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Black:White Disparities in HIV Mortality in the United States: 1990–2009

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Abstract
Objectives The aim of this study was to assess whether racial disparities in human immunodeficiency virus (HIV) mortality in the USA have changed over time.
Methods Using vital records from the National Center for Health Statistics and census data from the US Census Bureau, we calculated the race- and gender-specific HIV mortality rates and corresponding racial rate ratios for non-Hispanic Blacks and non-Hispanic Whites in the USA for four 5-year increments from 1990–2009. Rates were age-adjusted using the 2000 USA standard population. Additionally, we calculated excess Black deaths for 2005–2009.
Results For the total, male, and female populations, we observed a statistically significant increase in the Black:White HIV mortality disparity between T1 (1990–1994) and T4 (2005–2009). The increasing disparity was due to the fact that the decrease in mortality rates from T1 to T4 was greater among Whites than Blacks. This disparity led to 5603 excess Black deaths in the USA at T4.
Conclusions Previous research suggests that as HIV becomes more treatable, racial disparities widen, as observed in this study for both men and women. Existing disparities could be ameliorated if access to care were equal among these groups. Equal access would enable more individuals to achieve viral suppression, the final step of the HIV Care Continuum.

Keywords HIV mortality · Disparities · HIV excess deaths

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Introduction

Throughout the late 1980s and into the mid-90s, human immunodeficiency virus (HIV) held steady as one of the top 15 leading causes of death in the United States of America (USA), claiming a high of 50,628 American lives in 1995[1–4]. Following the introduction of effective combination antiretroviral therapy (ART) in 1996, HIV diagnoses and mortality began rapidly decreasing and eventually leveled off around 1998. Consequently, HIV infection is no longer a major leading cause of death in the USA [1].

Despite this notable progress, racial disparities are prominent. For example, in the USA, the rates of diagnoses and prevalence of HIV among non-Hispanic Blacks (Blacks) are 9 and 7 times higher, respectively, than those of non-Hispanic Whites (Whites) [5]. Among men, the magnitude of the Black:White disparities in diagnoses and prevalence is 8 and 6, respectively [5]. The differences are larger among women at 20 and 18, respectively [5]. The overall trend has been a decrease in disparities in diagnoses over time, with some populations increasing in diagnoses, namely young black men [6]. Similarly, HIV is the 25th leading cause of death among Whites but is ranked 13th among Blacks [7].

These numbers suggest that the devastating effects of HIV are being disproportionately experienced by Blacks and that racial and gender disparities in HIV mortality, which were present early on, have persisted—and possibly even grown—well into the 2000s [8, 9]. Given the documented declines in HIV diagnoses, as well as the advancements in treatment that have occurred since the mid-90s, it would be instructive to examine mortality rates and disparities therein to gain a better understanding of how these patterns have changed over time and what might underlie these changes [10–14]. Thus, the purpose of this analysis is to examine the race- and gender-specific HIV mortality rates and corresponding rate ratios for Blacks and Whites in the USA for the four 5-year increments from 1990–2009.

Methods

Deaths where the underlying cause was human immunodeficiency virus infection (ICD-9=042–044) and human immunodeficiency virus disease (ICD-10=B20-B24) were included in this analysis. Numerator data for 1990–2009 were abstracted from death files obtained from the National Center for Health Statistics [15]. Population-based denominators for the non-Hispanic White (White) and non-Hispanic Black (Black) populations were obtained from the US Census Bureau for 1990, 2000, and 2010. Population-based denominators for years other than 1990, 2000, and 2010 were estimated using linear interpolation as the intercensal population estimates do not provide the level of detail necessary for this analysis. For each of the two data sources, Black and White classifications were obtained by cross-tabulating two demographic variables: Hispanic ethnicity and racial identity. For the census, these variables are self-reported; for the death files, these variables are reported by the next of kin. Age-adjusted rates per 100,000 population were calculated employing the year 2000 standard US population [16].

Five-year average annual rates were calculated for 1990–1994 (T1), 1995–1999 (T2), 2000–2004 (T3), and 2005–2009 (T4) (2009 is the most recent year for which city-level data were available). Because 1990–1998 mortality data employ the International Classification of Diseases, Ninth Revision (*ICD-9*) codes while 1999–2009 data employ the *ICD*, *Tenth Revision* (*ICD-10*) codes, we used an age-specific comparability ratio formula designed for transforming age-adjusted rates from the ICD-9 to ICD-10 coding so that the rates were comparable across the four time points [17–19]. Data are provided for the total population, as well as, for males and females.

Statistical Analysis

The disparity in HIV mortality was measured by calculating the Black:White rate ratio (RR) for each population at each time period. An RR was considered statistically significant if the 95 % confidence interval did not contain 1.00. Confidence intervals for the RRs were calculated using a Taylor series expansion technique [20]. All data were analyzed using SAS v 9.2 [21].

