

# Understanding the HIV disparities between black and white men who have sex with men in the USA using the HIV care continuum: a modelling study



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## Summary

**Background** Disparities in HIV incidence and prevalence between black and white men who have sex with men (MSM) in the USA remain largely unexplained. We assessed the effect of interventions for black MSM that might reduce disparities in HIV care continuum and incidence in MSM.

**Methods** Using data from the US Centers for Disease Control and Prevention (CDC), we constructed the HIV care continuum for black and white MSM for 2009–10. These data were used in a deterministic model to estimate race-specific transmissions, transmission rates, incidence rate, and rate ratios.

**Findings** Disparities were noted throughout the care continuum, with 28 251 (16%) of 180 477 black MSM and 83 223 (34%) of 243 174 white MSM achieving viral suppression. An estimated 9833 and 9710 new HIV transmissions per year were attributable to HIV-positive black and white MSM, respectively (transmission rate ratio 1·36 and incidence rate ratio 7·92). In a model in which black and white MSM had identical care outcomes, the transmission rate ratio was 1·00 and incidence rate ratio was 5·80. In scenarios of 95% diagnosis, 95% retention, and concurrent 95% diagnosis and 95% retention, the transmission rate ratios were 1·00, 1·02, and 0·56, respectively, and incidence rate ratios were 5·81, 5·93, and 3·28, respectively.

**Interpretation** Disparities in the rates of HIV transmission could be reduced by improving the outcomes of the HIV care continuum, but racial disparities in HIV prevalence are likely to continue sustaining the higher incidence in black MSM for decades to come.

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## Introduction

In the USA, the incidence of HIV infection is rising among men who have sex with men (MSM), and as with many other illnesses important racial differences exist.<sup>1–3</sup> Black MSM have had disproportionately higher incidence and prevalence of HIV infection since the start of the epidemic.<sup>4</sup> Although the factors that gave rise to disparities between black and white MSM in HIV infection are not completely understood, data are emerging to suggest that some factors are important for sustaining those disparities. Results of meta-analyses have shown that black MSM do not have more risk-associated behaviours than do white MSM.<sup>5</sup> Possible hypotheses have been proposed that take into account the effects of social network structures and treatment disparities.<sup>6</sup> Existing disparities in HIV prevalence and socioeconomic factors might also contribute to ongoing disparities.<sup>7–9</sup> For example, because of higher HIV prevalence and lower rates of viral suppression in black MSM and substantial racial concordance in sexual partnerships, equivalent risk behaviours in black MSM confer a higher probability of exposure to an HIV-transmitting male partner than in white MSM.<sup>8</sup> In a study of MSM in Atlanta, GA, USA, having black partners significantly accounted for the disparities in HIV incidence between black and white MSM.<sup>10</sup> Other

investigators have suggested that racial differences in clinical care outcomes in HIV-infected MSM exacerbate such disparities.<sup>11,12</sup>

New HIV infections in a population are a function of behavioural and biological factors, including the number of serodiscordant sexual partnerships, number of unprotected sex acts, and viral load in infected partners.<sup>13</sup> Within a serodiscordant partnership, the transfer of HIV might be seen from the perspective of the person acquiring or transmitting HIV.

According to reports, disparities exist between racial or ethnic groups in HIV prevalence (infection burden) or HIV incidence (new infections).<sup>10,11,14,15</sup> Disparities in HIV transmission (ie, the extent to which HIV-infected black MSM are more likely to transmit infection than are HIV-infected white MSM) have been assessed in only a few studies.<sup>12,16</sup> The differences in the risk behaviours associated with HIV transmission in MSM by race have been assessed to help explain high infection rates in black MSM.<sup>17,18</sup> Following these studies, HIV transmission rates (average transmissions per person living with HIV) were calculated with HIV surveillance data for diagnosed and undiagnosed infection in a recent study, and although only a fifth of the men in the USA are black, there are about the same number of black and white MSM with HIV without viral suppression.<sup>19</sup>

