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ORIGINAL PAPER

Where is Rural? Examining the Effect of Rural Classification Method on Disparities in HIV and STI Testing Uptake Among Men Who Have Sex with Men in the United States

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Abstract

Men who have sex with men (MSM) account for the majority of new HIV diagnoses in the United States, including in rural areas, and MSM in rural areas face additional barriers to accessing culturally competent and appropriate HIV/STI preventive care. Multiple methods have been used to classify areas in the United States as rural, but none of these methods is specifically designed to classify areas with respect to access to culturally competent care for MSM. Using data from a large, cross-sectional study of MSM we assessed the effect of using three different methods for classifying rurality on measurements of sexual behavior and HIV/STI testing uptake. We found that the prevalence of condomless anal sex and PrEP eligibility was similar across levels of rurality regardless of the method of classification used. Across all measures of rurality, rural MSM were less likely to have tested for HIV and STIs than non-rural MSM. The disparity in HIV/STI testing persisted even in the most inclusive measure of rurality used, indicating that HIV/STI prevention studies should consider using an inclusive approach to identifying and defining rurality.

Keywords HIV testing · STI testing · Rural · Men who have sex with men

Introduction

The Ending the HIV Epidemic (EHE) initiative prioritizes jurisdictions for enhanced HIV prevention services, including seven states with a high burden (>10%) of new HIV diagnoses among rural residents [1]. The majority of new HIV diagnoses annually in the United States are among men who have sex with men (MSM), who accounted for 66% of new diagnoses in 2018 [2]. MSM account for the majority of new HIV diagnoses regardless of rurality. In 2018, 77% of new HIV diagnoses among people in the rural US were among men. Of those diagnoses, 77% were attributable to male-to-male sexual intercourse; an additional 7% were attributable to male-to-male sexual intercourse and injection drug use [3]. However, more data are needed to describe the sexual behavior and healthcare utilization of rural MSM. Granular data on the sexual behavior and HIV/STI diagnoses among rural MSM are difficult to obtain due to sparse numbers [4].

Previous studies have demonstrated that rural MSM experience additional or heightened barriers to HIV prevention compared to MSM in urban areas. Rural MSM receive inadequate sexual education relevant to their experiences [5] and are less likely to have access to culturally competent healthcare [6, 7]. Experiences of stigma and fears of being outed are additional barriers to accessing sexual healthcare among rural MSM [8]. Thus, rural MSM are less likely to have been tested for HIV or STIs in the past year compared to non-rural MSM, despite having similar sexual risk profiles [9].

One complicating factor in studying HIV risk among rural MSM is that there is not a standard, commonly accepted definition of what constitutes a rural area. Rather, there are multiple methods available for classifying geographic areas [10]. Common measures include a six-level scheme from the National Center for Health Statistics (NCHS) [11], Rural-Urban Commuting Area (RUCA) Codes from the Economic Research Service of the US Department of Agriculture [12], and the Index of Relative Rurality (IRR) [13]. The NCHS

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rural-urban classification scheme categorizes counties as large, medium, or small metropolitan; micropolitan; or noncore based on population size and density and proximity to urban centers. RUCA codes are similarly based on population size and density but also reflect the flow of commuting patterns to differentiate between bedroom communities and employment centers. The IRR is derived based on an area's population size and density, remoteness from urbanized areas, and the proportion of land that is developed.

Each of these measures has frequently used, but not definitive, cutoffs available to categorize areas as rural and urban. However, none is designed to specifically categorize areas with respect to the accessibility of culturally competent healthcare for MSM. Thus, it is not clear which of these different methods has the most utility in identifying rural areas with respect to identifying place-based effects on HIV risk and prevention among MSM.

Using data from a large, cross-sectional study of MSM in the United States, we examined sexual behavior and HIV prevention services uptake using three different definitions of rural areas to assess how the different geographic categorizations affect measurement of rural/urban disparities in sexual health.

