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HIV Prevalence Rates Among Men Who Have Sex with Men in the Southern United States: Population-Based Estimates by Race/Ethnicity

Spencer Lieb · Joseph Prejean · Daniel R. Thompson · Stephen J. Fallon · Hannah Cooper · Gary J. Gates · Thomas M. Liberti · Samuel R. Friedman · Robert M. Malow

Abstract States across the U.S. lack effective ways to quantify HIV prevalence rates among men who have sex with men (MSM). We estimated population-based HIV prevalence rates among MSM in the 17 southern states by race/ethnicity. Through 2007, estimated HIV prevalence rates per 100,000 MSM ranged from 2,607.6 among white (non-Hispanic) MSM in Maryland to 41,512.9 among black (non-Hispanic) MSM in the District of Columbia. Black MSM rates significantly exceeded Hispanic and white MSM rates in each state. Significant racial/ethnic disparities in rates persisted in a sensitivity analysis examining the possibility that minority MSM populations had been underestimated in each state. Compared with black, Hispanic, and white non-MSM males, respectively, rates at the regional level were 25.2 times higher for black MSM, 43.0 times higher for Hispanic MSM, and 106.0 times higher for white MSM. State-level analysis of racial/ethnic-specific MSM HIV prevalence rates can help guide resource allocation and assist advocacy.

Keywords Men who have sex with men · HIV/AIDS · HIV prevalence · Epidemic modeling · Racial/ethnic disparities

The findings and conclusions are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

S. Lieb (✉) · D. R. Thompson · T. M. Liberti
Florida Department of Health, Bureau of HIV/AIDS,
2585 Merchants Row Boulevard, Suite 350, Tallahassee,
FL 32399-1715, USA
e-mail: spencer_lieb@doh.state.fl.us

J. Prejean
Division of HIV/AIDS Prevention, Centers for Disease Control
and Prevention, 1600 Clifton Road, Atlanta, GA 30333, USA

S. J. Fallon
Skills4, Incorporated, Fort Lauderdale, Florida, USA

H. Cooper
Rollins School of Public Health, Emory University, Grace Crum
Rollins Building, 1518 Clifton Road, Atlanta, GA 30322, USA

G. J. Gates
The Williams Institute, UCLA School of Law, Los Angeles,
California, USA

S. R. Friedman
National Development and Research Institutes, Inc,
71 West 23rd Street, 8th Floor, New York 10010, USA

S. R. Friedman
Johns Hopkins Bloomberg School of Public Health,
Johns Hopkins University, 615 N. Wolfe Street, Baltimore,
MD 21205, USA

R. M. Malow
Robert Stempel College of Public Health and Social Work,
Florida International University, 11200 S.W. 8 Street,
Miami, FL 33199, USA

Introduction

Assessing the impact of HIV on racial/ethnic-specific groups of men who have sex with men (MSM) can improve

allocation of limited resources for outreach, prevention, care, and treatment. Yet, our literature review reveals a paucity of research on this impact by state and race/ethnicity. Raw HIV case numbers provide information only on the absolute magnitude of the epidemic. However, these numbers can be converted to population-based HIV prevalence rates via dividing the numbers of cases by previously developed estimates of the numbers of MSM [1]. Such rates are required to evaluate the disproportionate impact of HIV on various subgroups of MSM across various locations. Thus, impact can be directly compared between subgroups, regardless of population size. Documenting disparities can stimulate the development of new, culturally specific strategies to confront local epidemics. Increasing awareness of epidemic intensity within particular subgroups provides an opportunity to focus and scale up individual-level, community-level, and structural prevention efforts to prevent further infections or premature adverse outcomes for MSM living with HIV.

MSM in the U.S. bear the greatest HIV burden of any behaviorally defined risk group, accounting for the majority of estimated incident and the largest proportion of estimated prevalent HIV infections [2, 3]. The 17 southern states accounted for 34% (2.36 million) of an estimated 7.1 million MSM in the U.S., based on our prior research [1], but 43% (7,319) of the 16,871 estimated AIDS cases among MSM reported in 2007 [4]. Of the four U.S. regions (Northeast, Midwest, South, and West), only in the South did AIDS cases among black MSM ($N = 3,326$) outnumber those among white MSM ($N = 2,620$). In 2007, the South accounted for 40% (183,825) of the total 455,636 persons living with AIDS in the U.S. [5]. In 2008, 13 of the 15 states that were ranked lowest in "overall health" were located in the South [6].

Local research studies of HIV seroprevalence rates among MSM have been conducted in selected American cities, based on findings from selected samples of MSM [7–11]. A previous report for a single state (Florida) provided statewide estimates of HIV incidence, prevalence, and mortality rates among MSM at the population level [12]. HIV prevalence rates in each study were extremely high, compared with rates in the general population [3, 13]. This report presents population-based estimates of HIV prevalence rates among MSM, overall and by race/ethnicity (blacks/African Americans [blacks], Hispanics/Latinos [Hispanics], and whites) for the southern region of the U.S. and each of its 17 states. We evaluate racial/ethnic disparities within and across states. To our knowledge, this is the first study to attempt to quantify such estimates among MSM by race/ethnicity for a region of the U.S. The estimates should help focus and advance primary and secondary HIV prevention and HIV patient care and treatment efforts in the South, and encourage other regions and states to develop their own estimates.