Excess deaths due to the racial disparity in HIV mortality were calculated by multiplying the age-specific White mortality rates by the corresponding Black populations in each age category. The sum of these products is the number of Black deaths that would be expected if White death rates were applied to this population. We then subtracted the number of expected deaths from the number of observed deaths to obtain the excess number of deaths for each population group [22].

Results

Figure 1 displays the age-adjusted HIV mortality rates for the Black and White male and female populations in the USA for the intervals 1990–1994 (T1), 1995–1999 (T2), 2000–2004 (T3), and 2005–2009 (T4). At each of the four time points examined, the rates are higher among men than women and among Blacks than Whites. Although the rates decreased for all groups over the study period, the Black male rate remained substantially higher than the rates for all other groups. Additionally, the Black female rate was higher than the White male rate at T2-T4. White females demonstrated the lowest rates at all time points examined.

Table 1 presents age-adjusted HIV mortality rates for the Black and White total, male, and female populations in the USA for T1-T4, and the corresponding RRs and confidence intervals. For the total, male, and female populations, we observed a statistically significant increase in the Black:White RR between T1 and T4. The total population RR in the USA was 4.33 at T1, and it grew steadily to 11.38 by T4. Within the male population, the RR was 3.91 at T1, and it more than doubled by T4 to 9.66. For females, the RR was 14.00 at T1, and it grew by about 1.5 times to 21.22 by T4. Boldfaced rate ratios indicate statistical significance. At all time points examined, the RRs for the total, male, and female populations were statistically significant. Taken together, these observations demonstrate that the Black:White HIV mortality disparity in the USA worsened over this 20-year period.

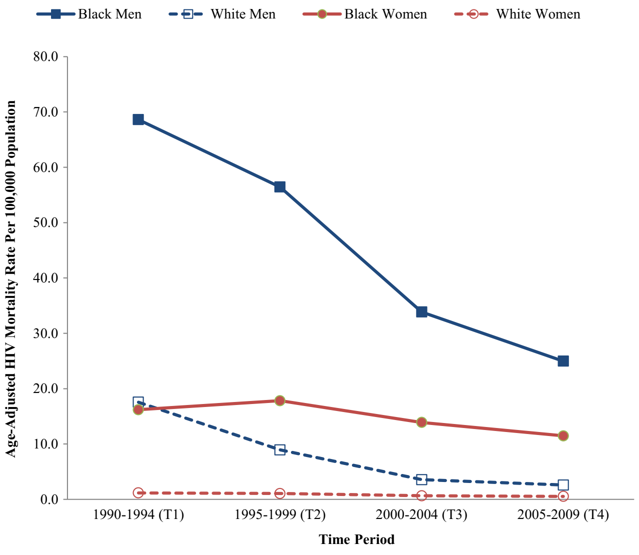

Fig. 1 Age-adjusted HIV mortality rates by race and gender: USA, 1990–2009

Table 1 Five-year average annual HIV mortality rates and rate ratios for non-Hispanic Black (Black) and non-Hispanic White (White) total population, men, and women in the USA, 1990–2009

	Total population				Men				Women			
	Black rate	White rate	Rate ratio	95 % CI	Black rate	White rate	Rate ratio	95 % CI	Black rate	White rate	Rate ratio	95 % CI
1990–1994 (T1)	40.3	9.3	4.33	4.3–4.4	68.6	17.6	3.91	3.9–4.0	16.2	1.2	14.00	13.6–14.5
1995–1999 (T2)	35.6	5.0	7.15	7.0–7.3	56.5	8.9	6.31	6.2–6.4	17.8	1.1	16.81	16.1–17.6
2000–2004 (T3)	23.1	2.1	11.01	10.8–11.2	33.9	3.6	9.51	9.3–9.7	13.9	0.7	21.29	20.5–22.1
2005–2009 (T4)	17.7	1.6	11.38	11.2–11.6	25.0	2.6	9.66	9.5–9.9	11.5	0.5	21.22	20.3–22.1

A comparison of the male and female populations reveals that, while the rates of HIV mortality are higher among men than women for both races at each time point, the racial disparities are significantly higher within the female than the male population (Table 1). For example, the T1 female RR (14.00) is about 3.5 times larger than the T1 male RR (3.91). By T4, the difference between the male (9.66) and female (21.22) RRs had narrowed but was still over twice as large among the female population. This is largely attributable to the substantially lower rates observed among White women.

Table 2 displays the within race T1 to T4 percent decrease in HIV mortality rates for Blacks and Whites. For the total, male, and female populations, we observed that the decrease in mortality rates from T1 to T4 was greater among Whites than Blacks. For example, while the White rate decreased by 83 % between T1 and T4, the Black rate decreased by just 56 % over the same period. For the male population, the White rate decreased by 85 %, while the Black rate decreased by 64 %. Among females, Whites saw a 53 % decrease, while Blacks experienced only a 29 % decrease.

We also calculated the number of excess Black deaths due to the racial disparity in HIV mortality (Table 2). Excess deaths are a function of the size of the population of each area and the size of the disparity. The annual number of Black excess deaths in the USA at T4 was 5603. Among men and women in the USA, there were 3580 and 2050 annual excess Black deaths, respectively.

