to learn about the sample population and identify barriers to recruitment. The second stage involves creating a sampling frame, which includes venues and the venue day/time periods (VDT) when it is possible to conduct sampling. Venues and VDTs are then randomly selected in two stages to create monthly sampling calendars. The third stage of VBS entails randomly selecting, screening, and interviewing participants within the venues.

Men attending venues were enumerated to undergo screening; those eligible were administered a face to face, standardized questionnaire in English or Spanish using a handheld computer in a private room. No identifying information was collected. Eligible participants were also offered HIV testing by collecting oral specimens (for either rapid testing in the field or blood for laboratory-based testing following the interview [4, 25]). A non-reactive rapid test was considered a definitive negative result: a reactive (preliminary positive) rapid test result was considered a definitive positive result only if confirmed by western blot analysis [26–28]. During wave 1, HIV testing was not conducted; HIV status was self-reported by participants.

Measures

The standardized questionnaire gathered self-reported data on respondents' HIV and STI testing behaviors, exposure to and utilization of HIV prevention and care services, and sexual and drug use practices. Given the adaptive nature of the NHBS survey, only those questions which remained constant over the four waves of analysis were utilized in this study.

Dependent Variables

Routine HIV testing was defined per CDC recommendations for sexually active MSM as having at least four HIV tests in a 2-year period [29, 30]. All participants were asked whether, in the past 12 months, they were exposed to and utilized various HIV prevention services such as free condoms, community services, or needle exchange programs. Individuals were also asked whether they had heard of anyone taking PrEP or PEP and had taken either of these medications themselves. The use of ART medication was assessed among those respondents who were laboratory confirmed as HIV positive. ART medication use was defined as self-reported current use of ARTs by those who have seen a medical provider for their HIV infection. PEP/PrEP awareness was defined as use of or awareness of others using PEP/PrEP and was only available during waves 3 and 4.

Participants were asked about the number and types of sex partners they had in the 12 months prior to the survey. They were asked to classify their sexual partners by type, either main (“...men you have sex with and who you feel committed to above anyone else”) or casual (“...men you have sex with but do not feel

committed to or don't know very well”). They were also asked, for each partner, whether or not condoms were used during anal sex and whether or not any drugs or alcohol were used before or during sex. Condomless sex was defined as participation in anal sex without the use of a condom at least once with any partner type (main or casual partner) in the previous 12 months. Number of total partners was defined as having >5 total partners or ≤5 total partners in the previous 12 months. Number of sexual partners was defined as the number of male sexual partners, either main or casual, in the previous 12 months. The use of drugs or alcohol during sex was categorized as using neither, using drugs only, using alcohol only, or using both.

Independent Variables

Independent variables included age, education, race/ethnicity, HIV diagnosis, insurance status, and disclosure of sexual orientation to a healthcare provider. Age was categorized as 18–24, 25–29, 30–39, 40–49, and >50 years old. Education was categorized as less than high school, high school graduate, some college, and college graduate. Race/ethnicity was categorized as Hispanic, non-Hispanic black, non-Hispanic white, and non-Hispanic other. HIV diagnosis was defined as HIV positive or HIV negative (wave 1: self-reported, waves 2 to 4: laboratory confirmed). Insurance status and disclosure of sexual orientation to healthcare provider were both binary (yes/no) variables.

Statistical Analysis

Descriptive analysis was conducted using chi-squared tests to determine differences between the outcomes and the independent variables. Variables were then assessed by bivariate logistic regression. Multivariable logistic regression was performed to identify variables that were independently associated with each outcome. Interactions between study wave and independent variables were assessed to determine change in independent variables over the study period. Variables significant at the $p \leq 0.05$ level in bivariate analysis were entered in the multivariable model. To be retained in the final model, all variables had to be significant at the $p \leq 0.05$ level or previously identified confounders, either biological or identified by previous research.

During wave 1, NHBS did not conduct in-field HIV testing in order to maximize community participation.

