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Black-White Disparities During an Epidemic: Life Expectancy and Lifespan Disparity in the US, 1980-2000[1]

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Abstract: Covid-19 has demonstrated again that epidemics can affect minorities more than the population in general. We consider one of the last major epidemics in the United States: HIV/AIDS from ca. 1980-2000. We calculate life expectancy and lifespan disparity (a measure of variance in age at death) for thirty US states, finding noticeable differences both between states and between the black and white communities. Lifespan disparity allows us to examine distributional effects, and, using decomposition methods, we find that for six states lifespan disparity for blacks increased between 1980 and 1990, while life expectancy increased less than for whites. We find that we can attribute most of this to the impact of HIV/AIDS.

JEL codes: I14, J15, N32

Keywords: AIDS, HIV, life expectancy, lifespan disparity

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1. Introduction

Health crises, such as the ongoing Covid-19 pandemic, affect countries in different ways, but a growing body of literature emphasizes that they can also have vastly differing impacts on different groups within societies. Thus, Furceri et al (2020) demonstrate that past pandemics have had a significant impact on inequality in incomes, and they present preliminary evidence that the distributional consequences of the current pandemic might be even larger. We turn to inequalities in length of life, and consider the most major recent pandemic, the Human Immunodeficiency Virus (HIV) / Acquired Immunodeficiency Syndrome (AIDS) in the United States. From the first case in 1981 until an effective treatment (HAART) became available in 1996[3], HIV ravished the United States and much of the rest of the world. In particular, we study differences in mortality between blacks[4] and whites in the US. We find, in common with previous findings, that the life expectancy of blacks was disproportionally affected by HIV, albeit with major regional differences between states in the US. Beyond analyzing life expectancy, we demonstrate that more can be learned from looking at variation in length of life or lifespan disparity.

Lifespan disparity is a measure that has been given great attention in the demographic literature, but is almost unheard of in economics. It expresses the uncertainty in the timing of death at the individual level and heterogeneity in underlying population health at the macro level. Lifespan disparity matters because uncertainty about how long a person will live can have important implications for decisions over the life course, such as optimal investments in education, savings, and age of retirement (Edwards 2013, Kalemli-Ozcan and Weil 2010, Kristensen 2020). It is, therefore, important that life expectancy (the first statistical moment of the distribution of lifespans) is complemented with indicators that account for variation in length of life (the second statistical moment) to quantify the true cost of epidemics on the longevity of minorities. Thus, as economists have considered the importance of measuring economic inequality via gross national income and further complement this indicator with the Gini coefficient to study how income varies within countries, mortality and health can be considered in a similar way (van Raalte et al 2018). Lifespan disparity is thus an additional and important measure for policymakers aiming to reduce inequality in health and economic status, since it provides information important for capturing inequality in economic status.

Although the current epidemic is still unfolding, evidence has been reported in the media that ethnic minorities might be more severely affected by COVID-19 than other groups in society. For example, almost one third of infections in the US have affected blacks, despite them only representing 13% of the population[5],

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[3] There is no cure for HIV, but treatment can help people with HIV live longer.

[4] This is the group coded by the CDC as 'Blacks or African Americans', but we will refer to them as blacks throughout.

[5] *National Geographic*, 'African Americans struggle with disproportionate COVID death toll', April 24, 2020, https://www.nationalgeographic.com/history/2020/04/coronavirus-disproportionately-impacts-african-americans/.

and black people have been found to be four times more likely to die from Covid-19 in the UK[6]. Similarly, in Sweden there is a fear that ethnic minorities have been at a higher risk of Covid-19 infection[7]. Sadly, however, such concerns are nothing new, and there is a wealth of studies on the black-white mortality gap in the US. Satcher et al (2005) find a persistence of health inequalities between 1960 and 2000 despite progress in closing the gap for civil rights, housing, education and income. Harper et al (2007), find that this gap narrowed between 1983-2003 due to relative improvements in homicides and HIV, (although it actually widened in the first decade, with half of this increase driven by HIV). Similarly, Harper et al (2014) calculated annual state-level life expectancies for blacks and whites from 1990 to 2009, finding significant national variation in the life expectancy gap, at a magnitude of just below 3 years to above 8 years. A number of studies then demonstrated that lifespans are more variable for blacks than for whites (see for example Edwards and Tuljapurkar 2005; Lynch et al. 2003; and Tuljapurkar and Edwards 2011), but the sources of this difference remained unexplored until the work of Firebaugh et al (2014). Using data for the US in 2010, they decompose the black-white difference in lifespan disparity by causes of death. They found that the gap in lifespan disparity was not so much due to blacks more often dying of causes which disproportionately strike the young and middle-aged, but rather because age at death varies more for blacks than whites in general.[8] We contribute to this literature by following the entire course of a pandemic, and calculating and comparing changes in life expectancy and lifetime disparity at the state level over time.

Thus, we demonstrate that the HIV epidemic in the US not only led to a stagnation in life expectancy for the black population between 1980 and 2000 in some states, but that for some parts of the country the setback in health for blacks came with the additional cost of increased lifespan disparity, which is the main contribution of the present work.[9] The reasons why blacks were harder hit is a topic for future research but is almost certainly connected to their lower socioeconomic status more generally (Franks et al 2006), and their distrust of public health advice and measures. Thus, Thomas and Quinn (1991) explain that many blacks at the time believed AIDS was a form of genocide perpetuated by whites, and trace this back to legitimate distrust of public health authorities beginning at the least with the Tuskegee syphilis trials, during which black men were passively monitored for syphilis despite effective treatment being available (see also Alsan and Wanamaker 2018). Higher lifespan disparity can reinforce the impact of socioeconomic inequalities by lowering investments in education. Thus, Kristensen (2020) demonstrates that for two populations differing

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[6] CNN, 'Black people in the UK four times more likely to die from Covid-19 than white people, new data shows', May 7, 2020, https://edition.cnn.com/2020/05/07/uk/uk-coronavirus-ethnicity-deaths-ons-scli-gbr-intl/index.html.

[7] *The Times*, 'Ethnic minorities bear the brunt of Sweden's coronavirus deaths', April 12, 2020, https://www.thetimes.co.uk/article/ethnic-minorities-bear-the-brunt-of-swedens-coronavirus-deaths-gh62g8hxp.

[8] Lariscy et al (2016) also uses data from 2010 but looks at the experience of Hispanics, finding that the life expectancy advantage of non-Hispanic whites is also the case for lifespan variability.

[9] Rashad (2008) finds that this period also saw unchanged levels of heights (a frequently used proxy for health) for blacks, whereas white heights increased slightly.

only in lifespan disparity, but with the same life expectancy, the optimal level of education will be lower as lifespan disparity increases, creating a vicious circle of underinvestment and worsening health outcomes.

The remainder of this paper proceeds as follows. In the following section, we introduce the concept of lifespan disparity, and in Section 3 we give a brief historical overview of the HIV/AIDS epidemic. In Section 4, we present our data and methodology, and Section 5 gives our results. Section 6 concludes.

2. Lifespan disparity: an indicator of inequalities in length of life

Life expectancy at birth is one of the most common metrics employed for summarizing mortality and the health status of populations. It expresses the average years a newborn is expected to live given the age-specific death-rates at a point in time. As an indicator of average mortality, life expectancy conceals substantial variation in length of life which can be measured by an index of variation or inequality (Tuljapurkar 2010), such as the standard deviation, years of life lost (lifespan disparity) or the interquartile range. Although life expectancy has historically been negatively correlated with lifespan disparity (Smits and Monden 2009 and Vaupel et al 2011), recent studies have found a positive association between these two indicators in some countries and subpopulations, often reflecting mortality crises at younger ages (Brønnum-Hansen 2017, García and Aburto 2019 and Permanyer et al 2019). Therefore, determining the health status of a population based only on life expectancy might lead one to ignore substantial divergences in the equality of health more generally.[10] For instance, two populations with approximately the same life expectancy can display very different levels and trajectories of lifespan disparity (Edwards and Tuljapurkar 2006).

Reductions in mortality at any age increase life expectancy, but will influence the variation differently. For lifespan disparity to decrease when life expectancy is increasing more lives need to be saved at younger rather than older ages (Aburto et al 2020). What constitutes “younger” or “older” depends on a well-defined threshold age that separates early from late death, usually around the level of life expectancy (Zhang and Vaupel 2009, Gillespie et al 2014, and Aburto et al 2019). A reduction in mortality below the threshold age will compress mortality and hence decrease variation, whereas a reduction in mortality in old age will increase the variation. Gillespie et al (2014) studies this divergence in age patterns of mortality and show that even while life expectancy has increased, lifespan inequality has varied greatly both within and among countries over the last six decades.

[10] See Gallardo-Albarrán (2018) for a country-level analysis of the relationships between health inequality between countries and economic development.

3. The HIV / AIDS epidemic in the US[11]

The first cases of HIV were reported in the US in 1981. In the absence of treatment HIV eventually leads to AIDS and death. As the 1980s progressed, HIV/AIDS became one of the leading causes of death, and in 1994 it became the *most common* cause of death for all Americans aged 25 to 44. To put this in perspective, by the end of October 1995, 500,185 AIDS cases had been reported in the US (HIV Surveillance reports 1982-1995), while 258,826 had died from the disease (CDC Wonder). A 2006 report by the National Minority Aids Council (NMAC) explains how New York City, including parts of the Metropolitan Area in New Jersey, was particularly hard hit. It was the epicenter of the US HIV epidemic, and its poorest neighborhoods, which are heavily populated by blacks, were particularly effected. Mortality was also high in cities with similar characteristics, such as the District of Colombia, Los Angeles County, and Chicago (Fullilove 2006). This provides, of course, a striking parallel to the present COVID-19 pandemic. The NMAC report continues with some speculations about why blacks were particularly affected, including unstable housing, meaning that families had less to spend on basic necessities, and a higher rate of incarceration, with infections contracted in prison spreading to communities upon release.

Several factors might have led to the decline of HIV. An important factor was the breakthrough in 1985, when the first commercial blood test for HIV was licensed, allowing those affected to actively avoid passing on the infection. This initiated reporting of HIV in Minnesota, Colorado and Wisconsin in the same year. Testing and reporting of HIV cases was introduced by all states over the next 18 years, with the last being Georgia in 2003[12] (Institute of Medicine (US), 2004).The second major factor for the decline of HIV was the production of the first antiretroviral medication, azidothymidine (AZT), which became available in 1987, although it was not until the introduction of active antiretroviral treatment (HAART) in 1996, that treatment seems to have had an effect on mortality. Thus, in 1997 the Centers for Disease Control and Prevention (CDC) reported the first substantial decline in HIV/AIDS deaths (Lichtenberg 2003).