Methods

Definition of MSM

As in our prior research [1], we defined *MSM* as adult males who ever had sex with another male, without regard to the type of sexual contact (e.g., oral or anal). This broad and inclusive definition was selected because we relied on a key national research study that defined MSM similarly [14]. The definition also corresponded closely to the broad CDC national HIV surveillance definition of MSM, i.e., males who had sex [of an unspecified type] with another male after 1977 and preceding their first positive HIV antibody test or AIDS diagnosis [15]. We considered adult males to be those aged ≥18 years because available research on the percentage of males who are MSM tends to address adults only, although the cutoff age for adults varies. MSM who used injection drugs also were counted as MSM.

Numerators of the HIV Prevalence Rates

Estimated numbers of men living with HIV (LWH) included males LWH aged ≥18 years with a diagnosis of HIV infection, regardless of stage of disease at diagnosis, living at the end of 2007. Cases included those reported to CDC at the end of June 2008, from 13 of the 17 southern states included in the analysis with mature, confidential, name-based HIV infection reporting system (confidential, name-based HIV reporting since at least 2003), resulting in de-duplicated counts of diagnosed HIV infection. Estimates were based on numbers of reported cases, adjusted for delays in reporting of cases and deaths and for missing risk factor information [5, 16, 17], but not for incomplete reporting. Cases included were men LWH, including MSM and all other men (also referred to as "non-MSM males"). The 13 states with mature, confidential name-based HIV infection reporting were: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Data on estimated cases of HIV were lacking for four states without a name-based HIV infection reporting system implemented as of 2003: Delaware, the District of Columbia (DC, which is treated as if it were a state), Kentucky, and Maryland.

Extrapolation of HIV Prevalence Rate Numerators

In the four states without mature, confidential, name-based HIV reporting the numbers of MSM and all non-MSM males LWH were extrapolated from estimates of the number of MSM and other men living with AIDS. We computed the race/ethnicity-age specific ratio (by 5-year age groups)

of MSM and all men LWH to those who were living with AIDS in the 13 areas with mature, confidential, name-based HIV reporting. We applied this ratio to the number of those in the corresponding race/ethnicity-age groups living with AIDS in each of the four states without such reporting. The number of non-MSM males LWH was obtained by subtracting the extrapolated number of MSM LWH from the extrapolated number of all men LWH in each of the states. Data analysis indicated that the extrapolated estimation of MSM and non-MSM males LWH may over- or underestimate the true estimated number of MSM LWH and non-MSM male LWH by up to 15%, with the largest discrepancies in the smallest race/ethnicity-risk-age groups.

The estimated numbers of MSM LWH among Asians, Native Hawaiian/Other Pacific Islanders, American Indian/Alaska Natives, and multi-racial persons were too small at the state level for reliable LWH rate analysis. Collectively, MSM in these other racial/ethnic populations accounted for approximately 1% of all MSM LWH. Thus, this report describes estimates of LWH rates by state and region for black, Hispanic, and white MSM only.

Denominators of the HIV Prevalence Rates

The methods for developing estimates of the numbers of MSM in the South in 2007 (the LWH rate denominators), by state and race/ethnicity, have been described in our previous report [1]. In brief, a first model differentiated the states by the proportion of each state's total population residing in rural, suburban, and urban areas in the 2000 U.S. census [18]. The proportions residing in each geographic area were then multiplied by estimates of the percentage of men who are MSM (the "percentage MSM") in each area (respectively, 1%, 4% and 9%), based on a nationally representative sample [19], and these products were summed to obtain the state-level percentage MSM estimates. A second model differentiated the states by an "MSM Index", which equaled the ratio of each state's proportion of same-sex male unmarried partner households in the U.S. to the state's proportion of all households in the U.S., based on the U.S. Census Bureau's American Community Survey [20]. Each state's MSM Index was multiplied by 6.0%, which was an estimated overall nationally representative percentage MSM obtained from the National Survey of Family Growth [14], to produce state-level percentage MSM estimates. The findings from these two models were averaged to obtain the final statewide percentage MSM estimates.

We devised a third model to partition the statewide MSM population estimates by race/ethnicity. Based on national racial/ethnic percentage MSM findings from the National Survey of Family Growth (6.5% for whites, 6.2% for Hispanics and 5.0% for blacks) [14], the model

assumed that a history of male–male sexual contact in southern states was most common among whites, followed by Hispanics and blacks. Specifically, Hispanic MSM were set as equal to 95% (6.2/6.5) of the state-specific estimated white percentage MSM, and black MSM were set as equal to 77% (5.0/6.5) of the white percentage MSM. The statewide total numbers of MSM were allocated via the third model in such a way that Hispanic and black MSM consistently accounted for 95% and 77%, respectively, of the state-specific estimated white percentage MSM, which varied from state to state. Thus, the black and Hispanic percentage MSM also varied by state.

Each state's racial/ethnic percentage MSM estimates were multiplied by the corresponding midyear 2007 adult male population estimates [21] to compute the estimated numbers of MSM, by state and race/ethnicity. Populations of non-MSM males were estimated by subtracting the numbers of MSM from the total populations of all men.