To assess how this difference may affect our findings, we performed sensitivity analyses for all regressions which included HIV status as a covariate. To do this, we eliminated HIV status for all wave 1 participants and re-ran our models noting any changes to our estimates.

Results

The NHBS project sampled 3298 MSM in Chicago across four waves of data collection from 2004 to 2014. Across all waves, participants were sampled from 127 unique venues (wave 1 = 100, wave 2 = 74, wave 3 = 49, and wave 4 = 41). In wave 3, 1426 were approached, 586 screened, and 508 completed the interview. In wave 4, 1798 were approached, 719 screened, and 553 completed the interview. This data was not collected in waves 1 and 2.

Baseline demographic characteristics are presented in Table 1 and are stratified by wave of collection (wave 1: $n = 1258$, wave 2: $n = 702$, wave 3: $n = 611$, wave 4: $n = 727$). Participants were, on average, oldest in wave 4 (36.3 ± 11.9 years) and youngest in wave 2 (32.0 ± 10.0). In waves 1 and 4, the majority of individuals were aged 30–39, while in waves 2 and 3, the majority was aged 18–24. Across all waves, the majority of individuals were college graduates (50.4%), non-Hispanic white (50.7%), had insurance of any type (68.2%), and had not revealed their sexual orientation to their primary healthcare provider (59.0%). The proportion of HIV-seropositive individuals increased across waves (9.2% in wave 1 to 12.7% in wave 4), although wave 1 status was self-reported and may have been under reported. The proportion of participants engaging in condomless sex increased across waves (36.4% in wave 1 to 46.8% in wave 4) as did the percent of HIV-positive individuals who were on ART medication (76.9% in wave 1 to 93.1% in wave 4). Additionally, awareness of both PEP (1.35 to 4.2%) and PrEP (0.7 to 6.6%) increased between waves 3 and 4.

In multivariable analyses, we found that condomless sex (Table 2) increased significantly in waves 3 and 4, compared to wave 1: wave 3 (AOR = 2.07; 95% CI 1.53, 2.78) and wave 4 (AOR = 2.19; 95% CI 1.62, 2.96). This pattern did not change when condomless sex was stratified by partner type (main or casual) (data not shown). Participants with >5 sexual partners, compared to those with ≤ 5 sexual partners, were significantly more likely to have condomless sex (AOR = 1.81; 95% CI

1.52, 2.17). We found that participants with an HIV-positive diagnosis, compared to those with an HIV-negative diagnosis, were significantly more likely to engage in condomless sex (AOR = 1.91; 95% CI 1.44, 2.51). We also found that condomless sex was more often reported by those who used drugs (AOR = 1.99; 95% CI 1.17, 3.40) or both drugs and alcohol (AOR = 1.50; 95% CI 1.13, 2.00) before or during sex compared to those who never did so.

The proportion of participants reporting five or more sex partners decrease significantly in wave 2, compared to wave 1 (AOR = 0.53; 95% CI 0.40, 0.70) (Table 2). Participants who self-reported HIV diagnosis, compared to those who did not self-report HIV diagnosis, are significantly more likely to have >5 sexual partners (AOR = 1.42; 95% CI 1.09, 1.86). We found that, compared to non-Hispanic whites, both non-Hispanic blacks (AOR = 0.64; 95% CI 0.51, 0.81) and Hispanics (AOR = 0.67; 95% CI 0.53, 0.84) are significantly less likely to have >5 sexual partners. We found that, compared to those who report no substance use during sex, those who use alcohol only (AOR = 1.34; 95% CI 1.03, 1.73), drugs only (AOR = 3.04; 95% CI 1.79, 5.15), and either drugs or alcohol during sex (AOR = 2.14; 95% CI 1.59, 2.89) are significantly more likely to have >5 sexual partners.

