Trends in Disparity by Sex and Race/Ethnicity for the Leading Causes of Death in the United States—1999-2010

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Context: Temporal trends in disparities in the leading causes of death within and between US demographic subgroups indicate the need for and success of interventions to prevent premature death in vulnerable populations. Studies that report recent trends are limited and outdated. **Objective:** To describe temporal trends in disparities in death rates by sex and race/ethnicity for the 10 leading causes of death in the United States during 1999-2010. **Design:** We used underlying cause of death data and population estimates from the National Vital Statistics System to calculate age-adjusted death rates for the 10 leading causes of death during 1999-2010. We measured absolute and relative disparities by sex and race/ethnicity for each cause and year of death; we used weighted linear regression to test for significance of trends over time. **Results:** Of the 10 leading causes of death, age-adjusted death rates by sex and race/ethnicity declined during 1999-2010 for 6 causes and increased for 4 causes. But sex and racial/ethnic disparities between groups persisted for each year and cause of death. In the US population, the decreasing trend during 1999-2010 was greatest for cerebrovascular disease (−36.5%) and the increasing trend was greatest for Alzheimer disease (52.4%). For each sex and year, the disparity in death rates between Asian/Pacific Islanders (API) and other groups varied significantly by cause of death. In 2010, the API–non-Hispanic black disparity was largest for heart disease, malignant neoplasms, cerebrovascular diseases, and nephritis; the API-American Indian/Alaska Native disparity was largest for unintentional injury, diabetes mellitus, influenza and pneumonia, and suicide; and the API–non-Hispanic white disparity was largest for chronic lower respiratory diseases and Alzheimer disease. **Conclusions:** Public health practitioners can use these findings to improve policies and practices and to evaluate progress in eliminating disparities and their social determinants in vulnerable populations.

KEY WORDS: disparity, mortality, race and ethnicity, sex

Disparities in health status and health care in the United States are well documented and are being addressed in the Patient Protection and Affordable Care Act (ACA) provisions that attach several data collection and monitoring requirements to federally funded programs.[1,2] *Healthy People* is a broad health promotion and disease prevention initiative of the US Department of Health and Human Services (HHS). The most recent iteration of the *Healthy People* agenda, *Healthy People 2020*, revised the overarching goal of *Healthy People 2000* of reducing US health disparities to eliminating them altogether.[3] The *Healthy People 2020* initiative will assess health disparities in the US population by tracking rates of death, acute and chronic diseases, injuries, and health-related behaviors for population groups defined by race, ethnicity, gender identity, sexual

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orientation, disability status or special health care needs, and geographic location.[4] The HHS Disparities Action Plan adopts the national health disparity goals in *Healthy People 2020* and leverages key provisions of the ACA and other cutting-edge initiatives.[5] Eliminating racial/ethnic health disparities would have resulted in an estimated reduction of more than $1 trillion in direct and indirect costs associated with illness and premature deaths between 2003 and 2006.[6]

Monitoring trends in disparities allows researchers to evaluate progress made toward reducing disparities that affect vulnerable populations. Disparities in cause-specific mortality trends are well documented elsewhere.[7-10] However, many disparity reports focus on specific disease condition or racial/ethnic differences and pay less attention to both racial/ethnic and sex differences for multiple conditions. For example, a study conducted by Keppel and colleagues[7] examined changes in relative disparities between racial/ethnic populations for the 5 leading causes of death in the United States from 1990 to 2006. They did not report racial/ethnic disparities in mortality rates by sex. Differences in mortality between males and females have intrigued scientists and led to extensive debates for many years.[10,11] Evidence indicates that the survival advantage males have at a younger age decreases with age, and cardiovascular diseases tends to account for the majority of the sex gap in adult mortality.[10,11] For coronary heart disease, reduction in sex disparities has been reported; however, the disparities by race/ethnicity have remained the same.[11]

In 2010, the 10 leading causes of death for the US population were, in rank order, as follows: diseases of heart; malignant neoplasms; chronic lower respiratory diseases; cerebrovascular diseases; accidents (unintentional injuries); Alzheimer disease; diabetes mellitus; nephritis, nephrotic syndrome, and nephrosis; influenza and pneumonia; and intentional self-harm (suicide). These 10 causes accounted for 75% of all deaths occurring in the United States.[12] The order of these rankings varied among different demographic groups by age, sex, race, and Hispanic origin. Several studies have reported on the disparities in the leading causes of death; however, many previous studies examined the disparities between demographic groups but did not examine the disparity trends across years or population subgroups. Some studies reported disparities using a single measure but did not report disparities in both absolute and relative measures.[7] Moreover, there are limited studies conducting statistical tests on the temporal trends in disparity in mortality rates among the US demographic subgroups.[13]

In the first Health Disparities and Inequalities Report published by the Centers for Disease Control and Prevention (CDC) in 2011, health disparities were defined as the differences in health outcomes and their determinants between segments of the population as defined by social, demographic, environmental, and geographic attributes.[14] "Health inequalities" is sometimes used interchangeably with the term "disparities" and is used to refer to summary measures of population health associated with individual- or group-specific attributes. Health inequities are a subset of health inequalities that are modifiable, associated with social disadvantage, and considered ethically unfair. In this article, we used the terms "health disparities" and "health inequalities" interchangeably. We examined change over time in death rates by sex and race/ethnicity for each of the 10 leading causes of death in the United States from 1999 to 2010, using both absolute and relative measures. We identified disparity gaps in sex and racial/ethnic subgroups in comparison with the groups that had the most and least favorable results. Finally, we tested for significant linear trends in disparities in age-adjusted mortality rates between sex and racial/ethnic groups.

