Archives of Sexual Behavior (2024) 53:2765–2775
https://doi.org/10.1007/s10508-024-02840-6

ORIGINAL PAPER

Rural–Urban Differences in HIV Sexual Risk Behaviors and HIV Service Utilization Among Adolescent Sexual Minority Males in the United States

Christopher Owens[1] · Manuel Hurtado Jr.[2] · David A. Moskowitz[3] · Brian Mustanski[2,4] · Kathryn Macapagal[2,4]

Received: 24 December 2021 / Revised: 19 February 2024 / Accepted: 20 February 2024 / Published online: 25 March 2024

Abstract

In the United States, HIV prevalence is increasing in rural areas, specifically among rural adolescent sexual minority males (ASMM). However, it is unclear what HIV sexual risk behaviors rural ASMM engage in and what HIV preventative services they utilize. This study aimed to (1) document the lifetime HIV sexual risk behaviors and service utilization of rural ASMM and (2) compare rural–urban differences in the prevalence of HIV sexual risk behaviors and service utilization. We analyzed data collected from 1615 ASMM who participated in a baseline survey for an online HIV prevention program from April 2018 to June 2020. We compared the prevalence of lifetime HIV sexual risk behaviors and HIV healthcare utilization among rural and urban participants via descriptive statistics, chi-square tests, linear and logistic regressions, and zero-inflated Poisson regressions. These analyses indicated that rural ASMM were more likely than urban ASMM to engage in condomless sex when they had anal sex. Rural ASMM could benefit from offline and online evidence-based HIV prevention interventions, especially interventions that increase condom use.

Keywords Rural · HIV · Sexual behaviors · Adolescents · Sexual minority males · Sexual orientation · Condomless anal sex

Introduction

The Centers for Disease Control and Prevention (2019a) reports that adolescent sexual minority males (ASMM) accounted for 79% of new HIV infections among adolescents in the United States. While estimates show that Americans who were newly diagnosed with HIV primarily live in urban areas, HIV infections are increasing in rural areas, with 20% of new HIV infections occurring in rural areas (Centers for Disease Control & Prevention, 2019b). Male-to-male sexual contact is the most prevalent transmission mode in rural areas (Centers for Disease Control & Prevention, 2019b). Although rural ASMM are at elevated risk for contracting HIV, little is known about their engagement in HIV transmission risk behaviors and utilization of HIV services.

There is a nascent amount of literature comparing the sexual behaviors and sexual healthcare service use of rural and urban ASMM. One study of 219 youth found that rural ASMM were less likely to have met a male partner online but more likely to engage in condomless anal sex (CAS) than their urban counterparts (Macapagal et al., 2021). Another study of 491 adolescents found that rural ASMM were more likely than their urban peers to be HIV pre-exposure prophylaxis (PrEP) candidates (Moskowitz et al., 2021). Finally, a study of 699 adolescents found that rural ASMM were less likely to get HIV tested than their urban counterparts (Mustanski et al., 2020a). These studies utilized data from a large, unique, and highly diverse sample of ASMM who participated in a pragmatic trial of an online HIV prevention intervention (Mustanski et al., 2020b), which has yielded the only published work on rurality/urbanity among this demographic group to date. However, these prior papers used subsamples of this dataset of over 1600 ASMM, and included

✉ Brian Mustanski
brian@northwestern.edu

1 Department of Health Behavior, School of Public Health, Texas A&M University, College Station, TX, USA

2 Institute for Sexual and Gender Minority Health and Wellbeing, Northwestern University Feinberg School of Medicine, 625 N Michigan Ave., Suite 1400, Chicago, IL 60611, USA

3 Department of Public Health Sciences, The University of Chicago, Chicago, IL, USA

4 Department of Medical Social Sciences, Northwestern University Feinberg School of Medicine, Chicago, IL, USA

rurality/urbanity as one out of many correlates rather than being a primary focus of the analyses. As such, these studies did not report on similarities and differences across numerous HIV/STI transmission risk behaviors and sexual healthcare experiences.

Prior literature has reported differences between rural and urban sexual minority male adults regarding CAS, hookup app use, PrEP awareness and use, and HIV testing. Research is mixed on CAS differences, with some research demonstrating that rural men engage in more CAS than their urban peers (Kakietek et al., 2011), while others suggest rural men are less likely to engage in CAS (Sarno et al., 2021). Others have found no differences between CAS prevalence among rural and urban sexual minority males (McKenney et al., 2018). Adult sexual minority males who reside in rural settings commonly use hookup apps and the internet to find male sexual partners (Bowen et al., 2004; Horvath et al., 2006; Hubach et al., 2014; Kakietek et al., 2011; Rosenberger et al., 2014; Schnarrs et al., 2010). Research demonstrates that adult rural sexual minority males are less likely to be aware of PrEP and use it than their urban counterparts (Li et al., 2019; Rossiter et al., 2021; Sarno et al., 2021). Studies comparing lifetime HIV testing between rural and urban sexual minority male adults report that rural men are less likely to have ever been HIV tested compared to urban men (Bowen et al., 2004; McKenney et al., 2018; Nelson et al., 2018; Sarno et al., 2021).

Results from studies that compared the sexual behaviors and HIV service utilization of urban and rural sexual minority male adults may not be generalized to adolescents because of the unique sexual, social, cognitive, and legal contexts surrounding the HIV transmission risk behaviors or HIV service utilization of adolescents (Fortenberry, 2014; Garofalo & Harper, 2003). For example, adult sexual minority males may use hookup apps to hook up with male partners. In contrast, ASMM may use hookup apps for more social and development reasons, such as finding potential friends, searching for information about the LGBTQ community, and developing their identities (Owens et al., 2023b; Paceley et al., 2022; White Hughto et al., 2017; Williams et al., 2005; Wongsomboon et al., 2023). Moreover, many states restrict the HIV testing and prevention services that adolescents can consent to without parental or guardian permission, creating a legal barrier for ASMM utilizing HIV services (Nelson et al., 2022).