Methods

Participants

Data were obtained from the American Men's Internet Survey (AMIS), an annual, cross-sectional survey of cisgender MSM in the United States [14]. Eligible participants are cisgender men, age 15 and older, who report ever having had sex with a man, and live in the United States. For this analysis, we excluded respondents from territories of the United States (i.e., American Samoa, Puerto Rico, U.S. Virgin Islands). Study methods have been previously reported [14]. Briefly, participants were recruited via online advertisements on social and sexual networking platforms and emails to previous AMIS respondents. Participants provided informed consent and took an online survey comprising demographics, sexual and substance use behaviors, HIV and sexually transmitted infection (STI) testing and diagnosis, and use of HIV prevention or treatment. Because one of our primary outcomes is HIV testing, this analysis is limited to participants who reported a negative or unknown HIV status. Recruitment occurred from September to December 2020. No incentives were provided for participation. All study procedures were approved by the Emory University Institutional Review Board.

Rural Definitions

Participant residence was determined by self-reported ZIP code. ZIP codes were then matched to county of residence using crosswalk data from the United States Department of Housing and Urban Development [15]. Rurality of residence was then determined using three different categorizations. The National Center for Health Statistics (NCHS) assigns counties to one of six levels of population density: large central metropolitan, large fringe metropolitan, medium metropolitan, small metropolitan, micropolitan, and noncore. We considered areas categorized as micropolitan and noncore to be rural, which includes urban clusters with fewer than 50,000 residents [11]. Rural-Urban Commuting Areas (RUCA) are produced by the Economic Research Service of the US Department of Agriculture [12]. RUCAs combine Census Bureau rurality classifications with commuting patterns to classify ZIP codes on a scale of 1 (most urban) to 10 (most rural). We classified areas with an assigned RUCA code = 4 as rural. RUCA codes are also generated at the level of the census tract; however, our participants reported ZIP code so we used the ZIP-code-level classification. The Index of Relative Rurality (IRR) is a continuous measure from 0.0 (most urban) to 1.0 (most rural) determined based on population size and density, remoteness, and built-up area [13]. We categorized areas with IRR = 0.4 as rural.

There is no standard cutoff for the NCHS and RUCA methods to determine rurality. For both schemes, we opted to classify areas that are not metropolitan as rural. For the IRR measure, we used a cutoff of ≥ 0.4 to identify rural areas as suggested by the developers of the scale [13].

Dependent Measures

Participants were asked to self-report history of testing for HIV, STIs (gonorrhea, chlamydia, and syphilis), any extragenital (i.e., rectal or pharyngeal) STI testing, and STI diagnoses in the past 12 months.

Additional Demographic and Sexual Behavior Covariates

Participants reported their age, race/ethnicity, annual income, educational attainment, and insurance status. Census region of residence was determined based on ZIP code. We also examined the prevalence of condomless anal sex in the past 12 months, serodiscordant condomless anal sex in the past 12 months, and PrEP eligibility. PrEP eligibility was determined by matching CDC guidelines [16] as closely as possible to survey questions. Participants were considered to be eligible for PrEP if they were at least 18 years old,

reported at least 2 male sex partners in the past 12 months, and reported at least one of the following: condomless anal sex with a man in the past 12 months; diagnosis of gonorrhea, chlamydia, or syphilis in the past 12 months; or a main partner with diagnosed HIV infection.

Analysis

Stratified demographics, sexual behavior, and healthcare utilization results are presented for each rurality definition. Generalized linear models with logarithmic link functions were used to estimate prevalence ratios for ever testing for HIV; receiving an HIV test in the past 12 months; receiving a test for gonorrhea, chlamydia, and/or syphilis in the past 12 months; and receiving any extragenital STI testing in the past 12 months comparing rural and non-rural MSM. Separate models were used to estimate unadjusted and adjusted prevalence ratios for each testing outcome within each rural classification method. In addition to an indicator for rural status, adjusted models also included age group, race/ethnicity, educational attainment, insurance status, condomless anal sex in the past 12 months, and PrEP eligibility.

