


HIV Risk Behaviors and Utilization of Prevention Services, Urban and Rural Men Who Have Sex with Men in the United States: Results from a National Online Survey

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Abstract Rural men who have sex with men (MSM) are heavily affected by HIV, and many lack culturally competent HIV prevention resources. Rural MSM may find sexual partners on the internet, which may also be a way to deliver prevention services to them. To understand the differences between rural and urban MSM with respect to HIV risk factors and behaviors and the utilization of online HIV prevention services, we used data from the 2012 Web-Based HIV Behavioral Survey (WHBS). Using WHBS data collected between June and August 2012, we compared the characteristics of MSM with positive or unknown HIV infection status who had sex with a male in the past 12 months, from rural vs urban areas using Chi square tests and median tests. We used logistic regression and calculated adjusted prevalence ratios (aPR) and 95% confidence intervals (CI) to compare self-reported HIV risk behaviors, HIV/STI testing behaviors, use of prevention services, and perceived discrimination. Of the 8166 MSM included in our analysis, 3583 (44%) were from rural areas, and 4583 (56%) were from urban areas. Compared to urban MSM, rural MSM were less likely to ever test for HIV (aPR = 0.94, CI 0.92–0.95), to be tested for HIV in the last

year (aPR = 0.83, CI 0.79–0.87), or to receive free condoms (aPR = 0.83, CI 0.79–0.86) or individual prevention counseling in the past year (aPR = 0.86, CI 0.78–0.95). Rural MSM were less likely to have been tested in the last year for syphilis, gonorrhea, or chlamydia (aPR = 0.70, CI 0.62–0.78; aPR = 0.72, CI 0.64–0.81; aPR = 0.75, CI 0.67–0.85, respectively). Rural MSM also reported perceiving less tolerance of gays and bisexuals within their community (aPR = 0.80, CI 0.77–0.84). HIV prevalence is lower among MSM in rural areas compared to MSM in urban areas, but rural MSM report that they are more likely to face intolerance and are less likely to use basic HIV prevention services compared to urban MSM. Therefore, this hard-to-reach population could benefit from prevention services offered through the internet.

Keywords HIV · MSM · Rural · Urban

Introduction

Gay, bisexual and other men who have sex with men (MSM) represent the most heavily affected group at risk for HIV infection in the United States (U.S.) [1], and the only risk group for whom new annual HIV diagnoses continue to increase [1, 2]. The number of MSM living with HIV infection is highest in urban areas [3] and as a result, HIV prevention program funding for MSM has been focused there [4–6]. In addition, several studies have reported that MSM in the U.S. are somewhat more likely to reside in urban settings than rural ones, likely due to the more gay-friendly culture found in cities compared to rural areas [7–9]. Consequently, greater proportions of MSM live in states with large metropolitan cities [10].

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Despite having lower HIV rates compared to urban MSM, rural MSM are heavily affected by HIV and have rates higher than the general population, and in some areas is similar to what we see in large metropolitan areas [11, 12]. However, the availability of culturally competent HIV prevention resources decreases as the degree of rurality increases, leaving MSM in rural areas without sufficient prevention tools, compared to urban MSM [13]. Hence, there are important reasons to monitor the HIV prevention needs and services available to rural MSM in the U.S., and remediate where needed.

Providing HIV prevention services to MSM in rural areas is difficult in part because placing stand-alone agencies in areas where population density is low is not cost-effective. A potential solution however, is the internet, which may be capable of diffusing HIV prevention services to MSM in rural areas [14]. Although there has historically been a “digital divide”, by which people in rural areas have had less access to high-speed internet [15] and lower data speeds [16], this gap has lessened in recent years [17]. Moreover, MSM today often rely on the internet to build their social and sexual networks and receive support, making the internet a more promising medium to distribute HIV prevention services [18–20].

To better understand HIV risk factors and behaviors of rural MSM, compared to urban MSM, and also determine the extent to which these men access online HIV prevention services compared to urban MSM, we utilized data from the 2012 Web-Based HIV Behavioral Survey (WHBS), a national convenience sample of internet-using MSM in the U.S. [21]. Results from this analysis may also identify unique prevention needs and ways in which to deliver services.