Rural sexual minority male adolescents represent an intersectional disparity group (National Institute on Minority Health & Health Disparities, 2021). Although rural adolescent and young adult sexual minority males represent a population at elevated risk of HIV (Centers for Disease Control & Prevention, 2019b; Moskowitz et al., 2021), relatively limited research has been able to recruit large enough samples of these youth to draw comparisons to their urban counterparts regarding their sexual behavior, HIV transmission risk behavior, and their use of sexual health services. Shedding light on these behaviors is critical to informing the development of HIV prevention interventions inclusive of the needs of rural ASMM. Here we leveraged the baseline data of the SMART trial (Mustanski et al., 2020b) to (1) document the prevalence of sexual behavior, HIV transmission risk behavior, and use of sexual health services among rural ASMM across the United States, and (2) compare rural–urban differences in these behaviors.

Method

Participants

Baseline data were collected between April 2018 and June 2020 from an online cross-sectional survey that was part of a pragmatic trial of an online HIV prevention intervention for ASMM (Mustanski et al., 2020b). Participants were recruited through various efforts including social media/internet advertisement campaigns, dating app outreach, LGBTQ-specific events (e.g., "queer prom," Pride festivals), peer recruitment, and by posting flyers in public spaces (e.g., coffeeshop bulletin boards, community-based organizations). Participants first completed an online eligibility survey that included the following eligibility criteria (1) being assigned male at birth, (2) being 13–18 years old, (3) identifying as gay, bisexual, queer, or reporting attraction to cisgender men, (4) being able to comprehend English or Spanish at no less than a 6th grade level, (5) having prior sexual contact with a person (touching someone else's penis or vagina, or having oral, vaginal or anal sex), (6) having an HIV-negative or unknown status, and (7) having reliable internet access.

Eligible participants completed an online consent form and a capacity to consent assessment (The University of California at San Diego Task Force on Decisional Capacity, 2003). Staff confirmed the identity and eligibility of participants via a brief videochat or through verification of an identification card. Survey data were collected using REDCap (Harris et al., 2009), and participants were paid $25. The Institutional Review Board at Northwestern University approved all procedures with waivers of parental permission (Mustanski, 2011). A total of 1615 ASMM were included in the sample.

Measures

Demographic Characteristics

Participants reported their age, sexual orientation identity, gender identity, and race/ethnicity. Race/ethnicity was selected from one of the following categories in the survey:

Asian, Black or African American, Latinx, Native American or Native Alaskan, Native Hawaiian or Other Pacific Islander, White, and not listed. For analyses, we collapsed these into Black or African American, Latinx, White, and another racial/ethnic identity. Sexual orientation was selected from one of the following categories in the survey: gay, bisexual, pansexual, queer, unsure/questioning, or other. For analyses, we collapsed these into gay or any other sexual orientation identity. ZIP codes were categorized as urban or rural according to the Rural–Urban Commuting Area (RUCA) (Rural Health Research Center, 2014). ZIP codes were categorized as urban if they fell within an urbanized area (cities with 50,000 people are more) and at least 30% of residents commuted to an urbanized area (RUCA codes of 1-3). Participants reported the U.S. state in which they resided, and we categorized this into the four U.S. geographic regions: Northeast, Midwest, South, and West (United States Census Bureau, 2021). We assessed socioeconomic status via, "How well off do you think your family is?" (1 = *not at all*, 5 = *well*) (Svedberg et al., 2016). Participants were also asked if they were out to their mother and separately if they were out to their father (*no, yes*). Participants who were out to their parents rated how accepting each parent was of their sexual orientation (1 = *accepting*; 4 = *rejecting*). Finally, we created a variable representing those that were out to either their mother or father (i.e., out to at least one parent).

Past Year Healthcare Experiences

Four questions were created to assess the sexual healthcare communication experiences of participants during the prior 12 months (Fisher et al., 2017). First, participants were asked if they had one person that they thought of as a primary care doctor (*no, yes*). Then, participants were asked to answer items that assessed if they had ever spoken to a healthcare provider in the past 12 months about their sexual orientation, having sex with male partners, or other issues related to sexual health like HIV/STI testing or PrEP (*no, yes*).

Lifetime HIV Sexual Risk Behaviors

Four items assessed lifetime HIV sexual risk behaviors. Participants reported the number of male partners with whom they ever had anal sex with and the number of male partners with whom they had CAS. Participants were asked, "How long have you been using gay, bisexual, and queer (GBQ) social media or dating platforms? (for example, Grindr, Scruff, Adam4Adam, etc.)." Responses ranged from 1 (*never/don't use*) to 5 (*for more than six months)*. Participants were asked, "In your lifetime, how many times have you hooked up with someone you met from GBQ social media/dating platforms (such as Grindr, Scruff, Adam4Adam, Jackd, etc.)?" Response ratings were from 0 (*never*) to 10 (*more than 10 times*).

Lifetime HIV/STI Healthcare Utilization

Five items assessed lifetime utilization of HIV and sexually transmitted infection (STI) services. Lifetime HIV testing was assessed by asking whether participants had ever been tested for HIV (*no, yes*). Lifetime STI testing was assessed by asking whether participants had ever been tested for an STI (*no, yes*). PrEP awareness was measured as, "Before today, have you ever heard of pre-exposure prophylaxis (PrEP)?" (*no, yes*). Lifetime PrEP use was measured as, "In your entire life, have you ever taken any pre-exposure prophylaxis (PrEP) medication such as Truvada or Descovy?" (*no, yes*). Participants were determined to be a PrEP candidate if they reported an HIV-negative or HIV-unknown status, at least one lifetime anal sex male partner, and met a modified version of the CDC criteria: (1) sex with an HIV-positive male partner in the prior three months, (2) any STI-positive diagnosis, or (3) CAS with a male partner in their lifetime (CDC, 2018). The CDC criteria uses six-month timeframes for the above indications; however, lifetime STI diagnosis and lifetime CAS experiences were used due to the young age of the sample (Moskowitz et al., 2021). The three-month window for sex with an HIV-positive male partner was used as all items in this survey inquired about lifetime or past three-month sexual behavior.