Use of any drug or alcohol before or during sex (Table 2) increased significantly in waves 2 through 4, compared to wave 1: wave 2 (AOR = 29.23; 95% CI 20.05, 42.75), wave 3 (AOR = 46.42; 95% CI 25.60, 84.17), and wave 4 (AOR = 56.76; 95% CI 29.77, 108.22). Compared to those aged 18–24, participants aged 25–29 (AOR = 1.52; 95% CI 1.05, 2.20) were significantly more likely to use drugs or alcohol during sex. Additionally, we found that older participants, compared to those aged 18–24, are significantly more likely to be HIV positive: 25–29 (AOR = 2.30; 95% CI 1.23, 4.32), 30–39 (AOR = 4.54; 95% CI 2.57, 8.03), 40–49 (AOR = 6.77; 95% CI 3.78, 12.13), and >50 (AOR = 6.80; 95% CI 3.57, 12.96).

Compared to wave 1, regular HIV testing (Table 3) decreased significantly at wave 2 (AOR = 0.69; 95% CI 0.51, 0.94) while increasing significantly at wave 4 (AOR = 1.42; 95% CI 1.04, 1.95). Among HIV-negative participants, compared to those aged 18–24, older participants are significantly less likely to be routinely tested: 30–39 (AOR = 0.63; 95% CI 0.48, 0.83), 40–49 (AOR = 0.40; 95% CI 0.29, 0.55), and 50+ (AOR = 0.28; 95% CI 0.18, 0.43). Participants who

Table 1 Participant demographics and characteristics stratified by wave in Chicago, NHBS ($N = 3298$) 2004–2014

Characteristic	Wave 1 2004 ($n = 1258$)	Wave 2 2008 ($n = 702$)	Wave 3 2011 ($n = 611$)	Wave 4 2014 ($n = 727$)	χ^2 p value	Total ($N = 3298$)
Age, n (%)					<0.001	
18–24	251 (21.1)	193 (27.5)	146 (24.0)	113 (15.7)		703 (21.4)
25–29	255 (20.4)	157 (22.4)	116 (19.1)	150 (20.8)		678 (26.7)
30–39	402 (32.2)	178 (25.4)	129 (21.2)	213 (29.5)		922 (28.1)
40–49	243 (19.4)	125 (17.8)	136 (22.3)	122 (16.9)		626 (19.1)
50+	99 (7.9)	49 (7.0)	82 (13.5)	123 (17.1)		353 (10.8)
Education, n (%)					<0.001	
Less than high school	48 (3.9)	35 (5.3)	25 (4.7)	9 (1.6)		117 (3.9)
High school	211 (16.9)	124 (18.8)	85 (16.1)	70 (12.5)		490 (16.4)
Some college	328 (26.3)	214 (32.5)	196 (37.1)	140 (24.9)		878 (29.3)
College graduate	659 (52.9)	286 (43.4)	222 (42.1)	343 (31.0)		1510 (50.4)
Race/ethnicity, n (%)					<0.001	
Non-Hispanic black	259 (21.1)	190 (27.3)	168 (27.7)	143 (19.9)		760 (23.3)
Non-Hispanic white	642 (52.1)	320 (45.9)	278 (45.9)	411 (57.1)		1651 (50.7)
Hispanic	269 (21.8)	152 (21.8)	139 (22.9)	142 (19.7)		702 (21.6)
Non-Hispanic other	63 (5.1)	35 (5.0)	21 (3.5)	24 (3.3)		143 (4.4)
Substance use ^a , n (%)	649 (51.6)	81 (11.5)	106 (17.4)	185 (25.5)	<0.001	1021 (32.8)
Alcohol only	288 (23.1)	314 (44.7)	229 (37.5)	205 (28.2)	<0.001	1036 (33.3)
Drugs only ^b	52 (4.1)	8 (1.1)	11 (1.8)	5 (0.7)	0.170	76 (2.4)
Drugs ^b and alcohol	86 (6.8)	299 (42.6)	265 (43.4)	332 (45.7)	0.478	982 (31.5)
Any drug or alcohol use ^c	952 (75.7)	455 (64.8)	363 (59.4)	479 (65.9)	<0.001	2249 (68.2)
Insured, n (%)	848 (67.4)	456 (65.0)	409 (66.9)	478 (65.8)	<0.001	2191 (66.4)
Sexual orientation revealed to healthcare provider, n (%)	401 (32.3)	179 (29.6)	182 (34.9)	218 (39.5)	0.002	980 (33.6)
>5 Sexual partners, n (%) ^a	456 (36.3)	292 (41.6)	311 (50.9)	340 (46.8)	<0.001	1399 (42.4)
Condomless anal sex, n (%)	116 (9.2)	60 (8.6)	79 (12.9)	92 (12.7)	0.006	347 (10.5)
HIV seropositive, n (%)	90 (76.9)	40 (67.8)	69 (84.2)	95 (93.1)	<0.001	294 (81.7)
Currently taking antiretrovirals ^d	249 (19.8)	147 (20.9)	138 (22.6)	199 (27.4)	0.001	733 (22.2)
Four HIV tests in the past 2 years	–	–	7 (1.1)	19 (2.6)	0.010	26 (2.8)
Awareness of PEP, n (%)	–	–	3 (0.5)	30 (4.1)	<0.001	33 (3.7)
Awareness of PrEP, n (%)						