Table 2 Percent decrease in T1 (1990–1994) to T4 (2005–2009) Non-Hispanic Black (Black) and Non-Hispanic White (White) HIV mortality rates for the USA

	T1 to T4 (%) decrease		T4 annual excess Black deaths
	Black	White	
USA	56	83	5603
Men	64	85	3580
Women	29	53	2050

Discussion

Despite decreasing mortality rates for both Blacks and Whites in the USA, the mortality disparity between Blacks and Whites increased significantly between 1990–1994 (T1) and 2005–2009 (T4) for the total, male, and female populations, with the largest disparity occurring among women. Among the total population, the disparity was 11.38, indicating that Blacks were more than 11 times more likely to die from HIV compared to Whites at T4. Among men and women, Blacks were 9.66 and 21.22 times more likely to die from HIV at T4, respectively (Table 1). The Black:White HIV mortality disparity was 2.6 times higher at T4 compared to T1, 2.5 times higher among men, and 1.5 times higher among women. The rate at which mortality decreased over time varied by both race and sex, with White rates decreasing at a faster pace than Black rates regardless of gender, and Black women showing the slowest decline (Table 2). Notably, at every time point except T1, the death rates for Black women were higher than those for White men (Table 1). Finally, the Black:White HIV mortality disparity resulted in 5603 excess Black deaths annually in the USA. These data demonstrate an indisputable White advantage with respect to HIV mortality, which has been occurring since at least 1990 [23, 9, 24, 25, 13].

The HIV Care Continuum (treatment cascade) outlines the steps a person living with HIV should go through in order to achieve viral suppression and thus reduce or eliminate the risk of death from HIV. The steps include the following: diagnosis of HIV infection, linkage to care, retention in care, receipt of antiretroviral therapy, and achievement of viral suppression [26]. The population engaged at each step has been documented, and areas for improvement have been identified. However, racial differences in engagement at various stages in the Care Continuum, which are less systematically documented, likely contribute to the observed disparities in HIV mortality. Furthermore, access to care is imperative to one's ability to follow the Care Continuum, and any differences in access to care will thus impact individual success in achieving viral suppression.

The first step in being diagnosed with HIV is being tested for HIV. However, there have been notable differences in testing among Blacks versus Whites. One reason for this may be that early prevention and testing messaging focused mainly on White risk groups (e.g., White gay men) as opposed to risky behavior (e.g., unprotected sex) and the initial classification of AIDS as gay-related immunodeficiency disease (GRID) resulted in a stigma related to HIV/AIDS and an exclusion of Blacks, women, and heterosexuals from initial messaging [27]. This highly targeted messaging may have resulted in a lack of perceived risk among certain segments of the population, impacting their motivation to prevent the transmission of or be tested for HIV [27]. Indeed, since 2007, more black men have been infected with HIV compared to white men; however, an often overlooked population has been women of color, and most of whom report a risk category of heterosexual contact with fewer reporting injection drug use [28, 12, 5]. Thus, historical differences in perceived risk and testing behaviors may have contributed to observed racial disparities in HIV mortality.

Early detection of HIV infection coupled with timely treatment are of great importance for reducing mortality [29]. Routine testing improves the likelihood of identifying HIV at this early stage, reducing transmission and decreasing the risk for progression to AIDS and/or death [29, 10, 11, 30, 12]. Unfortunately, it was not until 2006 that the Centers for Disease Control and Prevention (CDC) released recommendations for routine screening regardless of risk in medical settings with an HIV prevalence greater than 0.1 % [31]. These issues as well as the fact that some groups have historically been less able to access health care regularly have likely contributed to differences in who has been screened, generally, and who has done so routinely, specifically [32]. The CDC estimates that approximately 14 % of persons in the USA are unaware of their infection and, as of 2009, a majority of these undiagnosed infections were among people of color, predominantly young and male, and are often identified at late stages of the disease when they are identified [1, 10, 33–38]. Given that treatment is contingent upon knowledge of infection, it is not hard to see how these differences would contribute directly to disparities in mortality.

For those persons who are diagnosed with HIV, the next step in the Care Continuum is linkage to care. However, there are documented disparities in the percent linked to, as well as engaged or retained in care, favoring Whites [39]. These differences will undoubtedly impact the receipt of prescribed antiretroviral therapy, the next stage in the Care Continuum.

Treatment is arguably the most important avenue through which HIV mortality can be reduced. Combination antiretroviral medications (ART) have allowed infected persons to live healthy lives by improving immune function and enabling the body to defend itself against opportunistic infections or an AIDS diagnosis [10, 40, 41]. Sharp declines in mortality associated with the introduction of ART demonstrate its effectiveness in treating HIV and preventing death [10, 11]. However, the present analysis, along with previous research, has shown that the declines in mortality have not been shared equally by all race groups in the USA.

