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Emerging regional and racial disparities in the lifetime risk of HIV infection among men who have sex with men: A comparative life table analysis in King County, WA and Mississippi

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Abstract

Background—Little is known about the lifetime risk of HIV diagnosis among U.S. men who have sex with men (MSM), trends in risk and how risk varies between populations.

Methods—We used census and HIV surveillance data to construct life tables to estimate the cumulative risk of HIV diagnosis among cohorts of MSM born 1940–94 in King County, Washington (KC) and Mississippi (MS).

Results—The cumulative risk of HIV diagnosis progressed in 3 phases. In phase 1, risk increased among MSM in successive cohorts born 1940–64. Among men born 1955–65 (the peak risk cohort), by age 55 45% of White KC MSM, 65% of Black KC MSM, 22% of White MS MSM, and 51% of Black MS MSM had been diagnosed with HIV. In phase two, men born 1965–84, risk of diagnosis among KC MSM declined almost 60% relative to the peak risk cohort. A similar pattern of decline occurred in White MS MSM, with a somewhat smaller decline observed in Black MS MSM. In phase 3, men born 1985–94, the pattern of risk diverged. Among White KC MSM, Black KC MSM, and White MS MSM, HIV risk increased slightly compared to men born 1975–84, with 6%, 14%, and 2% diagnosed by age 27, respectively. Among Black MS MSM born 1985–94, HIV risk rose dramatically, with 35% HIV diagnosed by age 27.

Conclusion—The lifetime risk of HIV diagnosis has substantially declined among MSM in KC and among White MSM in MS, while skyrocketing among Black MSM in MS.

The number of new infections occurring in women and persons who inject drugs in the U.S. is now declining and the HIV epidemic is becoming more concentrated, with almost 70% of all infections occurring in men who have sex with men (MSM) in 2014¹. Overall, the number of new HIV diagnoses among U.S. MSM is stable, but that stability masks substantial regional and racial heterogeneity. New HIV diagnoses among MSM in places like Seattle and San Francisco are declining^{2,3}, but many areas, particularly in the southern U.S., continue to report high but stable numbers of new diagnoses in MSM^{4,5}. Nationally, the proportion of all infections occurring in Black MSM is increasing¹, and several reports have documented extremely high rates of incident infection in young Black MSM^{6,7}.

The magnitude of racial and regional disparities in HIV and how they are changing over time remain ill-defined. Life table analyses provide an estimate of a person's cumulative risk of experiencing a health outcome as they age^{8–10}. Although the exact proportion of men who are MSM remains uncertain, recent studies provide estimates of the proportion of the male population comprised of MSM^{11–13}, making it possible to create life tables estimating the age-specific risk of HIV among MSM. In this paper, we present a life table analysis estimating trends in the incidence of HIV in successive birth cohorts of White and Black MSM in King County, Washington and the state of Mississippi. We focus on these areas because of their demographic and cultural dissimilarity and prior evidence that the HIV epidemic in these areas may be moving in opposite directions.

METHODS

We constructed life tables for the period 1982–2012 to estimate the cumulative risk of HIV diagnosis among MSM born between 1940 and 1994 and residing in King County, Washington and Mississippi.

MSM population size estimates

We used U.S. Census data to define the number of White and Black males residing in the two areas in each year between 1982 and 2012. For each year we estimated the number of male residents born in each year between 1940 and 1994. Because the census provides estimates for the number of men in 5-year age groups, we interpolated data to smooth changes in population size over time.

Our model required us to estimate the percentage of men who are MSM. Based on a meta-analysis of national, population-based studies conducted 1993 to 2008, Purcell estimated that 2.9% of men had sex with another man in the prior year, 3.9% did so in the prior 5 years and that 6.9% had ever had sex with another man¹¹. Surveys asking U.S. men about their sexuality consistently find that men in specific areas are more likely to report same sex sexual behavior, suggesting that MSM often migrate to urban centers^{12,14}. For example, the Behavioral Risk Factor Surveillance Survey (BRFSS) 2013–14 found that 5.7% of adult men in King County report being gay or bisexual, while a Gallup poll found that 4.8% of Seattle metropolitan statistical area residents self-identify as lesbian, gay, bisexual or transgender¹⁵; both of these estimates exceed Gates's national estimate that 3.6% of U.S. men identify as being gay, bisexual or transgender¹⁶. Based on census data on the proportion of households with same-sex couples, Gates estimated that 6.5% of adults in the Seattle metropolitan

statistical area, and 2.3% of adults in Mississippi were lesbian, gay, bisexual or transgender¹⁶. More recently, Grey used a variant of this approach and estimated that 8% and 1.8% of men in King County, WA and Mississippi, respectively, were MSM¹³. However, other analyses suggest that survey findings showing that MSM concentrate in specific areas reflect a measure of how “out” the population is as much as true differences in proportion of the population that are MSM^{17,18}. For our base-case model we assumed that 4% of all U.S. men are MSM and, based on King County BRFSS data, that 5.7% of men age ≥30 in King County are MSM, respectively. We assumed that 3% of Mississippi age >30 are MSM, an estimate that assumes substantial net out-migration of MSM from the state.