As an additional analysis, the data were restricted to respondents living in the seven EHE priority states with high burdens of rural HIV diagnoses: Alabama, Arkansas, Kentucky, Mississippi, Missouri, Oklahoma, and South Carolina. The regression models described above were then estimated for the restricted data set to examine whether rural disparities in HIV and STI testing differed in these states. Due to the smaller sample size, generalized linear models with a logarithmic link did not converge for all outcomes. Therefore, these models were estimated using logistic regression with predicted margins to estimate prevalence ratios [17]. All analyses were conducted in SAS v9.4.

Results

A total of 13,048 participants completed the AMIS survey in 2020; of these, 913 were HIV-positive and excluded. Participants who could not be categorized with respect to all three rurality schemes were also excluded. One observation could not be categorized by any measure because it was from a military base; one did not have a RUCA code available; and eight were from a county without an IRR designation. The final sample size after exclusions was 12,124. Demographic characteristics of AMIS respondents, stratified by rurality for each of the NCHS, RUCA, and IRR categorization methods, are presented in Table 1. Overall, the majority (68.9%) of participants were 29 years old or younger, most had at least some college education (79.1%), and most had some form of health insurance (89.5%). The proportion of participants living in rural areas differed based on the definition used. Using the NCHS, RUCA, and IRR definitions of rurality, 10.4% (n = 1259), 11.7% (n = 1423), and 29.7% (n = 3601) of participants were classified as living in rural areas, respectively.

The prevalence of condomless anal sex and serodiscordant condomless anal sex was consistent across rurality for the NCHS, RUCA, and IRR methods (Table 2). For all three methods of determining rurality, approximately 70% of respondents reported condomless anal sex in the past 12 months and just over 20% reported serodiscordant condomless anal sex in the past 12 months. PrEP eligibility was also consistent, with approximately 71% of respondents being PrEP-eligible across levels of rurality for all three definitions.

Rural disparities were observed for all testing outcomes (Table 2). Across the three methods for defining rural areas, fewer than 70% of rural MSM had ever tested for HIV. Similar proportions had ever tested in NCHS rural areas (65.1%) and RUCA rural areas (65.0%), with slightly more reporting ever testing for HIV in IRR rural areas (68.5%). Among non-rural MSM, the proportions who had ever tested for HIV ranged from a low of 76.5% (NCHS rural) to a high of 78.2% (IRR rural). Among those who had ever tested for HIV, rural disparities for HIV testing in the last 12 months were attenuated. STI testing in the past 12 months was much less common among both rural and non-rural MSM; however, disparities persisted. Across definitions of rural, approximately 20% of rural MSM and approximately 30% of non-rural MSM had received a STI test in the past 12 months. Fewer than 10% of rural MSM and approximately 15% of non-rural MSM had received any extragenital STI testing in the past 12 months. Rural MSM were less likely to report a STI diagnosis in the past 12 months compared to non-rural MSM.

Disparities in ever having tested for HIV were somewhat attenuated across all methods of defining rural MSM when adjusting for age, race/ethnicity, income, educational attainment, insurance status, condomless anal sex in the past 12 months, and PrEP eligibility (Table 3). For example, the unadjusted prevalence ratio (PR) for ever testing for HIV comparing rural to non-rural MSM using the IRR definition of rural was 0.88 (95% confidence interval (CI): 0.85, 0.90). Although the disparity persisted in the adjusted model, it was smaller in magnitude (adjusted PR (aPR) = 0.94, 95% CI: 0.92, 0.96). Similarly, following adjustment the disparity in STI testing in the past 12 months was attenuated. For example, among men classified as rural using the NCHS definition, STI testing was 28% lower (PR = 0.72, 95% CI: 0.65, 0.81) compared to non-rural MSM. Following adjustment, the disparity was reduced to 8% lower prevalence of testing in the past 12 months (aPR = 0.92, 95% CI: 0.87, 0.97). There was much

Table 1 Demographic characteristics of HIV-negative and HIV-serostatus-unknown respondents to the 2020 cycle of the American Men's Internet Survey, stratified by rurality using three different definitions to determine rural status