Analytic Plan

Data were analyzed using primarily SPSS 28. Descriptive statistics were calculated for all variables. To assess demographic differences between rural and urban participants, we conducted a series of chi-square tests of independence (see Table 1). Rural–urban differences in HIV sexual risk behaviors were assessed using a series of Mann–Whitney *U* tests. We also assessed rural–urban differences in HIV healthcare utilization using a series of chi-square tests of independence (see Table 2). Then, we conducted simple linear (lifetime GBQ app use) and logistic regressions (HIV test, STI test, PrEP awareness, PrEP use, PrEP candidacy) to assess rural–urban differences in lifetime HIV sexual risk behaviors and utilization of HIV/STI services (see Table 3). Additionally, we ran two Zero-Inflated Poisson (ZIP) regressions using the *pscl* library in R 4.2.2 (R Core Team, 2021), due to the distribution of the data and excess zeros, to assess rural–urban differences in lifetime HIV sexual risk behaviors (anal sex with a male partner, CAS with a male partner). Beta coefficients were standardized (β) and odds ratio (OR) with 95% confidence intervals (95% CI) were calculated for the linear and logistic regression analyses. To ease interpretation, the ZIP model coefficients are presented as ORs for the

Table 1 Participant demographic characteristics by urbanity/rurality (N = 1,615)

	Total N (%)	Urban N (%)	Rural N (%)	χ^2	*p*-value
Age				7.58[b]	0.416
13 years old	18 (1.1)	13 (1.0)	5 (1.9)		
14 years old	97 (6.0)	77 (5.7)	20 (7.4)		
15 years old	206 (12.8)	174 (12.9)	32 (11.9)		
16 years old	329 (20.4)	271 (20.1)	58 (21.6)		
17 years old	370 (22.9)	300 (22.3)	70 (26.0)		
18 years old	595 (36.8)	511 (38.0)	84 (31.2)		
Gender identity				0.86	0.479
Cisgender	1517 (93.9)	1,261 (93.7)	256 (95.2)		
Transgender and gender diverse	98 (6.1)	85 (6.3)	13 (4.8)		
Sexual orientation				3.03	0.260
Gay	1078 (66.8)	887 (65.9)	192 (71.4)		
Any other sexual orientation	536 (33.2)	459 (34.1)	77 (28.6)		
Race/Ethnicity				**37.95**	**< 0.005**
White	595 (36.8)	453 (33.7)	142 (52.8)		
Black or African American	185 (11.5)	165 (12.3)	20 (7.4)		
Latinx	588 (36.4)	520 (38.6)	68 (25.3)		
Another racial/ethnic identity	247 (15.3)	208 (15.5)	39 (14.5)		
Region				**29.27**	**< 0.005**
Northeast	257 (15.9)	233 (17.3)	24 (8.9)		
Midwest	302 (18.7)	224 (16.6)	78 (29.0)		
South	637 (39.4)	532 (39.5)	105 (39.0)		
West	419 (25.9)	357 (26.5)	62 (23.0)		
How well off do you think your family is?				5.01	0.472
Not at all	72 (4.5)	54 (4.0)	18 (6.7)		
Not particularly	328 (20.3)	273 (20.3)	55 (20.4)		
Fairly	769 (47.6)	639 (47.5)	130 (48.3)		
Rather	347 (21.5)	294 (21.8)	53 (19.7)		
Very	99 (6.1)	86 (6.4)	13 (4.8)		
Have you told your mother, or the woman who raised you, about your sexual orientation? ($n = 1547$)[a]				0.50	0.610
No	521 (33.7)	440 (34.1)	81 (31.8)		
Yes	1026 (66.3)	852 (65.9)	174 (68.2)		
How accepting is your mother, or the woman who raised you, of your sexual orientation? ($n = 1026$)[a]				0.49	0.921
1—Accepting	528 (51.5)	437 (51.3)	91 (52.3)		
2	277 (27.0)	229 (26.9)	48 (27.6)		
3	147 (14.3)	125 (14.7)	22 (12.6)		
4—Rejecting	74 (7.2)	61 (7.2)	13 (7.5)		
Have you told your father, or the man who raised you, about your sexual orientation? ($n = 1428$)[a]				0.87	0.479
No	683 (47.8)	572 (48.4)	111 (45.1)		
Yes	745 (52.2)	610 (51.6)	135 (54.9)		
How accepting is your father, or the man who raised you, of your sexual orientation? ($n = 745$)[a]				11.39	0.063
1—Accepting	274 (36.8)	234 (38.4)	40 (29.6)		
2	218 (29.3)	185 (30.3)	33 (24.4)		
3	146 (19.6)	113 (18.5)	33 (24.4)		
4—Rejecting	107 (14.4)	78 (12.8)	29 (21.5)		

Table 1 (continued)

	Total N (%)	Urban N (%)	Rural N (%)	χ^2	*p*-value
Do you have one person you think of as your regular doctor, like a pediatrician or family doctor?				0.02	0.921
No	553 (34.2)	462 (34.3)	91 (33.8)		
Yes	1062 (65.8)	884 (65.7)	178 (66.2)		
In the last 12 months, I have spoken to a doctor, nurse or other healthcare provider about my sexual orientation				1.21	0.472
No	1070 (66.3)	884 (65.7)	186 (69.1)		
Yes	545 (33.7)	462 (34.3)	83 (30.9)		
In the last 12 months, I have spoken to a doctor, nurse or other healthcare provider about having sex with male partners				0.47	0.610
No	1161 (71.9)	963 (71.5)	198 (73.6)		
Yes	454 (28.1)	383 (28.5)	71 (26.4)		
In the last 12 months, have you seen any other medical provider for issues related to your sexual health, like HIV testing, STI testing, or PrEP?				1.93	0.416
No	1276 (79.0)	1,055 (78.4)	221 (82.2)		
Yes	339 (21.0)	291 (21.6)	48 (17.8)		

Bold values denote statistical significance at the $p < 0.05$ level

[a]Differencing N's in individual sections are due to excluding participants selecting "I don't have such a person in my life" or survey branching logic

[b]Denotes that the Fischer's Exact Test was utilized

logistic part of the analysis (i.e., zero-inflated model) and as adjusted incidence rate ratios (IRRs) with 95% CI for the Poisson regression part of the analysis (i.e., count model). A *p*-value (*p*) of < 0.05 was reported as statistically significant for all analyses. To deal with Type-I error rate inflation due to multiple comparisons, we employed an alpha correction that adjusted the false discovery rate using the Benjamini–Hochberg procedure (Jafari & Ansari-Pour, 2019), and we report the corrected significance levels.