Methods

The WHBS collected cross-sectional, self-reported data on HIV risk behaviors, HIV testing behaviors, and access and use of HIV prevention services among internet-using MSM in the U.S. between June and August 2012, respondents were recruited through an internet-based convenience sampling method using banner ads, social media, and peer referral [21]. Men who clicked on an ad or link were directed to a consent page where they were given a brief online screening questionnaire. Men were eligible for the survey if they were 18 years of age or older, considered themselves to be male (not transgender), a resident of the U.S. or a dependent area, able to take the survey in either English or Spanish, and had ever had oral or anal sex with a man. Internet protocol (IP) addresses were collected to identify potential duplicate respondents and were then permanently deleted from the dataset.

Respondents who completed the consent page and were deemed eligible to participate in the survey completed a 15-min, self-administered, confidential survey administered entirely on the internet. Respondents were asked questions on demographics, sexual behavior with male and female partners, HIV testing history, drug and alcohol use, and use of HIV prevention services. Additionally, respondents' ZIP code of residence was obtained in order to categorize them as urban or rural. Respondents were also randomized to complete one of three additional survey modules covering topics such as experiences with harassment and discrimination due to sexual orientation and HIV status, non-occupational post-exposure prophylaxis (nPEP) and pre-exposure prophylaxis (PrEP) use, and sexually transmitted infection (STI) diagnosis and testing.

Measures

Population density was determined using a composite measure, taking into account both U.S. Census Bureau data as well as respondents' self-reported zip code. Rural and urban designations were determined using the U.S. Census Bureau's data and definition of rural: population density < 1000 people/square mile, and definition of urban: population density \geq 1000 people/square mile (which includes micropolitan, suburban, and core urban areas) [22, 23]. However, because we included self-reported zip codes in our population density measure, our definition of rural and urban may not perfectly align with the U.S. Census Bureau's definition.

The behavioral measures were adapted from those used in multiple cycles of the National HIV Behavioral Surveillance system (NHBS) [24, 25]. The following sexual behavior measures were assessed within the past 12 months: having male sex partner(s) identified as either main, casual or both; and having condomless anal sex with a male partner of any type. The following sexual behavior measures were assessed with the most recent male sex partner (within the past year) of any partner type: condomless anal sex; condomless anal sex with a partner first met on the internet; and any type of sex with a partner who was HIV-positive or of unknown HIV status.

Discrimination related to sexual identity was adapted from several previously published instruments and were only asked for one-third of randomized respondents [26–28]. Respondents were asked if they experienced any of the following situations in the past year because someone knew or assumed the respondent was attracted to men: called names or insulted; physically attacked or injured; received poorer services than other people in restaurants, stores, other businesses or agencies; treated unfairly at work or school; or denied or given lower quality of health care. Respondents were also queried on the extent to which

they agreed or disagreed that people in their area were tolerant of gays and bisexuals using questions adapted from Preston et al. [29]. Tolerance was measured on a 5-point Likert scale, from strongly agree, agree, neither agree nor disagree, disagree, to strongly disagree.

Respondents were asked whether they had ever been previously tested for HIV. Those who had been previously tested were asked to provide the month and year of their most recent test and responses were coded as being within the past year or not. If respondents could not recall the exact month and year of their most recent HIV test, they were asked whether it had been within the past year. Respondents who had never been tested for HIV infection were also coded as not having been tested in the past year. STI testing and diagnosis in the past year were only asked for one-third of randomized respondents and included gonorrhea, Chlamydia and syphilis.

In accordance with the federal human subject protection regulations [30] and guidelines for defining public health research [31], WHBS was determined to be a non-research, public health surveillance activity used for disease control program or policy purposes. The survey received Institutional Review Board (IRB) approval by Emory University. No monetary incentive was provided to respondents.