In developing our model, we assumed that the likelihood of being an MSM did not vary among 18 year olds, that variance in the fraction of men who are MSM in different areas reflects migration. This assumption is supported by studies of twins, which suggest that being an MSM is substantially heritable¹⁹, meaning that the number of children and adolescents who are MSM is not likely to vary greatly by geography. We did not have MSM specific migration data. However, census data demonstrate that the number of men in each birth cohort residing in King County increases between the age of 18 and 29 and then plateaus. Thus, we assumed that the growth in the proportion of men within each birth cohort in King County who are MSM increases linearly from 4% to 5.7% between the ages of 18 and 29, and that the number of men who are MSM in Mississippi decreases from 4% to 3% between these same ages. We assumed that the proportion of men who are MSM does not vary by race.

We conducted sensitivity analyses examining cumulative lifetime risk of HIV by varying the percentage of men age ≥30 who are MSM from 2 to 4% in Mississippi and from 4 to 8% in King County. The ranges include estimates based on national Census data^{13,16}.

New HIV diagnoses

We used surveillance data from the enhanced HIV/AIDS Reporting System (eHARS) in King County and Mississippi to define the number of HIV diagnoses in MSM age ≥18 occurring each year by race and year of birth. (Less than 1% of HIV diagnoses among MSM in both jurisdictions occurred in persons aged <18.) Washington State has legally required diagnosing clinicians to report cases of AIDS since 1985 and to report newly diagnosed HIV infections since 1999. The law has required laboratories to report positive HIV diagnostic tests since 1985, and to report all CD4 lymphocyte and HIV RNA test results since 2006. Mississippi has legally required medical providers and laboratories to report cases of AIDS and HIV since 1983 and 1988, respectively. Viral load and CD4 lymphocyte count reporting was not mandatory in Mississippi during the study period. HIV case reports in both areas include information about gender, age, race, and HIV transmission risk. In both areas, MSM behavior is ascertained through a combination of information on the case report, investigations of new cases that include review of medical records, and partner notification interviews.

Assessment of potential bias in ascertainment of MSM behavior

Changing estimates in the rate of HIV diagnoses in MSM could result from true changes in the rate of diagnosis or from changes in the ascertainment of MSM behavior among newly diagnosed cases. To assess for ascertainment bias, we compared the number of women, MSM, and male non-MSM diagnosed with HIV each year in King County, WA and in Mississippi, reasoning that increasing ascertainment of MSM risk would lead to a decline in the ratio of diagnoses in non-MSM men compared to women.

Life tables

We constructed life tables for the period 1982–2012, including lines of data for men born each year 1940–1994, and columns for each age from 18 to 65. Equations used in the lifetables are presented in the Supplementary Appendix.

The study did not use any individual level data and was not human subjects research.

RESULTS

Study population

In 2012, an estimated 28,682 White and 2,646 Black MSM age 18 resided in King County, WA, and 21,019 White and 11,324 Black MSM were living in Mississippi (Table 1). As of the end of 2012, 7,699 White and 753 Black MSM had been diagnosed with HIV infection in King County, and 2,030 White and 3,555 Black MSM had been diagnosed with HIV infection in Mississippi (Table 2).

The ratio of non-MSM male to female cases was elevated in Mississippi in the late 1980s and early 1990s, but since 1992 has varied little, from .89 to 1.2. Variance has been greater in King County, though the number of female cases is very low, from 1 to 62 each year. These findings suggest that ascertainment of MSM risk has been relatively stable over the most recent 20 years of the analysis period (Supplemental Figure 1).

Cumulative risk of HIV diagnosis among different birth cohorts

Figure 1 presents the lifetime risk of being diagnosed with HIV by age in 10-year birth cohorts among MSM born 1940 to 1994. Looking at sequential birth cohorts, the cumulative risk of HIV diagnosis progressed in 3 phases. In the first phase, age-specific risk increased in MSM born in successive birth cohorts between the 1940s to the mid-1960s. The highest risk occurred among MSM born in 1955 to 1964, a group that were young adults when the HIV/AIDS epidemic began in the 1980s. In King County, an estimated 45% of White and 65% of Black MSM born 1955–64 had been diagnosed with HIV by age 55. In Mississippi, approximately 22% of White MSM and 51% of Black MSM in this cohort had been diagnosed with HIV by age 55.