	Total N (%)	NCHS[a]		RUCA[b]		IRR[c]	
		Rural (n = 1259)	Non-rural (n = 10,865)	Rural (n = 1423)	Non-rural (n = 10,701)	Rural (n = 3601)	Non-rural (n = 8,523)
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Age group							
15–24 years	5316 (43.8)	590 (46.9)	4726 (43.5)	674 (47.4)	4642 (43.4)	1730 (48.0)	3586 (42.1)
25–29 years	3034 (25.0)	257 (20.4)	2777 (25.6)	293 (20.6)	2741 (25.6)	785 (21.8)	2249 (26.4)
30–39 years	1233 (10.2)	94 (7.5)	1139 (10.5)	104 (7.3)	1129 (10.6)	295 (8.2)	938 (11.0)
40 + years	2541 (21.0)	318 (25.3)	2223 (20.5)	352 (24.7)	2189 (20.5)	791 (22.0)	1750 (20.5)
Race							
Hispanic	2400 (20.2)	127 (10.2)	2273 (21.4)	155 (11.1)	2245 (21.4)	550 (15.5)	1850 (22.2)
Non-Hispanic Black	1275 (10.7)	85 (6.9)	1190 (11.2)	86 (6.1)	1189 (11.4)	259 (7.3)	1016 (12.2)
Non-Hispanic White	7274 (61.2)	943 (76.1)	6331 (59.5)	1061 (75.7)	6213 (59.3)	2488 (70.2)	4786 (57.4)
Other/Multiple	931 (7.8)	85 (6.9)	846 (8.0)	100 (7.1)	831 (7.9)	248 (7.0)	683 (8.2)
Income							
$0-$19,999/year	1536 (14.1)	229 (19.9)	1307 (13.4)	259 (20.1)	1277 (13.3)	594 (18.3)	942 (12.3)
$20,000-$39,999/year	2402 (22.0)	273 (23.7)	2129 (21.8)	312 (24.2)	2090 (21.7)	796 (24.5)	1606 (21.0)
$40,000-$74,999/year	2859 (26.2)	305 (26.5)	2554 (26.2)	331 (25.6)	2528 (26.3)	839 (25.8)	2020 (26.4)
$75,000/year or more	4114 (37.7)	343 (29.8)	3771 (38.6)	389 (30.1)	3725 (38.7)	1025 (31.5)	3089 (40.3)
Education							
< High School Diploma	313 (2.6)	51 (4.1)	262 (2.4)	56 (4.0)	257 (2.4)	119 (3.3)	194 (2.3)
High School Diploma or Equivalent	2214 (18.4)	292 (23.3)	1922 (17.8)	334 (23.6)	1880 (17.7)	770 (21.5)	1444 (17.0)
Some College or Technical Degree	4324 (35.8)	510 (40.8)	3814 (35.3)	587 (41.5)	3737 (35.1)	1462 (40.9)	2862 (33.7)
College Degree or Higher	5211 (43.2)	398 (31.8)	4813 (44.5)	436 (30.9)	4775 (44.8)	1226 (34.3)	3985 (47.0)
Insurance status							
Private only	8060 (69.0)	770 (63.6)	7290 (69.6)	870 (63.6)	7190 (69.7)	2263 (65.6)	5797 (70.4)
Public only	1714 (14.7)	214 (17.7)	1500 (14.3)	245 (17.9)	1469 (14.2)	591 (17.1)	1123 (13.6)
Other/multiple	681 (5.8)	71 (5.9)	610 (5.8)	79 (5.8)	602 (5.8)	203 (5.9)	478 (5.8)
None	1228 (10.5)	156 (12.9)	1072 (10.2)	173 (12.7)	1055 (10.2)	393 (11.4)	835 (10.1)
Region							
Midwest	2473 (20.4)	387 (30.7)	2086 (19.2)	434 (30.5)	2039 (19.1)	927 (25.7)	1546 (18.1)
Northeast	2081 (17.2)	156 (12.4)	1925 (17.7)	187 (13.1)	1894 (17.7)	373 (10.4)	1708 (20.0)
South	4796 (39.6)	528 (41.9)	4268 (39.3)	556 (39.1)	4240 (39.6)	1577 (43.8)	3219 (37.8)
West	2774 (22.9)	188 (14.9)	2586 (23.8)	246 (17.3)	2528 (23.6)	724 (20.1)	2050 (24.1)