Methods

Study design

Cause of death counts and age-adjusted mortality rates were calculated by year, sex, and race/ethnicity from 1999 to 2010. Racial and ethnic subgroups were non-Hispanic white, non-Hispanic black, Hispanic or Latino, non-Hispanic Asian/Pacific Islander, and non-Hispanic American Indian/Alaska Native. The number of deaths by underlying cause of deaths and age-adjusted standardized rates were obtained from the Compressed Mortality database on WONDER[15] collected by states and compiled by the National Vital Statistics System in the National Center for Health Statistics at the CDC.[16] Death rates for each of the 10 leading causes of death were age-adjusted per 100 000 persons based on the 2000 US Census standard population. The underlying causes of death were classified according to the *International Classification of Diseases, Tenth Revision* (*ICD-10*), coding and selection rules.[17] The 10 leading causes of death were selected on the basis of the mortality statistics in 2010: heart disease (I00-I09, I11, I13, I20-I51), malignant neoplasms (C00-C97), chronic lower respiratory disease (J40-J47), cerebrovascular disease (I60-I69), unintentional injury (V01-X59, Y85-Y86), Alzheimer disease (G30), diabetes mellitus (E10-E14), nephritis (N00-N07, N17-N19, N25-N27), influenza and pneumonia (J09-J18), and intentional self-harm (suicide) (X60-X84,Y87.0). Death rates for 1999 and 2001-2009 were calculated from the bridged-race intercensal estimates of the July 1 population estimates; 2000 and 2010 rates were based on bridged-race April 1 Census estimates.[18]

Statistical analysis

We examined temporal trends in disparity of age-adjusted death rates (AADRs) from 1999 to 2010 for the 10 leading causes of death. We calculated both absolute and relative disparities within sex and between racial and ethnic subgroups for each year from 1999 to 2010. An absolute measure of disparity in mortality rates is the absolute arithmetic difference between a group mortality rate and the mortality rate of a specified referent group.[19] If R_i is the mortality rate for the ith group and R_r is the mortality rate for the referent group, the absolute disparity in mortality rates between the ith group and the referent group is given by $R_i - R_r$ and the standard error of the disparity between the 2 groups is given by $\sqrt{(SE_{R_i})^2 + (SE_{R_r})^2}$, where SE_{R_i} and SE_{R_r} are the standard errors of R_i and R_r, respectively. The relative measure of disparity in mortality rates between the ith group and the referent group is given by $\frac{R_i - R_r}{R_r}$. The variance of the relative disparity is given by:

$$V\left(\frac{R_i - R_r}{R_r}\right) = \left(\frac{R_i}{R_r}\right)^2 \left[\frac{V(R_i)}{R_i^2} + \frac{V(R_r)}{R_r^2}\right],$$

where $V(R_i)$ and $V(R_r)$ are the variances of R_i and R_r, respectively.

Absolute and relative disparities in AADRs by race/ethnicity were calculated separately for males and females by year. To compare mortality rates for racial/ethnic populations by sex in the US population, we generally used the group with the lowest mortality rates as the reference group.[20] On the basis of this criterion, non-Hispanic Asian/Pacific Islander was used as the reference group for both males and females for most of the conditions. The reference group for cerebrovascular disease was non-Hispanic American Indian/Alaska Natives for males and Hispanic or Latinos for females. We calculated the difference in mortality rates between sex and racial/ethnic groups of interest and the reference group. Temporal trends in absolute and relative disparities were also calculated by sex and race/ethnicity. Second, employing these techniques, we compared AADRs of non-Hispanic blacks (the group with the largest mortality rate generally) to other racial/ethnic groups. Finally, to assess the statistical significance of trends in both AADRs and disparities between sex and racial/ethnic groups, we used the weighted linear regression for trend test in the GENMOD procedure in SAS to account for the variations on variance of the disparity by year.[21] Significance is reached at $P < .05$ in a 2-tailed test. Although we calculated both absolute and relative disparities in AADRs, we highlight the findings on relative disparities to respect the word limit.

Results

Mortality trends in the leading causes of death

The 10 leading causes of death in the overall population were the same during 1999-2010, except that septicemia, number 10 in 1999, was replaced by suicide in 2010 (Table 1). The rank order of the 10 leading causes of death in 2010 was slightly different from 1999. Heart disease, malignant neoplasms, and unintentional injury remained the first, second, and fifth leading causes of death, respectively, in 2010. Chronic lower respiratory diseases, Alzheimer disease, and nephritis moved up in rank, whereas cerebrovascular diseases, diabetes mellitus, and influenza and pneumonia moved down in rank from 1999 to 2010.