The pattern of risk of new HIV diagnosis observed in second phase birth cohorts – men born 1965–1984 – varied somewhat among the four groups defined by race and geography. In King County, risk among both White and Black MSM declined, with an estimated 12% of White and 18% of Black MSM born 1975–84 being diagnosed with HIV by age 35, an

almost 60% reduction in risk compared to men born 1955–1964. The pattern of HIV diagnoses among White MSM in Mississippi was similar to that observed in King County; the risk of HIV diagnosis declined in successive birth cohorts between 1965 and 1984. By age 35, 5% among White MSM born 1975–84 had been diagnosed with HIV infection compared to 14% of White MSM born 1955–64, a 64% decline. The pattern among Black MSM in Mississippi was notably different. The age of diagnosis in men born 1965–74 and 1975–84 was earlier than in men born 1955–64. However, among men born 1965–74 the risk curve is essentially superimposed on that from the cohort born 1955–65 at ages in the mid-30s forward, suggesting a similar level of cumulative risk despite earlier age of diagnosis. Risk of diagnosis declined somewhat in the cohort born 1975–84, though the magnitude of that decline was lower than in King County and among White MSM in Mississippi.

The pattern of risk diverges dramatically in the most recent birth cohort, men born 1985–94. Among both Whites and Blacks in King County and among Whites in Mississippi, HIV risk in this youngest cohort is slightly higher than that seen in men born 1975–84. In contrast, the risk among Black MSM born 1985–94 skyrockets. By age 27, approximately 35% of men in this cohort have been diagnosed with HIV. We did not observe a similarly elevated level of risk in any other studied birth cohort in either area.

Racial disparities in cumulative HIV risk

In both King County and Mississippi, Black MSM consistently experienced a higher risk of HIV infection than White MSM. However, the absolute and relative magnitude of these disparities, and how they changed over time differed between King County and Mississippi. Figure 2 highlights the comparison of cumulative HIV risk between Black and White MSM in three selected 10-year birth cohorts. Among men born 1945–54 in King County, we observed almost no disparity in risk during the initial decade of the epidemic, though the risk of HIV diagnosis among Black MSM in this group exceeds that of White MSM at older ages by approximately 9% (44% vs 35%), a relative disparity of 21%. The size of both the absolute and relative disparity between Blacks and Whites is similar among King County MSM born 1965–74. In contrast, the relative disparity is greater while the absolute disparity has remained stable among MSM born 1985–94. Black MSM born in 1965–1974 were 33% more likely to have an HIV diagnosis by age 35 than White MSM, whereas Black MSM born in 1985–1994 were twice as likely to have been diagnosed with HIV by age 27 compared to White MSM. At the same time, the absolute disparity between these final two cohorts was similar (7.2% and 7%) since the risk of HIV diagnoses declined among both Blacks and Whites.

Racial disparities in Mississippi were more pronounced than in King County (Figure 2b), and displayed a pattern of consistently widening absolute and relative disparity. Comparing Black and White MSM born 1945–1954 and 1965–74, the absolute disparity in HIV diagnoses by age 35 increased from 0.2% to 26%, while the relative disparity increased from 11% to 75%. For the youngest birth cohort of men born 1985–94, by age 27, Black MSM were more than ten times as likely to have been diagnosed with HIV than White MSM (35% vs 3%); the absolute disparity in the risk of HIV diagnosis increased to 32%.

Sensitivity analysis

Assuming that 8% of men 30 in King County are MSM (rather than 5.7%), 33% of white and 47% of Black MSM born 1955–64 (peak risk cohort) would have been diagnosed by age 55 (Table 3). Among men born 1985–94 (contemporary young MSM cohort), 6% of white and 12% of Black MSM would be diagnosed by age 27. If only 2% of Mississippi men 30 are MSM, then 34% and 78% of White and Black MSM in the peak birth cohort would have been diagnosed by age 55; 4% of white and 40% of Black MSM in the contemporary young MSM cohort would be infected by age 27. The supplemental figure presents how varying assumptions on the percentage of men who are MSM affects our estimates of cumulative HIV diagnosis risk among persons in the 1955–64 and 1975–84 birth cohorts. As shown, varying this assumption does not substantially affect our estimates among young persons since our model assumes variance in the percentage of men who are MSM results from migration between the ages of 18 and 29.