Results

Participants

Table 1 presents the sample's demographic characteristics ($N = 1615$), with 16.7% of the sample being rural and 83.3% being urban. Most participants were 16–18 years old (80.1%), cisgender (93.6%), and gay (66.8%). Approximately two-thirds of the sample identified as a racial or ethnic minority (63.3%). About one-third of the sample (39.4%) lived in the Southern region of the United States. Three-quarters of the sample (75.2%) rated their family as doing fairly, rather, or very well off. Two-thirds of the sample were out to their mothers (66.3%) and over half (52.2%) were out of their fathers. This resulted in almost two-thirds (65.6%; $n = 1060$) of the sample reporting being out to at least one parent. Perceptions of how accepting either parent was of their sexual orientation varied, with 51.5% indicating their mother was accepting and 36.8% indicating their father was accepting of their sexual orientation. Although most (65.8%) reported having a regular doctor, few had spoken to a healthcare provider about their sexual orientation (33.7%), about having sex with male partners (28.1%), or about general sexual health issues (21.0%) in the past 12 months. Rural and urban status differed significantly by race/ethnicity, with a significant proportion of rural participants identifying as White than as a member of a racial/ethnic minority community ($\chi^2 = 37.95$, $p < 0.005$). Similarly, significant differences were found by geographic region, a greater proportion of rural participants resided in the Midwest or the South compared to the Northeast and the West regions ($\chi^2 = 29.27$, $p < 0.005$).

Rural–Urban Differences in Lifetime HIV Sexual Risk Behaviors and HIV Healthcare Utilization

Table 2 shows mean lifetime HIV sexual risk behaviors and HIV healthcare utilization by rural and urban designation. Overall, rural and urban ASMM in this sample had similar proportions of engaging in anal sex and CAS, GBQ app use, and having had sex with a partner met from an app. They also reported similar rates of lifetime HIV testing and STI testing (roughly 30%), PrEP awareness (roughly 70%), and low rates of lifetime PrEP use (just under 4%). No statistically significant differences were found in mean lifetime HIV

Table 2 Lifetime sexual behaviors and healthcare utilization by urbanity/rurality ($N = 1615$)

Lifetime HIV Sexual Risk Behaviors	Total N	M	Mean Rank	Mann–Whitney *U*	*z* value	*p*-value
Anal sex with male partner				179,172	− 0.27	0.971
Urban	1346	4.24	809.39			
Rural	269	4.71	801.07			
Total	1615	4.32				
CAS with male partner				174,923	-0.92	0.726
Urban	1346	2.08	803.46			
Rural	269	2.72	830.73			
Total	1615	2.18				
Lifetime GBQ App Use				82,199	− 0.04	0.971
Urban	895	2.92	540.16			
Rural	184	2.92	539.23			
Total[a]	1079	2.92				
Lifetime GBQ App Hookup				78,238	− 1.14	0.726
Urban	895	4.73	544.58			
Rural	184	4.16	517.71			
Total[a]	1079	0.83				
Lifetime Sexual Healthcare Utilization	Total N (%)		Urban N (%)	Rural N (%)	χ^2	*p*-value
Lifetime HIV test					1.09	0.472
No	1,097 (67.9)		907 (67.4)	190 (70.6)		
Yes	518 (32.1)		439 (32.6)	79 (29.4)		
Lifetime STI test					5.43	0.095
No	1,135 (70.3)		930 (69.1)	205 (76.2)		
Yes	480 (29.7)		416 (30.9)	64 (23.8)		
PrEP awareness						
No	456 (28.2)		367 (27.3)	89 (33.1)	3.75	0.201
Yes	1,159 (71.8)		979 (72.7)	180 (66.9)		
Lifetime PrEP use					0.13	0.921
No	1,553 (96.2)		1,294 (96.1)	259 (96.3)		
Yes	62 (3.8)		52 (3.9)	10 (3.7)		
PrEP eligible/ineligible					1.19	0.472
Ineligible	697 (43.2)		589 (43.8)	108 (40.1)		
Eligible	918 (56.8)		757 (56.2)	161 (59.9)		

Bold values denote statistical significance at the $p < 0.05$ level

[a]Different N's in individual section due to survey branching logic

transmission risk behaviors or mean lifetime sexual healthcare utilization.

Table 3 presents ZIP regressions, comprised of simple logistic and linear regressions, that were employed to assess the impact of rural–urban status on our key outcome (i.e., CAS). For clarity, it is important to discuss two distinct processes that occurred within the ZIP regression analyses. First, ZIP regressions applied a logistic regression (the zero-inflated model), which accounted for participants who reported no anal sex. These zero-inflated models were moot given condomless anal intercourse cannot occur among ASMM who have never had sex. Second, ZIP regressions applied a Poisson model (the count model), which accounted for participants who reported *at least one* anal sex partner. While no differences were found between rural and urban participants regarding having at least one partner, we did find rural ASMM with at least one anal sex partner were significantly more likely to engage in CAS during those encounters than were urban ASMM (IRR = 1.24, 95% CI [1.14–1.35], $p = 0.010$). No additional significant rural–urban differences were found in HIV transmission risk behaviors and lifetime HIV healthcare utilization.