Analysis of temporal trends between 1999 and 2010 in the US population showed a decline in AADRs for 6 conditions and an increase for 4 conditions (Table 2; see Supplemental Digital Content Figure 1, available at: http://links.lww.com/JPHMP/A154). The 6

TABLE 1 List of 10 Leading Causes of Death and *ICD-10* Codes in the United States in 1999 and 2010

	Causes of Death	
Rank	1999	2010
1	Heart disease (I00-I09, I11, I13, I20-I51)	Heart disease (I00-I09, I11, I13, I20-I51)
2	Malignant neoplasms (C00-C97)	Malignant neoplasms (C00-C97)
3	Cerebrovascular diseases (I60-I69)	Chronic lower respiratory diseases (J40-J47)
4	Chronic lower respiratory diseases (J40-J47)	Cerebrovascular diseases (I60-I69)
5	Unintentional injury (V01-X59, Y85-Y86)	Unintentional injury (V01-X59, Y85-Y86)
6	Diabetes mellitus (E10-E14)	Alzheimer disease (G30)
7	Influenza and pneumonia (J10-J18)	Diabetes mellitus (E10-E14)
8	Alzheimer disease (G30)	Nephritis (N00-N07, N17-N19, N25-N27)
9	Nephritis (N00-N07, N17-N19, N25-N27)	Influenza and Pneumonia (J09-J18)
10	Septicemia (A40-A41)	Suicide (X60-X84,Y87.0)

TABLE 2 ● **Annual Age-Adjusted Death Rates and Absolute and Relative Changes in Age-Adjusted Death Rates From 1999 to 2010 for the 10 Leading Causes of Death, United States, 1999-2010**

Causes of Death	Age-Adjusted Death Rate per 100 000 Population												Absolute Change 1999-2010,[a] n (SE)	% Relative Change 1999-2010,[a] n (SE)
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
Heart disease	266.5	257.6	249.5	244.6	236.3	221.6	216.8	205.5	196.1	192.1	182.8	179.1	−87.3 (0.4)	−32.8 (0.1)
Malignant neoplasms	200.8	199.6	196.5	194.3	190.9	186.8	185.1	181.8	179.3	176.4	173.5	172.8	−28.0 (0.4)	−13.9 (0.2)
Chronic lower respiratory diseases	45.4	44.2	43.9	43.9	43.7	41.6	43.9	41.0	41.4	44.7	42.7	42.2	−3.2 (0.2)	−7.1 (0.4)
Cerebrovascular diseases	61.6	60.9	58.4	57.2	54.6	51.2	48.0	44.8	43.5	42.1	39.6	39.1	−22.5 (0.2)	−36.5 (0.2)
Unintentional injury	35.3	34.9	35.7	37.1	37.6	38.1	39.5	40.2	40.4	39.2	37.5	38.0	2.7 (0.2)	7.6 (0.5)
Alzheimer disease	16.5	18.1	19.3	20.8	22.1	22.6	24.0	23.7	23.8	25.8	24.2	25.1	8.6 (0.1)	52.4 (0.9)
Diabetes mellitus	25.0	25.0	25.4	25.6	25.5	24.7	24.9	23.6	22.8	22.0	21.0	20.8	−4.2 (0.1)	−16.7 (0.5)
Nephritis	13.0	13.5	14.1	14.4	14.7	14.5	14.7	14.8	14.9	15.1	15.1	15.3	2.3 (0.1)	17.3 (0.8)
Influenza and pneumonia	23.5	23.7	22.2	23.2	22.6	20.4	21.0	18.4	16.8	17.6	16.5	15.1	−8.4 (0.1)	−35.7 (0.4)
Suicide	10.5	10.4	10.7	10.9	10.8	11.0	10.9	11.0	11.3	11.6	11.8	12.1	1.6 (0.1)	15.7 (0.9)

[a]Significance at $P < .05$ for all causes of death.