DISCUSSION

We used life tables to estimate the cumulative, age-specific risk of HIV diagnosis among successive birth cohorts of MSM in King County, WA and Mississippi. Our findings highlight the disparate trajectory of the HIV epidemic in these two areas. In King County, the risk of HIV diagnosis peaked among MSM born in the late 1950s and early 1960s, declined in subsequent birth cohorts and is now relatively stable. Although important racial disparities persist, the absolute size of these disparities is stable and the risk of HIV has decreased in all groups. The epidemic in Mississippi is different. As in King County, HIV risk among White MSM has declined and stabilized. In contrast, the epidemic among Black MSM is explosive, with approximately 35% of young Black MSM diagnosed with HIV infection by age 27. To our knowledge, this level of risk is unprecedented in the U.S. and represents a public health crisis.

Our findings highlight the alarming risk of HIV experienced by Black MSM and are consistent with some prior reports. Assuming that 4% of men are MSM, the estimated overall annual incidence of HIV among U.S. MSM in 2010 was under 1%.²⁰ HPTN 061, a cohort study of Black MSM in 6 U.S. cities conducted 2009–2011, observed a 5.9% annual risk of HIV infection in men aged 30, while smaller cohort studies of young African American MSM in Atlanta and Mississippi have observed incidences of 10% and higher.^{6,7,21} At the same time, HIV risk among Black MSM in King County is much lower, highlighting that risk among Black MSM is heterogeneous, and that high levels of infection in that population are not inevitable.

Our findings vary somewhat from other analyses related to the lifetime risk of HIV among MSM and highlight areas of continued uncertainty related to the demography of MSM. To our knowledge, the only published estimate of the lifetime HIV risk among U.S. MSM suggested that 40% of MSM will be HIV infected by age 40²². That estimate was derived by applying a single annual incidence estimate to all MSM regardless of age, birth cohorts, race/ethnicity or geography. However, as illustrated by our data, incidence is not stable over the life course. More recently, CDC estimated the risk of HIV among MSM using recent age and race specific diagnosis rates and assuming that 6.9% of men are MSM²³. They

estimated that half of all Black MSM and 9% of White MSM would be diagnosed with HIV over their lifetime. Our findings highlight that these risks vary substantially in different parts of the U.S., and have changed over time.

Our analysis has a number of limitations. First, our estimate of the percentage of men who are MSM is imprecise. An overestimate of the proportion of men who are MSM would lead to an underestimate of the cumulative risk of HIV diagnoses, while an underestimate would lead to an overestimate of that risk. To address this issue, we conducted sensitivity analyses allowing readers to see how different estimates of the percentage of men who are MSM might affect the estimated risk of HIV among White and Black MSM in Seattle and MS. Of note, imprecision in our estimate of the proportion of men who are MSM would not affect the trends we observed, nor would such an error affect our estimates of racial disparities unless there is variability in the proportion of men who are MSM by race. Second, we utilized surveillance data to define the number of HIV diagnoses in MSM. Incomplete ascertainment of MSM as a risk factor would lead to underestimation of the HIV incidence among MSM. Our analysis assessing the ratio of non-MSM male cases to female cases suggests that ascertainment has been stable over the most recent 20 years of the analysis period, though the risk of HIV among MSM in both King County and MS was likely underestimated early in the epidemic leading to a potential underestimate of cumulative HIV risk in the oldest birth cohorts. Third, because surveillance data provides the date of diagnosis, we estimated the risk of HIV diagnoses, not the risk of HIV infection. The risk of infection at each age is somewhat higher than we estimate. Also, insofar as HIV testing is increasing, the time from HIV infection to diagnosis is declining²⁴ and some of the trend toward higher rates of diagnosis in young MSM we observed may reflect changing testing patterns, not a longer term trend toward increasing lifetime risk. Fourth, there may have been differences in ascertainment of race over time given changes in the number of racial categories included in the U.S. census, though we did not see significant anomalies in the proportions of men in different groups over time. Finally, recent studies suggest that national HIV surveillance data is likely incompletely de-duplicated resulting in an overestimate of the number of persons living with HIV²⁵. This would lead to an overestimate of HIV risk among MSM which could vary by region. However, it seems likely that this limitation in surveillance data would affect men of all races within a single area, and thus is unlikely to explain the disparities we observed.