To provide some context to our findings on lifespan disparity, Figure 1 presents the HIV crude death rates, and Figure A1 in the appendix shows the HIV age standardized death rate, ASDR[13], for blacks and whites for the years 1980, 1990 and 2000 by state, which shows similar patterns. First, what is striking is that the death rates from HIV/AIDS were higher for blacks than for whites, in all states, and at all times: In 1990 blacks died

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[11] This section draws heavily on *AIDS.gov: A timeline of HIV/AIDS*, https://www.hiv.gov/sites/default/files/aidsgov-timeline.pdf [Retrieved: May 18 2020].

[12] By the end of 2003 all states had some type of HIV reporting, either name-based, code-based or some combination of the two systems. By 2008 all states had a name-based system similar to the AIDS reporting system.

[13] Using the white population share in 1980 in Alabama as the standard population. Having one standard population allows us to compare death rates over time, across races and between states. In contrast to CDR, the ASDR takes into consideration the possible difference in the age structure between blacks and whites, and the change in age structure over time.

at a rate three times higher than whites, and in 2000 death rates from HIV/AIDS were more than eight times greater for blacks compared to whites (see Table A1). This was particularly the case in states such as New Jersey, which was among those hit hardest. Figure A2 and Table A1 in the appendix further demonstrate that all-causes age standardized death rates were on average 1.39 and 1.35 times higher for blacks in 1990 and 2000 respectively. Already in 1986, the CDC reported that HIV/AIDS cases were disproportionally affecting blacks, although it was not until 1998 that Congress voted to fund the *Minority AIDS Initiative* to improve the effectiveness in preventing and treating HIV/AIDS among blacks, Hispanics, and other minority groups.

Second, it is clear that the epidemic rolled out very differently across states. Thus, Figure 1 also displays the timing of when the reporting of HIV cases in each state was introduced as a supplement to the mandatory AIDS reporting system (green), and when the HAART treatment was made available (orange). We see this as some preliminary evidence that early reporting was usually linked to smaller and more controlled outbreaks. Clearly HAART, being a successful treatment, led rapidly to declines in mortality, although this was more marked for whites than for blacks, possibly due to unequal access of the latter to healthcare more generally (Levine et al 2007, 2010). We leave a more formal analysis of this to future research. The findings of Collazos et al (2007) show that women obtain additional benefits from HAART over men during the initial phases of treatment.

The demographic characteristics of HIV cases and deaths has changed over time – not only has it shifted towards blacks but also towards women (Fenton 2007), Figure A3 in the appendix illustrates the fact that all states witnessed a higher rate of HIV deaths among men than women. However, the composition changed over time, so that relatively more women died from HIV in 2000 compared to 1990. In both 1990 and 2000, the share of black women was higher than the share of white women. The pattern across states seems similar, but with some variation. Beyond the factors touched on above, the aforementioned NMAC report notes that black homosexual men were the worst affected group[14]. This is attributed to a number of factors: that they were tested less frequently, and at a later stage of the infection, and might therefore be more likely to pass the disease on to others; they had higher rates of sexually transmitted diseases, which can facilitate the transition and acquisition of HIV; and they were less likely to identify as gay and disclose their sexual behavior to others due to a stigma attached to being black and homosexual. Given that the report was published fourteen years ago, it is distressing that many of the report's policy suggestions are no less relevant today: that the root causes of the health disparities affecting black communities should be addressed, including unstable housing, incarceration, poverty, and, particularly relevant in the case of combatting HIV, the stigma surrounding homosexuality. This latter has however been countered somewhat since 2006, for

[14] The disease was first discovered among white homosexual men.

example with Barack Obama's critique shortly before coming president: "If we are honest with ourselves, we'll acknowledge that our own community has not always been true to Martin Luther King's vision of a beloved community ... We have scorned our gay brothers and sisters instead of embracing them"[15].

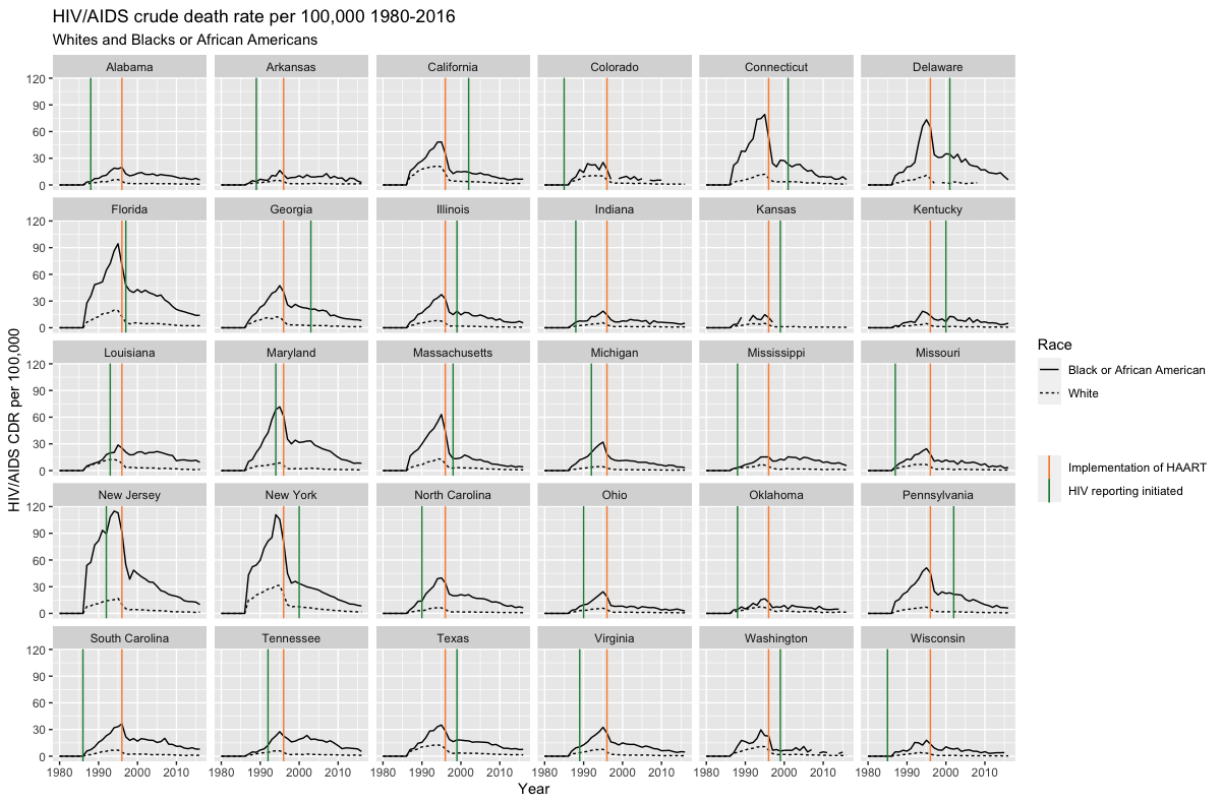


Figure 1: HIV/AIDS crude death rate per 100,000 for whites and blacks in the 30 states included 1980-2000

Source: CDC data.

4. Data and methodology

We restrict our sample to include states with at least five percent share or 100,000 total of black population in 1980, leaving us with a total of thirty states.[16] Then, all-cause death counts as well as deaths due to HIV/AIDS[17] for each state in the years 1980, 1990 and 2000 were downloaded from the CDC[18]. Due to confidentiality restrictions all sub-national data with zero to nine deaths are suppressed from the CDC database, and these data have therefore been supplemented manually from the Vital Statistics for the years

[15] Harwood, Matthew (28 March 2008). "Obama Takes On The Black Community's Homophobia". *Huffington Post*.

[16] Alabama, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, and Wisconsin.

[17] From 1979-1998 death from HIV had the ICD-9 codes 024-044, from 1999-2016 death from HIV had the ICD-10 codes B20-B24.

[18] CDC Wonder (Compressed Mortality) [Retrieved: April 8 2020]

1990[19] and 2000[20]. This gives us three years: 1980 from before the first HIV death, 1990 during the pandemic, and 2000 after the peak of the epidemic which came before the introduction of HAART in 1996. From the CDC, data was available for those under 1 year, and thereafter in 5-year age groups from ages 1-24, and then in 10-year age groups from 25-84 years, and with an open-ended group of 85+. The Vital Statistics from 1990 only provides counts of deaths in 10-year age groups except for those under 1, and 1-4 years. Again, the death count for those 85+ are grouped as one category. The Vital Statistics from 2000 provide deaths counts individually for those under 1 year, and hence at 5-year intervals for all ages up until 99, and group deaths counts for those 100+ years. From CDC the corresponding sub-national denominator population is also suppressed if deaths counts are between zero and nine, and so population data by sex, race, age group and state have been collected separately, also from CDC[21].

To increase accuracy and comparability, death counts and population estimates were ungrouped into single years of age using efficient estimation of smooth distributions with a penalized composite model (Rizzi et al 2015). After ungrouping deaths into single age and generating state and race/ethnicity-specific lifetables for the 30 states included in the sample, life expectancy and lifespan disparity were estimated for whites and blacks individually for the years 1980, 1990 and 2000 for all 30 states.

We use lifespan disparity ($e^{\dagger}$) as indicator of variation in length of life (Vaupel and Canudas-Romo 2003). We chose $e^{\dagger}$ (pronounced "e-dagger") because of its easy interpretation and because of its decomposition properties. $e^{\dagger}$ is measured in years and quantifies average years of life lost due to death (or alternatively the average remaining life expectancy at death). The measure has an additive property, which means that after being decomposed by age between two periods, the sum of each age group's contribution to $e^{\dagger}$ is simply the total change in $e^{\dagger}$ between the two periods (Shkolnikov et al 2011). In the demographic literature various measures/indicators have been proposed to analyze lifespan variation and they are highly correlated when measured from birth, which suggests that our results would not change using other indicators (see Wilmoth and Horiuchi 1999, and Van Raalte and Caswell 2013).

To disentangle the contribution of specific ages and causes of death to the change in life expectancy and lifespan disparity, we apply the linear integral decomposition model by Horiuchi et al 2008, and use numerical integration algorithms to estimate age and cause specific effects. Suppose f (e.g. $e^{\dagger}$ or life expectancy) is a differentiable function of n covariates (e.g. each age-cause specific mortality rate) denoted by the vector

[19] https://www.cdc.gov/nchs/products/vsus/vsus_1980_2003.htm Vital Statistic of the United States 1990. Volume II, Mortality Part A. Table 1.42: Deaths and death rates for Human immunodeficiency virus infection, by 10-year age groups, race, and sex: Unites States and each State, 1990. Vital Statistic of the United States 1990. Volume II, Mortality Part B. Table 8.3: Deaths by 10-year age groups, race, and sex, for metropolitan and nonmetropolitan countries: United States and each States, 1990.