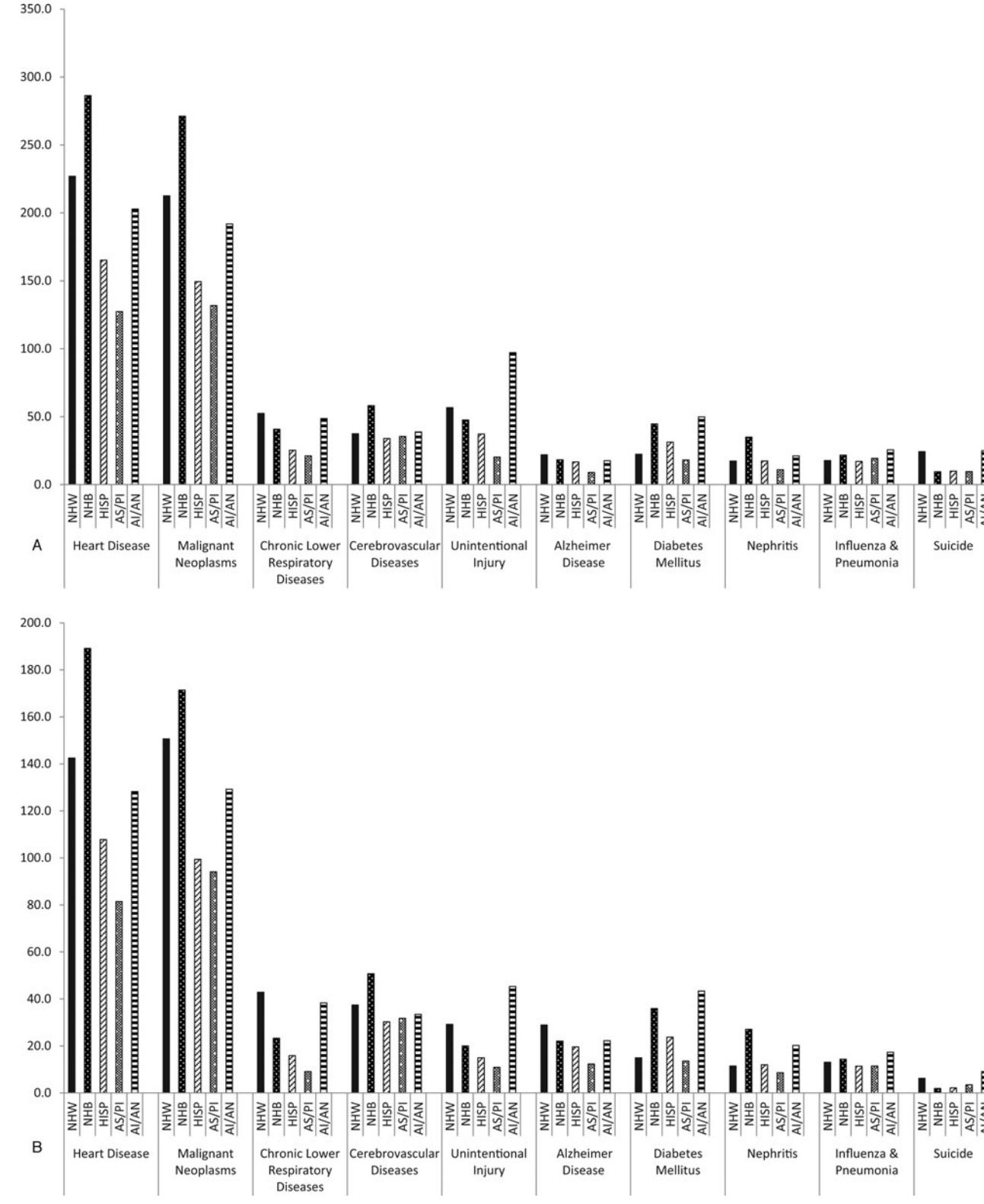
conditions with a declining trend in percent change (relative difference) in AADRs included heart disease (32.8%), malignant neoplasms (13.9%), chronic lower respiratory diseases (7.1%), cerebrovascular diseases (36.5%), diabetes (16.7%), and influenza and pneumonia (35.7%). In contrast, 4 conditions had an increasing trend on AADRs in the overall US population including a dramatic increase of 52.4% in Alzheimer disease, followed by nephritis (17.3%), suicide (15.7%), and unintentional injury (7.6%). Figures 1A and 1B present the AADRs for the 10 leading causes of death for males and females by race/ethnicity in 2010. In 2010, non-Hispanic black males had the highest AADRs for heart disease, malignant neoplasms, cerebrovascular diseases, and nephritis compared with males in other race/ethnic groups. American Indian/Alaska Native males had the highest AADRs from unintentional injury and diabetes mellitus compared with other racial/ethnic males. Similar findings were observed for females in 2010.

Change over time in AADRs for specific sex and racial/ethnic populations

The declining or increasing trends (measured in relative difference) in AADRs were generally consistent for both males and females in all racial/ethnic groups for most conditions from 1999 to 2010 (see Supplemental Digital Content Table 1, available at: http://links.lww.com/JPHMP/A154; Figure 2). A declining trend from 1999 to 2010 for each sex for each racial/ethnic group was observed for heart disease, cerebrovascular disease, diabetes mellitus, and influenza and pneumonia. In contrast, Alzheimer disease showed an increasing trend for both sexes in all racial/ethnic groups. The larger sex disparities in the extent of AADR changes were observed in several diseases. For example, large sex disparities were noted in Alzheimer disease among Asian/Pacific Islanders (95.2% for male vs 144.1% for females) and American Indian/Alaska Natives (146.4% for male vs 85.4% for female), in nephritis among American Indian/Alaska Natives (42.4% for male vs 13.1% for female), and in suicide among American Indian/Alaska Natives (25.7% for male vs 97.3% for female).