Inherent in the notion of a continuum is the idea that differences present at any given stage will directly impact differences in the stages that follow. In order to be prescribed ART, one must be linked to care and in order to achieve viral suppression, one must be adherent to ART. However, racial differences are observed at each of these stages with a higher percentage of Whites being prescribed ART (among those retained in care) and achieving viral suppression (among those prescribed ART) [39]. Some portion of the racial difference in the percent prescribed ART may be accounted for by guidelines at the time which recommended ART based on disease severity [42]. And some portion of the racial difference in the percent achieving viral suppression may be accounted for by differences in either response or adherence to ART [9, 13, 23, 40, 43–50].

However, the crucial element to achieving viral suppression is gaining access to care, without which one cannot be diagnosed with HIV nor obtain ART. Thus, we argue that the racial disparity in HIV mortality is the result of differential access to health care. Despite the availability of effective treatment for HIV, the mortality rates declined much more slowly for Blacks compared to Whites (Table 2), suggesting differences in access to and/or timing of diagnostic testing and treatment favoring Whites.

This explanation aligns closely with the “Fundamental Cause Perspective”, which posits that as tests become more sophisticated at detecting early stages of diseases, and treatments become more effective at treating disease, those with resources and power are most likely to benefit and those of lower socioeconomic status (SES) and minorities benefit least [9, 51, 52].

Exploring this in the context of HIV mortality disparities, we infer that the disparities documented in the continuum measures in diagnosis, linkage to care, prescription to ART, and viral suppression among Blacks have contributed substantially to the widening disparities. Blacks in the USA have routinely faced barriers to receiving health care, and even when seeking care, perceived risk may impact the likelihood of being tested [32, 53]. Additionally, factors such as poor reimbursement for HIV tests, competing health needs, and possible provider biases or comfort level in providing positive results to certain patients have been cited as potential barriers to HIV testing by clinicians [54–56]. Thus, even when connected to health care, certain populations are less likely to be offered testing [57, 58].

The notion that Blacks experience unequal access to treatment is supported by studies demonstrating disparities in ART receipt by race (favoring Whites) and by insurance status (favoring the privately insured) [59–65]. Some studies have suggested that disease severity qualifiers or income restrictions for public insurance plans contribute to delays in care or mortality from HIV [11, 64]. These studies reveal that Blacks are more likely to experience delays in HIV care and less likely to receive ART at earlier stages, both indicators of disparities in HIV care quality, again, favoring Whites.

Rubin et al., studying the effect of ART on mortality from HIV/AIDS, found that once ART became available, disparities by race and SES began to develop, eventually displaying the same widening trend reported in the present study [9]. These findings provide additional support for the Fundamental Cause Perspective and align with reports on other diseases, including certain screen-detectable cancers [51, 52].

Limitations

Our analysis included deaths for which HIV was the underlying cause of death, but these could potentially be undercounted in cases where the individual completing the death certificate was unaware of the decedent's HIV status. Our analysis did not include deaths for which HIV was any contributing cause of death. A recent report documenting changes in racial disparities in mortality (from any cause) among known HIV positives using the CDC National HIV Surveillance Database identified higher population-based HIV mortality rates among Blacks and Whites, yet noted similar levels of disparities that were demonstrated in our study [66].

Furthermore, as those infected with HIV live longer, they are more likely to die of a cause other than HIV, meaning that HIV may have become less likely over time to be the underlying cause of death [67, 68]. Additionally, there is some documentation suggesting a small amount of underreporting of HIV as a cause of death in minority populations which could impact the counts of deaths due to HIV among Blacks [69, 70].

Two factors prevented us from including data from the 1980s in our analysis. First, the ICD-9 codes for HIV were not introduced until 1987. Prior to this year, HIV deaths were coded as "human T cell lymphotropic virus-III/lymphadenopathy associated virus (HTLV-III/LAV) infection" [3]. Second, prior to the 1989 revision to the US Standard Certificate of Death, Hispanic origin was not included on the death certificate. Thus, one could not accurately count the deaths of non-Hispanic Blacks and non-Hispanic Whites prior to 1989. As a result, we were unable to look at the full history of HIV mortality disparities beginning in the early 1980s. However, the National Vital Statistics Report published in 1987 shows higher HIV mortality rates among Blacks than Whites, though we cannot determine the effect of including Hispanics in these rates and earlier reports suggest disparities as early as 1985 [3, 71].

Social determinants, which contribute to the health of individuals with HIV, and include mental health conditions, violence, gender inequalities, drug use, SES, HIV knowledge, discrimination, racism and stigma, are not included in death certificate data [72–74]. Clinical indicators, such as ART use and CD-4 count or viral load are also not available from the death certificate. We were therefore unable to include these types of data in our analysis.

Implications/Future Research

Access to care is imperative for early diagnosis and treatment of HIV. However, patient and health care system barriers are often cited as reasons for poor clinical outcomes among those with HIV [26, 72, 73, 75–77]. Incorporating navigation, such as removing barriers to receiving care, providing social support and appointment coordination, into HIV testing programs is effective in both linking patients to HIV care and engaging patients in care [78–82]. Thus, incorporating navigation could both reduce mortality and likely prevent further transmission of HIV, although these effects have not been reported.