Table 3 Rural–urban differences in lifetime HIV sexual risk behaviors and healthcare utilization using ZIP regression, logistic and linear regression models

	IRR	OR	95% CI	*p* value
Anal sex with male partner (count model)[a]	1.06		0.99–1.13	0.150
Anal sex with male partner (ZIP model)[a]		0.85	0.64–1.15	0.426
CAS with male partner (count model)[a]	**1.24**		**1.14–1.35**	**0.010**
CAS with male partner (ZIP model)[a]		0.88	0.67–1.15	0.442
		OR	95% CI	*p* value
Ever had a HIV test[b]		0.86	0.64–1.14	0.426
Ever had a STI test[b]		0.70	0.51–0.94	0.100
Aware of PrEP[b]		0.76	0.57–1.00	0.150
Ever used PrEP[b]		0.96	0.48–1.91	0.994
Eligible for PrEP[b]		1.16	0.89–1.51	0.426
	B (SE)	*β*	95% CI	*p* value
Lifetime GBQ App Use[c]	− 0.001 (0.14)	0.000	− 0.28–0.27	0.994

Bold values denote statistical significance. Urban is the reference group

[a]Zero-inflated Poisson (ZIP) regression was conducted for this analysis

[b]Logistic regression was conducted for this analysis

[c]Linear regression was conducted for this analysis

Discussion

Historically, HIV prevention research seldomly recruits or reports on ASMM who reside in rural areas. Given that HIV prevalence is increasing in rural areas and thus rural ASMM are at elevated risk for HIV, it is essential to understand their sexual behaviors and HIV service utilization. This study analyzed baseline data from a nationwide online HIV prevention clinical trial for ASMM to (1) document the prevalence of HIV sexual risk behaviors and HIV healthcare engagement among rural ASMM and (2) compare rural–urban differences in the prevalence of HIV sexual risk behaviors and the utilization of HIV services. This study makes novel contributions to the scholarship as one of the first studies to document the prevalence of sexual risk behaviors among rural ASMM and to compare these behaviors and sexual healthcare service use between rural and urban ASMM. We observed few statistically significant differences between rural and urban ASMM, suggesting that rural and urban ASMM are relatively similar in their sexual behaviors (such as CAS, hookup app use) and sexual health service engagement (such as HIV and STI testing). Findings from this study can potentially inform sexual health policy, education, and healthcare efforts that aim to encourage the sexual wellbeing of rural ASMM, especially regarding condom use.

Our study found that while rural and urban ASMM engage in anal sex with a male partner at similar rates, sexually active rural ASMM were more likely to have condomless sex with their male partners compared to urban ASMM. This reflects findings from Kakietek et al. (2011) who found that rural adult sexual minority males engaged in more CAS than their urban counterparts. Additional epidemiological studies have found that sexual minority male adults in rural areas commonly engage in CAS (Hubach et al., 2014; Preston et al., 2004, 2007; Rosenberger et al., 2014; Schnarrs et al., 2010). Sexually active rural ASMM might be more likely to have CAS than urban ASMM because of more limited condom availability in rural areas. McKenney et al. (2018) reported that rural adult sexual minority men were less likely to have received free condoms in the last year than urban men. Other studies noted that adult sexual minority men who live further away from an HIV service organization are at an increased risk of engaging in CAS (Bauermeister et al., 2015), and HIV service organizations typically provide free condoms and condom use education to their communities. One intervention implication is providing rural ASMM information on where to obtain condoms. LGBTQ youth use the internet to find free condoms (DeHaan et al., 2013), so sexual health practitioners working in rural areas could share this information online. Additionally, ASMM may have concerns about acquiring condoms due to fear of stigma or being recognized, and as such interventions could suggest ways that adolescents could more discreetly order and store condoms.

Rural ASMM might be more likely to have CAS with male partners than their urban peers because of the lack of comprehensive sex education in rural areas. In previous work, rural adult sexual minority men reflected that they were not taught how to use condoms, and this lack of condom use education was attributed to school-based sex education

policies (Currin et al., 2017, 2020). ASMM also reported that condom education is rarely discussed with 36% of ASMM who had CAS reported their parents talked to them about how to use a condom, 48% received formal education about how to use condoms, and 55% searched how to use a condom on a website/phone app (Nelson et al., 2019). Moreover, Nelson et al. (2019) noted that 90% of sexual minority male teens who ever had CAS thought it would be helpful for sex education programs to include visuals on how to use condoms correctly. Organizations and groups can advocate for their state legislature to approve of comprehensive sex education that educates adolescents on how to use condoms correctly and consistency to reduce the possible transmission of HIV and other STIs.

ASMM who live in rural areas might be more likely than their urban counterparts to have CAS in part due to rural primary care providers' discomfort in offering sexual healthcare services to adolescents. Indeed, a national study demonstrated that rural primary care providers are more uncomfortable asking adolescent patients about their sexual behaviors and providing them with sexual risk reduction counseling than urban primary care providers (Owens et al., 2023a). Given that medical residents and providers self-reported that they received minimal to no educational training on sexual history taking and sexual risk counseling, rural medical schools and clinics can provide sexual health training opportunities to their students, residents, and providers. Doing so could increase the number of rural adolescents being identified as candidates for sexual health services such as testing and PrEP, increase providers' comfort discussing the importance of condom use and demonstrating condom use on medical models, and increase the number of adolescents who use a condom when they do have sex.

Limitations

The findings of this study must be considered in light of several limitations. The sample is not representative of all sexual minority male adolescents. Although the sample included ASMM from across the United States, the sample included only those who participated in an online HIV prevention program (Mustanski et al., 2020b). Participants who signed up for this HIV prevention program may have been more likely to have engaged in HIV transmission risk behaviors than those who do not participate in HIV prevention programs. The largest proportion of participants were from the South, which also had the largest representation of rural participants. There might be regional differences in sexual behaviors and sexual healthcare utilization due to differences in social, cultural, and political environments (CDC, 2020). Although our sample was racially and ethnically diverse, sampling more Latinx, African American, and other persons of color in rural spaces is needed to address intersectional HIV disparities. We used RUCA as our rurality measure and dichotomized the rural–urban continuum as in our prior studies (Macapagal et al., 2020, 2021; Matson et al., 2021; Moskowitz et al., 2021). We acknowledge an rural–urban gradient, and future research should examine sexual behaviors on this gradient (Li et al., 2019; Rosser et al., 2009; Rossiter et al., 2021; Sarno et al., 2021). In addition, researchers should endeavor to reach a consensus on what rural–urban classification system to use so results are comparable across studies. We used a modified version of the CDC PrEP criteria (CDC, 2018), so our PrEP candidacy variable is not directly comparable to the CDC's definition. Participants may have over- or underreported their sexual behaviors and HIV healthcare utilization due to social desirability or recall bias. Moreover, participants self-reported relatively high socioeconomic status regardless of rural–urban residence, which may impact access to HIV testing, prevention, and care; however, as we did not ask about household income, it is unclear whether their perceptions were accurate (Svedberg et al., 2016). Despite these limitations, this study contributes critically to the scholarship on the sexual behaviors and utilization of HIV services among rural ASMM.