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	Data	Reference	Estimation notes*
Step 1: total living with HIV infection	50 US states, DC, Puerto Rico, and five other US dependent areas; 2009 and 2010	Hall et al, 2013; <sup>19</sup> CDC, 2013 <sup>1</sup>	Black and white MSM total diagnosed (step 2), divided by black and white MSM proportion diagnosed
Step 2: diagnosed	50 US states, DC, Puerto Rico, and five other US dependent areas; 2010	CDC, 2013 <sup>1</sup>	Black and white MSM totals provided
Step 3: retained in care†	50 US states, DC, Puerto Rico; 2009	Beer et al, 2013 <sup>12</sup>	Black and white MSM totals provided¶
Step 4: on antiretroviral therapy‡	50 US states, DC, Puerto Rico; 2009	Beer et al, 2013 <sup>12</sup>	Black and white MSM total retained in care (step 3), multiplied by proportion on antiretroviral therapy¶
Step 5: achieved viral suppression§	50 US states, DC, Puerto Rico; 2009	Beer et al, 2013 <sup>12</sup>	Black and white MSM total retained in care (step 3), multiplied by proportion currently suppressed¶

MSM=men who have sex with men. CDC=US Centers for Disease Control and Prevention. \*The chosen method for the estimation of the continuum of care with data from the US CDC National HIV Surveillance System and Medical Monitoring Project more closely resembles that used to construct national care continuum for the USA by subgroups<sup>22</sup> than does another method with the same data systems; in that method, some of the data were from a 19 jurisdiction subset and undiagnosed individuals were excluded; this method has been applied to the care continuum for black people in the USA.<sup>23</sup> †Had a medical care visit in the first 4 months of 2009. ‡Based on self-report. §Most recent viral load documented as undetectable or less than 200 copies per mL. ¶The estimate for the total number of individuals retained in care is based on all MSM in care, whereas the estimated proportion of individuals on antiretroviral therapy and currently suppressed is based on the MSM population who were sexually active in the previous year; it might represent a minimum source of error if these care indicators were different by sexual activity in the previous year.

**Table 1: Data sources for estimation of HIV continuums of care for black and white MSM in the USA during 2009–10**

The HIV care continuum has become an important model for the measurement of HIV/AIDS care in populations through nested steps of HIV infection, diagnosis, retention in care, prescription of antiretroviral therapy, and viral suppression.<sup>20,21</sup> A full HIV care continuum for MSM by race (ie, including those living with undiagnosed HIV infection) has not been constructed and the degree to which dropout from the continuum contributes to disparities in HIV infection has not been modelled. Using available national data sources, we assessed how existing disparities in HIV prevalence and in the HIV care continuum between races translate into and explain differences in incidence in MSM.

## Methods

### HIV care continuum

Using nationally representative data from the US Centers for Disease Control and Prevention (CDC) for people with HIV in 2009 and 2010 in the USA (table 1), we estimated separate HIV care continuums for black and white MSM.<sup>1,12,19</sup> When more than one set of estimates were available, we selected those with greater sub-population details.

Population sizes along the care continuum were represented in three ways. The first was the typical cumulative prevalence method in which population size decreases monotonically from HIV infection to viral suppression.<sup>20,22</sup> The second was the percentage of the population who attained a particular step of care, conditional on attaining the previous step. Third, by subtraction, we obtained the number of individuals at three broader, mutually exclusive stages of care; HIV-infected but undiagnosed, diagnosed but not virologically suppressed, and virologically suppressed. These stages are the most informative for understanding the relative contribution of individuals at each stage to

ongoing transmission, and thus for the targeting of prevention efforts.

### HIV transmission

We used published yearly per-person transmission rates from individuals with HIV in the USA in 2009 for those with undiagnosed infection (rate 0.108), diagnosed infection but not virally suppressed (0.046), and individuals virally suppressed (0).<sup>19,24</sup> An estimated 83% of MSM diagnosed but not virally suppressed are out of care.<sup>22</sup> Stage-specific transmission rates, and thus transmission risk behaviours, were kept constant between black and white MSM, consistent with previous research for the comparison of sexual behaviours by race because of the unavailability of race-specific estimates.<sup>5,11</sup>

Next, we estimated the number of HIV transmissions from black and white MSM with HIV infection at each step of care by multiplying the number of MSM of each race at each care step with the transmission rate for that step. Division by the race-specific number of MSM living with HIV provided the race-specific transmission rate, the ratio of which was an estimate of the transmission rate ratio or the disparity in HIV transmission.