HIV Prevalence Rates Among MSM

The estimated LWH rate among MSM was first expressed in the conventional way, as a rate per 100,000 MSM at the end of 2007. Estimated LWH rate ratios (RRs) were computed, comparing black and Hispanic MSM, respectively, to white MSM in each state. The RRs were tested for significant difference from 1.0 (two-tailed test).

LWH rates were expressed in an equivalent but more easily visualized way, as rounded "one-in" statements. For example, in South Carolina, approximately 1 in 26 white MSM were living with HIV at the end of 2007. Here, the "one-in" number (variable X) was computed as $X_{\text{state } i,\text{ group } j} =$ (No. MSM$_{\text{state } i,\text{ group } j}$)/(No. MSM LWH$_{\text{state } i,\text{ group } j}$), rounded to the nearest whole number.

Note that the one-in number (X) is the rounded reciprocal of the conventional rate times 100,000. The states were ranked from highest to lowest one-in LWH rate by race/ethnicity to provide a way to grasp the distribution of the rates at a glance.

Sensitivity Analysis

We conducted a sensitivity analysis to test the robustness of the MSM LWH rate estimates under the assumption that minority MSM were misidentified as heterosexuals to a greater extent than white MSM, consistent with a number of other reports [22–26]. In the sensitivity analysis, we set the estimated percentage MSM among blacks and Hispanics within each state as equal to the higher white percentage MSM in that state. We then estimated the numbers and LWH rates of MSM according to this scenario. We evaluated whether racial/ethnic disparities persisted in the sensitivity analysis.

HIV Prevalence Rates Among Males Who Are Not MSM

To compare the impact of HIV on MSM with that on all other males at the regional level, by race/ethnicity, we first obtained the total numbers of non-MSM males LWH. We then subtracted the corresponding estimated numbers of MSM from the total adult male populations to obtain the estimated numbers of non-MSM males (the denominators of the non-MSM male LWH rates) for the entire South. Ratios of the estimated MSM LWH rates to the estimated non-MSM male LWH rates were computed to illustrate the extent of disparities between the two at the regional level.

Data Analysis

Statistical tests of significance of the LWH rates were conducted using the Katz method [27]. P-values of the RRs were determined using R software (R Core Development Team [computer software], Version 2.5.1. Vienna: R Foundation for Statistical Computing; 2004). For the individual states and for the southern region as a whole, we computed point-estimates of the HIV prevalence RRs, by race/ethnicity, but did not show 95% confidence intervals for this variable. The only expression of statistical tests is the p-value. Confidence intervals would quantify variation due to randomness, but since these are estimates, they are also dependent on the validity of the underlying assumptions. To account for the random variability in the estimates would require that the random variability in the assumptions also be assessed, which is beyond the scope of this paper and is perhaps too complex to be accomplished within practical limits.

Results

In 2007, there were a total of 172,166 black, Hispanic, and white MSM living with HIV in the South (Table 1), of an estimated 2.36 million MSM in these racial/ethnic groups who lived in this region [1]. (Note: the estimated numbers of southern MSM, by state and race/ethnicity, from [1] are displayed in an expanded Table 1a as Electronic Supplemental Material.) Thus, the regional estimated HIV prevalence rate (LWH rate) was 7,280.4 per 100,000 MSM. The rate by state varied from 3,110.5 in West Virginia to 26,406.5 in DC. DC, the only city-state in the South, had by far the highest estimated LWH rates among black MSM (41,512.5), Hispanic MSM (16,192.1), and white MSM (14,192.8). The black MSM LWH rates were significantly higher than the white and Hispanic MSM LWH rates across all 17 southern states (all $P < 0.001$). In contrast, the Hispanic MSM LWH rates were significantly higher

than the white MSM LWH rates in 10 of the 17 states, significantly lower in two states, and not significantly different ($P \geq 0.05$) in five states. The lowest black MSM LWH rate (15,390.5 in Oklahoma) exceeded the highest white rate (14,192.8 in DC) and was slightly lower than the highest Hispanic rate (16,192.1 in DC). HIV prevalence rates among the states were highly correlated among black and Hispanic MSM ($r = 0.81$; $r^2 = 0.66$; $P < 0.001$); black and white MSM ($r = 0.91$; $r^2 = 0.83$; $P < 0.001$); and Hispanic and white MSM ($r = 0.88$; $r^2 = 0.77$; $P < 0.001$).

Estimated black-to-white MSM LWH RRs varied from 2.9 ($P < 0.001$; DC) to 7.1 ($P < 0.001$; Maryland), while the Hispanic-to-white RRs varied from 0.7 ($P < 0.01$; Arkansas) to 2.2 ($P < 0.001$; Kentucky; Table 1). The four states with the highest estimated white MSM LWH rates per 100,000 MSM (DC, 14,192.8; Louisiana, 5,894.9; Texas, 5,879.6; and Florida, 5,761.9) also had the lowest estimated RRs for black-to-white MSM (respectively, 2.9, 3.7, 3.5, and 3.6; all $P < 0.001$).

When ranked by state and expressed as one-in statements, the estimated MSM LWH rates were clearly the highest and varied the least among black MSM (Table 2). The range of estimated LWH rates among black MSM was 1 in 2 (DC) to 1 in 6 (Oklahoma and West Virginia) (total South, 1 in 5 black MSM). Twelve of the 17 states had an estimated rate among black MSM of 1 in 5. Among Hispanic MSM, the estimated rates tended to fall between those for white MSM and black MSM (range, 1 in 6 in DC to 1 in 33 in Arkansas; total South, 1 in 16 Hispanic MSM). Among white MSM, the estimated LWH rates ranged from 1 in 7 in DC to 1 in 38 in Maryland; total South, 1 in 22 white MSM.