Analyses

Data were analyzed using SAS version 9.4 (SAS Institute, Cary, NC) and SUDAAN version 11 (Research Triangle Institute, Research Triangle Park, NC). The analyses were restricted to men who reported having oral or anal sex with another man in the 12 months prior to the survey and to men who reported their ZIP code of current residence. We compared the characteristics of respondents from rural and urban areas and tested for significant differences (p value < 0.05) between groups using Chi square tests of independence for categorical variables and median tests for non-normally distributed continuous variables. To compare the prevalence of self-reported HIV risk behaviors, HIV/STI testing behaviors, use of prevention services, and perceived discrimination, we calculated unadjusted prevalence ratios (PRs) comparing the responses of rural MSM with HIV-negative or unknown HIV status with urban MSM. Because of observed differences in age, race/ethnicity and education between the rural and urban men and previously reported behavioral differences among these groups [23, 24, 32, 33], we also calculated adjusted prevalence ratios (aPR) controlling for age, race/ethnicity, and educational attainment.

Results

Between June and August 2012, 13,147 individuals were screened and consented for the survey, of whom 11,178 (85%) were eligible for participation. Of these, 10,384 (93%) completed the survey. We excluded 583 men who did not report sex with a man in the past 12 months, resulting in an analytic sample of 9019 men, of whom 3886 (43%) were from rural areas, and 5133 (57%) were from urban areas.

Rural MSM respondents differed significantly ($p < 0.05$) from urban MSM on most sociodemographic characteristics (Table 1). For example, non-White respondents comprised 18.6% of rural respondents, compared to 20.8% of urban respondents. Rural MSM respondents were younger than urban MSM, approximately a third of rural respondents were aged 18–24, compared to a fifth of urban respondents. There were also significant differences in education and income, with trends towards lower education and income among rural respondents.

With respect to risk behaviors among self-reported HIV-negative MSM and MSM who were unaware of their HIV status ($n = 8166$) (Table 2), there was no significant difference between rural and urban men in the prevalence of self-reported condomless anal sex in the past year or with the most recent sex partner (aPR = 1.00, 95% confidence interval (CI) 0.97–1.04 and aPR = 1.19, CI 0.87–1.64, respectively). Nor was there a significant difference between rural and urban MSM reporting their most recent sex partner was HIV-positive or had unknown status (aPR = 0.93, CI 0.86–1.01), or they had met on the internet (aPR = 1.17, CI 0.66–2.06). However, rural MSM reported a lower prevalence than urban MSM of both ever being tested for HIV and being tested for HIV in the last year (aPR = 0.94, CI 0.92–0.95 and aPR = 0.83, CI 0.79–0.87, respectively). Finally, rural MSM were less likely to receive free condoms or individual prevention counseling in the past year, compared to urban MSM (aPR = 0.83, CI 0.79–0.86 and aPR = 0.86, CI 0.78–0.95, respectively)- however, there was no difference in participation in a small group prevention activity in the past year between the two groups of MSM (aPR = 1.15, CI 0.99–1.34).

Among 2794 HIV-negative or HIV-status unknown respondents who were randomly selected to answer questions regarding STI testing, a lower proportion of rural MSM reported being tested in the last year for syphilis, gonorrhea, or chlamydia, compared to urban MSM (aPR = 0.70, CI 0.62–0.78; aPR = 0.72, CI 0.64–0.81; and aPR = 0.75, CI 0.67–0.85, respectively). Rural MSM were also less likely to report being diagnosed with an STI

Table 1 Demographic characteristics of MSM reporting sex with men in the previous 12 months, recruited online via the Web-based MSM HIV Behavioral Survey, United States, 2012