Participant demographics and characteristics in the past 12 months are shown

PEP post-exposure prophylaxis, PrEP pre-exposure prophylaxis

^a With last male sexual partner^b Includes marijuana, speedball (heroin and cocaine), heroin, crack and/or powdered cocaine, methamphetamine (tina, crank, ice), ecstasy, painkillers (oxycotin, vicodin, percocet), hallucinogens (LSD, mushrooms), GHB, ketamine, and poppers^c In the past 12 months^d Not all columns add to 100% due to missing data; among HIV-positive individuals

have revealed their sexual orientation to their healthcare provider, compared to those who have not, are significantly more likely to be regularly tested for HIV (AOR = 2.36; 95% CI 1.85, 3.01). Awareness of both

PEP and PrEP increased significantly in wave 4 compared to wave 3 (AOR = 3.13; 95% CI 1.22, 8.03 and AOR = 10.02; 95% CI 2.95, 34.01), respectively. The use of antiretroviral medication among HIV-positive

Table 2 Multivariable logistic regression models for behavioral characteristics over the last 12 months: among participants in Chicago, National HIV Behavioral Surveillance (2004–2014)

	Condomless sex (<i>n</i> = 2441)	>5 Sexual partners (<i>n</i> = 2441)	Drug or alcohol use during sex (<i>n</i> = 2441)
Variable	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age			–
18–24	Ref	Ref	Ref
25–29	0.89 (0.69–1.16)	0.88 (0.67–1.16)	1.52 (1.05–2.20)*
30–39	0.86 (0.67–1.11)	1.02 (0.79–1.33)	1.13 (0.79–1.59)
40–49	0.75 (0.56–0.99)*	0.96 (0.72–1.28)	0.99 (0.67–1.46)
50+	0.47 (0.33–0.67)**	0.78 (0.54–1.13)	0.85 (0.50–1.42)
Education			
Less than high school	Ref	Ref	Ref
High school	1.32 (0.81–2.15)	0.72 (0.43–1.22)	1.27 (0.65–2.50)
Some college	1.22 (0.76–1.95)	0.99 (0.60–1.62)	1.34 (0.70–2.56)
College graduate	1.31 (0.82–2.10)	1.42 (0.86–2.34)	1.16 (0.60–2.22)
Race/ethnicity			
Non-Hispanic white	Ref	Ref	Ref
Non-Hispanic black	0.84 (0.65–1.02)	0.64 (0.51–0.81)**	0.79 (0.58–1.08)
Hispanic	1.16 (0.93–1.45)	0.67 (0.53–0.84)**	0.74 (0.54–1.01)
Non-Hispanic other	1.05 (0.70–1.60)	0.94 (0.62–1.42)	0.72 (0.42–1.24)
Substance use ^a			
None	Ref	Ref	Ref
Alcohol only	0.98 (0.76–1.25)	1.34 (1.03–1.73)*	–
Drugs only ^b	1.99 (1.17–3.40)*	3.04 (1.79–5.15)**	–
Drugs ^b and alcohol	1.50 (1.13–2.00)**	2.14 (1.59–2.89)**	–
Sexual partners			
≤5 Sexual partners	Ref	–	Ref
>5 Sexual partners	1.81 (1.52–2.17)**	–	1.65 (1.29–2.11)**
Any condomless sex			
No	–	Ref	Ref
Yes	–	1.82 (1.52–2.17)**	1.20 (0.95–1.51)
HIV diagnosed			
No	Ref	Ref	Ref
Yes	1.91 (1.44–2.51)**	1.42 (1.09–1.86)**	1.37 (0.93–2.02)
Wave			
1	Ref ^c	Ref	Ref ^c