Conclusion

Our study is among the first to report on HIV sexual risk behaviors and HIV healthcare service utilization among rural ASMM, and the first compare rural and urban differences in these behaviors. Our findings suggest that rural and urban ASMM are relatively similar regarding multiple HIV transmission risk behaviors and HIV healthcare utilization. However, rural adolescents were more likely than their urban peers to have condomless anal sex when they did have anal sex with a male partner. Our findings highlight the importance of publicizing, implementing, and sustaining condom use interventions in rural locales. Research has demonstrated that place matters in HIV prevention services engagement (Bauermeister et al., 2017). Rurality is no exception, especially regarding the utilization of HIV prevention services (Kimmel et al., 2018; Masiano et al., 2019; Ohl et al., 2014; Pitasi et al., 2019). Given that rural areas lack resources that focus on LGBTQ youth, HIV, and sexual health (Sallabank et al., 2021), it is essential that rural HIV, sexual health, and adolescent health organizations create effective and sustainable condom use programs. Future research should investigate the developmental and environmental context of HIV prevention among rural ASMM, examine implementation factors of effective HIV prevention programs that seek to engage with sexual minority male adolescents living in rural areas, and test the feasibility and effectiveness of adolescent-targeted HIV prevention efforts in rural settings.

Acknowledgements The authors would like to thank the SMART Youth Advisory Council and the study participants for their time.

Authors Contributions DM, BM, and KM contributed the conceptualization and methodology of the baseline survey. CO, DM, and KM contributed to the conceptualization of this study. MH, DM, and CO contributed to data preparation and analysis. All authors contributed to manuscript writing.

Funding This work was supported by a grant from the National Institute on Minority Health and Health Disparities (U01MD011281; PI: Mustanski). The sponsor had no involvement in conducting the research or in the preparation of the paper for publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Data availability Not applicable.

Code Availability Not applicable.

Declarations

Conflict of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

Consent to participate Informed consent was obtained from all participants, with waivers of guardian permission.

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Northwestern University institutional review board.

References

Bauermeister, J. A., Connochie, D., Eaton, L., Demers, M., & Stephenson, R. (2017). Geospatial indicators of space and place: A review of multilevel studies of HIV prevention and care outcomes among young men who have sex with men in the United States. *Journal of Sex Research, 54*(4–5), 446–464. https://doi.org/10.1080/00224499.2016.1271862

Bauermeister, J. A., Eaton, L., Andrzejewski, J., Loveluck, J., VanHemert, W., & Pingel, E. S. (2015). Where you live matters: Structural correlates of HIV risk behavior among young men who have sex with men in Metro Detroit. *AIDS and Behavior, 19*(12), 2358–2369. https://doi.org/10.1007/s10461-015-1180-1

Bowen, A., Williams, M. L., & Horvath, K. (2004). Using the internet to recruit rural MSM for HIV risk assessment: Sampling issues. *AIDS and Behavior, 8*(3), 311–319. https://doi.org/10.1023/B:AIBE.0000044078.43476.1f

CDC. (2018). *Preexposure prophylaxis for the prevention of HIV infection in the United States—2017 update*. https://www.cdc.gov/hiv/pdf/risk/prep/cdc-hiv-prep-provider-supplement-2017.pdf.

CDC. (2020, January 8, 2021). *State laws that enable a minor to provide informed consent to receive HIV and STD services*. https://www.cdc.gov/hiv/policies/law/states/minors.html.

Centers for Disease Control and Prevention. (2019a). *HIV surveillance—Adolescents and young adults 2018 (preliminary)*. https://www.cdc.gov/hiv/pdf/library/slidesets/cdc-hiv-surveillance-adolescents-young-adults-2018.pdf.

Centers for Disease Control and Prevention. (2019b). *HIV surveillance in urban and nonurban areas 2018 (preliminary)*. https://www.cdc.gov/hiv/pdf/library/slidesets/cdc-hiv-surveillance-urban-nonurban-2018.pdf

Currin, J. M., Hubach, R. D., & Croff, J. M. (2020). Sex-ed without the stigma: What gay and bisexual men would like offered in school based sex education. *Journal of Homosexuality*, *67*, 1779–1797. https://doi.org/10.1080/00918369.2019.1616429

Currin, J. M., Hubach, R. D., Durham, A. R., Kavanaugh, K. E., Vineyard, Z., & Croff, J. M. (2017). How gay and bisexual men compensate for the lack of meaningful sex education in a socially conservative state. *Sex Education, 17*(6), 667–681. https://doi.org/10.1080/14681811.2017.1355298

DeHaan, S., Kuper, L. E., Magee, J. C., Bigelow, L., & Mustanski, B. S. (2013). The interplay between online and offline explorations of identity, relationships, and sex: A mixed-methods study with LGBT youth. *Journal of Sex Research, 50*(5), 421–434. https://doi.org/10.1080/00224499.2012.661489

Fisher, C. B., Fried, A. L., Desmond, M., Macapagal, K., & Mustanski, B. (2017). Facilitators and barriers to participation in PrEP HIV prevention trials involving transgender male and female adolescents and emerging adults. *AIDS Education and Prevention, 29*(3), 205–217. https://doi.org/10.1521/aeap.2017.29.3.205

Fortenberry, J. D. (2014). Sexual learning, sexual experience, and healthy adolescent sex. *New Directions for Child and Adolescent Development, 144*, 71–86. https://doi.org/10.1002/cad.20061

Garofalo, R., & Harper, G. W. (2003). Not all adolescents are the same: Addressing the unique needs of gay and bisexual male youth. *Adolescent Medicine Clinics, 14*(3), 595–611.

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics, 42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Horvath, K. J., Bowen, A. M., & Williams, M. L. (2006). Virtual and physical venues as contexts for HIV risk among rural men who have sex with men. *Health Psychology, 25*(2), 237–242. https://doi.org/10.1037/0278-6133.25.2.237

Hubach, R. D., Dodge, B., Cola, T., Battani, P., & Reece, M. (2014). Assessing the sexual health needs of men who have sex with men (MSM) residing in rural and mixed rural areas. *The Health Education Monograph Series, 31*(2), 33–39.