### HIV incidence

The total numbers of transmissions by race were used to imply incident infections (in different racial mixing scenarios), and these were compared with CDC back-calculation estimates of 2009 race-specific incident infection counts.<sup>2</sup> Although national incidence rates are not published, we estimated these from other population-based sources. The number of MSM living in the USA was computed by use of 2008 estimates from a meta-analysis of population-based surveys with behavioural definitions of MSM, accounting for population growth in individuals aged 13 years and older from 2008 to 2010 (appendix).<sup>25,26</sup> Race-specific totals were calculated for the overall

distribution of the races in the USA.<sup>25</sup> Using the number of black and white MSM living with HIV, we next computed race-specific HIV prevalence, number of men living without HIV, and thus the incidence rate, and incidence rate ratio for the comparison of black versus white MSM.

### Intervention scenarios

We used hypothetical interventions along the continuum of care for black MSM as both a sensitivity analysis and to understand the relative contributions of the steps of care and existing prevalence to transmission and incidence in black MSM.<sup>20</sup> Using the known care continuum as a base case (observed continuum), we assessed HIV transmission rates, incidence, and rate ratios in counterfactual scenarios that began with the same number of black MSM with HIV infection, but altered coverage of subsequent steps in the care continuum by modifying the percentages of individuals attaining subsequent steps. These four scenarios were equivalent care achievement as white MSM (racially equivalent care), 95% diagnosis, 95% retention, or concurrent 95% diagnosis and 95% retention.

### Race-mixing sensitivity analyses

For the primary analysis, we assumed all serodiscordant MSM partnerships were with same-race men. Results of previous studies have indicated greater racial mixing among MSM than among the heterosexual population, but mixing varies regionally and no nationally representative partnership race-mixing data are available for MSM.<sup>27</sup> Furthermore, transmission analyses require race-mixing data for the specific subset of HIV-serodiscordant partnerships, ideally those in which transmission is likely to occur or has occurred. In sensitivity analyses, we reassessed all outcomes in different race-mixing scenarios. These included hypothetical scenarios and those based on data from 5978 partnerships with anal intercourse and 432 with serodiscordant anal intercourse from three sources: a national online study, and an Atlanta-based cohort, and an Atlanta-based sexual networks study (appendix).<sup>28–30</sup> To account for all MSM transmissions in the population, a third group of Hispanic or other race MSM was included, with a care continuum approximated from the above sources.<sup>19,22</sup> The results are reported on an interactive spreadsheet.

### Role of the funding source

The funding source had no role in data analysis or interpretation, writing of the report, or the decision to submit the report. The corresponding author had full access to all of the published data in the study and final responsibility for the decision to submit for publication.

## Results

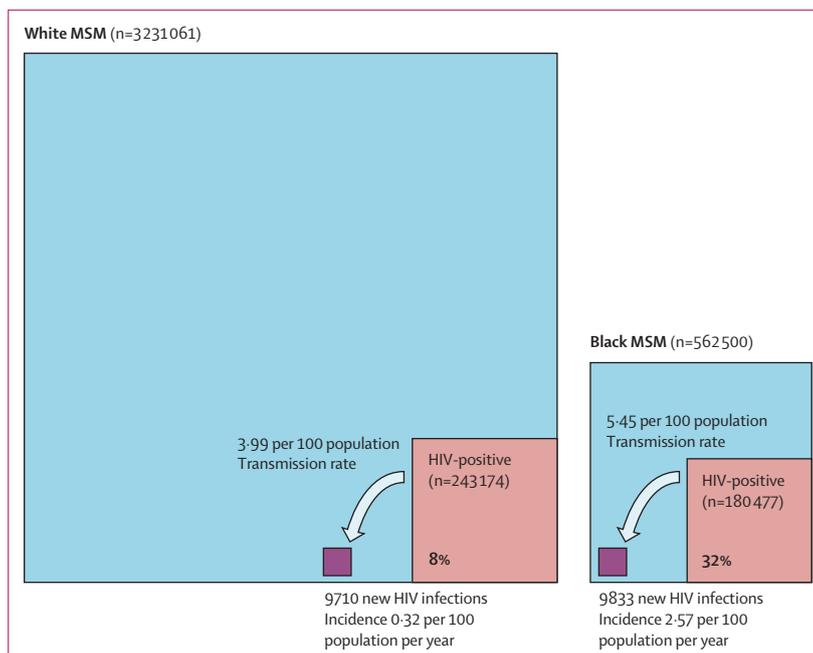
In 2010, about 562 500 black and 3 231 061 white adult MSM were living in the USA (figure 1). Of these, an