Recent initiatives have been developed with the overarching goal of reducing racial disparities in HIV outcomes. These programs, which aim to identify infected persons and link them to care, should be expanded. For example, the CDC funds programs for expanded and routine HIV testing and linkage to care [83]. Additionally, under the Health Resources and Services Administration's (HRSA) Ryan White program, the AIDS Drug Assistance Program (ADAP) provides life-saving ART to those who cannot afford it, saving lives and averting transmissions and outreach services for persons who have fallen out of care, and Medical Case Management to increase treatment adherence [84]. Continued evaluation of these programs and collaboration between CDC and HRSA will be key to determining their effectiveness and impact on HIV surveillance outcomes.

More research is needed to understand why HIV mortality rates remain so much higher among Black women compared to both White men and women. Literature on this topic is scant, though one study reported that even after controlling for education (a proxy for SES), Black women still had higher HIV mortality rates than White men starting in 1999.[23] As reported in the present study, Black women have experienced the slowest decline in HIV mortality and understanding why this is the case should help us determine how to address the high rates among this group.

Additionally, research is needed to understand the relationship between access to HIV treatment and subsequent mortality, again by race/ethnicity. Changes in clinical recommendations on when to begin ART should be examined as a possible contributor to disparities in HIV mortality as these may have differentially impacted the timing of ART uptake across race/ethnic groups.

Conclusion

Our results have implications for the HIV epidemic in the USA. The HIV mortality rates have declined for both Blacks and Whites in the USA over the last 20 years. However, the pace of the decline has been much steeper for Whites than Blacks, suggesting that existing disparities could be ameliorated if access to care were equal among these groups. Coupled with expanded HIV testing, the addition of patient navigators might be particularly effective in linking to and retaining in care those populations whose mortality rates have been slowest to decline.

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Conflicts of Interest The authors declare that they have no competing interests.

Informed Consent No animal or human studies were carried out by the authors for this analysis.

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References

1. Centers for Disease Control and Prevention. HIV surveillance=—United States, 1981-2008. MMWR Morb Mortal Wkly Rep. 2011;60:689–93.
2. Centers for Disease Control. Mortality attributable to HIV infection/AIDS—United States, 1981-1990. MMWR Morb Mortal Wkly Rep. 1991;40:41–4.
3. National Center for Health Statistics. Vital Statistics of the United States, 1987, Volume II - Mortality, Part A. Washington, D.C.: US Governmenet Printing Office; 1990.
4. Peters KD, Kochanek KD, Murphy SL. Deaths: final data for 1996. Hyattsville: National Center for Health Statistics; 1998.
5. Centers for Disease Control and Prevention. HIV Surveillance Report, Vol. 24. http://www.cdc.gov/hiv/pdf/statistics_2012_HIV_Surveillance_Report_vol_24.pdf(2012). Accessed 3/5/2015.
6. An Q, Prejean J, Hall HI. Racial disparity in U.S. diagnoses of acquired immune deficiency syndrome, 2000–2009. Am J Prev Med. 2012;43:461–6. doi:10.1016/j.amepre.2012.07.040.
7. Centers for Disease Control and Prevention. LCWK10. Deaths, percent of total deaths, and rank order for 113 selected causes of death and Enterocolitis due to *Clostridium difficile*, by race and sex Unites States, 2011. National Center for Health Statistics; 2011.
8. National Center for Health Statistics. Vital statistics of the United States 1989 volume II - mortality, part a. National center for health statistics. Washington: US Government Printing Office; 1993.
9. Rubin MS, Colen CG, Link BG. Examination of inequalities in HIV/AIDS mortality in the United States from a fundamental cause perspective. Am J Public Health. 2010;100:1053–9. doi:10.2105/ajph.2009.170241.
10. Ray M, Logan R, Sterne JA, Hernandez-Diaz S, Robins JM, Sabin C, et al. The effect of combined antiretroviral therapy on the overall mortality of HIV-infected individuals. AIDS. 2010;24:123–37.
11. Palella FJ, Delaney KM, Moorman AC, Loveless MO, Fuhrer J, Satten GA, et al. Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. New Engl J Med. 1998;338:853–60.
12. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med. 2011;365:493–505.
13. Singh GK, Azuine RE, Siahpush M. Widening socioeconomic, racial, and geographic disparities in HIV/AIDS mortality in the united states, 1987-2011. Adv Prev Med. 2013;2013:657961.
14. Johnson AS, Hall HI, Hu X, Lansky A, Holtgrave DR, Mermin J. Trends in diagnoses of HIV infection in the United States, 2002-2011. JAMA. 2014;312(4):432–4.
15. National Center for Health Statistics. Mortality - All County (micro-data), as compiled from data provided by 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. National Center for Health Statistics; 1990–2009.
16. Klein RJ, Schoenborn CA. Age adjustment using the 2000 projected U.S. population. Healthy People 2010 Statistical Notes : from the Centers for Disease Control and Prevention/National Center for Health Statistics. 2001(20):1–10.
17. World Health Organization. International classification of diseases, ninth revision. Geneva, Switzerland: World Health Organization; 1980.
18. Centers for Disease Control and Prevention. A Guide to State Implementation of ICD-10 for Mortality Part II: Applying Comparability Ratios. Washington, D.C.: National Center for Health Statistics; 2000
19. World Health Organization. International classification of diseases, tenth revision. Geneva, Switzerland: World Health Organization; 1992.
20. Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research: principals and quantitative methods. Belmont, CA: Lifetime Learning Publications; 1982.
21. SAS Institute I. SAS. In. 9.2 for Windows ed. Cary, NC: SAS Institute, Inc.; 2002-2008.
22. Gamble VN, Stone D. U.S. policy on health inequities: the interplay of politics and research. J Health Polit Policy Law. 2006;31:93–126.
23. Simard EP, Fransua M, Naishadham D, Jemal A. The influence of sex, race/ethnicity, and educational attainment on human immunodeficiency virus death rates among adults, 1993-2007. Arch Intern Med. 2012;172:1591–8.
24. Wong MD, Shapiro MF, Boscardin WJ, Ettner SL. Contribution of major diseases to disparities in mortality. N Engl J Med. 2002;347:1585–92.
25. Harper S, Lynch J, Burris S, Davey SG. Trends in the black-white life expectancy gap in the United States, 1983-2003. JAMA. 2007;297:1224–32.
26. Gardner EM, McLees MP, Steiner JF, Del Rio C, Burman WJ. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. Clin Infect Dis. 2011;52(6):793–800.
27. Merson MH, O'Malley J, Serwadda D, Apisuk C. The history and challenge of HIV prevention. Lancet. 2008;372:475–88.
28. Hodder SL, Justman J, Haley DF, Adimora AA, Fogel CI, Golin CE, et al. Challenges of a hidden epidemic: HIV prevention among women in the United States. J Acquir Immune Defic Syndr. 2010;55 Suppl 2:S69–73.
29. Moyer VA. Screening for HIV: U.S. Preventive Services Task Force Recommendation Statement. Ann Intern Med. 2013;159:51–60.
30. Palella Jr FJ, Deloria-Knoll M, Chmiel JS, Moorman AC, Wood KC, Greenberg AE, et al. Survival benefit of initiating antiretroviral