[20] https://www.cdc.gov/nchs/nvss/mortality/gmwkiii.htm (GMIII_1_2000). Tables III. Deaths from 358 selected causes by 5-year age groups, race, and sex: U.S and each State, 2000. Human immunodeficiency virus (HIV) disease (B20-B24) and all causes.

[21] CDC Wonder (Bridged-Race Population (from NCHS))

$\mathbf{A} = [\mathrm{x}_1, \mathrm{x}_2, \ldots, \mathrm{x}_\mathrm{n}]^\mathrm{T}$. Assume that f and $\mathbf{A}$ depend on the underlying dimension t, which is time in this case, and that we have observations available in two time points t_1 and t_2. Assuming that $\mathbf{A}$ is a differentiable function of t between t_1 and t_2, the difference in f between t_1 and t_2 can be expressed as follows:

$$f_2 - f_1 = \sum_{i=1}^{n} \int_{x_i(t_1)}^{x_i(t_2)} \frac{\partial f}{\partial x_i} dx_i = \sum_{i=1}^{n} c_i,$$

where c_i is the total change in f (e.g. $\mathrm{e}^\dagger$ or life expectancy) produced by changes in the i-th covariate, x_i. This approach has been previously used to analyze lifespan disparity and life expectancy (e.g. Aburto and van Raalte 2018).

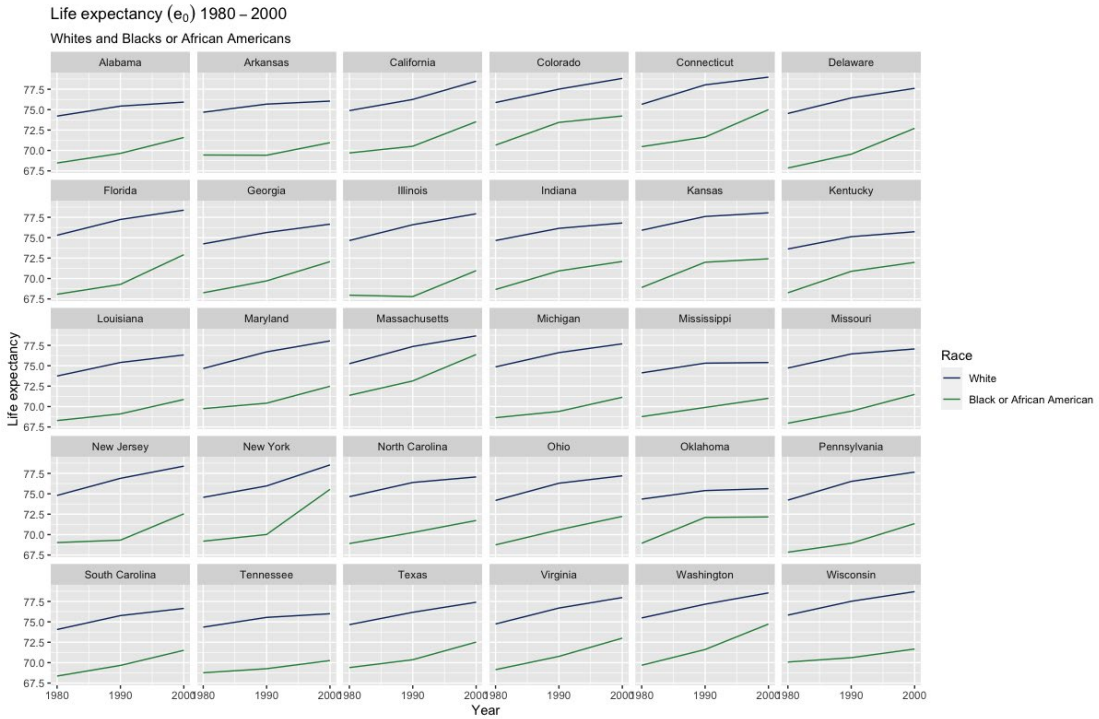
5. Results

Trends in life expectancy and lifespan disparity

Figure 3 illustrates life expectancy and lifespan disparity by year and state, divided into white and black. Panel (a) gives the general picture which reflects that life expectancy was increasing over the period 1980-2000 and was higher for whites than for blacks. Thus, in 1980 the average gap in life expectancy between whites and blacks was 5.7 years, increasing to 6.1 years in 1990, and returning to 5.6 years in 2000. The gap increased in 1990 as a result of a lower increase in life expectancy for the black population in several states, compared with that for the white population. In fact, not only did life expectancy stagnate for blacks in some states between 1980 and 1990, two states even experienced a decrease in life expectancy for blacks (Arkansas, 0.03 years and Illinois, 0.17 years). From 1990-2000, on the other hand, the increase in life expectancy slowed for the white population compared to the black population, thus narrowing the gap between whites and blacks again.

From Figure 3 (b) it can be observed that lifespan disparity, which is higher for blacks in all states, was unchanged or even increased for the black population in some states between 1980 and 1990. For the white population lifespan disparity on the other hand had decreased steadily, for all states except California and New York where it was almost unchanged from 1980-1990. The lifespan disparity gap between blacks and whites in 1980 was on average 3 years (lowest in Washington at 2 years, highest in South Carolina at 4.2 years), it increased to 3.2 years in 1990 (lowest in Kentucky at 1.9 years, highest in New Jersey at 4.78 years), and in 2000 it fell to 2.7 years (lowest in Washington at 1.4 years, highest in Illinois at 3.79 years).

(a) Life expectancy



(b) Lifespan disparity

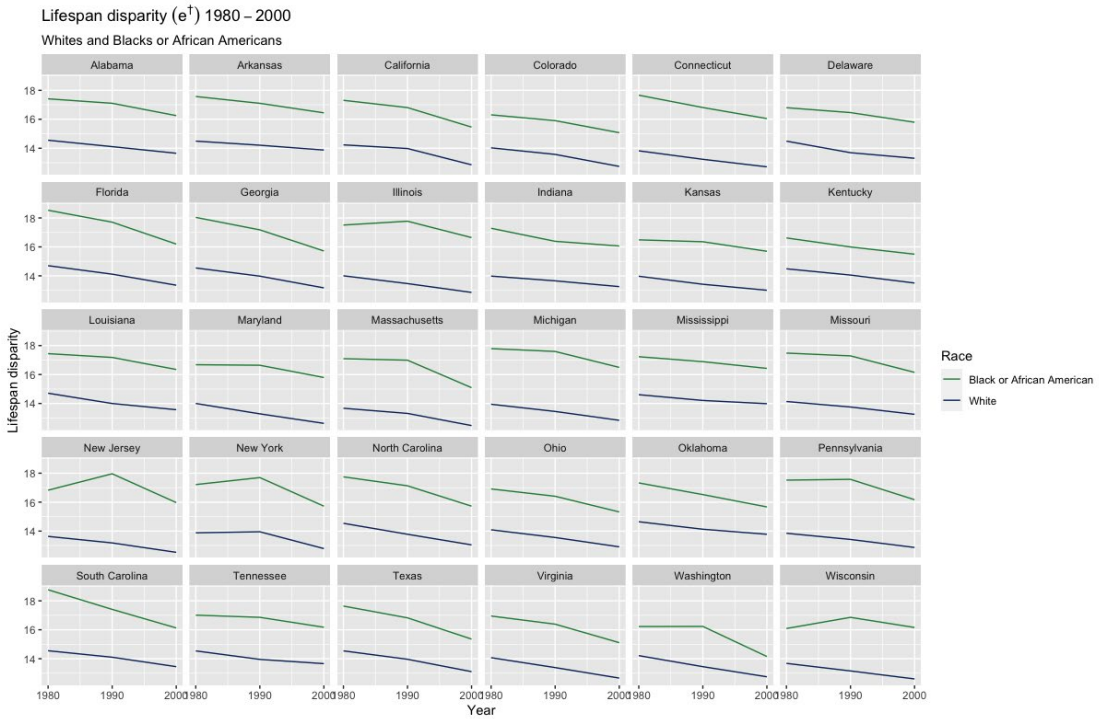


Figure 3: Trends in (a) life expectancy (e_0) and (b) lifespan disparity $(e^{\dagger})$ for blacks and whites in the 30 states included 1980-2000

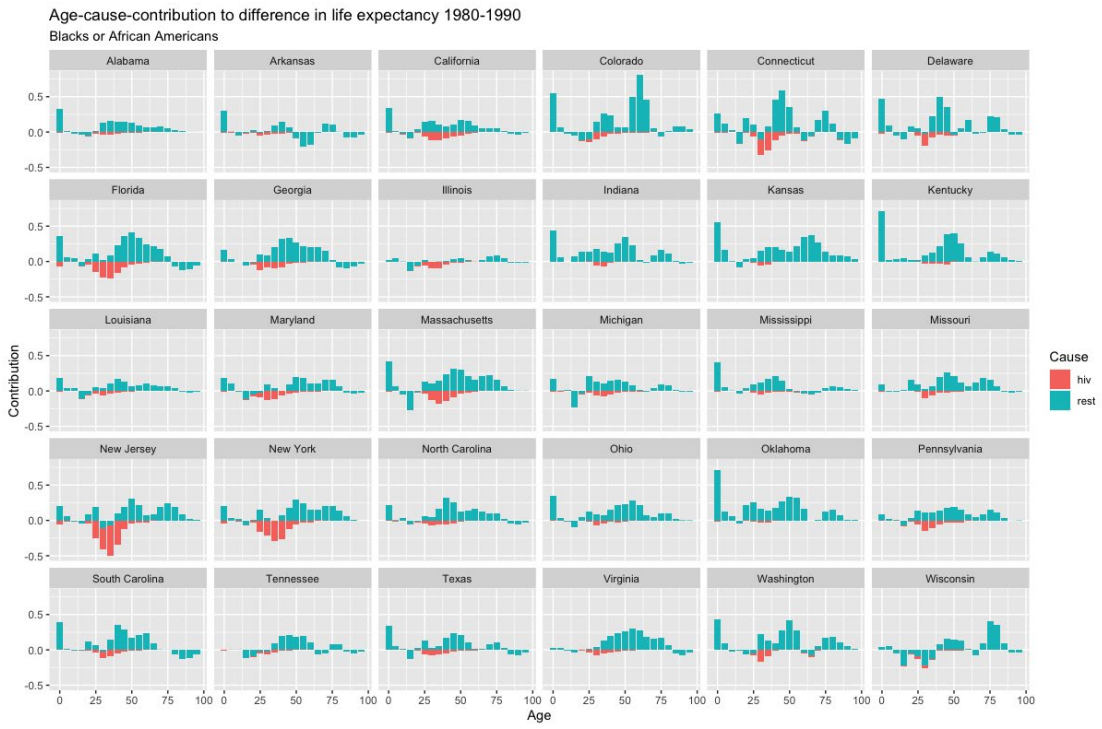
Source: Own calculations based on CDC data.