2	1.20 (0.93–1.54)	0.53 (0.40–0.70)**	29.28 (20.05–42.75)**
3	2.07 (1.53–2.78)**	1.03 (0.76–1.39)	46.42 (25.60–84.17)**
4	2.19 (1.62–2.96)**	1.12 (0.83–1.51)	56.76 (29.77–108.22)**

OR odds ratio, CI confidence interval

* $p < 0.05$; ** $p < 0.001$ ^a With last male sexual partner^b Includes marijuana, speedballs (heroin + cocaine), heroin, crack and/or powdered cocaine, methamphetamines (tina, crank, ice), ecstasy, painkillers, hallucinogens (LSD, mushrooms), GHB, special K, and poppers^c Chi-squared test for trend $p < 0.01$

Table 3 Multivariable models for biomedical characteristics in the past 12 months among participants in Chicago, National HIV Behavioral Surveillance (2004–2014)

	Regular testing ^d (<i>n</i> = 2462)	Awareness of PEP (<i>n</i> = 676)	Awareness of PrEP (<i>n</i> = 728)	Ever taken ARV ^c (<i>n</i> = 328)
Variable	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Age				
18–24	Ref	Ref	Ref	Ref
25–29	1.00 (0.76–1.31)	0.86 (0.26–2.79)	0.70 (0.22–2.25)	0.89 (0.27–2.97)
30–39	0.63 (0.48–0.83)**	0.52 (0.15–1.76)	0.60 (0.20–1.82)	2.15 (0.66–7.02)
40–49	0.40 (0.29–0.55)**	0.50 (0.12–1.97)	0.54 (0.15–2.02)	4.76 (1.35–16.82)*
50+	0.28 (0.18–0.43)**	0.25 (0.03–2.31)	0.41 (0.07–2.38)	9.98 (1.65–60.20)*
Education				
Less than high school	Ref	Ref	Ref	Ref
High school	1.47 (0.81–2.66)	1.39 (0.35–5.58)	0.27 (0.03–2.31)	0.32 (0.06–1.76)
Some college	1.30 (0.78–2.51)	1.68 (0.65–4.34)	0.92 (0.36–2.32)	0.40 (0.08–2.04)
College graduate	1.47 (0.81–2.65)	–	–	0.45 (0.08–2.34)
Race/ethnicity				
Non-Hispanic white	Ref	Ref	Ref	Ref
Non-Hispanic black	1.12 (0.87–1.43)	0.44 (0.12–1.62)	0.19 (0.02–1.50)	1.08 (0.47–2.49)
Hispanic	0.91 (0.71–1.16)	0.29 (0.08–1.05)	1.08 (0.42–2.75)	1.04 (0.42–2.62)
Non-Hispanic other	0.55 (0.33–0.93)*	–	1.46 (0.29–7.25)	2.22 (0.36–13.79)
Substance use ^a				
None	Ref	Ref	Ref	Ref
Alcohol only	1.16 (0.87–1.55)	0.54 (0.21–1.39)	0.20 (0.02–2.11)	1.21 (0.43–3.38)
Drugs only ^b	1.26 (0.67–2.39)	–	–	1.39 (0.29–6.72)
Drugs ^b and alcohol	1.65 (1.20–2.28)**	–	0.47 (0.05–4.42)	1.03 (0.37–2.84)
Insured				
No	Ref	Ref	Ref	Ref
Yes	1.10 (0.87–1.38)	1.05 (0.36–3.09)	3.51 (0.77–16.00)	3.10 (1.54–6.27)**
Sexual orientation revealed to healthcare provider				
No	Ref	Ref	Ref	Ref
Yes	2.36 (1.85–3.01)**	1.56 (0.45–5.46)	2.50 (0.57–11.01)	1.81 (0.52–6.25)
Any condomless sex				
No	Ref	–	–	–
Yes	1.10 (0.88–1.29)	–	–	–
Wave				
1	Ref ^e	No data	No data	Ref ^e
2	0.69 (0.51–0.94)*	No data	No data	0.67 (0.26–1.70)
3	0.97 (0.71–1.34)	Ref ^e	Ref ^e	2.37 (0.86–6.52)
4	1.42 (1.04–1.95)*	3.13 (1.22–8.03)*	10.02 (2.95–34.01)**	3.95 (1.31–11.91)*