estimated 180 477 black and 243 174 white MSM had HIV, giving prevalences of 32% and 8% respectively (figures 1 and 2). Disparities were noted at all steps of the HIV care continuum, most notably in retention in care—33% of black and 51% of white MSM diagnosed with HIV infection were retained in care (figure 2). An estimated 16% of black and 34% of white MSM achieved HIV suppression (figure 2).

With application of per-person transmission rates to each care continuum, 9710 transmissions were attributable to white MSM and 9833 to black MSM (observed continuum; table 2), resulting in a transmission rate ratio of 1·36 (5·45 per 100 black MSM vs 3·99 per 100 white MSM) and an incidence rate ratio of 7·92 (2·57 per 100 black MSM vs 0·32 per 100 white MSM; table 2). The higher incidence rate ratio, as opposed to transmission rate ratio, was a result of the smaller total population of HIV-negative black MSM than the total population of HIV-negative white MSM and the larger proportion of prevalent HIV-positive black MSM (figures 1 and 2).

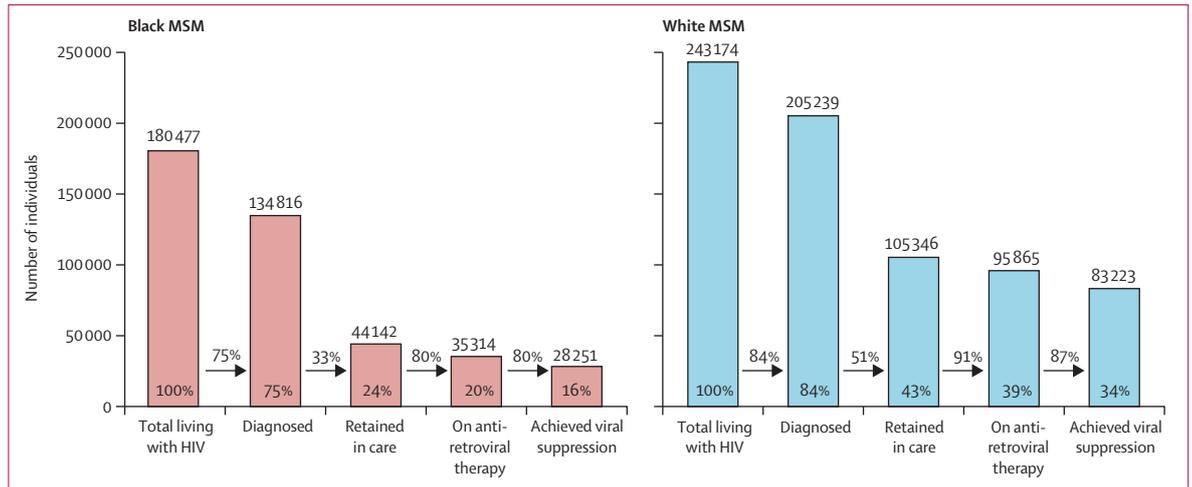
In a scenario of racially equivalent care in which black MSM have the same care continuum as do white MSM, the HIV transmission rate ratio is defined as 1·00. The equalisation of transmission likelihood through the equality of care alone results in a 27% reduction in the estimated incidence rate and 27% reduction in the rate ratio in black MSM compared with scenario 1 (table 2).