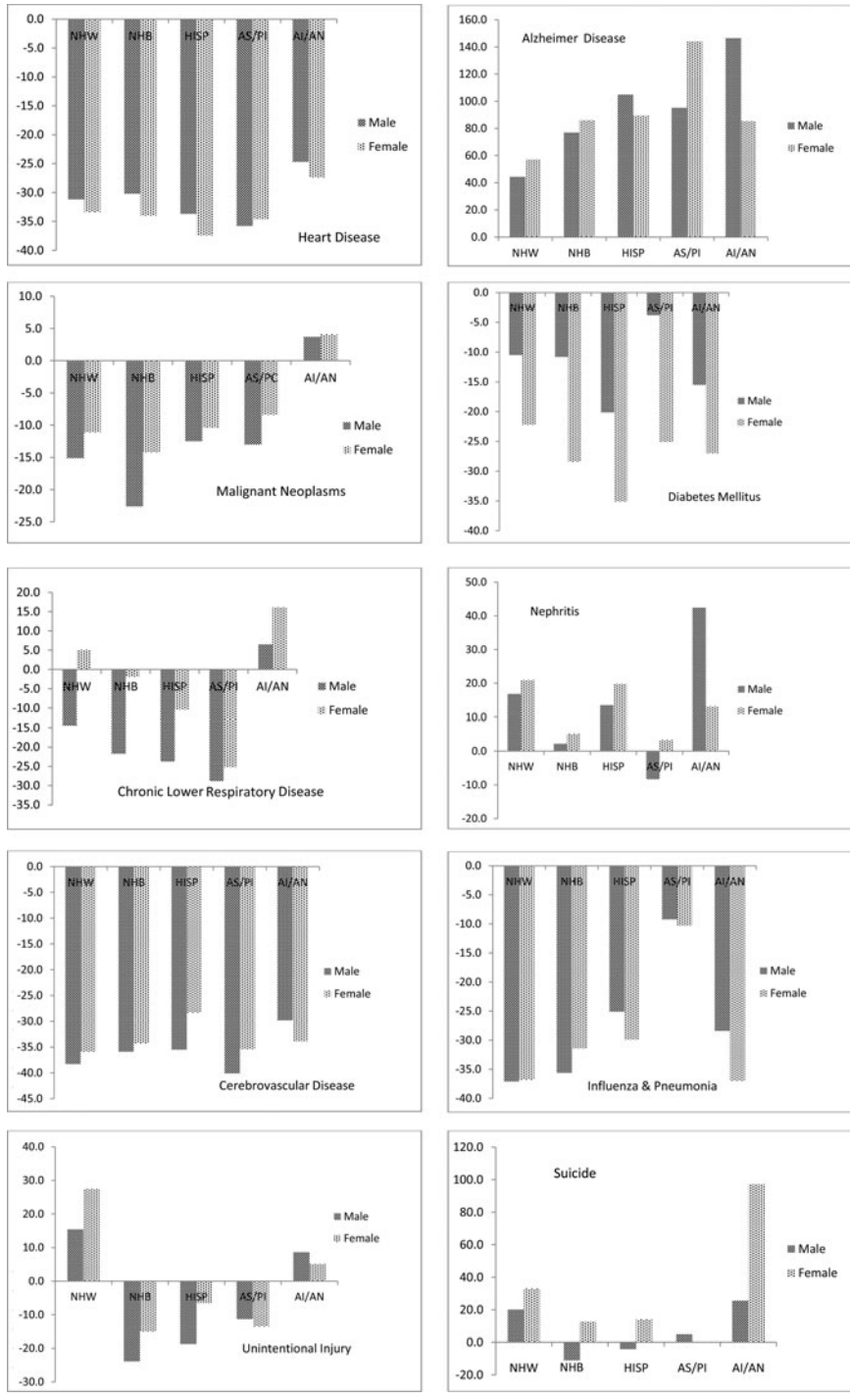
A few variations of sex disparities in different directions were observed including a declining trend among males (−14.4%) and an increasing trend for females (5.1%) in chronic lower respiratory disease for non-Hispanic whites. Similar results were observed for nephritis among Asian/Pacific Islander males (−8.3%) and females (3.3%) and for suicide among non-Hispanic black males (−10.9%) and females (12.8%) and Hispanic males (−4.2%) and females (14.2%).

FIGURE 1 ● (A) Age-Adjusted Death Rates for 10 Leading Causes of Death Among Males, by Race/Ethnicity, United States, 2010 (B) Age-Adjusted Death Rates for 10 Leading Causes of Death Among Females, by Race/Ethnicity, United States, 2010



Abbreviations: AI/AN, American Indian/Alaska Native; AS/PI, Asian/Pacific Islanders; HISP, Hispanic; NHB, non-Hispanic black; NHW, non-Hispanic white.

FIGURE 2 ● Relative Percent Change[a] in Age-Adjusted Death Rates From 1999 to 2010 for the 10 Leading Causes of Death by Sex and Race/Ethnicity—United States



Abbreviations: AI/AN, American Indian/Alaska Native; AS/PI, Asian/Pacific Islanders; HISP, Hispanic; NHB, non-Hispanic black; NHW, non-Hispanic white.
[a]The standard errors for relative percent change are available in the Supplemental Digital Content Table 1 (available at: http://links.lww.com/JPHMP/A154).

For males, the largest declining trends in relative disparity of AADRs from 1999 to 2010 were for cerebrovascular disease among Asian/Pacific Islanders (−40.1%), and for females, in heart disease among the Hispanic population (−37.4%). On the contrary, the largest increasing trends were seen among American Indian/Alaska Native males (146.4%) and Asian/Pacific Islander females (144.1%) in Alzheimer disease.

Temporal trends in racial/ethnic disparities in comparison with the most favorable group

Supplemental Digital Content Tables 2 and 3 (available at: http://links.lww.com/JPHMP/A154) present the absolute and relative disparity and statistical test for trend in comparison with Asian/Pacific Islanders (ie, the most favorable group) in 10 leading causes of death by year, sex, and race/ethnicity from 1999 to 2010. Estimates of relative difference (%) for these conditions in 1999 and 2010 are presented in Figure 3. The significant ($P < .05$) decline or increase in temporal trends in relative disparity varied across sex, race/ethnicity, and disease. In general, racial/ethnic disparities decreased from 1999 to 2010 for 4 conditions: cerebrovascular diseases, Alzheimer disease, diabetes mellitus, and influenza and pneumonia. In contrast, disparity increased for heart disease, chronic lower respiratory diseases, and nephritis.