Using logistic regression models

HIV human immunodeficiency virus, PEP post-exposure prophylaxis, PREP pre-exposure prophylaxis, ARV antiretroviral medication, OR odds ratio, CI confidence interval

* $p < 0.05$; ** $p < 0.001$ ^a With last male sexual partner^b Includes marijuana, speedballs (heroin + cocaine), heroin, crack and/or powdered cocaine, methamphetamines (tina, crank, ice), ecstasy, painkillers, hallucinogens (LSD, mushrooms), GHB, special K, and poppers^c Among those who are HIV+^d Defined as four HIV tests in the past 2 years^e Chi-squared test for trend $p < 0.01$

participants increased significantly at wave 4, compared to wave 1 (AOR = 3.95; 95% CI 1.31, 11.91).

The number of new diagnoses of syphilis increased significantly ($p < 0.001$) during the study period (Fig. 1). This increase coincided with significant increases in both condomless sex ($p < 0.001$) and the number of participants reporting >5 sexual partners ($p < 0.001$). All sensitivity analyses removing self-reported HIV status from wave 1 arrived as similar conclusions as those reported above.

Discussion

In this study, we summarized trends in NHBS data on behavioral and biomedical factors associated with HIV risk in Chicago's MSM community over a 10-year period. First, we found that the prevalence of HIV among NHBS participants increased across waves, although the frequency of regular testing for HIV varied inconsistently. Second, we found that the frequency of condomless sex increased over time with higher frequency among those who self-report as HIV positive as well as among those who report either alcohol or drug use during sex. Third, we found that older MSM are more likely to have fewer sexual partners while also less likely to both use condoms and to get tested for HIV.

Finally, we found that awareness of both PEP and PrEP increased between waves 3 and 4.

Overall, we found significant demographic differences across all waves of NHBS in Chicago. This is due, in large part, to the increasing attention paid to obtaining a more representative sample over time. Wave 1 was conducted as a pilot/feasibility study, and thus, less attention was focused on obtaining more representative sample; however, this was greatly improved in the following waves. For example, the first wave had a high number of both non-Hispanic white participants and those aged 30–39; however, subsequent waves were better at recruiting younger, non-Hispanic blacks. Subsequent waves were also focused on obtaining a more representative sample by employing “roving venues” where recruiters would follow certain theme nights or DJs which changed venues frequently, allowing for the recruitment of a more diverse and representative sample. It is due to these later changes in recruitment that we see significant demographic differences; however, these changes also yielded a more representative sample.