For the spreadsheet of results see <http://sgiz.mobi/s3/03589c4b2f09>



**Figure 1: Estimated HIV transmission and incidence as per the observed HIV care continuum**

White and black MSM have similar numbers of new HIV infections, but the total black MSM population is smaller and the proportion of prevalent HIV-positive men is greater, resulting in disparities in the incidence rates between the black and white MSM. The boxes are proportionally scaled to the corresponding group sizes. In this figure, the scenario is that of 100% racial concordance in HIV serodiscordant relationships; five alternative scenarios are described in the appendix. MSM=men who have sex with men.



**Figure 2: Estimated HIV care continuum for black and white MSM in the USA during 2009–10**  
 Numbers above the bars are the estimated total MSM at that step in the HIV care continuum. Percentages within bars are the estimates of MSM at that step in the HIV care continuum. Percentages within arrows are the MSM at that step in the HIV care continuum, conditional on attaining the previous step. MSM=men who have sex with men.

The remaining 73% of excess incidence was attributable to current disparities in prevalence of HIV infection.

At a constant care continuum for white MSM, the estimated transmission and incidence in the 95% diagnosis scenario for all black MSM were nearly

identical to those in the racially equivalent care scenario (table 2). Similar to scenario 1, in the 95% retention scenario for black MSM, the estimated transmission rate ratio was 1.02 and incidence rate ratio was reduced by 25%. In the concurrent 95% diagnosis and 95% retention scenario, the estimated transmission rate ratio fell to 0.56 and the incidence rate ratio fell by 59%. In this scenario, however, the estimated incidence rate ratio remains increased at 3.28 because of the larger prevalent HIV-positive black MSM population, of whom 76 233 (42%) of 180 477 do not have suppression of the virus. The results were nearly identical with the same interventions at 100% coverage (data not shown).

In sensitivity analyses of different race-mixing configurations, estimates of the incidence rate ratio for black and white MSM in the observed continuum scenario varied from 7.89 to 9.22 (appendix). In all race-mixing scenarios, reductions achieved in the incidence of HIV infection in the black MSM population through improvements in diagnosis and care were attenuated because these changes partly reduced HIV transmission to other races, and were responsible for unmodified and continued transmission to black MSM.

Comparison of the estimates from the observed continuum scenario with those from other studies of US surveillance data in which independent methods were used enabled validation of the findings from the model. Predicted infection totals were similar to previously reported back-calculated incidence estimates of 10 800 for black MSM and 11 400 for white MSM (table 2).<sup>2</sup>

### Discussion

According to our model, the disparity in HIV transmission rate between black and white men is substantially lower than the disparity in HIV incidence rates: the black–white

	New HIV infections	HIV transmission		HIV incidence		Change in rate ratio from scenario 1
		Transmission rate*	Transmission rate ratio (black vs white)	Incidence rate†	Incidence rate ratio (black vs white)	
<b>Scenario 1: observed continuum (for each race)</b>						
White MSM	9710	3.99	..	0.32	..	..
Black MSM	9833	5.45	1.36	2.57	7.92	..
<b>Black MSM receiving interventions in HIV care continuum‡</b>						
Scenario 2: racially equivalent care	7206	3.99	1.00	1.89	5.80	-27%
Scenario 3: 95% diagnosis	7209	3.99	1.00	1.89	5.81	-27%
Scenario 4: 95% retention	7362	4.08	1.02	1.93	5.93	-25%
Scenario 5: concurrent 95% diagnosis and 95% retention	4066	2.25	0.56	1.06	3.28	-59%
<b>Estimated incident HIV infections, 2009§</b>						
White MSM	11 400	..	..	0.35	..	..
Black MSM	10 800	..	..	2.55	7.21	..

MSM=men who have sex with men. \*Number of new HIV infections per 100 individuals living with an HIV infection. †Number of new HIV infections per 100 individuals living without an HIV infection. ‡Interventions applied to black MSM only, with diagnosis and care for white MSM remaining at the levels for 2009–10. §Presented to show similarities in estimated incident infections and incidence rate ratios between published US Centers for Disease Control and Prevention estimates and our current estimates.