therapy in HIV-infected persons in different CD4+ cell strata. Ann Intern Med. 2003;138:620–6.
31. Branson BM, Handsfield HH, Lampe MA, Janssen RS, Taylor AW, Lyss SB, et al. Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. MMWR Recomm Rep. 2006;55:1–17.
32. Mahmoudi E, Jensen GA. Diverging racial and ethnic disparities in access to physician care: comparing 2000 and 2007. Med Care. 2012;50:327–34.
33. Centers for Disease Control and Prevention. Monitoring selected national HIV prevention and care objectives by using HIV surveillance data–United States and 6 U.S. dependent area–2010. Vol 17. Atlanta, GA: U.S. Department of Health and Human Services; 2012.
34. Chen M, Rhodes PH, Hall IH, Kilmarx PH, Branson BM, Valleroy LA. Prevalence of undiagnosed HIV infection among persons aged >/=13 years—National HIV Surveillance System, United States, 2005-2008. MMWR Morb Mortal Wkly Rep. 2012;61(Suppl): 57–64.
35. Bradley H, Hall HI, Wolitski RJ, Van Handel MM, Stone AE, LaFlam M, et al. Vital Signs: HIV diagnosis, care, and treatment among persons living with HIV–United States, 2011. MMWR Morb Mortal Wkly Rep. 2014;63:1113–7.
36. Centers for Disease Control and Prevention. Late versus early testing of HIV—16 Sites, United States, 2000-2003. MMWR Morb Mortal Wkly Rep. 2003;52:581–6.
37. Centers for Disease Control and Prevention. Late HIV testing - 34 states, 1996–2005. MMWR Morb Mortal Wkly Rep. 2009;58(24): 661–5.
38. Hall HI, McDavid K, Ling Q, Sloggett A. Determinants of progression to AIDS or death after HIV diagnosis, United States, 1996 to 2001. Ann Epidemiol. 2006;16:824–33.
39. Hall HI, Frazier EL, Rhodes P, Holtgrave DR, Furlow-Parmley C, Tang T, et al. Differences in human immunodeficiency virus care and treatment among subpopulations in the United States. JAMA Intern Med. 2013;173(14):1337–44.
40. Harrison KM, Song R, Zhang X. Life expectancy after HIV diagnosis based on national HIV surveillance data from 25 states, United States. J Acquir Immune Defic Syndr. 2010;53:124–30.
41. Walensky RP, Paltiel AD, Losina E, Mercincavage LM, Schackman BR, Sax PE, et al. The survival benefits of AIDS treatment in the United States. J Infect Dis. 2006;194:11–9.
42. Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the use of antiretroviral agents in HIV-1-infected adults and adolescents: US Department of Health and Human Services, 2013.
43. Levine RS, Briggs NC, Kilbourne BS, King WD, Fry-Johnson Y, Baltrus PT, et al. Black-White mortality from HIV in the United States before and after introduction of highly active antiretroviral therapy in 1996. Am J Public Health. 2007;97:1884–92.
44. Levine RS, Rust GS, Pisu M, Agboto V, Baltrus PA, Briggs NC, et al. Increased Black-White disparities in mortality after the introduction of lifesaving innovations: a possible consequence of US federal laws. Am J Public Health. 2010;100:2176–84.
45. Murphy K, Hoover DR, Shi Q, Cohen M, Gandhi M, Golub ET, et al. Association of self-reported race with AIDS death in continuous HAART users in a cohort of HIV-infected women in the United States. AIDS. 2013;27:2413–23.
46. Silverberg MJ, Leyden W, Quesenberry Jr CP, Horberg MA. Race/ethnicity and risk of AIDS and death among HIV-infected patients with access to care. J Gen Intern Med. 2009;24:1065–72.
47. Moore RD, Keruly JC, Bartlett JG. Improvement in the health of HIV-infected persons in care: reducing disparities. Clin Infect Dis. 2012;55:1242–51.
48. Muthulingam D, Chin J, Hsu L, Scheer S, Schwarcz S. Disparities in engagement in care and viral suppression among persons with HIV. J Acquir Immune Defic Syndr. 2013;63:112–9.