Sensitivity Analysis

When the MSM LWH rates were recomputed in the sensitivity analysis, where we assumed that the percentage MSM among black and Hispanic MSM equaled the white percentage MSM, the estimated LWH RRs for black-to-white MSM remained quite elevated (data not shown), but were 22–24% lower than in the original analysis (shown in Table 1). The median black-to-white MSM LWH RR for the 17 states was 5.3 in the original analysis and 4.1 in the sensitivity analysis (both $P < 0.001$). The P-values associated with the black-to-white MSM LWH RRs in both analyses were <0.001 for every state.

Estimated Hispanic-to-white MSM LWH RRs were roughly the same or only slightly lower in the sensitivity analysis (data not shown). The median Hispanic-to-white MSM LWH RRs were the same in both analyses (1.4). The Hispanic-to-white MSM LWH RRs remained significant in 11 states, were significant in the original analysis but not

Table 1 Estimated numbers[a] and rates of MSM living with HIV, by race/ethnicity and state, southern U.S., through 2007

State, race/ethnicity	MSM living with HIV		Estimated rate MSM living with HIV per 100,000 MSM	Rate ratio	P
	Number	Percentage of total			
Alabama					
Black/African American	2,812	55	20,379.9	5.2	<0.001
Hispanic/Latino[b]	111	2	5,712.8	1.4	<0.001
White	2,176	43	3,948.4	1.0	Referent
Total[c]	5,099	100	7,196.1		
Arkansas					
Black/African American	942	35	18,583.5	4.3	<0.001
Hispanic/Latino[b]	71	3	3,038.1	0.7	<0.01
White	1,662	62	4,338.1	1.0	Referent
Total[c]	2,675	100	5,851.1		
Delaware					
Black/African American	583	49	19,317.4	5.4	<0.001
Hispanic/Latino[b]	56	5	4,541.8	1.3	NS
White	554	46	3,590.9	1.0	Referent
Total[c]	1,193	100	6,062.3		
District of Columbia					
Black/African American	5,153	69	45,512.9	2.9	<0.001
Hispanic/Latino[b]	472	6	16,192.1	1.1	<0.01
White	1,833	25	14,192.8	1.0	Referent
Total[c]	7,458	100	26,406.5		
Florida					
Black/African American	11,431	28	20,891.1	3.6	<0.001
Hispanic/Latino[b]	9,771	24	9,245.2	1.6	<0.001
White	20,054	49	5,761.9	1.0	Referent
Total[c]	41,256	100	8,114.1		
Georgia					
Black/African American	10,223	62	20,725.0	5.5	<0.001
Hispanic/Latino[b]	731	4	3,864.5	1.0	NS
White	5,538	34	3,743.0		Referent
Total[c]	16,492	100	7,628.2		
Kentucky					
Black/African American	782	23	19,712.6	5.3	<0.001
Hispanic/Latino[b]	136	4	8,252.4	2.2	<0.001
White	2,431	73	3,703.9	1.0	Referent
Total[c]	3,349	100	4,700.4		
Louisiana					
Black/African American	4,261	53	21,873.7	3.7	<0.001
Hispanic/Latino[b]	291	4	10,135.8	1.7	<0.001
White	3,491	43	5,894.9	1.0	Referent
Total[c]	8,043	100	9,860.0		
Maryland					
Black/African American	5,758	67	18,633.7	7.1	<0.001
Hispanic/Latino[b]	388	5	4,213.7	1.6	<0.001
White	2,417	28	2,607.6	1.0	Referent
Total[c]	8,563	100	6,448.0		

Table 1 continued

State, race/ethnicity	MSM living with HIV		Estimated rate MSM living with HIV per 100,000 MSM	Rate ratio	P
	Number	Percentage of total			
Mississippi					
Black/African American	2,428	66	23,806.3	5.1	<0.001
Hispanic/Latino[b]	63	2	7,175.4	1.5	<0.001
White	1,192	32	4,710.5	1.0	Referent
Total[c]	3,683	100	10,123.1		
North Carolina					
Black/African American	5,468	55	20,706.6	6.7	<0.001
Hispanic/Latino[b]	573	6	4,665.7	1.5	<0.001
White	3,874	39	3,074.5	1.0	Referent
Total[c]	9,915	100	6,020.3		
Oklahoma					
Black/African American	607	21	15,390.5	4.0	<0.001
Hispanic/Latino[b]	181	6	3,922.0	1.0	NS
White	2,046	72	3,832.2	1.0	Referent
Total[c]	2,834	100	4,574.7		
South Carolina					
Black/African American	3,621	59	20,597.3	5.4	<0.001
Hispanic/Latino[b]	161	3	4,642.4	1.2	<0.01
White	2,324	38	3,785.1	1.0	Referent
Total[c]	6,107	100	7,407.2		
Tennessee					
Black/African American	3,622	46	24,915.7	6.3	<0.001
Hispanic/Latino[b]	187	2	4,203.2	1.1	NS
White	4,113	52	3,975.4	1.0	Referent
Total[c]	7,922	100	6,469.7		
Texas					
Black/African American	9,560	26	20,320.5	3.5	<0.001
Hispanic/Latino[b]	9,950	27	5,401.9	0.9	<0.001
White	17,240	47	5,879.6	1.0	Referent
Total[c]	36,750	100	7,007.3		
Virginia					
Black/African American	4,851	49	18,421.1	5.4	<0.001
Hispanic/Latino[b]	620	6	5,204.0	1.5	<0.001
White	4,526	45	3,409.4	1.0	Referent
Total[c]	9,998	100	5,846.8		
West Virginia					
Black/African American	121	15	17,090.4	6.3	<0.001
Hispanic/Latino[b]	11	1	4,166.7	1.5	NS
White	697	84	2,714.2	1.0	Referent
Total[c]	829	100	3,110.5		