In conclusion, our findings illustrate the evolving heterogeneity in the U.S. HIV epidemic. In places like King County, the epidemic peaked years ago in a population that is now in its 50s. The epidemic is relatively stable, and progress has affected both White and Black MSM, though important racial disparities persist. In contrast, in places like Mississippi, we are facing a crisis, with rising racial disparities and an unprecedented incidence of HIV diagnoses occurring in young, Black MSM. There is an urgent need for new, more aggressive and innovative prevention interventions focused on Black MSM, particularly in the southern U.S.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Summary

The estimated lifetime risk of HIV infection among men who have sex with men in King County, WA peaked among men born in the early 1960s and has since declined, while the risk among MSM in Mississippi initially declined, but has recently skyrocketed among young Black MSM.

Figure 1.
Cumulative risk of HIV diagnosis by age among birth cohorts of White and Black MSM in King County, WA and Mississippi*
*Y-axis scales differ for different panels

Figure 2.
Racial disparities in the cumulative risk of HIV diagnosis by age in selected birth cohorts of White and Black MSM in (A) King County, WA and (B) Mississippi

Table 1

Estimated number of MSM in King County, Washington and in Mississippi

	KING COUNTY, WA				MISSISSIPPI			
	White	Black	N	%	White	Black	N	%
Estimated Total Adult MSM Population (2012)	28,682	2,646			21,019	11,324		
% of Men Estimated to be MSM	5.7%	5.7%			3%	3%		
Estimated MSM Population in 2012 by Birth Cohort	N	%	N	%	N	%	N	%
1985–1994	3,662	13%	448	17%	4,422	21%	3,244	29%
1975–1984	5,595	20%	590	22%	3,368	16%	2,130	19%
1965–1974	5,961	21%	597	23%	3,512	17%	1,859	16%
1955–1964	6,069	21%	541	20%	3,796	18%	1,946	17%
1945–1954	4,545	16%	312	12%	3,208	15%	1,381	12%
1940–1944	1,236	4%	77	3%	1,155	5%	341	3%
Before 1940	1,614	6%	81	3%	1,558	7%	423	4%

Table 2
Number of HIV Diagnoses among MSM in King County, WA and Mississippi (1982–2012)

	KING COUNTY, WA				MISSISSIPPI			
	White	Black	White	Black	White	Black	White	Black
Total MSM Diagnosed with HIV (1982–2012)	7,699	753			2,030	3,555		
HIV Diagnoses by Birth Cohort	N	%	N	%	N	%	N	%
1985–1994	132	2%	30	4%	63	3%	573	16%
1975–1984	508	7%	73	10%	153	8%	677	19%
1965–1974	1,513	20%	168	22%	417	21%	903	25%
1955–1964	2,934	38%	299	40%	854	42%	975	27%
1945–1954	1,953	25%	145	19%	393	19%	341	10%
1940–1944	345	4%	24	3%	75	4%	39	1%
Born before 1940	314	4%	14	2%	75	4%	47	1%

Table 3

Sensitivity analysis -- Cumulative lifetime HIV risk based on variable estimates of the percentage of men who are MSM at age 30*

King County, WA										Mississippi									
White	Black	White	Black	White	Black	White	Black	White	Black	White	Black	White	Black	White	Black	White	Black	White	Black
MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM	MSM
Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort	Birth Cohort
1955–64	1955–64	1975–84	1975–84	1985–94	1985–94	1985–94	1985–94	1955–64	1955–64	1955–64	1955–64	1975–84	1975–84	1975–84	1975–84	1985–94	1985–94	1985–94	1985–94
Age 55	Age 55	Age 35	Age 35	Age 27	Age 27	Age 35	Age 27	Age 55	Age 55	Age 55	Age 55	Age 35	Age 35	Age 35	Age 35	Age 27	Age 27	Age 27	Age 27
Percentage of men age 30 who are MSM																			
2%	NA	NA	NA	NA	NA	NA	NA	33%	75%	7%	46%	4%	40%						
3%	NA	NA	NA	NA	NA	NA	NA	22%	51%	5%	35%	3%	35%						
4%	62%	90%	16%	17%	9%	23%	17%	17%	39%	4%	29%	3%	31%						
5%	51%	73%	14%	15%	8%	19%	15%	NA	NA	NA	NA	NA	NA						
6%	43%	62%	12%	14%	7%	17%	14%	NA	NA	NA	NA	NA	NA						
7%	38%	54%	10%	13%	7%	15%	13%	NA	NA	NA	NA	NA	NA						
8%	33%	47%	9%	12%	6%	14%	12%	NA	NA	NA	NA	NA	NA						

* All analyses assume that 4% of men are MSM at age 18 with the percentage changing based on in-migration (King County) or out-migration (Mississippi) between ages 18 and 29.