49. McFall AM, Dowdy DW, Zelaya CE, Murphy K, Wilson TE, Young MA, et al. Understanding the disparity: predictors of virologic failure in women using highly active antiretroviral therapy vary by race and/or ethnicity. J Acquir Immune Defic Syndr. 2013;64:289–98.
50. Palella Jr FJ, Baker RK, Buchacz K, Chmiel JS, Tedaldi EM, Novak RM, et al. Increased mortality among publicly insured participants in the HIV outpatient study despite HAART treatment. AIDS. 2011;25:1865–76.
51. Phelan JC, Link BG. Controlling disease and creating disparities: a fundamental cause perspective. J Gerontol B Psychol Sci Soc Sci. 2005;60(Spec No 2):27–33.
52. Tehranifar P, Neugut AI, Phelan JC, Link BG, Liao Y, Desai M, et al. Medical advances and racial/ethnic disparities in cancer survival. Cancer Epidemiol Biomarkers Prev. 2009;18:2701–8.
53. Call KT, McAlpine DD, Garcia CM, Shippee N, Beebe T, Adeniyi TC, et al. Barriers to care in an ethnically diverse publicly insured population: is health care reform enough? Med Care. 2014;52:720–7.
54. Herrin J, Wesolowski LG, Heffelfinger JD, Bostick N, Hall HI, Ethridge SF, et al. HIV screening practices and hospital characteristics in the US, 2009-2010. Public Health Rep. 2013;128:161–9.
55. Burke RC, Sepkowitz KA, Bernstein KT, Karpati AM, Myers JE, Tsoi BW, et al. Why don't physicians test for HIV? A review of the US literature. AIDS. 2007;21:1617–24.
56. Myers JJ, Koester KA, Dufour MS. Barriers and facilitators to enhancing HIV testing in publicly funded primary care clinics: findings from San Francisco. AIDS Educ Prev. 2011;23:84–95.
57. Jenness SM, Murrill CS, Liu KL, Wendel T, Begier E, Hagan H. Missed opportunities for HIV testing among high-risk heterosexuals. Sex Transm Dis. 2009;36:704–10.
58. Chin T, Hicks C, Samsa G, McKellar M. Diagnosing HIV infection in primary care settings: missed opportunities. AIDS Patient Care STDS. 2013;27:392–7.
59. Gebo KA, Fleishman JA, Conviser R, Reilly ED, Korthuis PT, Moore RD, et al. Racial and gender disparities in receipt of highly active antiretroviral therapy persist in a multistate sample of HIV patients in 2001. J Acquir Immune Defic Syndr. 2005;38:96–103.
60. Lemly DC, Shepherd BE, Hulgan T, Rebeiro P, Stinnette S, Blackwell RB, et al. Race and sex differences in antiretroviral therapy use and mortality among HIV-infected persons in care. J Infect Dis. 2009;199:991–8.
61. Palacio H, Kahn JG, Richards TA, Morin SF. Effect of race and/or ethnicity in use of antiretrovirals and prophylaxis for opportunistic infection: a review of the literature. Public Health Rep. 2002;117: 233–51.
62. Johnston SS, Juday T, Seekins D, Hebden T, Fulcher N, Farr AM, et al. Patterns and correlates of linkage to appropriate HIV care after HIV diagnosis in the US Medicaid population. Sex Transm Dis. 2013;40:18–25.
63. Bhattacharya J, Goldman D, Sood N. The link between public and private insurance and HIV-related mortality. J Health Econ. 2003;22:1105–22.
64. Johnson EN, Roediger MP, Landrum ML, Crum-Cianflone NF, Weintrob AC, Ganesan A, et al. Race/ethnicity and HAART initiation in a military HIV infected cohort. AIDS Res Ther. 2014;11:10.
65. Siddiqi AE, Hu X, Hall HI. Mortality among blacks or African Americans with HIV infection—United States, 2008-2012. MMWR Morb Mortal Wkly Rep. 2015;64:81–6.
66. Valdez H, Chowdhry TK, Asaad R, Woolley IJ, Davis T, Davidson R, et al. Changing spectrum of mortality due to human immunodeficiency virus: analysis of 260 deaths during 1995–1999. Clin Infect Dis. 2001;32:1487–93.