IBM Corp. (2021). *SPSS Statistical for Windows* (Version 27). https://www.ibm.com/analytics/spss-statistics-software.

Jafari, M., & Ansari-Pour, N. (2019). Why, when and how to adjust your P values? *Cell Journal, 20*(4), 604–607. https://doi.org/10.22074/cellj.2019.5992

Kakietek, J., Sullivan, P. S., & Heffelfinger, J. D. (2011). You've got male: Internet use, rural residence, and risky sex in men who have sex with men recruited in 12 U.S. cities. *AIDS Education and Prevention, 23*(2), 118–127. https://doi.org/10.1521/aeap.2011.23.2.118

Kimmel, A. D., Masiano, S. P., Bono, R. S., Martin, E. G., Belgrave, F. Z., Adimora, A. A., Dahman, B., Galadima, H., & Sabik, L. M. (2018). Structural barriers to comprehensive, coordinated HIV care: Geographic accessibility in the U.S. South. *AIDS Care, 30*(11), 1459–1468. https://doi.org/10.1080/09540121.2018.1476656

Li, J., Berg, C. J., Kramer, M. R., Haardörfer, R., Zlotorzynska, M., & Sanchez, T. H. (2019). An integrated examination of county-and individual-level factors in relation to HIV pre-exposure prophylaxis awareness, willingness to use, and uptake among men who have sex with men in the US. *AIDS and Behavior, 23*(7), 1721–1736. https://doi.org/10.1007/s10461-018-2334-8

Macapagal, K., Moran, K., Newcomb, M. E., Moskowitz, D. A., Owens, C., & Mustanski, B. (2021). Patterns of online and offline partnering, partnership characteristics, and condomless

sex among adolescent sexual minority males in the USA. *AIDS and Behavior*, *25*, 2033–2045. https://doi.org/10.1007/s10461-020-03133-4

Macapagal, K., Nery-Hurwit, M., Matson, M., Crosby, S., & Greene, G. J. (2020). Perspectives on and preferences for on-demand and long-acting PrEP among sexual and gender minority adolescents assigned male at birth. *Sexuality Research and Social Policy, 18*(1), 39–53. https://doi.org/10.1007/s13178-020-00441-1

Masiano, S. P., Martin, E. G., Bono, R. S., Dahman, B., Sabik, L. M., Belgrave, F. Z., Adimora, A. A., & Kimmel, A. D. (2019). Suboptimal geographic accessibility to comprehensive HIV care in the U.S.: Regional and urban–rural differences. *Journal of the International AIDS Society, 22*(5), e25286. https://doi.org/10.1002/jia2.25286

Matson, M., Nery-Hurwit, M., Crosby, S., Greene, G. J., & Macapagal, K. (2021). Awareness and knowledge of pre-exposure prophylaxis among sexual and gender minority adolescents assigned male at birth in the United States. *Archives of Sexual Behavior, 50*, 1701–1711. https://doi.org/10.1007/s10508-020-01904-7

McKenney, J., Sullivan, P. S., Bowles, K. E., Oraka, E., Sanchez, T. H., & DiNenno, E. (2018). 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. *AIDS and Behavior, 22*(7), 2127–2136. https://doi.org/10.1007/s10461-017-1912-5

Moskowitz, D. A., Moran, K. O., Matson, M., Alvarado-Avila, A., & Mustanski, B. (2021). The PrEP cascade in a national cohort of adolescent men who have sex with men. *Journal of Acquired Immune Deficiency Syndromes, 86*(15), 536–543. https://doi.org/10.1097/QAI.0000000000002613

Mustanski, B. (2011). Ethical and regulatory issues with conducting sexuality research with LGBT adolescents: A call to action for a scientifically informed approach. *Archives of Sexual Behavior, 40*(4), 673–686. https://doi.org/10.1007/s10508-011-9745-1

Mustanski, B., Moskowitz, D. A., Moran, K. O., Newcomb, M. E., Macapagal, K., Rodriguez- Díaz, C., Rendina, H. J., Laber, E. B., Li, D. H., & Matson, M. (2020b). Evaluation of a stepped-care eHealth HIV Prevention program for diverse adolescent men who Have sex with men: Protocol for a hybrid type 1 effectiveness implementation trial of SMART. *JMIR Research Protocols, 9*(8). https://doi.org/10.2196/19701

Mustanski, B., Moskowitz, D. A., Moran, K. O., Rendina, H. J., Newcomb, M. E., & Macapagal, K. (2020a). Factors associated with HIV testing in teenage men who have sex with men. *Pediatrics, 145*(3). https://doi.org/10.1542/peds.2019-2322

National Institute on Minority Health and Health Disparities. (2021, April 1). *Overview*. https://www.nimhd.nih.gov/about/overview/.

Nelson, K. M., Pantalone, D. W., & Carey, M. P. (2019). Sexual health education for adolescent males who are interested in sex with males: An investigation of experiences, preferences, and needs. *Journal of Adolescent Health, 64*(1), 36–42. https://doi.org/10.1016/j.jadohealth.2018.07.015

Nelson, K. M., Pantalone, D. W., Gamarel, K. E., Carey, M. P., & Simoni, J. M. (2018). Correlates of never testing for HIV among sexually active internet-recruited gay, bisexual, and other men who have sex with men in the United States. *AIDS Patient Care & STDs, 32*(1), 9–15. https://doi.org/10.1089/apc.2017.0244

Nelson, K. M., Skinner, A., & Underhill, K. (2022). Minor consent laws for sexually transmitted infection and HIV services. *Journal of the American Medical Association, 328*(7), 674–676. https://doi.org/10.1001/jama.2022.10777

Ohl, M. E., Richardson, K., Kaboli, P. J., Perencevich, E. N., & Vaughan-Sarrazin, M. (2014). Geographic access and use of infectious diseases specialty and general primary care services by veterans with HIV infection: Implications for telehealth and shared care programs. *Journal of Rural Health, 30*(4), 412–421. https://doi.org/10.1111/jrh.12070