**Table 2: HIV transmission and incidence, estimated from the HIV care continuum, for black and white MSM in the USA during 2009–10**

transmission rate ratio in our model was 1·36, but the HIV incidence rate ratio was 7·92 as a result of differences in HIV prevalence, population size, and the tendency towards racially concordant relationships (table 2).

Our counterfactual scenarios show the challenges in addressing HIV disparities by race because of the existing differences in HIV prevalence. Even with the assumption that black MSM have a similar continuum to that for white MSM and a reduced transmission rate ratio of 1·0, black MSM will still have an estimated HIV incidence 5·8 times that of white MSM (table 2). The disparity in the estimates of HIV transmission was reduced, under the ideal (but challenging to achieve) scenario of concurrent 95% diagnosis and retention in care for black MSM, with a rate ratio of less than 1 for black MSM; the disparity in incidences was also greatly reduced although incidence was still three times higher (table 2). These findings suggest that, even if disparities in transmission rates are addressed, the higher HIV prevalence in black MSM will continue to compound disparities in HIV incidence for many years to come. Reversal of this trend will only be possible through a sustained reduction in the HIV transmission rate to less than 1 for a sufficient period to allow a reduction in the current number of prevalent HIV-positive black MSM and an increase in HIV-negative cohorts in successive generations.

By synthesising existing nationally representative CDC estimates, we show the role of differences in HIV care continuums in the perpetuation of disparities in HIV between black and white MSM. Our results extend existing work (panel) by presenting separate HIV care continuums for black and white MSM, including those with HIV irrespective of their diagnosis status. Our results suggest important lessons that could inform prevention priorities and prospects for mitigating these disparities in MSM in the USA, one of many health-related racial disparities.

In the USA, one in three black MSM has HIV infection, compared with less than one in ten white MSM.<sup>25</sup> The results for the race-specific HIV care continuum show consistent disparities for black and white MSM at each step of the continuum: black MSM are less likely to be diagnosed with HIV infection, to be retained in care, to be on antiretroviral therapy, and to achieve viral suppression. These disparities in the care continuum culminate in black MSM achieving less than half of the virological suppression achieved by white MSM. Previous analyses have presented partial care continuums for black MSM<sup>30</sup> and for black and white MSM.<sup>31</sup> These partial care continuums exclude men living with undiagnosed HIV infection; therefore these results are not directly comparable to our results, but also show lower viral suppression among black MSM. Also, the previous partial continuums estimated retention in care based on 19 US jurisdictions, whereas our analysis used published CDC methodology to estimate retention.<sup>21</sup>

#### Panel: Research in context

##### Systematic review

We updated findings from a meta-analysis.<sup>11</sup> Additional US care-continuum and transmission results for white men who have sex with men (MSM) were found through PubMed searches from Jan 1, 2012, to Aug 15, 2014, with the terms "HIV care continuum MSM" and "HIV transmission MSM United States", and by searching the HIV case surveillance report listing on the US Centers for Disease Control and Prevention website.

##### Interpretation

Large gaps exist in both existing infections and care continuum outcomes between black and white MSM, resulting in even larger racial disparities in HIV incidence. Even if extreme care interventions resulted in 2·3 transmissions per 100 black MSM who were HIV positive, compared with four transmissions per 100 white MSM who were HIV positive, disparities in HIV incidences will persist because of many more prevalent positives in the black MSM community.

These disparities were validated in a meta-analysis of studies for the comparison of black and white HIV-infected MSM,<sup>11</sup> but the results of our analysis add to those findings by showing that disparate HIV transmission rates due to racial differences in care might help compound disparities in HIV incidence in the black MSM population.