67. Cohen MH, French AL, Benning L, Kovacs A, Anastos K, Young M, et al. Causes of death among women with human immunodeficiency virus infection in the era of combination antiretroviral therapy. Am J Med. 2002;113:91–8.
68. Lindan CP, Hearst N, Singleton JA, Trachtenberg AI, Riordan NM, Tokagawa DA, et al. Underreporting of minority AIDS deaths in San Francisco Bay area, 1985-86. Public Health Rep. 1990;105: 400–4.
69. Scheer S, McQuitty M, Denning P, Hormel L, Stephens B, Katz M, et al. Undiagnosed and unreported AIDS deaths: results from the San Francisco Medical Examiner. J Acquir Immune Defic Syndr. 2001;27:467–71.
70. National Center for Health Statistics. Vital statistics of the United States, 1985, volume II - mortality, part a. Washington, D.C.: US Governmenet Printing Office; 1988.
71. Rumptz MH, Tobias C, Rajabiun S, Bradford J, Cabral H, Young R, et al. Factors associated with engaging socially marginalized HIV-positive persons in primary care. AIDS Patient Care STDS. 2007;21 Suppl 1:S30–9.
72. Christopoulos KA, Massey AD, Lopez AM, Hare CB, Johnson MO, Pilcher CD, et al. Patient perspectives on the experience of being newly diagnosed with HIV in the emergency department/ urgent care clinic of a public hospital. PLoS One. 2013;8, e74199.
73. Fagan JL, Beer L, Garland P, Valverde E, Courogen M, Hillman D, et al. The influence of perceptions of HIV infection, care, and identity on care entry. AIDS Care. 2012;24:737–43.
74. Bauman LJ, Braunstein S, Calderon Y, Chhabra R, Cutler B, Leider J, et al. Barriers and facilitators of linkage to HIV primary care in New York City. J Acquir Immune Defic Syndr. 2013;64 Suppl 1: S20–6.
75. Rothman RE, Kelen GD, Harvey L, Shahan JB, Hairston H, Burah A, et al. Factors associated with no or delayed linkage to care in newly diagnosed human immunodeficiency virus (HIV)-1-infected patients identified by emergency department-based rapid HIV screening programs in two urban EDs. Acad Emerg Med. 2012;19:497–503.
76. Beer L, Fagan JL, Garland P, Valverde EE, Bolden B, Brady KA, et al. Medication-related barriers to entering HIV care. AIDS Patient Care STDS. 2012;26:214–21.
77. Bradford JB, Coleman S, Cunningham W. HIV System Navigation: an emerging model to improve HIV care access. AIDS Patient Care STDS. 2007;21 Suppl 1:S49–58.
78. Liau A, Crepaz N, Lyles CM, Higa DH, Mullins MM, DeLuca J, et al. Interventions to promote linkage to and utilization of HIV medical care among HIV-diagnosed persons: a qualitative systematic review, 1996-2011. AIDS Behav. 2013;17:1941–62.
79. Marks G, Gardner LI, Craw J, Crepaz N. Entry and retention in medical care among HIV-diagnosed persons: a meta-analysis. AIDS. 2010;24:2665–78.
80. Christopoulos KA, Kaplan B, Dowdy D, Haller B, Nassos P, Roemer M, et al. Testing and linkage to care outcomes for a clinician-initiated rapid HIV testing program in an urban emergency department. AIDS Patient Care STDS. 2011;25:439–44.
81. Gilman B, Hidalgo J, Thomas C, Au M, Hargreaves M. Linkages to care for newly diagnosed individuals who test HIV positive in nonprimary care settings. AIDS Patient Care STDS. 2012;26: 132–40.
82. Centers for Disease Control and Prevention. CDC - CAPUS - Demonstration Projects - Prevention Research - HIV/AIDS. http://www.cdc.gov/hiv/prevention/demonstration/capus/. (2015) Accessed: 3/20/2015.
83. Health Rescources and Services Administration. Ryan White HIV/ AIDS Program - Part C. http://hab.hrsa.gov/abouthab/partc.html. (2015) Accessed: 3/20/2015.
84. Pinkerton SD, Kibicho J, Galletly CL. Is the US AIDS drug assistance program cost-effective? AIDS Behav. 2013;17(1):1–4.