Owens, C., Mullen, C., & Hubach, R. D. (2023a). A comparison of rural and urban primary care physicians' comfort level of providing sexual healthcare practices to adolescent patients. *Sexuality Research and Social Policy, 20*, 1677–1688. https://doi.org/10.1007/s13178-023-00825-z

Owens, C., Shrodes, A., Kraus, A., Birnholtz, J., Moskowitz, D. A., & Macapagal, K. (2023b). Motivations to start and stop using sexual networking apps among adolescent sexual minority males. *Sexuality Research and Social Policy*, *20*, 329–339. https://doi.org/10.1007/s13178-021-00641-3

Paceley, M. S., Goffnett, J., Sanders, L., & Gadd-Nelson, J. (2022). "Sometimes you get married on Facebook": The use of social media among nonmetropolitan sexual and gender minority youth. *Journal of Homosexuality*, *69*, 41–60. https://doi.org/10.1080/00918369.2020.1813508

Pitasi, M. A., Delaney, K. P., Brooks, J. T., DiNenno, E. A., Johnson, S. D., & Prejean, J. (2019). HIV testing in 50 local jurisdictions accounting for the majority of new HIV diagnoses and seven states with disproportionate occurrence of HIV in rural areas, 2016–2017. *Morbidity Mortality Weekly Report, 68*(25), 561–567. https://doi.org/10.15585/mmwr.mm6825a2

Preston, D. B., D'Augelli, A. R., Kassab, C. D., Cain, R. E., Schulze, F. W., & Starks, M. T. (2004). The influence of stigma on the sexual risk behavior of rural men who have sex with men. *AIDS Education and Prevention, 16*(4), 291–303. https://doi.org/10.1521/aeap.16.4.291.40401

Preston, D. B., D'augelli, A. R., Kassab, C. D., & Starks, M. T. (2007). The relationship of stigma to the sexual risk behavior of rural men who have sex with men. *AIDS Education & Prevention, 19*(3), 218–230. https://doi.org/10.1521/aeap.2007.19.3.218

R Core Team. (2021). *R: A language and environment for statistical computing* (Version 4.0). https://cran.r-project.org.

Rosenberger, J. G., Schick, V., Schnarrs, P., Novak, D. S., & Reece, M. (2014). Sexual behaviors, sexual health practices, and community engagement among gay and bisexually identified men living in rural areas of the United States. *Journal of Homosexuality, 61*(8), 1192–1207. https://doi.org/10.1080/00918369.2014.872525

Rosser, B. S., Oakes, J. M., Horvath, K. J., Konstan, J. A., Danilenko, G. P., & Peterson, J. L. (2009). HIV sexual risk behavior by men who use the Internet to seek sex with men: Results of the Men's INTernet Sex Study-II (MINTS-II). *AIDS and Behavior, 13*(3), 488–498. https://doi.org/10.1007/s10461-009-9524-3

Rossiter, S., Sharpe, J. D., Pampati, S., Sanchez, T., Zlotorzynska, M., & Jones, J. (2021). Differences in PrEP awareness, discussions with healthcare providers, and use among men who have sex with men in the United States by urbanicity and region: A cross-sectional analysis. *AIDS and Behavior*, *25*, 4102–4114. https://doi.org/10.1007/s10461-021-03267-z

Rural Health Research Center. (2014). *Rural-Urban Commuting Areas (RUCAs) geographic taxonomy*. https://ruralhealth.und.edu/ruca.

Sallabank, G., Chavanduka, T. M., Walsh, A. R., Sullivan, P., Wolfe, J., Filipowicz, R., Bonar, E. E., Horvath, K. J., Hailu, B., & Bauermeister, J. (2021). Mapping LGBTQ+ youth resource density across four high HIV prevalence corridors in the US. *Sexuality Research and Social Policy, 20*, 300–315. https://doi.org/10.1007/s13178-021-00660-0

Sarno, E. L., Bettin, E., Jozsa, K., & Newcomb, M. E. (2021). Sexual health of rural and urban young male couples in the United States: Differences in HIV testing, pre-exposure prophylaxis use, and condom use. *AIDS and Behavior*, *25*, 191–202. https://doi.org/10.1007/s10461-020-02961-8

Schnarrs, P. W., Rosenberger, J. G., Satinsky, S., Brinegar, E., Stowers, J., Dodge, B., & Reece, M. (2010). Sexual compulsivity, the Internet, and sexual behaviors among men in a rural area of the United

States. *AIDS Patient Care and STDs, 24*(9), 563–569. https://doi.org/10.1089/apc.2010.0117

Svedberg, P., Nygren, J., Staland-Nyman, C., & Nyholm, M. (2016). The validity of socioeconomic status measures among adolescents based on self-reported information about parents occupations, FAS and perceived SES; implication for health related quality of life studies. *BMC Medical Research Methodology, 16*(1). https://doi.org/10.1186/s12874-016-0148-9

The University of California at San Diego Task Force on Decisional Capacity. (2003). *Procedures for determination of decisional capacity in persons participating in research protocols*. https://irb.ucsd.edu/Decisional-Capacity-Assessment.shtml.

United States Census Bureau. (2021, December 16). *Geographic terms and concepts—Census divisions and census regions*. https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html.

White Hughto, J. M., Pachankis, J. E., Eldahan, A. I., & Keene, D. E. (2017). "You can't just walk down the street and meet someone": The intersection of social–Sexual networking technology, stigma, and health among gay and bisexual men in the small city. *American Journal of Men's Health, 11*(3), 726–736. https://doi.org/10.1177/1557988316679563

Williams, M. L., Bowen, A. M., & Horvath, K. J. (2005). The social/sexual environment of gay men residing in a rural frontier state: Implications for the development of HIV prevention programs. *Journal of Rural Health, 21*(1), 48–55. https://doi.org/10.1111/j.1748-0361.2005.tb00061.x

Wongsomboon, V., Greenawalt, I., Owusu, J., Owens, C., Birnholtz, J., Moskowitz, D. A., & Macapagal, K. (2023). When reality does not meet expectations: What sexual minority assigned-male-at-birth adolescents learn from using geosocial networking apps. *Psychology of Sexual Orientation and Gender Diversity*. https://doi.org/10.1037/sgd0000654