Characteristic	Total N = 9019 n (%)	Rural ^a N = 3886 n (%)	Urban ^b N = 5133 n (%)	Rural prevalence % (95% CI)	p-value
Race/ethnicity^c					< 0.001
American Indian/Alaska Native	31 (0.3)	18 (0.5)	13 (0.3)	58.1 (40.4–73.9)	
Asian/Native Hawaiian/other Pacific Islander	217 (2.4)	66 (1.7)	151 (2.9)	30.4 (29.7–38.7)	
Black	426 (4.7)	145 (3.7)	281 (5.5)	34.0 (29.7–38.7)	
Hispanic/Latino	911 (10.1)	339 (8.7)	572 (11.1)	37.2 (34.1–40.4)	
Other/multiple	298 (3.3)	154 (4.0)	144 (2.8)	51.7 (46.0–57.3)	
White	7020 (77.8)	3123 (80.4)	3897 (75.9)	44.5 (43.3–45.7)	
Age, median (IQR)	31 (24–44)	30 (23–45)	32 (25–44)	N/A	<0.001
Age (years)					<0.001
18–19	491 (5.4)	303 (7.8)	188 (3.7)	61.7 (57.3–65.9)	
20–24	1977 (21.9)	968 (24.9)	1009 (19.7)	49.0 (46.8–51.2)	
25–29	1653 (18.3)	651 (16.8)	1002 (19.5)	39.4 (37.1–40.8)	
30–34	1084 (12.0)	411 (10.6)	673 (13.1)	37.9 (35.1–40.8)	
35–39	810 (9.0)	309 (8.0)	501 (9.8)	38.2 (34.9–41.6)	
40–44	793 (8.8)	268 (6.9)	525 (10.2)	33.8 (30.6–37.2)	
45–49	771 (8.5)	328 (8.4)	443 (8.6)	42.5 (39.1–46.1)	
50+	1440 (16.0)	648 (16.7)	792 (15.4)	45.0 (42.5–47.6)	
Education					<0.001
< HS diploma	81 (0.9)	44 (1.1)	37 (0.7)	54.3 (43.4–64.8)	
HS diploma or equivalent	666 (7.4)	411 (10.6)	255 (5.0)	61.7 (58.0–65.3)	
Some college or technical degree	2801 (31.1)	1477 (38.0)	1324 (25.8)	52.7 (50.9–54.6)	
College degree or postgraduate education	5357 (59.4)	1900 (48.9)	3457 (67.3)	35.5 (34.2–36.8)	
Sexual identity					0.003
Bisexual	606 (6.7)	300 (7.7)	306 (6.0)	49.5 (41.6–43.7)	
Heterosexual or Straight	26 (0.3)	9 (0.2)	17 (0.3)	34.6 (19.1–54.3)	
Homosexual or Gay	8321 (92.3)	3550 (91.4)	4771 (92.9)	42.7 (41.6–43.7)	
HIV status					<0.001
Indeterminate	6 (0.1)	3 (0.1)	3 (0.1)	50.0 (16.8–83.2)	
Negative	6713 (74.4)	2768 (71.2)	3945 (76.9)	41.2 (40.1–42.4)	
Never got results	58 (0.6)	27 (0.7)	31 (0.6)	46.5 (34.2–59.3)	
Never tested	1298 (14.4)	744 (19.1)	554 (10.8)	57.3 (54.6–60.0)	
Positive	853 (9.5)	303 (7.8)	550 (10.7)	35.5 (32.4–38.8)	
Region					<0.001
East North Central	1201 (13.3)	532 (13.7)	669 (13.0)	44.3 (41.5–47.1)	
East South Central	368 (4.1)	239 (6.2)	129 (2.5)	65.0 (59.9–69.7)	
Middle Atlantic	1133 (12.6)	280 (7.2)	853 (16.6)	24.7 (22.3–27.3)	
Mountain	654 (7.3)	526 (13.5)	128 (2.5)	80.4 (77.2–83.3)	
New England	494 (5.5)	202 (5.2)	292 (5.7)	40.9 (36.6–45.3)	
Pacific	1870 (20.7)	793 (20.4)	1077 (21.0)	42.4 (40.2–44.7)	
South Atlantic	1894 (21.0)	703 (18.1)	1191 (23.2)	37.1 (35.0–39.3)	
Territories	71 (0.8)	16 (0.4)	55 (1.1)	22.5 (14.3–33.7)	
West North Central	547 (6.1)	269 (6.9)	278 (5.4)	49.2 (45.0–53.4)	
West South Central	787 (8.7)	326 (8.4)	461 (9.0)	41.4 (40.2–44.7)	
Household income					<0.001
Yearly: \$0–19,999	1324 (14.7)	731 (18.8)	593 (11.6)	55.2 (52.5–57.9)	
Yearly: \$20,000–39,999	1729 (19.2)	861 (22.2)	868 (16.9)	49.8 (47.4–52.2)	