Table 1 continued

State, race/ethnicity	MSM living with HIV		Estimated rate MSM living with HIV per 100,000 MSM	Rate ratio	P
	Number	Percentage of total			
Total					
Black/African American	72,223	42	21,276.5	4.6	<0.001
Hispanic/Latino[b]	23,775	14	6,446.2	1.4	<0.001
White	76,168	44	4,598.1	1.0	Referent
Total[c]	172,166	100	7,280.4		

MSM men who have sex with men (includes MSM/injection drug users), *NS* not significant ($P \geq 0.05$).

Estimated numbers of MSM (denominators [not shown]) that are used to calculate rates are from Lieb et al. [1]. These denominators can also be accessed in Electronic Supplemental Material.

[a] These numbers are point estimates adjusted for delays in reporting cases and deaths and missing risk factor information, but not for incomplete reporting (see text)

[b] Hispanics/Latinos might be of any race

[c] Totals exclude MSM of all other races/ethnicities (i.e., Asian, Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, unknown race, and multiple races) as the numbers of MSM living with HIV for these racial/ethnic groups were too small to provide stable estimates of the LWH rates

Table 2 Estimated HIV prevalence rates[a] among MSM, by race/ethnicity, ranked by state, southern U.S., through 2007

Black/African American		Hispanic/Latino[b]		White		Total[c]	
State	One-in	State	One-in	State	One-in	State	One-in
District of Columbia	2	District of Columbia	6	District of Columbia	7	District of Columbia	4
Mississippi	4	Louisiana	10	Florida	17	Louisiana	10
Tennessee	4	Florida	11	Louisiana	17	Mississippi	10
Alabama	5	Kentucky	12	Texas	17	Florida	12
Arkansas	5	Mississippi	14	Mississippi	21	Georgia	13
Delaware	5	Alabama	18	Arkansas	23	South Carolina	13
Florida	5	Texas	19	Alabama	25	Alabama	14
Georgia	5	Virginia	19	Tennessee	25	Texas	14
Kentucky	5	North Carolina	21	Oklahoma	26	Tennessee	15
Louisiana	5	South Carolina	21	South Carolina	26	Maryland	16
Maryland	5	Delaware	22	Georgia	27	Arkansas	17
North Carolina	5	West Virginia	23	Kentucky	27	Delaware	17
South Carolina	5	Maryland	24	Delaware	28	North Carolina	17
Texas	5	Tennessee	24	Virginia	29	Virginia	17
Virginia	5	Georgia	26	North Carolina	33	Kentucky	21
Oklahoma	6	Oklahoma	26	West Virginia	37	Oklahoma	22
West Virginia	6	Arkansas	33	Maryland	38	West Virginia	32
Total	5	Total	16	Total	22	Total	14

MSM men who have sex with men (includes men who have sex with men and inject drugs)

[a] Rates are expressed as one-in statements, e.g., in DC, an estimated 1 in 7 white MSM were living with HIV at the end of 2007. The states are ranked from highest to lowest rate of MSM living with HIV. Rates are based on the point estimates of the numbers of MSM living with HIV (numerators; see text) and the estimated numbers of MSM (denominators [1]), available in the Electronic supplementary material

[b] Hispanics/Latinos can be of any race

[c] Totals exclude MSM of all other races/ethnicities (i.e., Asian, Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, unknown race, and multiple races) as the numbers for these racial/ethnic groups were too small to provide stable estimates when extrapolating from the number of MSM living with AIDS to the number living with HIV

Table 3 Estimated HIV prevalence rates[a] among MSM and other adult males, by race/ethnicity, southern region of the U.S., through 2007[b]

Race/Ethnicity	Estimated MSM HIV prevalence rate		Estimated other adult male HIV prevalence rate		Rate ratio[c]	P
	Per 100,000	One-In	Per 100,000	One-In		
Black/African American	21,276.5	5	845.9	118	25.2	<0.001
Hispanic/Latino[d]	6,446.2	16	149.8	668	43.0	<0.001
White	4,598.1	22	43.4	2,305	106.0	<0.001
Total[e]	7,280.4	14	201.8	496	36.1	<0.001

MSM men who have sex with men (includes MSM/injection drug users)

[a] Rates are based on the point estimates of the numbers of MSM and non-MSM males living with HIV (numerators; see text) and the estimated numbers of MSM and non-MSM males (denominators; [1]), available in the Electronic supplementary material

[b] Aggregate data are shown for the 17 southern states combined

[c] Ratio of MSM HIV prevalence rate to all other male HIV prevalence rate, by race/ethnicity

[d] Hispanics/Latinos can be of any race

[e] Totals exclude MSM and non-MSM males of all other races/ethnicities (i.e., Asian, Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, unknown race, and multiple races) as the numbers of those living with HIV for these racial/ethnic groups were too small to provide stable estimates of the HIV prevalence rates

significant ($P \geq 0.05$) in the sensitivity analysis in one state, and remained not significant in five states. In two states (Arkansas and Texas) the estimated Hispanic MSM LWH rates were significantly lower than the LWH rates among white MSM in both analyses ($P < 0.01$).