In 2010, compared with Asian/Pacific Islanders, non-Hispanic blacks had the largest disparity in 4 of the 10 leading causes of death (ie, heart disease, malignant neoplasms, cerebrovascular diseases, and nephritis); non-Hispanic American Indian/Alaska Natives had the largest disparity in 4 causes of death (ie, unintentional injury, diabetes mellitus, influenza and pneumonia, and suicide); and non-Hispanic whites had the largest disparity in 2 causes of death (ie, chronic lower respiratory diseases and Alzheimer disease).

Absolute versus relative measures of disparity trends

Although the pattern of disparity trends in absolute and relative measures varied by sex and racial/ethnic subgroup for each disease from 1999 to 2010, in general, both disparity measures provided a consistent direction in disparity trends in AADRs for 8 of 10 leading causes of death. The only 2 exceptions of inconsistent disparity trends were found in death rates for heart disease and Alzheimer disease. In 1999-2010, temporal trends in relative disparity increased for heart disease whereas their absolute disparity trends declined. Similarly, relative disparity trends decreased but absolute disparity trends increased for Alzheimer disease.

Disparity between non-Hispanic whites and non-Hispanic blacks

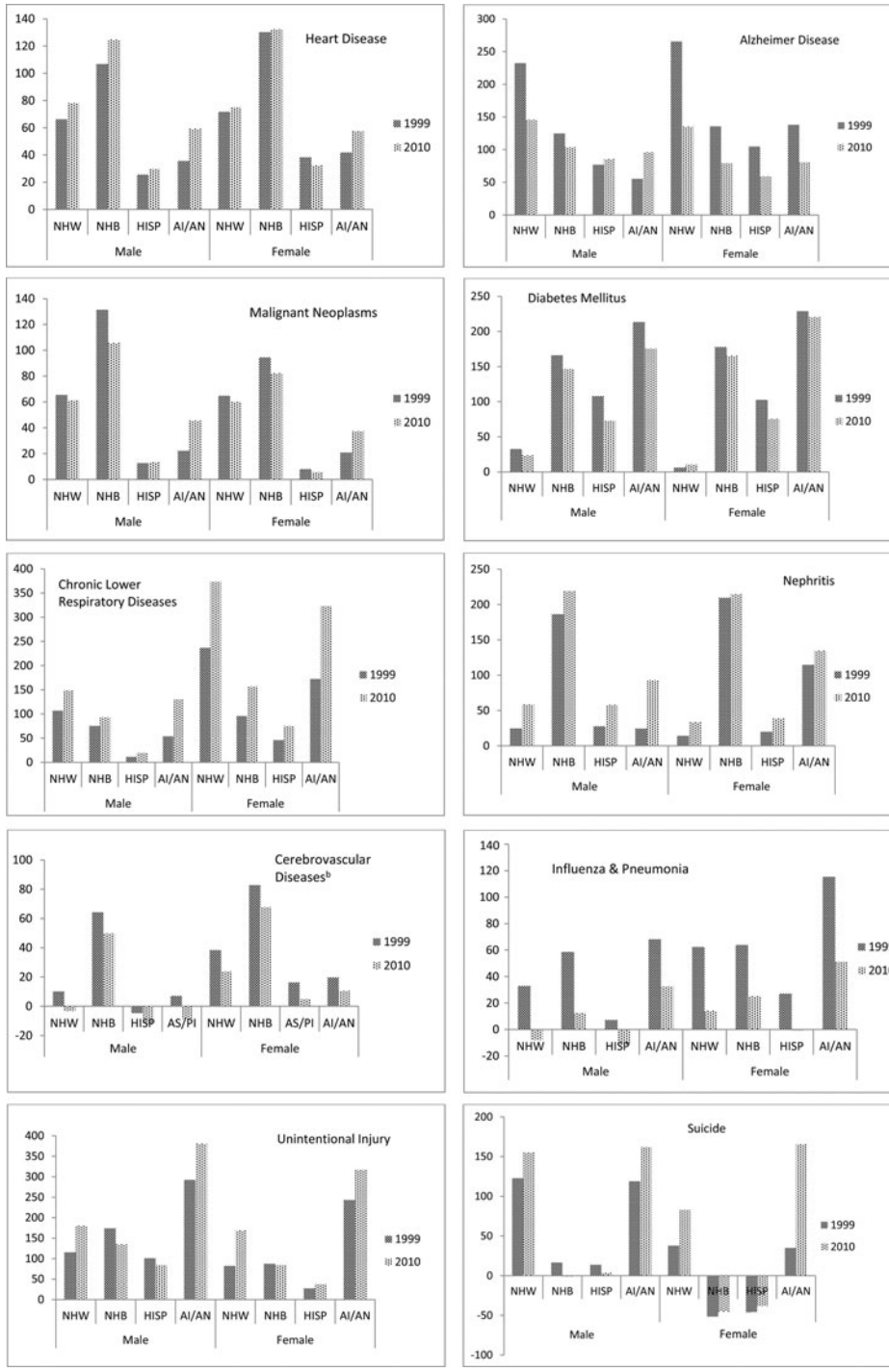
Non-Hispanic blacks generally had less favorable health profiles than non-Hispanic whites. Nevertheless, in 2010, both sexes in the non-Hispanic white population had a higher relative disparity in AADRs than those in the non-Hispanic black population in 4 leading conditions: chronic lower respiratory diseases, unintentional injury, Alzheimer disease, and suicide (see Supplemental Digital Content Tables 4 and 5, available at: http://links.lww.com/JPHMP/A154). For example, the largest disparities in suicide for non-Hispanic white males and non-Hispanic white females were 157.8% and 235.8% compared with non-Hispanic black males and females, respectively, in 2010.