Table 1 continued

Characteristic	Total N = 9019 n (%)	Rural ^a N = 3886 n (%)	Urban ^b N = 5133 n (%)	Rural prevalence % (95% CI)	p-value
Yearly: \$40,000–74,999	2262 (25.1)	959 (24.7)	1303 (25.4)	42.4 (40.4–44.4)	
Yearly: \$75,000 or more	2996 (33.2)	1000 (25.7)	1996 (38.9)	33.4 (31.7–35.1)	

Percentages may not total 100% due to missing data

^aRural is defined as a population density of < 1000 people/square mile

^bUrban is defined as a population density of \geq 1000 people/square mile (which includes micropolitan, suburban, and core urban areas)

^cPersons of Hispanic/Latino ethnicity might be of any race

in the past year, compared to urban MSM (aPR = 0.62, CI 0.46–0.84).

Among 2744 HIV-negative or HIV-status unknown respondents randomly selected to answer questions regarding discrimination and tolerance, there was no statistically significant difference between rural and urban MSM reporting experiencing discrimination related to sexual identity (aPR = 1.06, CI 0.98–1.14). However, there was a significant difference found in the prevalence of MSM who reported perceived tolerance of gays and bisexuals within their community, with rural men reporting less tolerance (aPR = 0.80, CI 0.77–0.84).

Discussion

The HIV prevention needs of gay, bisexual, and other MSM living in rural areas have received considerably less attention compared to MSM living in urban areas. There has also been a dearth of HIV research on rural MSM. Many of the studies that do exist have had small sample sizes and have focused on broad HIV topics, rather than specifically on HIV prevention services [32–36]. This paucity of research and prevention services among rural MSM has been described as an “urban bias” in HIV research and prevention [37]. More recently, the internet has created new opportunities to conduct research and provide prevention services to rural MSM, which hopefully will reduce the rural–urban divide [34, 38, 39].

Using data from a large national behavioral survey of U.S. MSM, we examined indicators of HIV-relevant behaviors, HIV testing, and use of prevention services [31]. We found significant differences in sexual risk behavior and use of prevention services between rural and urban MSM. Compared to urban MSM, rural MSM were less likely to have been tested for HIV and STIs in the past year. Though rates of most sexual risk behaviors were

similar to urban MSM, rural MSM were less likely to have received free condoms or individual HIV prevention services in the past year.

Our demographic results may reflect broader trends between residents in rural and urban areas of the U.S. [39]. Rural Americans, as a group, are more likely to be poor [40], and less likely to have health insurance [41], and to have less utilization of preventive services than urban residents [41]. Similarly, among MSM interviewed during CDC’s Rapid HIV Behavioral Assessments in 2004–2005, rural MSM reported lower levels of education than their urban counterparts [42]. However, MSM in rural areas face challenges less prevalent among either the general rural population or urban MSM. Although attitudes towards homosexuality and bisexuality have become less negative among Americans as a whole [43], these attitudes have been consistently more negative among rural Americans [44, 45]. A recent Institute of Medicine report reviewed a constellation of barriers to healthcare services in rural settings for lesbian, gay, bisexual, and transgender (LGBT) persons [29, 46]. That report highlighted stigma and lack of provider training and knowledge of LGBT patients’ health needs. [29, 46] The need for culturally competent, comprehensive primary care [47] is also compounded by other challenges MSM may face due to internalized stigma, such as depression, anxiety, and substance use [48].