LWH Rates Among All Other Males

At the regional level, for each racial/ethnic group, the LWH rate among all MSM was far greater than that among all non-MSM males (all $P < 0.001$), with an overall RR of 36.1 (Table 3). Among non-MSM males, the LWH rate was particularly low for whites (43.4 per 100,000 population, or 1 in 2,305), resulting in an extremely high white MSM-to-non-MSM white male RR (106.0).

Discussion

State-level analysis of population-based HIV prevalence rates among MSM by race/ethnicity provides insight into the epidemic dynamics of the men most impacted by HIV in the South. Compared with adult males who are not MSM, estimated HIV prevalence rates among MSM have reached a dramatically high level in the region (an overall rate of 1 in 14 MSM LWH compared with 1 in 496 non-MSM males LWH; RR, 36.1). Here, for the first time, we have quantified population-based HIV prevalence rate estimates among MSM across a broad region of the country, and assessed the disparate impact of HIV on racial/ethnic MSM populations.

By contributing these essential data to community planning processes, our analysis should help focus effective primary and secondary HIV prevention efforts in the South. For example, for primary prevention (prevention of HIV acquisition), service providers could consider how they can more effectively target HIV counseling and testing to those identified as most vulnerable to HIV, as reflected in our estimates. The MSM HIV prevalence rates have further implications for care and treatment of those living with HIV. If HIV clientele do not reflect the demographic profiles of the infected MSM populations, there should be increased outreach activities and linkage to care and treatment in targeted communities. Those who access treatment and have suppressed or undetectable viral loads are less likely to transmit HIV (secondary prevention), and this could result in reduced community viral load, which has been associated with reduced HIV incidence at the population level [28]. Additionally, improved secondary prevention interventions should be focused on those who are in care to decrease behaviors that contribute to onward HIV transmission [25, 26, 29].

In our study, there was a far greater and more uniform impact of HIV across the South on black MSM than on white or Hispanic MSM. The lowest estimated HIV prevalence rate among blacks was greater than the highest rate among whites. As with all other adult males, the epidemic among MSM is most intense among blacks. Despite evidence suggesting that black and white MSM have similar levels of risky behavior [26, 29], HIV infection has a greater impact on populations of black MSM, due to underlying factors rather than race/ethnicity. Patterns of sexual mixing can magnify initial differences in infection rates due to "assortative" (like-with-like) mixing, since each racial/ethnic group tends to have sex with members of its own group (and more so for blacks) [30]. The fact that HIV prevalence rates are so much higher in black MSM populations means that each unsafe sexual or drug-injection act

has a higher risk of exposure to an infected individual. Additionally, a smaller percentage of black MSM are aware of their infection, and they may be diagnosed at a later stage of HIV infection than white MSM [11], and thus might engage in risky behaviors for a longer period during which they are unaware of their infection. Social determinants of health like poverty, education, employment, housing, and stigma could also contribute to the racial/ethnic HIV disparities we observed [31].

The estimated black-to-white MSM LWH RRs were lowest in four states (DC, Florida, Louisiana and Texas) that had the highest estimated LWH rates among white MSM. This suggests that the epidemic among MSM is more widespread in these states across racial/ethnic populations. When the racial/ethnic groups of MSM were compared with each other, the HIV prevalence rates were very highly correlated, suggesting common underlying factors that influenced intrastate epidemics across racial/ethnic lines. Further research might help clarify these factors.

Hispanic MSM tended to have higher estimated LWH rates than white MSM, though these rates were not as elevated as those of black MSM. However, Arkansas and Texas had significantly lower estimated LWH rates among Hispanic MSM than among white MSM, a reversal of the general situation in the other states. Our estimated MSM HIV prevalence RR in Texas for Hispanics-to-whites was equivalent to 0.92. This closely compares with the Hispanic-to-white RR for all Texas LWH cases in 2007 (0.88) [32]. Arkansas only had 71 Hispanic MSM LWH, so the Hispanic MSM LWH rate and Hispanic-to-white RR are unstable and difficult to interpret.

Our study corroborates and helps generalize to the entire South the findings of the National HIV Behavioral Surveillance (NHBS) system, wherein black MSM in five cities (Baltimore, Los Angeles, Miami, New York, and San Francisco) had a much higher HIV seroprevalence rate (46%) than white MSM (21%) [11]. However, the regional, estimated black-to-white MSM LWH RR in our study (4.6) was twice the measured RR in the urban-centered NHBS study (2.3). This could reflect a relatively lower LWH rate among white MSM and/or a relatively higher rate among black MSM in the more rural South and/or in southern cities. The one city-state in our study (DC) had a black MSM LWH rate (equivalent to 41.6%) and a black-to-white MSM LWH RR (2.9) that were comparable to those in the NHBS cities.