It is especially interesting to note that the data display examples of states, such as New York, where lifespan disparity increased for blacks at the same time as life expectancy was increasing. This is historically unusual, and illustrates the point made above, that diseases which predominantly affect the young can increase lifespan disparity, with potentially large consequences on educational investment decisions, for example. We proceed to use decomposition techniques to reveal the contribution of AIDS to developments in life expectancy (e_0) and lifespan disparity ($e^\dagger$), and hence the increased health gap between whites and blacks.

Decomposition of changes in life expectancy and lifespan disparity

We decompose the change in life expectancy and lifespan disparity between 1980-1990 and 1990-2000 for blacks and whites for our thirty states. In the following, we focus on the first period and present the results for 1990-2000 in the appendix only, since the treatment, HAART, would be expected to divide the second period into both divergence and convergence periods, thus making the results difficult to interpret. In the graphs below, we illustrate the age-cause-specific decomposition of changes in life expectancy and lifespan disparity between 1980 and 1990 for blacks and whites separately. The contribution of HIV is displayed separately as red bars. The sum of all the bars (blue and red) is the total change over the given period. Thus, if for example the red bar gives a negative number, it means that, *ceteris paribus*, the counterfactual life expectancy or lifetime disparity from that age group would have been higher if it had not been for the negative impact of HIV. Figure 4 (Age-cause-contribution e_0) shows the age-cause-specific decomposition of the change in life expectancy between 1980 and 1990 for (a) blacks and (b) whites, respectively, and Figure 5 gives the corresponding graph for lifespan disparity. Figures A4 and A5 in the appendix provide the same for the period 1990-2000.

(a) Blacks



(b) Whites

Figure 4: Age-cause-specific contribution to the change in life expectancy (e_0) for (a) blacks and (b) whites, 1980-90

Source: Own calculations based in CDC data.

(a) Blacks

(b) Whites

Figure 5: Age-cause-specific contribution to the change in lifespan disparity $(e^{\dagger})$ for (a) blacks and (b) whites, 1980-90

Source: Own calculations based in CDC data.

Figure 4 (and Table A4 in the appendix giving the HIV-specific contribution to the black-white gap) reveals that, for the white population, in all states, life expectancy increased, with the major contribution coming from the middle-aged population, aged 50-75. Only very few states experienced a setback in mortality from any other cause than HIV, with deaths from HIV dominating for the age range 25-50. The corresponding graph for blacks, however, shows a rather different picture. As for whites, the ages 40-60 are those contributing the most to increasing life expectancy, although for some states those aged 0-5 also contribute considerably. Deaths from HIV in the ages 25-45 are the main cause of decreases in life expectancy, although several states also experienced a contraction in life expectancy from those aged 15-20, which was not caused by HIV.

In the state of Arkansas, which was one of the states that experienced a decrease in life expectancy for blacks, even in the absence of HIV life expectancy would only have increased by 0.14 years over the 10-year period. Arkansas alone had a substantial setback in life expectancy for those aged 55-65. As the other state with a decrease in life expectancy, Illinois had no major improvement in life expectancy for any age groups which could outweigh the decrease introduced from HIV, even though the impact of HIV was not substantial compared to other states. The states that were hit the hardest by HIV, listed by the impact on the black community, are New Jersey, where life expectancy could potentially have increased by 1.71 years for blacks and 0.25 years for whites in the absence of HIV, followed by New York (1.27 years blacks, 0.54 years whites), Florida (1.1 years blacks, 0.3 years whites), Connecticut (0.83 years blacks, 0.14 years whites), Massachusetts (0.69 years blacks, 0.15 years whites), California (0.57 years blacks, 0.42 years whites), Maryland (0.52 years blacks, 0.12 years whites), Pennsylvania (0.51 years blacks, 0.11 years whites), and Georgia (0.5 years blacks, 0.2 years whites).

Turning to lifespan disparity, Figure 5 (and Table A5 in the appendix giving the HIV-specific contribution to the black-white gap) reveals that six states, Illinois, New Jersey, New York, Pennsylvania, Washington and Wisconsin, had an increase for blacks between 1980-1990. In New York, Pennsylvania and Washington, in the absence of HIV, lifespan disparity could potentially have decreased between 0.17 and 0.21 years. In Illinois the total increase in lifespan disparity between 1980 and 1990 was 0.26 years, whereas HIV accounted for 0.19 years of the increase. In New Jersey it increased by 1.14 years, of which HIV contributed with 0.94 years. The increase in Wisconsin was 0.77 years, but only a very limited part of this was due to HIV (0.08 years) – the increase in these three states is also due to the fact that lives above the threshold age for blacks were saved, which increased lifespan disparity. Only New York had an increase in lifespan disparity for whites of 0.07 years, with HIV contributing by 0.36 years to the increase, meaning that in the absence of HIV lifespan disparity for whites in New York would have decreased.

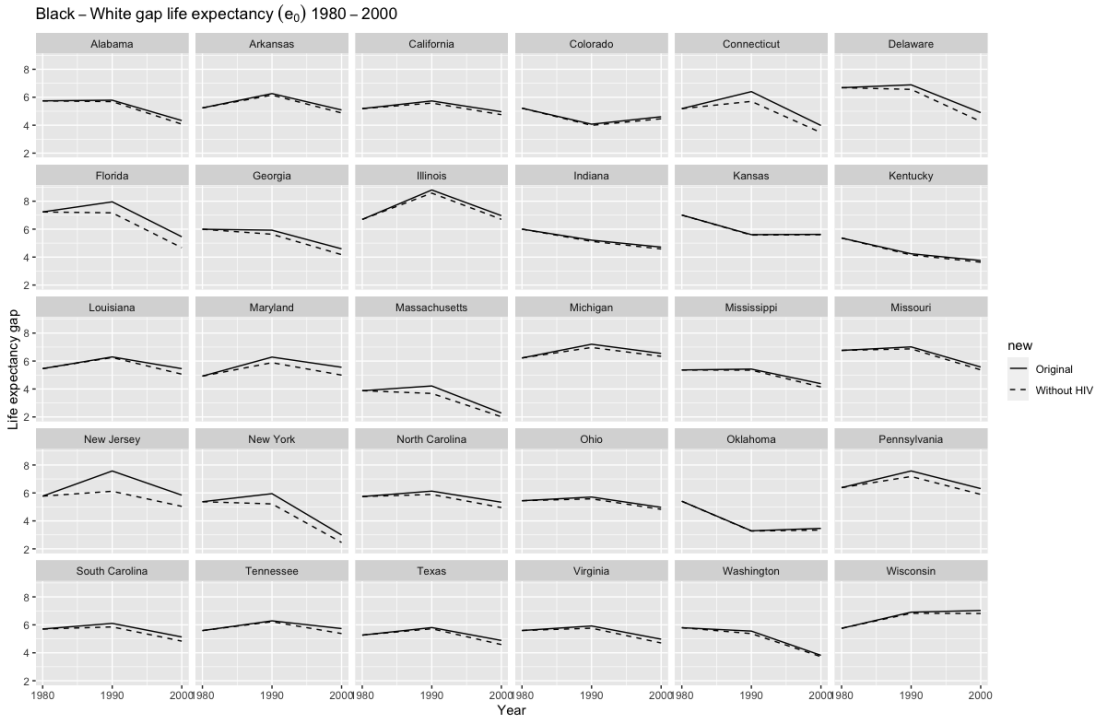
Figure A4 in the appendix shows the same decomposition for the period 1990 to 2000. The gains in life expectancy, e_0, is due to the reduction in HIV mortality in 2000 compared to 1990. In general, the black

population experienced greater increases in life expectancy over this period compared to the white population, and this is true for all states. No states witnessed a reduction in life expectancy for the white population due to HIV. Several states, did however experience a 'setback' in life expectancy for the black population due to HIV, namely Alabama, Arkansas, Delaware, Indiana, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, Tennessee, Texas, Virginia and Wisconsin, with Tennessee expressing the largest reduction – in the absence of HIV life expectancy would have increased by an additional 0.25 years.

As for lifespan disparity between 1990 and 2000, Figure A4 in the appendix reveals that this was higher for blacks than for whites, with the reduction in HIV deaths contributing somewhat to this, but there was also generally a greater improvement for all other causes for blacks than for whites. Delaware, Louisiana and Tennessee are the only three states where lifespan disparity would have decreased more in the absence of HIV (in the range of 0.07 to 0.13 years).

The obvious counterfactual is therefore to consider what life expectancy and lifespan disparity would have looked like in the absence of HIV. Figure 6 presents the gap between black and white for the period 1980-2000, with the levels given in Figure A6 in the appendix, and summaries in Tables A2 and A3. In the absence of HIV the gap in life expectancy between blacks and whites in 1980 would of course be unchanged at 5.7 years, but in 1990 it would have been 5.8 years (compared to 6.1 years in reality), and in 2000 4.7 years (compared to 5 years in reality). Lifespan disparity would again of course be unchanged in 1980 at 3 years, but in 1990 it would have been 3.1 (compared to 3.2), and in 2000 the gap could have narrowed to just 2.6 (compared to 2.7). An average improvement of 0.1 years might not seem large but seen in the light of the fact that lifespan disparity in average for blacks only improved by 0.3 years from 1980 to 1990, it is still considerable. Table A4 and A5 in the appendix reveal the variation across states in the black-white gap in life expectancy and lifespan disparity. They show the actual life expectancy gap and lifespan disparity gap between blacks and whites and how much of this gap was caused by HIV. They also show the counterfactual gaps (without HIV).