With the exception of small group HIV prevention discussions, rural MSM in our study reported less utilization of HIV testing and HIV prevention services. In general, rural Americans are less likely to have ever been tested for HIV, compared to Americans living in urban areas [6]. Lower coverage of HIV testing might be related, in part, to the lower levels of funding for community-based organizations providing targeted HIV testing for rural MSM compared to those in urban areas [6, 13]. Similarly, there is less support in rural areas for condom distribution services and individual risk reduction services other than the

Table 2 Prevalence ratios describing rural vs urban men, comparing sexual behavior, HIV and STI testing, use of prevention services, and stigma between rural and urban HIV-negative or HIV-status unknown MSM reporting sex with men in the previous 12 months: web-based MSM HIV Behavioral Survey United States, 2012

Characteristics	Rural ^a N = 3583 n (%)	Urban ^b N = 4583 n (%)	Prevalence ratio ^c (95% CI)	Adjusted prevalence ratio ^d (95% CI)
Sexual behaviors				
Partner types				
Main	1217 (34.3)	1340 (29.4)	1.16 (1.09–1.24)	1.16 (1.09–1.24)
Casual	981 (27.6)	1201 (26.4)	1.05 (0.97–1.13)	1.02 (0.94–1.09)
Both main and casual	1354 (38.1)	2012 (43.9)	0.93 (0.90–0.96)	0.93 (0.90–0.96)
Condomless anal sex in the past year	2242 (62.6)	2863 (62.5)	1.00 (0.97–1.04)	1.00 (0.97–1.04)
Condomless anal sex with most recent sex partner	74 (8.6)	79 (6.9)	1.24 (0.91–1.68)	1.19 (0.87–1.64)
Met most recent condomless anal sex partner on the Internet	23 (1.4)	25 (1.2)	1.16 (0.66–2.03)	1.17 (0.66–2.06)
Positive or unknown HIV status of most recent sex partner	847 (23.8)	1125 (24.7)	0.96 (0.89–1.04)	0.93 (0.86–1.01)
HIV/STI testing behaviors				
Ever tested for HIV	2819 (79.1)	4013 (87.9)	0.90 (0.88–0.92)	0.94 (0.92–0.95)
Tested for HIV in the past year	1557 (43.5)	2506 (54.7)	0.79 (0.76–0.83)	0.83 (0.79–0.87)
Tested for gonorrhea in the past year ^e	294 (25.9)	530 (37.6)	0.69 (0.61–0.77)	0.72 (0.64–0.81)
Tested for chlamydia in the past year ^e	305 (26.3)	516 (36.5)	0.72 (0.64–0.81)	0.75 (0.67–0.85)
Tested for syphilis in the past year ^e	318 (27.3)	587 (40.1)	0.68 (0.61–0.76)	0.70 (0.62–0.78)
STI diagnosis in the past year	59 (4.9)	121 (7.9)	0.62 (0.46–0.84)	0.62 (0.46–0.84)
Use of HIV Prevention Services				
Received free condoms in the past year	1772 (50.2)	2769 (61.4)	0.82 (0.79–0.85)	0.83 (0.79–0.86)
Received individual prevention services in the past year	565 (16.0)	838 (18.6)	0.86 (0.78–0.95)	0.86 (0.78–0.95)
Participated in small group session in the past year	317 (9.0)	352 (7.8)	1.16 (1.00–1.34)	1.15 (0.99–1.34)
Stigma and discrimination				
Discrimination related to sexual identity ^f	633 (52.6)	742 (48.3)	1.09 (1.01–1.17)	1.06 (0.98–1.14)
Perceived tolerance of gays and bisexuals ^f	842 (70.8)	1338 (88.4)	0.80 (0.77–0.83)	0.80 (0.77–0.84)

Table does not include self-reported HIV-positive respondents

^aRural is defined as a population density of < 1000 people/square mile

^bUrban is defined as a population density of ≥ 1000 people/square mile (which includes micropolitan, suburban, and core urban areas)

^cPrevalence ratios are calculated for the “yes” response option; “missing” data are excluded. A substantial amount (more than 10%) of data may be missing for some variables for multiple reasons, including not being asked the question because the respondent was not in the randomly selected subset, or not answering the question if asked

^dAdjusted for race/ethnicity, age and education

^eRandomly selected subset of sample (N = 2794, 1234 rural, 1560 urban)

^fRandomly selected subset of sample (N = 2744, 1208 rural, 1536 urban)

prevention counseling provided with HIV testing [6, 13]. This lack of community support may lead to our finding that rural MSM reported receiving fewer condoms and less use of individualized prevention services compared to those in urban settings.