The sensitivity analysis suggests that the original MSM LWH rate estimates were fairly robust to error associated with misclassification of some black and Hispanic MSM as heterosexual males, one of the strongest sources of potential bias in the denominators. Statistically significant racial/ethnic disparities that were evident in the original analysis persisted in the sensitivity analysis for black MSM in all states and for Hispanic MSM in most states. In particular, though the black-to-white MSM LWH RRs were less pronounced in the sensitivity analysis, they were still quite elevated and were consistently significant at $P < 0.001$ in all states in both analyses.

Our estimates are subject to a number of limitations and caveats. There is no gold standard for estimating the numbers of MSM in male populations, the denominators of our HIV prevalence rates. Ascertainment bias occurs in behavioral surveys because there are men with a history of male–male sexual contact who do not disclose being gay, bisexual, or other MSM. This appears particularly true among minority MSM [23, 25, 29], and our prior work modeling MSM populations relied on national behavioral survey data [19, 20]. The best we could do to address misclassification of MSM as heterosexuals in the current study was to conduct the sensitivity analysis, granting the assumption that minority MSM (denominators) are undercounted, while finding persistence in racial/ethnic disparities.

Our definition of MSM is broad and inclusive. It captures those with few male–male sexual encounters, as well as those without ongoing male–male sexual behavior, resulting in overestimates of those with frequent or recent male–male sexual contact. Additionally, it does not specify the type of sexual activity, e.g., oral or anal. However, our MSM definition is similar to the one used by CDC for national HIV surveillance [15]. Our estimates of the numbers of MSM living with HIV do not capture those who are infected but undiagnosed, which was beyond the scope of this study.

The adjustment procedures we applied to the numbers of reported HIV cases are imperfect. Extrapolating HIV cases from AIDS cases, as we had to do for four states that lacked mature HIV reporting systems, could lead to error. In this case, validation will be possible after a few more years, as their HIV reporting systems reach maturity, defined as having at least 4 years of name-based confidential HIV reporting [5]. The state-level HIV prevalence rates we estimated do not apply uniformly across rural and urban areas, and do not take into account city-to-city variability in visible gay friendliness and other local characteristics affecting both the numerators and denominators. Finally, our findings cannot be generalized to the other three regions of the U.S. Fresh empirical research is needed to validate the assumptions we have made here, as well as in our previous report.

In these resource-challenged times, forging partnerships among susceptible MSM, MSM living with HIV, and state/local health departments is crucial [33]. Compelling data, presented credibly and clearly, can increase awareness of the dire situation in the South [34, 35]. Our estimates of HIV prevalence rates among racial/ethnic MSM

populations across the South could help guide comprehensive recommendations for primary and secondary HIV prevention. Refinement of local MSM population estimates through behavioral surveys or further modeling could improve the estimates and advance an understanding of epidemic dynamics.

Policy makers, communities, clinicians, public health agencies, and community-based organizations can use the estimates presented here to frame a variety of culturally specific programs for MSM and minority MSM, in particular. Through community engagement, health professionals could adapt their strategies to ensure that their efforts can effectively address the target population's needs. These include confronting barriers to self-identification, perception of risk, and self-efficacy for behavioral change (whether to reduce risks of acquiring HIV or to increase access to and acceptance of care). The startling disparities between MSM and non-MSM males, as well as the disparities within racial/ethnic groups of MSM, could be a wake-up call that promotes community-wide advocacy and mobilization.