[a]National Center for Health Statistics: Micropolitan and non-core classified as rural; large central metropolitan, large fringe metropolitan, medium metropolitan, small metropolitan classified as non-rural

[b]Rural Urban Commuting Area Codes: >=4 classified as rural; 1–3 classified as non-rural

[c]Index of Relative Rurality: >=0.4 classified as rural; <0.4 classified as non-rural

Table 2 Sexual behavior, HIV/STI prevention services uptake, and STI diagnoses among HIV-negative and HIV-serostatus-unknown respondents to the 2020 cycle of the American Men's Internet Survey, stratified by rurality using three different definitions to determine rural status

	Total N (%)	NCHS[a]		RUCA[b]		IRR[c]	
		Rural (n = 1259)	Non-rural (n = 10,865)	Rural (n = 1423)	Non-rural (n = 10,701)	Rural (n = 3601)	Non-rural (n = 8523)
		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Condomless Sex							
Yes	8538 (70.4)	880 (69.9)	7658 (70.5)	1013 (71.2)	7525 (70.3)	2540 (70.5)	5998 (70.4)
No	3586 (29.6)	379 (30.1)	3207 (29.5)	410 (28.8)	3176 (29.7)	1061 (29.5)	2525 (29.6)
Serodiscordant condomless sex							
Yes	2591 (21.4)	279 (22.2)	2312 (21.3)	321 (22.6)	2270 (21.2)	782 (21.7)	1809 (21.2)
No	9533 (78.6)	980 (77.8)	8553 (78.7)	1102 (77.4)	8431 (78.8)	2819 (78.3)	6714 (78.8)
PrEP Eligible							
Yes	8665 (71.5)	892 (70.9)	7773 (71.5)	1026 (72.1)	7639 (71.4)	2571 (71.4)	6094 (71.5)
No	3459 (28.5)	367 (29.2)	3092 (28.5)	397 (27.9)	3062 (28.6)	1030 (28.6)	2429 (28.5)
HIV Test, ever							
Yes	8872 (75.2)	794 (64.9)	8078 (76.4)	899 (65.1)	7973 (76.6)	2390 (68.4)	6482 (78.1)
No	2919 (24.8)	429 (35.1)	2490 (23.6)	483 (35.0)	2436 (23.4)	1104 (31.6)	1815 (21.9)
HIV Test, p12m[d]							
Yes	5702 (64.3)	475 (59.8)	5227 (64.7)	524 (58.3)	5178 (64.9)	1430 (59.8)	4272 (65.9)
No	3170 (35.7)	319 (40.2)	2851 (35.3)	375 (41.7)	2795 (35.1)	960 (40.2)	2210 (34.1)
STI Test, p12m							
Yes	3420 (28.2)	265 (21.1)	3155 (29.0)	304 (21.4)	3116 (29.1)	813 (22.6)	2607 (30.6)
No	8704 (71.8)	994 (79.0)	7710 (71.0)	1119 (78.6)	7585 (70.9)	2788 (77.4)	5916 (69.4)
Extragenital STI Test, p12m							
Yes	1728 (14.3)	115 (9.1)	1613 (14.9)	127 (8.9)	1601 (15.0)	350 (9.7)	1378 (16.2)
No	10,396 (85.7)	1144 (90.9)	9252 (85.2)	1296 (91.1)	9100 (85.0)	3251 (90.3)	7145 (83.8)
STI Diagnosis, p12m							
Yes	924 (7.6)	62 (4.9)	862 (7.9)	67 (4.7)	857 (8.0)	203 (5.6)	721 (8.5)
No	11,200 (92.4)	1197 (95.1)	10,003 (92.1)	1356 (95.3)	9844 (92.0)	3398 (94.4)	7802 (91.5)