There was no significant ($p < 0.05$) difference between rural and urban MSM in our study who reported sex without a condom in the last year or with their most recent sex partner. This is in contrast to a 2004–2005 study of MSM recruited at gay pride events, in which rural MSM were more likely to report sex without a condom in the past

12 months, compared to urban MSM [42]. The same study also reported that meeting partners on the internet was associated with condomless anal sex for rural MSM, but not for urban MSM, suggesting approaches to risk reduction interventions might need to be different for rural MSM and that internet-based interventions could be an important modality for interventions in rural areas.

Compared to urban MSM in our study, rural MSM reported that their communities were less tolerant toward gay and bisexual persons. These results are consistent with other research that has shown that LGBT persons living in

rural areas perceive more stigma, compared to LGBT persons living in urban settings [29, 46, 49–55]. Discrimination has serious implications for psychosocial health outcomes among MSM, such as an increased risk for depression, which is associated with an increased risk of HIV acquisition [56–62]. Discrimination has also been associated with risky sexual behaviors and a decrease in preventive behaviors, such as HIV testing [58]. Therefore, social support from the community directly influences HIV risk among MSM and should be addressed in prevention interventions [63].

Our study is subject to important limitations. Our online convenience sample is not representative of all internet-using MSM or of all MSM in the U.S. However, with an increasing number of Americans gaining access to high speed internet, even within rural communities and among minorities, the external validity of the results of our study is likely to be enhanced [15, 16, 64]. Another study also found that MSM recruited on the internet and in real-world settings had comparable patterns of HIV testing [65]. Our definition of rural relied on self-reported ZIP code and is thus subject to misclassification. However, we also collected city and state information from respondents, and only ZIP codes within the state and city reported were allowed to be entered by respondents. Our comparison between rural and urban men is less than optimal for identifying differences across the spectrum of urbanicity, because we combined all non-rural men to comprise the comparison group. Thus, the “non-rural” group included men from a range of non-rural settings, including micropolitan, suburban, and core urban areas. This may weaken our ability to detect true differences between rural and urban men, assuming that true differences are graduated across the spectrum of urbanicity. Compared to urban MSM, rural MSM experience lower prevalence of HIV infection [3, 66], but we and others have found that they perceive more stigma [29, 46], and are less likely to have utilized HIV prevention and other sexual health services. Although our study did not detect differential associations between condomless anal sex and/or meeting partners on the internet in rural versus urban men, other research has detected this relationship [42, 55, 67, 68]. It appears that our study was not powered to detect a possible relationship, given the missing data for this variable. However, this has been observed in other studies and, coupled with the increasing access to high-speed internet and dearth of in-person services in rural areas, providing prevention services through the internet to rural MSM remains a promising approach. Additionally, the increasing availability of smartphones makes providing prevention services through mobile apps increasingly feasible, and is acceptable among rural MSM [69–73]. Giving proof of concept to internet- and app-based technologies are the results from

recent studies that have utilized these technologies. For example, a randomized control trial showed not only the feasibility of implementing an online HIV prevention intervention among rural MSM, it also demonstrated its effectiveness in surveying and administering such an intervention to an otherwise hard-to-reach population [54, 74]. Moreover, most of the published randomized behavioral interventions delivered online have demonstrated a reduction in at least one high-risk behavior, an increase in HIV testing, or an increase in HIV knowledge [54, 75–79]. Finally, because internet- and app-based interventions require less staff and have greater reach in terms of geography than traditional “in-person” interventions and are easily replicable, prevention services utilizing technology are likely more cost-effective than traditional “in-person” prevention interventions, making them an even more attractive way in which to provide services to high-risk and hard to reach populations [80]. Therefore, scale-up of prevention services available through the internet or through smartphone apps could be promising paths to narrow the gap in utilization of prevention services by rural MSM.

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Compliance with Ethical Standards

Conflict of interest All authors do not have a conflict of interest to declare.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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