(a)



(b)

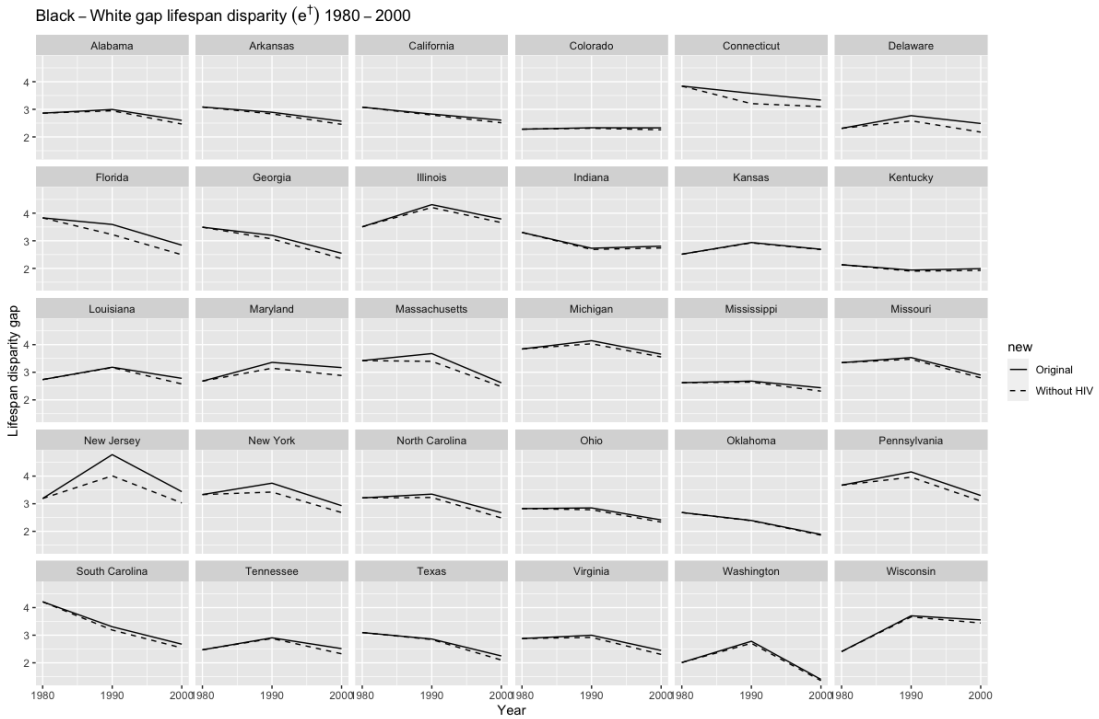


Figure 6: Gap in (a) life expectancy (e_0) and (b) lifespan disparity $(e^\dagger)$ between blacks and whites, compared with gap in the absence of HIV (dotted line)

Source: Own calculations based on CDC data and age-cause decomposition.

6. Conclusion

Life expectancy and lifespan disparity for thirty US states during the HIV/AIDS epidemic of ca. 1980-2000 demonstrate noticeable differences both between states and between the black and white communities. We find that for some states lifespan disparity for blacks actually increased between 1980 and 1990, while life expectancy increased less than for whites. Using decomposition methods we show that most of this can be attributed to the impact of HIV/AIDS. In summary, on average HIV cost blacks 0.42 years in life expectancy between 1980 and 1990, where the corresponding setback for whites was only 0.15 years. Over the whole period 1980-2000 the difference was even more substantial, with blacks losing 0.37 years in life expectancy while the figure for whites was just 0.05 years. Similarly, lifespan disparity for blacks would have decreased by an additional 0.23 years from 1980-1990 (on average) in the absence of HIV, whereas for whites this was only 0.1 years. Finally, for the whole period 1980-2000, the figures were 0.19 years for blacks and 0.04 years for whites[22]. In fact, HIV can, on average for the 30 states included, account for a far from trivial 75 percent of the *increased* gap in life expectancy between blacks and whites between 1980 and 1990, and 50 percent of the *increase*d gap in lifespan disparity in the same period.

Subsequently, the introduction of the HAART treatment, by reducing the impact of the virus on both measures, benefited black communities the most, presenting valuable opportunities for future research, not least given the similar divide during the present pandemic.

[22] Decomposition by age-cause-contribution to changes in of life expectancy and lifespan disparity between 1980 and 2000, can be shown on request.

Appendix

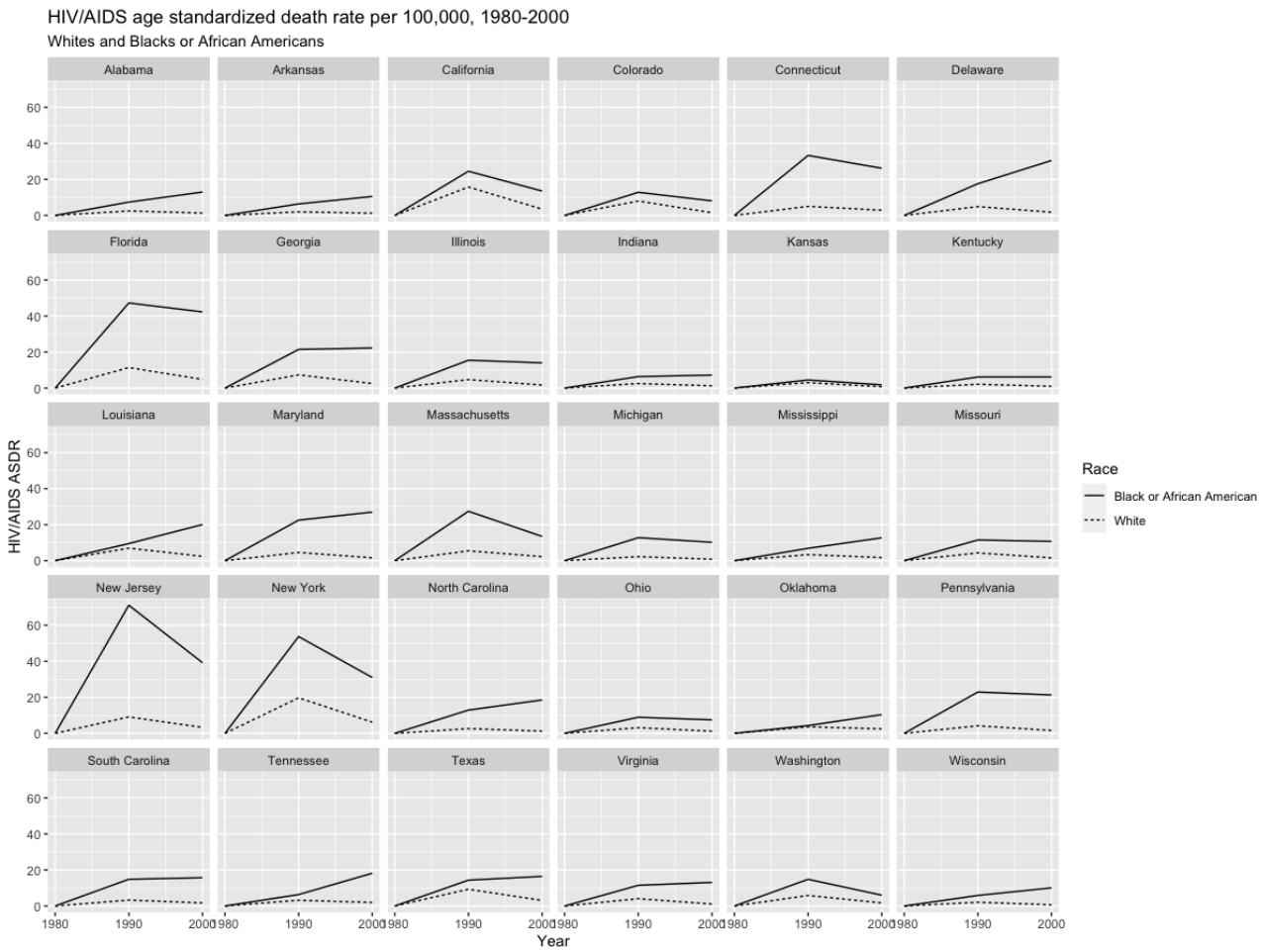


Figure A1: HIV age standardized death rate per 100,000 for whites and blacks in the 30 states included 1980-2016

Source: Own calculation based on CDC data, from 1980-1998 death from HIV had the ICD-9 codes 024-044, from 1999-2016 death from HIV had the ICD-10 codes B20-B24.

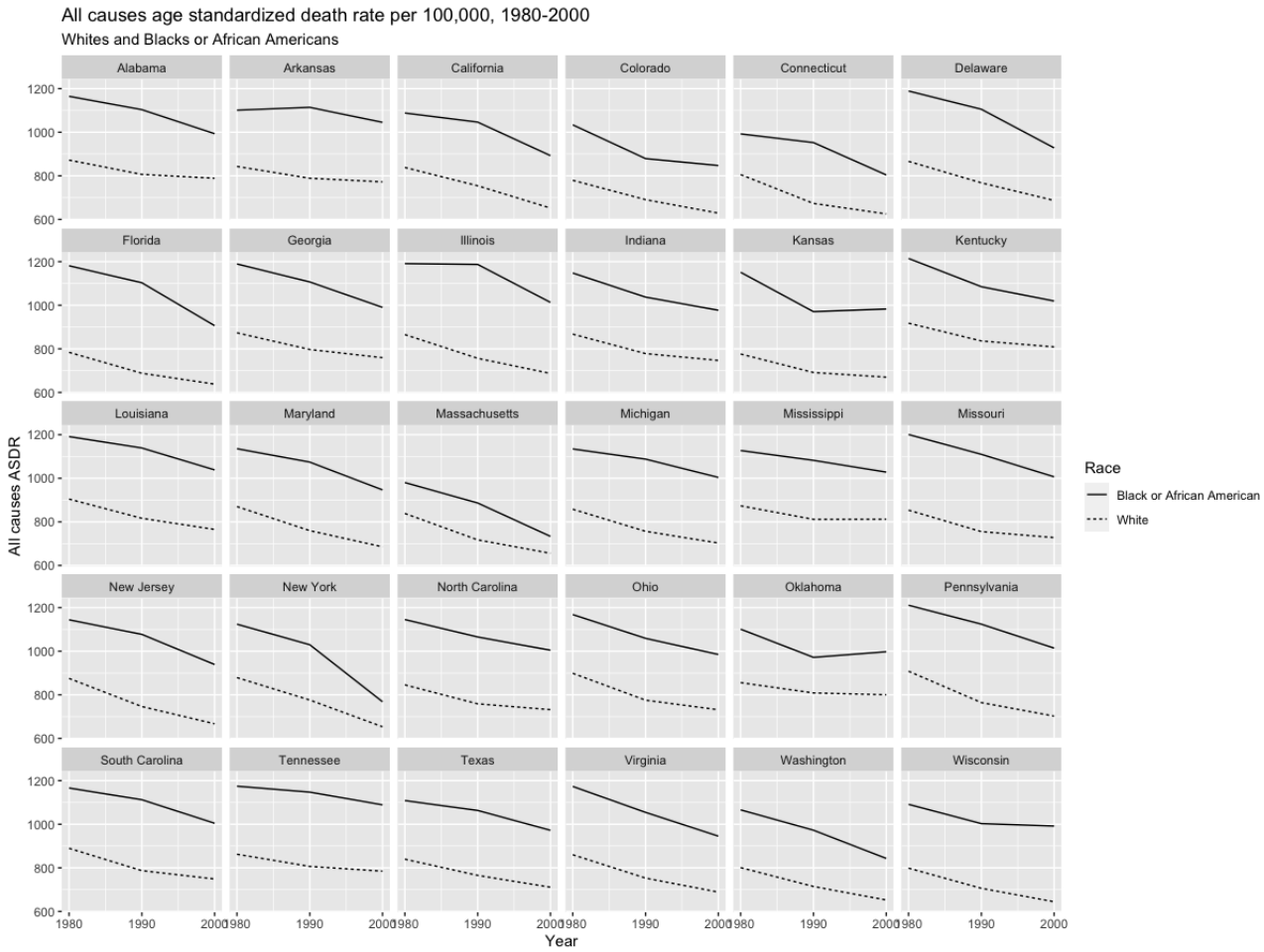


Figure A2: All causes age standardized death rate per 100,000 for blacks and whites in the 30 states included, 1980-2000

Source: Own calculations based on CDC data.