[a]National Center for Health Statistics: Micropolitan and non-core classified as rural; large central metropolitan, large fringe metropolitan, medium metropolitan, small metropolitan classified as non-rural

[b]Rural Urban Commuting Area Codes: >=4 classified as rural; 1–3 classified as non-rural

[c]Index of Relative Rurality: >=0.4 classified as rural; <0.4 classified as non-rural

[d]Among those who have ever tested for HIV

less attenuation of the rural/non-rural disparity for extragenital STI testing following covariate adjustment. When analyses were repeated only among EHE priority states, disparities for all four testing outcomes were similar to nationwide findings (Table 4).

Discussion

We examined the prevalence of sexual behaviors and HIV/STI prevention services utilization among MSM in the United States, stratified based on three different definitions of rurality. Overall, regardless of the method for determining rurality, there were few differences in sexual behavior and marked differences in HIV/STI testing comparing rural and urban areas. Two methods of determining rurality, NCHS and RUCA codes, resulted in approximately 10% of participants being classified as rural; the IRR method is much more inclusive, resulting in almost 30% of participants being classified as rural. The Ending the HIV Epidemic initiative highlights seven states that are high priority jurisdictions for HIV prevention; these states were identified because they did not have a county-level priority jurisdiction and >10% of new diagnoses in each state occurs among rural residents [1]. County-level data demonstrate that there are many rural

Table 3 Unadjusted and adjusted prevalence ratios (PR) for HIV and STI testing comparing rural and non-rural men who have sex with men using three different methods for defining rurality

	NCHS[a]		RUCA[b]		IRR[c]	
	Unadjusted PR (95% CI)	Adjusted[d] PR (95% CI)	Unadjusted PR (95% CI)	Adjusted[d] PR (95% CI)	Unadjusted PR (95% CI)	Adjusted[d] PR (95% CI)
HIV Testing, Ever						
Rural	0.85 (0.81, 0.89)	0.91 (0.88, 0.95)	0.85 (0.82, 0.88)	0.91 (0.88, 0.95)	0.88 (0.85, 0.90)	0.94 (0.92, 0.96)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref
HIV Testing, past 12 months[e]						
Rural	0.92 (0.87, 0.98)	0.95 (0.89, 1.01)	0.90 (0.85, 0.95)	0.93 (0.87, 0.98)	0.91 (0.87, 0.94)	0.92 (0.88, 0.95)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref
STI Testing, past 12 months						
Rural	0.72 (0.65, 0.81)	0.92 (0.87, 0.97)	0.73 (0.66, 0.81)	0.92 (0.88, 0.97)	0.74 (0.69, 0.79)	0.93 (0.90, 0.96)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref
Extragenital STI Testing, past 12 months						
Rural	0.62 (0.51, 0.74)	0.68 (0.56, 0.82)	0.60 (0.50, 0.71)	0.66 (0.56, 0.79)	0.60 (0.54, 0.67)	0.66 (0.59, 0.74)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref

[a]National Center for Health Statistics: Micropolitan and non-core classified as rural; large central metropolitan, large fringe metropolitan, medium metropolitan, small metropolitan classified as non-rural

[b]Rural Urban Commuting Area Codes: >=4 classified as rural; 1–3 classified as non-rural

[c]Index of Relative Rurality: >=0.4 classified as rural; <0.4 classified as non-rural

[d]Adjusted for age, race/ethnicity, income, education, insurance status, condomless anal sex, and prep eligibility

[e]Among those who have ever tested for HIV

Table 4 Unadjusted and adjusted prevalence ratios (PR) for HIV and STI testing comparing rural and non-rural men who have sex with men using three different methods for defining rurality in seven Ending the HIV Epidemic priority states