Discussion

In this study, we identified sex and racial/ethnic disparity trends in death rates for the 10 leading causes of death in the US population from 1999 to 2010. Despite the longstanding interest in health disparities between racial/ethnic groups in the United States, surprisingly few studies have analyzed trends in racial/ethnic disparities. The major focus on racial/ethnic disparities in the United States has been on disparities between non-Hispanic blacks and whites when the non-Hispanic white population has been used as the reference group. Alternatively, as recommended in the series of *Healthy People* reports,[3,20] measuring disparity trends using the group with the lowest death rates as the reference group has several advantages in monitoring progress in eliminating disparities. In this study, we conducted statistical tests to assess disparity trends in death rates by comparing the group with the most favorable death rates (ie, non-Hispanic Asian/Pacific Islander) with other racial/ethnic groups; we also measured the difference in death rates between the 2 major racial/ethnic groups in the United States: non-Hispanic whites and non-Hispanic blacks.

Our study shows that mortality rates for the overall population have declined between 1999 and 2010 for 6 of the 10 leading causes of death, but disparities in mortality rates for subpopulations, by race/ethnicity and sex, when controlling for age differences, still persist. From 1999 to 2010, death rates for the overall population declined in heart disease, malignant neoplasms, chronic lower respiratory diseases, cerebrovascular diseases, diabetes mellitus, and influenza and pneumonia.

FIGURE 3 ● Relative Percent Change[a] in Age-Adjusted Death Rates for the 10 Leading Causes of Death Within Sex by racial/Ethnic Group (Compared With Asian/Pacific Islanders)—United States, 1999 and 2010



Abbreviations: AI/AN, American Indian/Alaska Native; AS/PI, Asian/Pacific Islanders; HISP, Hispanic; NHB, non-Hispanic black; NHW, non-Hispanic white.
[a]The standard errors for relative percent change are available in the Supplemental Digital Content Table 1 (available at: http://links.lww.com/JPHMP/A154).
[b]Compared with non-Hispanic American Indian/Alaska Natives for males, and Hispanic or Latinos for females.

In contrast, death rates increased from 1999 to 2010 in the rest of 4 leading causes of deaths.

In general, the declining or increasing disparity trends in mortality rates were consistent between males and females and remain the same for each racial/ethnic group among males and females when examined separately. In 1999-2010, the greatest declining trend in percent change was observed for cerebrovascular disease in the overall population and the greatest increasing trend was seen in Alzheimer disease. The disparity gaps with Asian/Pacific Islanders from 1999 to 2010 varied by sex, racial/ethnic subgroups, and disease. Although the pattern of disparity trends varied by disease condition, sex, race/ethnicity, and measurement method, our results confirmed that both absolute and relative disparities led to the same conclusion for all the 10 leading causes of death, except in heart disease and Alzheimer disease.

There has been some debate over which measure (ie, absolute or relative inequality) should be used in measuring and reporting disparities. These 2 measures of disparities not only are different in the magnitude but can also suggest different directions of change.[22] For example, our results indicated that disparity gaps, when compared with Asian/Pacific Islander in heart disease, declined in absolute terms but did not show the same pattern when we measured the gaps using the percent change during the same study years. Both absolute and relative measures can be meaningful in monitoring disparities provided that the overall level of the outcome is taken into account.[23] Relative disparities tend to be higher at low overall rates, whereas absolute disparities tend to be lower at both very high and very low overall rates and higher at intermediate levels.[23] Because relative and absolute disparity measures can lead to different conclusions about change in disparity over time, most experts recommend that both types of measures be carefully examined. Measures of absolute disparity are used to quantify the absolute disproportionality in health disparity.[24] Relative disparity indicators may be useful when comparing disparities across outcomes measured on different scales for progress toward eliminating disparities.[25] For example, Keppel[26] recently ranked relative disparities across hundreds of *Healthy People 2010* objectives to identify the 10 "largest" health disparities for 5 racial/ethnic groups.

In this study, although we reported both absolute and relative disparities, we paid more attention to relative disparities in our results because this method has been used in a series of *Healthy People* reports to measure health disparities.[20] Therefore, our results in relative disparity can be used for comparisons across diseases or conditions in different units of measurement with other published reports.