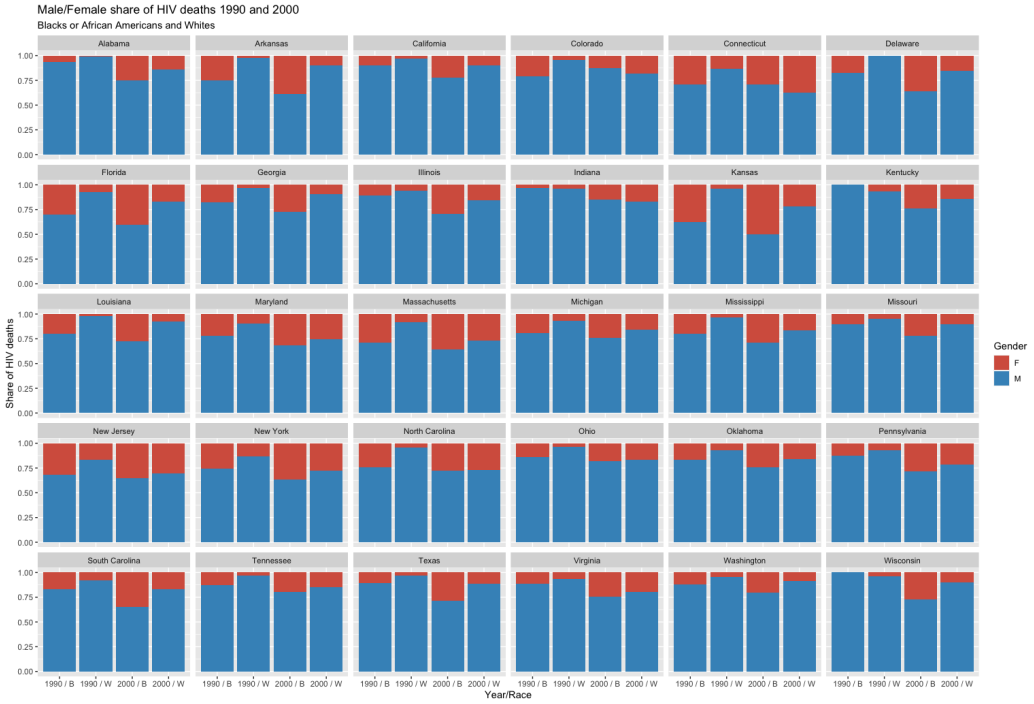
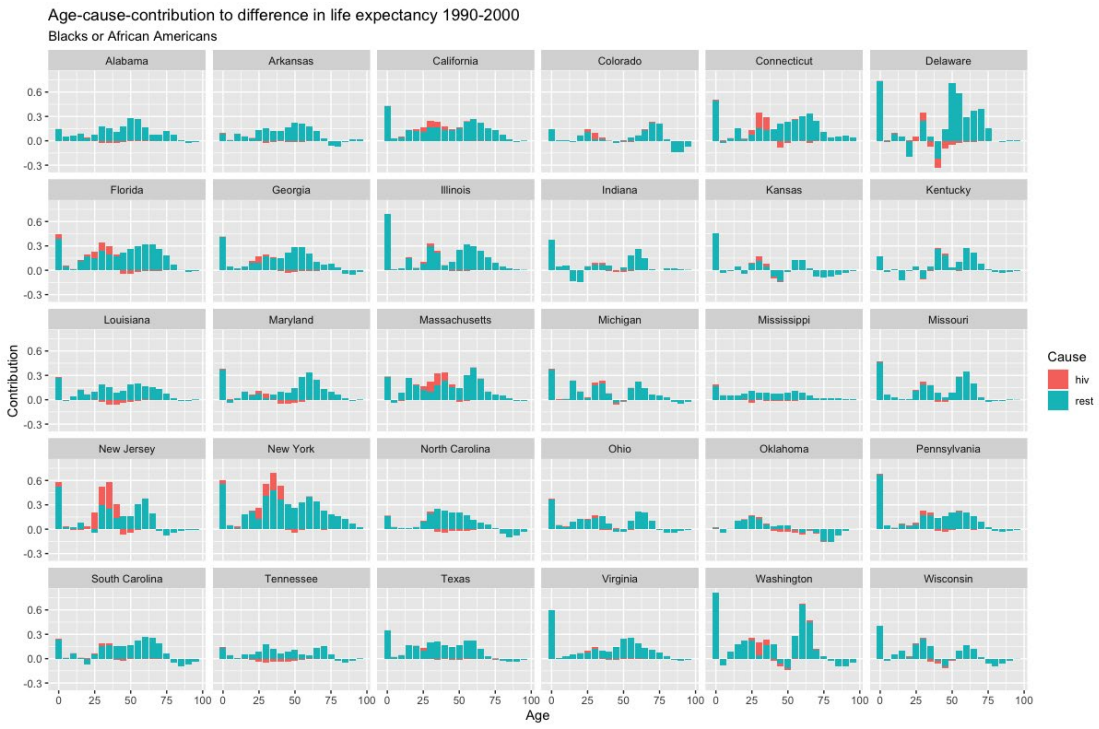


Figure A3: Gender share of HIV deaths for blacks and whites in 1990 and 2000

Source: Own calculations based on CDC data

(a)



(b)

Figure A4: Age-cause-specific contribution to the change in life expectancy for (a) blacks and (b) whites, 1990-2000

Source: Own calculations based on CDC data.

(a)

(b)

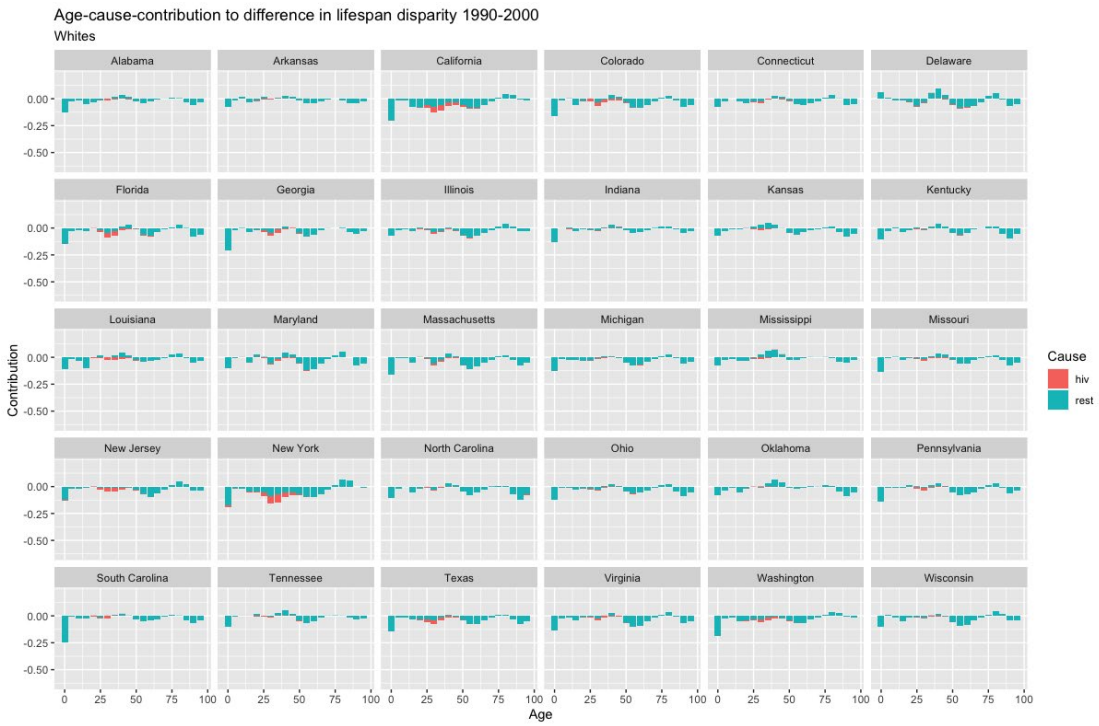
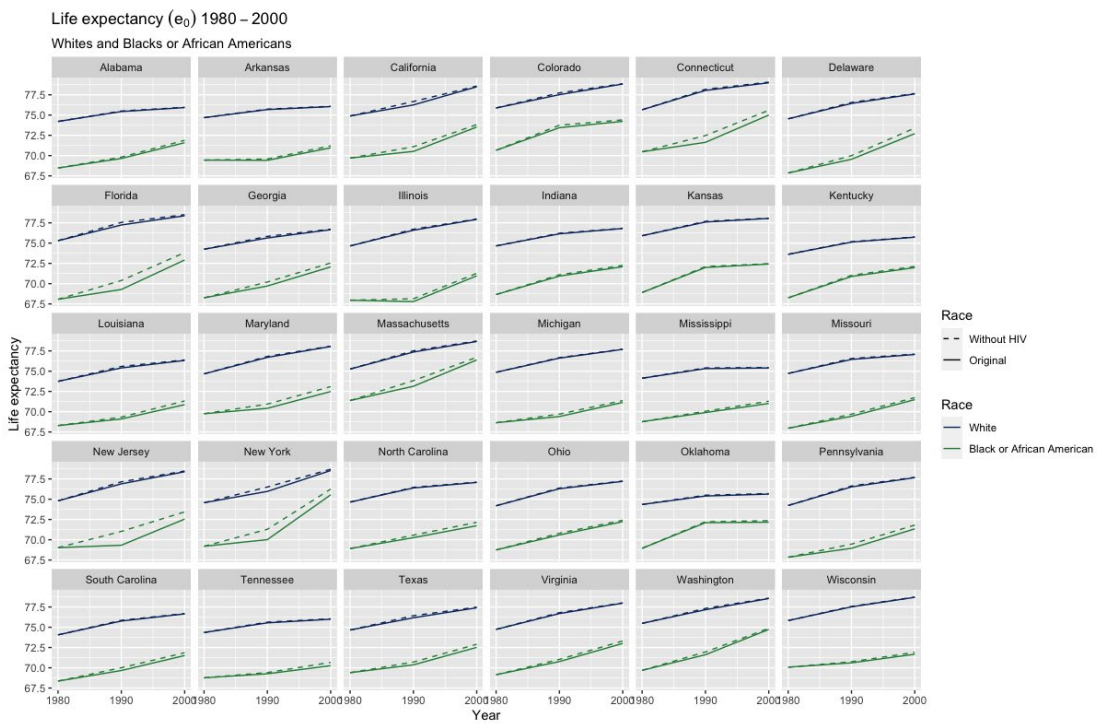


Figure A5: Age-cause-specific contribution to the change in lifespan disparity for (a) blacks and (b) whites, 1990-2000

Source: Own calculations based in CDC data.