	NCHS[a]		RUCA[b]		IRR[c]	
	Unadjusted PR (95% CI)	Adjusted[d] PR (95% CI)	Unadjusted PR (95% CI)	Adjusted[d] PR (95% CI)	Unadjusted PR (95% CI)	Adjusted[d] PR (95% CI)
HIV Testing, Ever						
Rural	0.93 (0.85, 1.02)	0.97 (0.89, 1.06)	0.90 (0.82, 0.99)	0.92 (0.85, 1.01)	0.88 (0.82, 0.95)	0.94 (0.88, 1.00)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref
HIV Testing, past 12 months[e]						
Rural	0.83 (0.72, 0.96)	0.86 (0.74, 0.99)	0.87 (0.76, 1.00)	0.90 (0.78, 1.04)	0.91 (0.82, 1.01)	0.92 (0.82, 1.02)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref
STI Testing, past 12 months						
Rural	1.09 (0.87, 1.37)	1.17 (0.94, 1.46)	1.05 (0.84, 1.31)	1.16 (0.93, 1.44)	0.76 (0.62, 0.92)	0.83 (0.68, 1.01)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref
Extragenital STI Testing, past 12 months						
Rural	0.77 (0.51, 1.16)	0.76 (0.51, 1.16)	0.82 (0.55, 1.21)	0.84 (0.57, 1.24)	0.58 (0.42, 0.80)	0.66 (0.48, 0.91)
Non-rural	Ref	Ref	Ref	Ref	Ref	Ref

[a]National Center for Health Statistics: Micropolitan and non-core classified as rural; large central metropolitan, large fringe metropolitan, medium metropolitan, small metropolitan classified as non-rural.

[b]Rural Urban Commuting Area Codes: >=4 classified as rural; 1–3 classified as non-rural

[c]Index of Relative Rurality: >=0.4 classified as rural; <0.4 classified as non-rural

[d]Adjusted for age, race/ethnicity, income, education, insurance status, condomless anal sex, and prep eligibility

[e]Among those who have ever tested for HIV

areas, particularly in the southern US where the HIV epidemic is concentrated, with high prevalence of HIV [18].

In previous research on HIV prevention among MSM in rural areas, multiple different definitions of rurality have been used, making comparisons across studies difficult. The similarity in results across the three definitions of rurality we examined suggests that the effects of living in a comparatively rural area are robust to the method of determining rurality. Indeed, the similarity in results for the much more inclusive IRR method suggests that a broad definition of rurality is appropriate for studies of rural MSM. One possible explanation for this is that experiences of stigma and concerns about sexual identity disclosure are distinctly different in urban cores compared to rural areas and areas not traditionally considered rural, such as suburbs.

We did not observe meaningful differences in sexual behavior based on rurality, replicating previous findings [9]. In fact, the proportion of respondents who were eligible for PrEP was essentially identical across rural and urban areas. The similar sexual risk profiles of rural and non-rural MSM suggest that they also share similar needs with respect to HIV and STI testing; however, our analysis demonstrated that testing uptake is lower among rural MSM. Our analysis also demonstrated that rurality was not the only factor accounting for the observed disparities. Controlling for demographic and behavioral factors meaningfully attenuated, but did not eliminate, disparities in ever testing for HIV and testing for STIs in the past 12 months. Interestingly, a similar attenuation was not observed in adjusted models for HIV testing in the past 12 months and extragenital STI testing in the past 12 months. Although extragenital testing was low overall, MSM in rural areas were much less likely than MSM in non-rural areas to have had an extragenital STI test in the past 12 months. Given the similarity in sexual behavior, this indicates a substantial unmet need and missed opportunities for HIV/STI treatment and prevention, particularly considering the role of STIs in HIV transmission [19, 20].