The results of our analyses show the substantial challenges in reducing or eliminating disparities in HIV incidence between black and white people in the short term. The results also suggest that we must address all elements of the HIV care continuum for all MSM to achieve meaningful reductions in the disparities in HIV incidences and, crucially, to achieve the care and transmission outcomes despite low levels of viral suppression in all races. Increasing HIV testing as a sole approach to reducing racial disparities is likely to have a small effect. Even public health approaches that substantially address disparities in transmission rates for black MSM will not lead to similar reductions in HIV incidence. Therefore, importantly, additional approaches such as pre-exposure prophylaxis have to be applied at scale as part of a combination HIV prevention strategy for black MSM.<sup>32</sup> Because adequate estimates of the protective effect of pre-exposure prophylaxis for black MSM have yet to be published, such interventions for HIV-uninfected black MSM are not included in our model of the HIV-infected population. Although pre-exposure prophylaxis has a great potential in reducing incidence, scale-up might be inhibited by the same social or structural barriers to care outcomes for black MSM with HIV.<sup>7</sup>

Our model and interpretations have important limitations. First, our input data were derived from different systems from both 2009 and 2010. However, our

sources were nationally representative data systems. Second, our primary model was based on the assumption that serodiscordant partnerships were 100% same race. Accordingly, all changes to HIV care for a racial group and resulting transmissions were attributed to that group's incident infections. Thus, the reported estimates of changes in incidence were best-case scenarios. From sensitivity analyses of racial mixing in serodiscordant partnerships, we expect that prioritising black MSM who are HIV-positive for intervention might have less effect on the incidence of HIV infection in this population than our model suggests, but would benefit other racial groups. Also, our overall estimate of HIV incidence for MSM was lower than that reported in a meta-analysis of HIV epidemics in mainly urban regions of the USA, Europe, and Australia.<sup>33</sup> Noteworthy is that previous HIV incidence rate estimates in MSM populations have been derived largely from men recruited in bars and similar venues associated with higher HIV acquisition risk, in urban areas, and represented mostly younger MSM, who tend to have higher HIV incidence rates than do older MSM. Furthermore, our estimates of HIV incidence are nearly identical to that derived from combining CDC's estimates of 2009 incident infections in MSM using independent methods. Also, our national estimate of HIV incidence rate improves on earlier work because we used incident infections, rather than diagnoses, in the numerator and adjusted the denominator of MSM at risk by subtracting the number of MSM living with HIV.<sup>25</sup> Transmission rates used might not fully capture the incompletely understood role of acute infection in the epidemic in the MSM population, possible undocumented behavioural or circulating viral differences between HIV-positive black and white MSM, or differences in host susceptibility.<sup>34</sup> Because some source data reports did not include estimates of random error, we could not include these for our model results.

Our study has clear programmatic and policy implications. Because disparities in the HIV care continuum likely account for most of the disparities in HIV transmission rates between black and white MSM, there is an urgent need to improve our rates of HIV testing, linkage and retention in care, and prescription of and adherence to antiretroviral therapy for black MSM living with HIV. Efficacious and cost-effective interventions are available to increase HIV testing, care engagement, and adherence to antiretroviral therapy, although more research is needed into tailored interventions and resource allocation for this population.<sup>35</sup> Additionally, important socioeconomic disparities between white and black MSM need to be addressed because these might negatively affect the effectiveness of the interventions in the care continuum. Dynamic models are needed to assess the long-term outcomes of interventions for prevention that achieve parity in HIV transmission rates in black and white MSM. Furthermore, the transmission rate ratio should be used as a proximate indicator of the success of

programmes designed to reduce disparities in HIV between black and white MSM. In terms of policy, our results draw attention to the importance of the 2013 presidential executive order focusing on the HIV care continuum and the National HIV/AIDS Strategy's prioritisation of reducing HIV-related health disparities.<sup>21</sup> Also, our data show the urgent need for research towards a cure or a highly effective HIV vaccine, or both. In the absence of such transformational biomedical advances in HIV prevention, disparities by race in HIV incidence rate in MSM are likely to persist in the US epidemic in the foreseeable future.

#### Contributors

ESR conceived the idea for the study, and led the analysis and writing of the manuscript. GAM and PSS contributed to the concept development, analysis, and writing. CdR and JWC contributed to the concept development and writing of the manuscript. All authors have seen and approved the final version of the manuscript for publication.

#### Declaration of interests

We declare no competing interests.

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