(a)



(b)

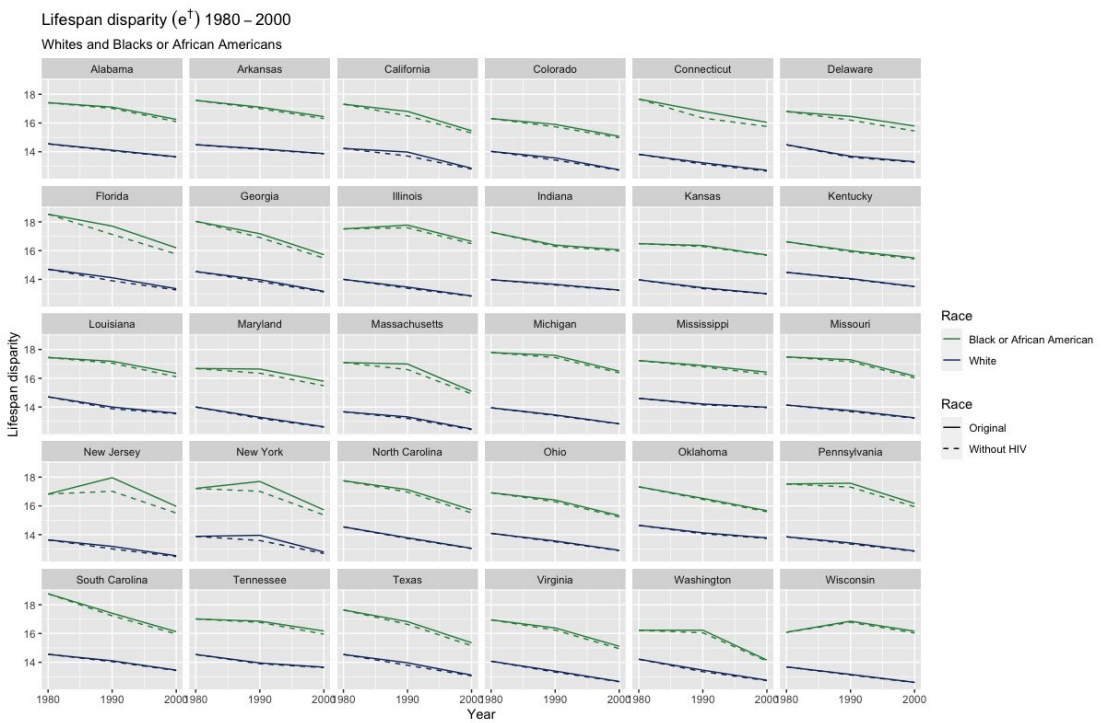


Figure A6: Trends in (a) life expectancy (e_0) and (b) lifespan disparity $(e^{\dagger})$ for blacks and whites in the 30 states included, 1980-2000, compared with trend in the absence of HIV (dotted line)

Source: Own calculations based on CDC data and age-cause decomposition.

Table A1: Summary statistics for HIV CDR and ASDR and all cause CDR and ASDR

	1980 (N=30)	1990 (N=30)	2000 (N=30)	Overall (N=90)
HIV CDR per 100,000 (whites)				
Mean (SD)	0 (0)	6.59 (5.21)	2.59 (1.65)	3.06 (4.14)
Median [Min, Max]	0 [0, 0]	4.84 [2.16, 23.8]	2.13 [0.860, 8.24]	2.13 [0, 23.8]
HIV CDR per 100,000 (blacks)				
Mean (SD)	0 (0)	20.0 (18.4)	18.9 (11.7)	13.0 (15.5)
Median [Min, Max]	0 [0, 0]	14.1 [5.13, 84.2]	15.8 [2.59, 48.6]	9.64 [0, 84.2]
Relative B-W HIV CDR				
Mean (SD)	NA (NA)	3.17 (1.63)	7.86 (3.66)	5.51 (3.67)
Median [Min, Max]	NA [NA, NA]	2.61 [1.23, 7.61]	7.42 [2.61, 16.4]	4.68 [1.23, 16.4]
Missing	30 (100%)	0 (0%)	0 (0%)	30 (33.3%)
HIV ASDR per 100,000 (whites)				
Mean (SD)	0 (0)	5.55 (4.12)	2.03 (1.21)	2.53 (3.36)
Median [Min, Max]	0 [0, 0]	4.25 [2.01, 19.7]	1.70 [0.683, 6.20]	1.70 [0, 19.7]
HIV ASDR per 100,000 (blacks)				
Mean (SD)	0 (0)	17.9 (15.6)	16.6 (9.80)	11.5 (13.3)
Median [Min, Max]	0 [0, 0]	12.9 [4.32, 71.1]	13.5 [1.80, 42.3]	8.53 [0, 71.1]
Relative B-W HIV ASDR				
Mean (SD)	NA (NA)	3.32 (1.65)	8.71 (3.94)	6.02 (4.05)
Median [Min, Max]	NA [NA, NA]	2.88 [1.19, 7.80]	8.47 [2.46, 17.1]	5.01 [1.19, 17.1]
Missing	30 (100%)	0 (0%)	0 (0%)	30 (33.3%)
All causes CDR pr 100,000 (whites)				
Mean (SD)	905 (99.3)	924 (92.5)	991 (99.9)	940 (103)
Median [Min, Max]	898 [709, 1130]	918 [711, 1110]	990 [726, 1190]	942 [709, 1190]
All causes CDR pr 100,000 (blacks)				
Mean (SD)	861 (150)	855 (142)	815 (112)	843 (135)
Median [Min, Max]	877 [530, 1110]	873 [549, 1100]	843 [577, 988]	868 [530, 1110]
Relative B-W all cause CDR				
Mean (SD)	0.957 (0.175)	0.927 (0.140)	0.825 (0.101)	0.903 (0.152)
Median [Min, Max]	0.980 [0.593, 1.21]	0.969 [0.621, 1.15]	0.848 [0.624, 0.987]	0.899 [0.593, 1.21]
All causes ASDR pr 100,000 (whites)				
Mean (SD)	853 (37.8)	760 (42.1)	711 (57.3)	775 (75.1)
Median [Min, Max]	861 [776, 918]	762 [674, 836]	703 [625, 812]	776 [625, 918]
All causes ASDR pr 100,000 (blacks)				
Mean (SD)	1140 (59.9)	1060 (73.2)	957 (84.3)	1050 (103)
Median [Min, Max]	1150 [980, 1210]	1080 [879, 1190]	988 [733, 1090]	1060 [733, 1210]
Relative B-W all cause ASDR				
Mean (SD)	1.33 (0.0631)	1.39 (0.0823)	1.35 (0.0876)	1.36 (0.0818)
Median [Min, Max]	1.32 [1.17, 1.51]	1.40 [1.20, 1.60]	1.36 [1.12, 1.54]	1.36 [1.12, 1.60]

Source: CDR and ASDR are own calculations based on data from CDC.

Table A2: Summary statistics for life expectancy (e_0) and lifespan disparity $(e^\dagger)$ with HIV

	1980 (N=30)	1990 (N=30)	2000 (N=30)	Overall (N=90)
Life expectancy (whites)				
Mean (SD)	74.7 (0.599)	76.4 (0.780)	77.4 (1.08)	76.2 (1.40)
Median [Min, Max]	74.7 [73.6, 75.9]	76.4 [75.1, 78.0]	77.6 [75.4, 79.0]	76.0 [73.6, 79.0]
Life expectancy (blacks)				
Mean (SD)	69.0 (0.873)	70.3 (1.26)	72.4 (1.47)	70.6 (1.87)
Median [Min, Max]	68.8 [67.8, 71.4]	70.1 [67.8, 73.4]	72.1 [70.3, 76.4]	70.4 [67.8, 76.4]
B-W gap in e0				
Mean (SD)	5.73 (0.687)	6.07 (1.17)	4.98 (1.08)	5.59 (1.09)
Median [Min, Max]	5.65 [3.88, 7.23]	6.03 [3.29, 8.80]	4.97 [2.28, 7.03]	5.60 [2.28, 8.80]
Life disparity (whites)				
Mean (SD)	14.2 (0.341)	13.7 (0.340)	13.1 (0.427)	13.7 (0.587)
Median [Min, Max]	14.2 [13.6, 14.7]	13.7 [13.2, 14.2]	13.0 [12.5, 14.0]	13.7 [12.5, 14.7]
Life disparity (blacks)				
Mean (SD)	17.2 (0.618)	16.9 (0.543)	15.8 (0.536)	16.7 (0.830)
Median [Min, Max]	17.3 [16.1, 18.8]	16.9 [15.9, 18.0]	15.9 [14.2, 16.6]	16.7 [14.2, 18.8]
B-W gap in e.dagger				
Mean (SD)	3.03 (0.563)	3.22 (0.624)	2.72 (0.526)	2.99 (0.602)
Median [Min, Max]	3.08 [2.01, 4.21]	3.09 [1.94, 4.78]	2.65 [1.40, 3.79]	2.89 [1.40, 4.78]

Source: Life expectancy and lifespan disparity are own calculations based on CDC data.