Although some evidence suggests that most new HIV transmissions occur with main sexual partners [31], our finding of increases in condomless sex among all partner types in Chicago is of interest. It may be that in Chicago, casual sex partners are also contributing significantly to HIV transmission among MSM who

Fig. 1 Surveillance trends in HIV prevalence and syphilis diagnosis among MSM transmission group and percentage of sexual risk behaviors, testing, and treatment, NHBS, Chicago, 2004–

2014. Among HIV positive (*superscript letter a*). Significant linear trend ($p < 0.001$) (*superscript letter b*). Data from 2015 CDPH Surveillance Report [36, 37] (*superscript letter c*)

primarily use condoms for risk reduction. Additionally, we found an increase in syphilis infections from surveillance data, which further suggests a decrease in condom use (i.e., “condom fatigue”) across partners over time. Our results suggest that more attention should be paid in Chicago to HIV prevention with casual partners, including potential strategies for encouraging the use of PrEP and PEP among MSM of all races and ethnicities in Chicago. Further, given the increasing trend in condomless sex observed over the four waves, future research should focus on addressing challenges in educating MSM on condom use and enhanced methods of modifying HIV risk behaviors.

We also found a complex mix of risk behaviors among older (>30 years) MSM suggesting a need for a renewed focus on their risk of acquisition of HIV. Our analysis suggests that older MSM are more likely to be living with HIV, to have fewer sexual partners, and are less likely to have condomless sex. Older MSM, however, are also less likely to get tested for HIV less frequently than their younger counterparts. When diagnosed with HIV, however, older individuals are significantly more likely to be using ARVs.

We found that, compared to non-Hispanic whites, non-Hispanic blacks and Hispanics are less likely to have greater than five sexual partners, although some literature does suggest that there is lower reporting of these behaviors among black MSM [32], perhaps due to social desirability biases. These participants may be less likely to recall, or be willing to accurately report, the number of sexual partners due to a desire to be seen as having fewer sexual partners. It is, however, encouraging to identify these associations given that recent research has found that young, black MSM are more likely to be in HIV transmission clusters [33, 34]. Additional research is needed to examine these trends further.

Similar to findings in the national NHBS report [35], we found an increasing, albeit limited awareness of both PrEP and PEP among NHBS participants in Chicago. Similar to our findings, previous research among high-risk MSM in both New York City [36] and California [37] has observed limited awareness of PEP and PrEP. PEP and PrEP awareness has been associated not only with provider knowledge of sexual orientation [36] but also with lower rates of HIV testing [38]. Still, other research among MSM in the iPrEx trial is encouraging and has observed that MSM who report high-risk behaviors have shown interest in PrEP [39]. Further

research is needed to understand the barriers to PEP and PrEP use and knowledge among MSM in Chicago.

Our study has limitations. This was four separate, cross-sectional surveys, and thus, our results do not allow for causal inference. However, serial sequential cross-sectional samples with rigorous sampling approaches can yield results favorable to better understanding the HIV epidemic in MSM in Chicago [40]. Additionally, the questionnaires changed over the study period in order to refine and better capture data, limiting consistency and the use of some variables. Further, NHBS appears to under-represent blacks and over-represent whites, most likely due to venue-based sampling, although generalizability and representativeness were improved in later waves. Third, this type of research is subject to multiple biases that include recall bias and social desirability bias which could have an impact on our results and their generalizability.

Even in the context of our study limitations, we see that HIV trends in Chicago changed over the last 10 years. There is some evidence that HIV increased across waves, perhaps due to a coincident increase in condomless sex frequency and either alcohol or drug use during sex. Future research is also necessary to determine the barriers to PEP and PrEP uptake among high-risk populations. These analyses should also be replicated following subsequent NHBS waves to assess whether these trends in risk behavior and biomedical prevention uptake continue or new ones emerge to better target future prevention and care interventions.

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