There are a number of likely reasons that HIV/STI testing uptake is lower among MSM in rural areas compared to those who live in non-rural areas. There is a lack of culturally competent care tailored to the unique experiences and health profiles of MSM living in rural areas of the United States compared to MSM living in urban areas [7]. This lack of culturally competent care has effects on the demand side because rural patients are less likely to disclose their sexual behavior to providers, and on the supply side because providers are less likely to offer appropriate sexual health services to patients [21]. Experiences of stigma are heightened among rural MSM [8], particularly MSM of color [22]. Previous experiences of stigma and anticipated stigma are both strong contributors to healthcare avoidance among MSM in rural areas [23, 24]. An additional concern for MSM in rural areas is fear of sexual identity disclosure (i.e., being outed). Rural communities tend to be small and tight-knit. Receiving appropriate sexual healthcare requires accurate disclosure of sexual risk; however, MSM in rural areas are less likely to disclose their sexual identity to a healthcare provider for fear of breaches of confidentiality [21]. A lack of information about appropriate testing schedules is likely a key contributor to reduced testing among rural MSM. MSM in rural areas are less likely to receive sexual education that is relevant to their sexual behavior [5], resulting in a deficit of knowledge about HIV/STI risk, available prevention options, and appropriate testing schedules.

Provider knowledge of patient sexual identity is lower among MSM in rural areas, decreasing the likelihood that suitable preventive and diagnostic health services such as HIV testing are recommended [21]. Studies have found that although there has been an increase in LGBTQ health knowledge among physicians in recent years, there is still a lack of formal education to train providers to serve this population, with approximately 50% of rural providers reporting not receiving specific training about treating LGBTQ patients during their professional degree program [25]. Homophobia and stigmatization of MSM patients persists, particularly among healthcare workers in rural areas of the United States [26]. Access to affordable care can also be a bigger challenge in states that have not expanded Medicaid under the Affordable Care Act [27], and these states are predominantly in the South and have large rural populations [28]. Finally, less densely populated areas also have fewer healthcare providers available and the distance required to travel for HIV prevention services, including PrEP [29], is greater compared to in more urban areas.

This analysis is subject to a number of limitations. First, AMIS utilizes a convenience sample of internet-using MSM. Thus, these results are not representative of all MSM in the US. Although there are concerns about internet access among rural MSM compared to non-rural MSM, the internet and smartphone coverage gap between urban and rural residents has been closing in recent years [30, 31]. It is possible that some of the same factors that might lead to reduced HIV prevention services uptake (e.g., fear of being outed) might also result in reduced likelihood to participate in an online survey of MSM; however, if this is the case, this would result in an underestimate of the true rural/non-rural disparity. These data were collected during the fall of 2020. Thus, sexual behavior and HIV prevention services uptake were likely affected by the COVID-19 pandemic and associated physical distancing and lockdown protocols. However, the general trends we observed are in line with data from previous years [9, 32]. Finally, RUCA

codes are generated at the census-tract and ZIP-code levels. Because we determined residence based on ZIP code, we used the ZIP-code level data. ZIP codes and census tracts do not perfectly overlap, so different results might be obtained using the census-tract level data. However, we do not expect this will be the case given the robustness of our findings to different definitions of rurality.

Conclusions

We observed no differences in the sexual risk profiles but stark disparities in HIV and STI testing uptake comparing rural and non-rural MSM. These findings were consistent across three different methods of determining rural residence. Future studies of rural MSM in the US should consider using an inclusive definition of rurality. Notably, a number of the disparities in testing uptake were attenuated when controlling for demographic and behavioral factors associated with HIV/STI testing. This indicates that some known factors that differ by rurality, such as insurance coverage in states that have not expanded Medicaid [33], account for a meaningful amount of the HIV/STI testing disparity. A multi-pronged approach to reduce disparities in insurance coverage; increase culturally competent care, including through the use of telehealth; and increase knowledge and awareness of appropriate HIV/STI testing schedules will be necessary to reduce disparities in sexual healthcare for rural MSM.

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Data Availability N/A.

Code Availability N/A.

Declarations

Conflict of interest None declared.

Ethical Approval This study was approved by the Emory University Institutional Review Board.

Consent to Participate Informed consent was electronically signed by all participants as approved by the Emory IRB.

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