Table A3: Summary statistics for life expectancy (e_0) and lifespan disparity $(e^\dagger)$ without HIV

	1980 (N=30)	1990 (N=30)	2000 (N=30)	Overall (N=90)
Life expectancy (whites), without HIV				
Mean (SD)	74.7 (0.599)	76.5 (0.799)	77.5 (1.09)	76.2 (1.43)
Median [Min, Max]	74.7 [73.6, 75.9]	76.6 [75.2, 78.2]	77.7 [75.4, 79.1]	76.1 [73.6, 79.1]
Life expectancy (blacks), without HIV				
Mean (SD)	69.0 (0.873)	70.7 (1.27)	72.8 (1.52)	70.8 (2.00)
Median [Min, Max]	68.8 [67.8, 71.4]	70.7 [68.1, 73.8]	72.4 [70.7, 76.7]	70.7 [67.8, 76.7]
B-W gap in e0, without HIV				
Mean (SD)	5.73 (0.687)	5.80 (1.09)	4.66 (1.08)	5.40 (1.09)
Median [Min, Max]	5.65 [3.88, 7.23]	5.74 [3.27, 8.58]	4.73 [2.01, 6.81]	5.45 [2.01, 8.58]
Life disparity (whites), without HIV				
Mean (SD)	14.2 (0.341)	13.6 (0.338)	13.1 (0.430)	13.6 (0.598)
Median [Min, Max]	14.2 [13.6, 14.7]	13.6 [13.0, 14.2]	13.0 [12.4, 14.0]	13.7 [12.4, 14.7]
Life disparity (blacks), without HIV				
Mean (SD)	17.2 (0.618)	16.7 (0.467)	15.6 (0.523)	16.5 (0.859)
Median [Min, Max]	17.3 [16.1, 18.8]	16.8 [15.7, 17.6]	15.6 [14.1, 16.5]	16.5 [14.1, 18.8]
B-W gap in e.dagger, without HIV				
Mean (SD)	3.03 (0.563)	3.08 (0.532)	2.57 (0.495)	2.89 (0.574)
Median [Min, Max]	3.08 [2.01, 4.21]	3.01 [1.90, 4.21]	2.49 [1.35, 3.66]	2.84 [1.35, 4.21]

Source: Life expectancy and lifespan disparity are own calculations based on CDC data, and decomposition by age-cause.

Table A4: HIV-specific contribution to the Black-White gap in life expectancy (e_0), 1980-1990 and 1980-2000

	Life expectancy gap			Life expectancy gap in the absence of HIV		1980-1990 Change attributable to			1980-2000 Change attributable to		
State	1980	1990	2000	1990	2000	Total	HIV	Rest	Total	HIV	Rest
Alabama	5.74	5.79	4.33	5.69	4.08	0.05	0.10	-0.06	-1.41	0.26	-1.67
Arkansas	5.24	6.26	5.09	6.15	4.88	1.02	0.11	0.92	-0.15	0.21	-0.36
California	5.19	5.74	4.96	5.58	4.75	0.55	0.15	0.39	-0.22	0.21	-0.43
Colorado	5.22	4.07	4.60	3.99	4.46	-1.15	0.08	-1.23	-0.61	0.14	-0.76
Connecticut	5.19	6.40	3.98	5.70	3.47	1.22	0.70	0.52	-1.20	0.51	-1.71
Delaware	6.68	6.89	4.90	6.56	4.26	0.21	0.33	-0.12	-1.78	0.64	-2.42
Florida	7.23	7.96	5.46	7.17	4.67	0.73	0.79	-0.06	-1.77	0.78	-2.56
Georgia	5.99	5.93	4.59	5.63	4.17	-0.07	0.29	-0.36	-1.40	0.42	-1.82
Illinois	6.69	8.80	6.97	8.58	6.70	2.11	0.23	1.88	0.27	0.26	0.01
Indiana	6.00	5.21	4.71	5.13	4.58	-0.79	0.09	-0.88	-1.29	0.13	-1.42
Kansas	7.01	5.61	5.63	5.58	5.60	-1.40	0.03	-1.43	-1.38	0.02	-1.41
Kentucky	5.37	4.24	3.75	4.15	3.64	-1.13	0.09	-1.22	-1.61	0.12	-1.73
Louisiana	5.46	6.30	5.46	6.25	5.06	0.84	0.05	0.79	0.00	0.39	-0.40
Maryland	4.92	6.28	5.56	5.88	4.99	1.36	0.40	0.96	0.63	0.56	0.07
Massachusetts	3.88	4.22	2.28	3.68	2.01	0.34	0.53	-0.20	-1.60	0.27	-1.87
Michigan	6.22	7.20	6.55	6.97	6.34	0.98	0.23	0.75	0.32	0.21	0.12
Mississippi	5.36	5.43	4.38	5.35	4.15	0.06	0.08	-0.02	-0.98	0.24	-1.22
Missouri	6.76	7.01	5.57	6.87	5.37	0.25	0.14	0.11	-1.19	0.20	-1.39
New Jersey	5.77	7.57	5.84	6.12	5.04	1.80	1.45	0.35	0.07	0.80	-0.73
New York	5.37	5.95	2.99	5.22	2.46	0.58	0.73	-0.16	-2.38	0.54	-2.92
North Carolina	5.74	6.13	5.34	5.89	4.95	0.39	0.24	0.15	-0.40	0.38	-0.79
Ohio	5.44	5.71	4.97	5.58	4.83	0.26	0.13	0.13	-0.47	0.14	-0.62
Oklahoma	5.41	3.29	3.46	3.27	3.34	-2.12	0.02	-2.14	-1.94	0.12	-2.06
Pennsylvania	6.38	7.57	6.31	7.18	5.90	1.19	0.40	0.80	-0.07	0.42	-0.48
South Carolina	5.70	6.11	5.13	5.85	4.83	0.40	0.25	0.15	-0.57	0.30	-0.87
Tennessee	5.59	6.29	5.73	6.22	5.38	0.70	0.06	0.63	0.14	0.36	-0.21
Texas	5.26	5.81	4.88	5.72	4.59	0.54	0.09	0.46	-0.38	0.30	-0.67
Virginia	5.60	5.92	4.97	5.76	4.70	0.33	0.16	0.17	-0.62	0.27	-0.89
Washington	5.80	5.55	3.82	5.37	3.72	-0.24	0.18	-0.42	-1.98	0.09	-2.07
Wisconsin	5.75	6.91	7.03	6.83	6.81	1.16	0.08	1.08	1.28	0.21	1.06

Source: Life expectancy are own calculations based on CDC data, and decomposition by age-cause.

Table A5: HIV-specific contribution to the Black-White gap in lifespan disparity ($e^{\dagger}$)), 1980-1990 and 1980-2000

	Lifespan disparity gap			Lifespan disparity gap in the absence of HIV		1980-1990 Change attributable to:			1980-2000 Change attributable to:		
State	1980	1990	2000	1990	2000	Total	HIV	Rest	Total	HIV	Rest
Alabama	2.86	3.00	2.60	2.95	2.47	0.13	0.05	0.09	-0.26	0.13	-0.39
Arkansas	3.08	2.89	2.57	2.83	2.46	-0.19	0.06	-0.25	-0.51	0.11	-0.63
California	3.08	2.83	2.61	2.79	2.51	-0.25	0.04	-0.29	-0.47	0.09	-0.56
Colorado	2.28	2.33	2.33	2.31	2.26	0.05	0.02	0.03	0.05	0.07	-0.02
Connecticut	3.84	3.58	3.33	3.21	3.10	-0.26	0.37	-0.64	-0.51	0.23	-0.74
Delaware	2.31	2.77	2.49	2.58	2.17	0.46	0.19	0.27	0.18	0.31	-0.14
Florida	3.83	3.59	2.84	3.22	2.50	-0.24	0.37	-0.60	-0.99	0.35	-1.33
Georgia	3.49	3.20	2.55	3.07	2.35	-0.29	0.13	-0.43	-0.94	0.20	-1.14
Illinois	3.51	4.31	3.79	4.21	3.66	0.80	0.10	0.70	0.28	0.13	0.15
Indiana	3.30	2.73	2.81	2.69	2.74	-0.57	0.04	-0.62	-0.50	0.07	-0.56
Kansas	2.51	2.94	2.69	2.92	2.68	0.42	0.01	0.41	0.18	0.01	0.17
Kentucky	2.13	1.94	1.99	1.90	1.93	-0.19	0.04	-0.23	-0.14	0.06	-0.20
Louisiana	2.73	3.18	2.78	3.17	2.58	0.45	0.01	0.44	0.05	0.20	-0.16
Maryland	2.68	3.36	3.17	3.15	2.88	0.68	0.21	0.47	0.49	0.29	0.20
Massachusetts	3.42	3.68	2.62	3.40	2.48	0.25	0.28	-0.03	-0.80	0.14	-0.94
Michigan	3.84	4.14	3.66	4.03	3.55	0.30	0.11	0.19	-0.19	0.10	-0.29
Mississippi	2.62	2.68	2.44	2.64	2.32	0.06	0.04	0.02	-0.18	0.12	-0.31
Missouri	3.35	3.53	2.90	3.47	2.80	0.19	0.06	0.13	-0.45	0.10	-0.55
New Jersey	3.19	4.78	3.44	4.01	3.03	1.59	0.77	0.82	0.25	0.41	-0.16
New York	3.33	3.74	2.93	3.42	2.68	0.41	0.32	0.09	-0.40	0.25	-0.65
North Carolina	3.21	3.35	2.68	3.23	2.49	0.14	0.12	0.02	-0.54	0.19	-0.73
Ohio	2.82	2.85	2.41	2.78	2.34	0.03	0.07	-0.04	-0.41	0.08	-0.49
Oklahoma	2.68	2.39	1.89	2.38	1.86	-0.29	0.01	-0.30	-0.79	0.03	-0.82
Pennsylvania	3.67	4.15	3.30	3.96	3.10	0.48	0.19	0.29	-0.37	0.20	-0.57
South Carolina	4.21	3.31	2.68	3.19	2.54	-0.90	0.12	-1.02	-1.54	0.14	-1.67
Tennessee	2.47	2.91	2.51	2.88	2.33	0.44	0.03	0.41	0.04	0.19	-0.14
Texas	3.10	2.86	2.25	2.84	2.10	-0.23	0.02	-0.25	-0.85	0.15	-1.00
Virginia	2.88	3.00	2.45	2.92	2.30	0.12	0.08	0.04	-0.43	0.14	-0.57
Washington	2.01	2.78	1.40	2.71	1.35	0.77	0.07	0.70	-0.61	0.05	-0.66
Wisconsin	2.41	3.70	3.55	3.66	3.44	1.30	0.04	1.26	1.15	0.11	1.03

Source: Lifespan disparity are own calculations based on CDC data, and decomposition by age-cause.

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