References

1. Lieb S, Thompson DR, Misra S, et al. Estimating populations of men who have sex with men in the southern United States. J Urban Health. 2009;86:887–901. Available at http://www.floridaaids.org/Southern_MSM_report.pdf. Accessed 14 February 2010.
2. Hall HI, Song R, Rhodes P, et al. Estimation of HIV incidence–United States. JAMA. 2008;300:520–9.
3. Campsmith ML, Rhodes P, Hall HI, et al. HIV prevalence estimates–United States, 2006. Morb Mortal Wkly Rep. 2008;57:1073–6.
4. Centers for Disease Control and Prevention. HIV/AIDS surveillance among men who have sex with men (MSM) (slide set). July 13, 2009. Available at http://www.cdc.gov/hiv/topics/surveillance/resources/slides/msm/index.htm. Accessed 24 August 2009.
5. Centers for Disease Control and Prevention. HIV/AIDS surveillance report, 2007. 2009;19. Available at http://www.cdc.gov/hiv/topics/surveillance/resources/reports/2007report/default.htm. Accessed 3 January 2009.
6. United Health Foundation. America's health rankings. Available at http://www.americashealthrankings.org/2008/results.html. Accessed 4 September 2009.
7. Holmberg SD. The estimated prevalence and incidence of HIV in 96 large US metropolitan areas. Am J Public Health. 1996;86:642–54.
8. Catania JA, Osmond D, Stall RD, et al. The continuing HIV epidemic among men who have sex with men. Am J Public Health. 2001;91:207–14.
9. MacKellar D, Valleroy L, Karon J, Lemp G, Janssen R. The young men's survey: methods for estimating HIV seroprevalence and risk factors among young men who have sex with men. Public Health Rep. 1996;111(Suppl 1):138–44.
10. Valleroy LA, Duncan A, MacKellar MA, et al. HIV prevalence and associated risks in young men who have sex with men. JAMA. 2000;284:198–204.
11. Centers for Disease Control and Prevention. HIV prevalence, unrecognized infection, and HIV testing among men who have sex with men—five U.S. Cities, June 2004–April 2005. Morb Mortal Wkly Rep. 2005;54:597–601.
12. Lieb S, White S, Grigg BL, Thompson DR, Liberti TM, et al. Estimated HIV incidence, prevalence, and mortality rates among racial/ethnic populations of men who have sex with men, Florida. J Acquir Immune Defic Syndr. 2010;54:398–405.
13. Holtgrave DR. Estimation of annual HIV transmission rates in the United States, 1978–2000. J Acquir Immune Defic Syndr. 2004;35:89–92.
14. National Center for Health Statistics. Sexual behavior and selected health measures: men and women 15–44 years of age, United States, 2002. Advance Data 362, 2005. Available at http://www.cdc.gov/nchs/data/ad/ad362.pdf. Accessed 3 January 2009.
15. Centers for Disease Control and Prevention. Adult HIV/AIDS confidential case report. Form CDC 50.42A, rev. 01/2003:1.
16. Green TA. Using surveillance data to monitor trends in the AIDS epidemic. Stat Med. 1998;17:143–54.
17. Harrison KM, Kajese T, Hall HI, Song R. Risk factor redistribution of the national HIV/AIDS surveillance data: an alternative approach. Public Health Rep. 2008;123(5):618–27.
18. U.S. Census Bureau, 2000 Census, Summary File 1 (SF 1), Table P.2. Urban and rural. Available at http://factfinder.census.gov/. Accessed 27 April 27 2009.
19. Laumann EO, Gagnon JH, Michael RT. In The social organization of sexuality: sexual practices in the United States. Chapter 8. Chicago: University of Chicago Press; 1994.
20. US Census Bureau. American Community Survey, 2005–2007. (Data averaged for the 3 years, 2005–2007.) Available at http://factfinder.census.gov/. Accessed 3 January 2009.
21. US Census Bureau. Midyear 2007 population estimates. Available at http://www.census.gov/popest/datasets.html. Accessed 3 January 2009.
22. Nyblade LC. Measuring HIV stigma: existing knowledge and gaps. Psychol Health Med. 2006;11:335–45.
23. Pathela P, Hajat A, Schillinger J, Blank S, Sell R, et al. Discordance between sexual behavior and self-reported sexual identity: a population-based survey of New York City men. Ann Intern Med. 2006;145:416–25.
24. Mays V, Cochran S, Zamudio A. HIV prevention research: are we meeting the needs of African American men who have sex with men? J Black Psychol. 2004;30:78–105.
25. Kennamer JD, Honnold J, Bradford J, Hendricks M. Differences in disclosure of sexuality among African American and white gay/bisexual men: implications for HIV/AIDS prevention. AIDS Educ Prev. 2000;12:519–31.
26. Centers for Disease Control and Prevention. HIV/STD risks in young men who have sex with men who do not disclose their

sexual orientation–six U.S. cities, 1994–2000. Morb Mortal Wkly Rep. 2003;2:81–5.

27. Katz D, Baptista J, Azen SP, Pike MC. Obtaining confidence intervals for the risk ratio in cohort studies. Biometrics. 1978;34: 469–74.

28. Das M, Chu PL, Santos GM, et al. Decreases in community viral load are accompanied by reductions in new HIV infections in San Francisco. PLoS ONE. 2010;5(6):e11068. doi:10.1371/journal. pone.0011068.

29. Millett G, Malebranche D, Mason B, Spikes P. Focusing 'down low': bisexual black men, HIV risk and heterosexual transmission. J Natl Med Assoc. 2005;97:52–9.

30. Morris M, Kurth AE, Hamilton DT, Moody J, Wakefield S. Concurrent partnerships and HIV prevalence disparities by race: linking science and public health practice. Am J Public Health. 2009;99:1023–31.

31. Dean HD, Fenton KA. Social determinants of health in the prevention and control of HIV/AIDS, viral hepatitis, sexually transmitted infections and tuberculosis. Public Health Rep. 2010;125(Suppl 4):1–5.

32. Texas Department of State Health Services. 2009 Texas integrated epidemiologic profile for HIV/AIDS prevention and services. Available at http://www.dshs.state.tx.us/hivstd/planning/ EpiProfile.pdf. Accessed 17 August 2009.

33. Bernard D, Kippax S, Baxter D. Effective partnership and adequate investment underpin a successful response: key factors in dealing with HIV increases. Sexual Health. 2008;5:193–201.

34. Lieb S, Santana AM, McKinley-Beach L, Arons P. Out in the open: the continuing crisis of HIV/AIDS among Florida's men who have sex with men. Monograph published by the Bureau of HIV/AIDS, Florida Department of Health, November 2007. Available at http://www.floridaaids.org. Accessed 10 December 2009.

35. Lieb S, Arons P, Thompson DR, et al. Men who have sex with men: racial/ethnic disparities in estimated HIV/AIDS prevalence at the state and county level, Florida. AIDS Behav. 2009;13: 716–23. Epub 2008 Jun 10.