Racial/ethnic differences in socioeconomic status, neighborhood residential conditions, and medical care can contribute to racial/ethnic differences in morbidity and mortality.[27,28] Several studies have provided population estimates of deaths attributable to social factors, for example, a study estimated more than 1 million deaths from 1996 to 2002 would have been avoided if all US adults had at least a college education.[29] Other studies estimated 2% to 6% mortality due to poverty,[30,31] 9% to 25% for income inequality,[32] and 18% to 25% for low socioeconomic status.[33] Galea et al[34] also estimated deaths attributable to social factors in the United States in 2000 based on the population attributable fraction of each social factor. According to their estimates, deaths attributable to low education, racial segregation, low social support, individual-level poverty, and income inequality numbered 245 000, 176 000, 162 000, 133 000, and 119 000, respectively.[34] Any disparity in the prevalence of these social risk factors among subpopulations could lead to disparities in the prevalence and mortality associated with disease. For example, in 2009, both non-Hispanic black and Hispanic groups had significantly higher age-standardized percentages of adults who had not completed high school than non-Hispanic whites.[35] Similar group disparities were observed in 2009 for poverty.[30] Difference in access to care is also one of the many factors accounting for the disparity in mortality rates observed among racial and ethnic groups. Approximately 2 of every 5 adults of Hispanic ethnicity and 1 of 5 non-Hispanic black adults were classified as uninsured during 2008, and both these groups had significantly higher uninsured rates than non-Hispanic whites.[36] Monitoring changes in distributions of social determinants of health is important because it can identify the progress in health disparity.[37] Information on social determinants of health for the US population has been published in a series of CDC Health Disparities and Inequalities Reports.[38,39] These reports examined some of the key factors that affect health and lead to health disparities in the United States. The community-level data for the US population on several key social determinants of health can be found in several sources, for example, the American Community Survey[40] and the Community Needs Assessment.[41] These sources provides a wealth of information needed to examine risk factors associated with population health and health disparities. In our study, we used race/ethnicity as a social determinant of health and measured absolute and relative disparities for changes in mortality between populations. A recent report presented a new method to estimate the difference in a health outcome (inequity) between 2 population groups and found that a difference of 22.8% in the prevalence of diabetes between non-Hispanic white and non-Hispanic black populations was attributable

to poverty.[42] This report provides both a more comprehensive way of studying health disparities between populations and an opportunity to reduce or eliminate health disparities among vulnerable populations. As indicated in *Healthy People 2020*, the determinants of health include a broad range of personal, biological and genetic, social, economic, and environmental factors that can influence both individual's and the population's health.[43] A complex relationship exists between health and many of these social factors. These social factors serve as intermediary factors that interact with each other and are associated with other racial and ethnic disparities that are linked to quality of health care, access to health care, and program and policy issues.

The disparity gaps and trends in mortality rates reported in this study enable health care professionals, public health officials, and policy makers to monitor trends and identify gaps in health disparities among vulnerable populations. The implementation of health reform under the ACA, such as coverage expansions, may reduce the inequality in access to health care and therefore reduce the disparities in mortality rates. One study estimates a 6% reduction in uninsured people in the US population by 2018 with the enactment of the ACA 2010.[44] In addition, according to the Congressional Budget Office, implementation of the health care reform legislation is expected to increase health insurance coverage in 2019 to approximately 30 million people who would otherwise have been uninsured.[45]

Although improved access to health care by expanding coverage is essential, reducing health disparities requires actions influencing the factors such as environmental and social determinants of the disparities that affect population health.[45] With the HHS Disparities Action Plan, the HHS commits to continuously assess the impact of all policies and programs on racial and ethnic disparities and to promote integrated approaches, evidence-based programs, and best practices to reduce these disparities.[46] In this regard, monitoring disparity trends in the AADR for the leading causes of death can provide insight on persistent gaps among US racial/ethnic subgroups, evaluate the progress in reducing disparities, assess the impact of intervention programs, and identify any differential effectiveness of public health policies and practices designed to eliminate disparities.

The findings of our study must be interpreted in light of several limitations. First, misclassification of race and ethnicity of the decedent on the death certificate might underestimate mortality rates among American Indians/Alaskan Natives, Asian/Pacific Islanders, and Hispanics[46-48]; and the mortality statistics are more accurate for blacks and whites than for other racial and ethnic populations. Studies have found that the misclassification of racial and ethnic groups on death certificates in the United States accounts for a net underestimate of 5% for total Hispanic deaths, 1% for total non-Hispanic black deaths, and a net overestimate of less than 0.5% for non-Hispanic white deaths.[46] In addition, our study does not assess data completeness to account for small proportion of deaths that lack complete information on death certificate. Mortality calculated in this study was based on complete counts assuming these counts have a Poisson distribution, and no sample variance for mortality was considered in the estimation of the variance of disparity among the mortality rates.

The magnitude of gaps in absolute disparity quantified in this study (eg, gaps between the majority group of white populations and the reference population) is likely to be reduced because of understated mortality rates in some racial/ethnic groups. However, the underestimation does not account for all the disparities noted and likely does not influence relative disparities over time. Second, the death rates reported in this study represent only the underlying causes of death and do not account for other contributing factors or comorbidities that may vary across racial and ethnic groups. Finally, Joinpoint regression has been commonly used to describe changes in time trends in mortality or incidence data.[49] This technique is a type of nonlinear regression that can be used to identify the best fitting points where a statistically significant change (increase or decrease) in the rates has occurred. A meaningful Joinpoint regression requires several years of data point to identify changes in trends. To eliminate bias from being introduced across the 2 *ICD* coding schemes, our study examined the trends for health conditions being coded on the basis of the latest *ICD-10* codes.[17] This practice has limited our ability in using few data points to test for pattern change in mortality trends in Joinpoint regression analysis.

Conclusion

Public health practitioners can use these findings to improve policies and practices and to evaluate progress in eliminating disparities and their social determinants in vulnerable populations. Despite substantial progress in reducing AADR overall and in subgroups, disparities by sex and race/ethnicity still exist. From 1999 to 2010, the AADR decreased for 6 and increased for 4 leading causes of death in the US population. Our study confirms that absolute and relative measures can suggest opposing trends in health outcome disparities and that both measures can be useful in monitoring disparities. The HHS Action Plan to Reduce Racial and Ethnic Health Disparities has focused the attention of policy makers and the public on this national priority.

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