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Epidemiology of Cardiovascular Diseases and Risk Factors Among Racial/Ethnic Populations in the United States

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The findings and conclusions in this chapter are those of the author and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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1. SUMMARY

Cardiovascular epidemiology plays a fundamental role in the assessment of disease burden and evaluation of health disparities. Although current epidemiologic data have important limitations, they nevertheless provide compelling evidence that racial and ethnic disparities in cardiovascular health are pervasive and that they contribute to a lower life expectancy, excess morbidity, and reduced quality of life in several racial and ethnic minority populations. The largest of these disparities is found in race–county comparisons of mortality and summary measures of morbidity. The causes of these disparities are complex. However, established racial and ethnic differences in traditional risk factors and socioeconomic, educational, and environmental determinants contribute to these health disparities. Although stroke and coronary heart disease mortality rates have declined for men and women in all racial and ethnic groups, they remain significantly higher than the national Healthy People 2010 targets in African-Americans. In particular, racial and ethnic disparities associated with these mortality rates have increased, and disparities in access to care and quality of health care persist. Elimination of these disparities, in addition to increasing years and quality of life for all Americans, must remain the overarching national health objectives in the years ahead.

2. INTRODUCTION

Contemporary and future considerations of cardiovascular diseases (CVD) in racial and ethnic minority populations must take into account the burden of cardiovascular events, risk factors, mortality, disabling sequelae, and secular trends by race and ethnicity (1). Cardiovascular epidemiology provides unique tools for assessing all of these and the opportunity to identify population subgroups at increased risk for CVD and outcomes (2). Through this exercise, cardiovascular epidemiology also provides the data for identifying the existence of health disparities. Additionally, the monitoring and surveillance components of cardiovascular epidemiology provide clues to new and emerging cardiovascular threats and permit assessment of the effectiveness of current measures to prevent and control established CVD. Taken together, these properties summarize the fundamental role that epidemiology plays in promoting and protecting cardiovascular health and informing program and policy development for the prevention and control of CVD (2–4).

This chapter begins with the strengths and limitations of the existing epidemiological data on CVD and risk factors by race and ethnicity in the United States. It then presents the most recently available data and trends for summary measures of overall health. Data on state-specific self-reported lifestyle and behavioral risk factors are then discussed. National preva-

lence of measured risk factors and their recent trends are also presented. Racial and ethnic differences in the recent epidemiological data on total CVD burden and measures of quality care and outcomes are then presented and discussed. Finally, epidemiological data from the mid-course review of the Healthy People 2010 national health objectives for heart disease and stroke by race and ethnicity are then discussed to show the progress made and persisting challenges in the endeavor to eliminate health disparities.

3. STRENGTHS AND LIMITATIONS OF THE EXISTING EPIDEMIOLOGIC DATA

Although the advantages of CVD epidemiology are well recognized, epidemiologic data are typically not available for all racial and ethnic groups. Often, data on specific racial and ethnic populations are not collected or collected in formats that differ from federal standards (5). The accuracy and quality of data on race and ethnicity may also vary by factors such as the type of data collected and the source of information (6,7). When high-quality data are appropriately collected, the data may be insufficient to generate reliable estimates for specific racial and ethnic groups where sample sizes are small (5). Additionally, even in settings where stable estimates can be generated, the miscoding or misclassification of race, which disproportionately affects American Indians and Alaska Natives (8–10) can lead to flawed data in these comparisons.

For example, Rhoades et al. (8) showed that vital events data unadjusted for racial misclassification show American Indians and Alaska Natives as having the lowest mortality rates from major CVD. However, after appropriate adjustment, American Indians and Alaska Natives had the highest mortality rates that demonstrated a rapidly growing disparity when compared with rates in the US all-races and white populations (8). These limitations and challenges in the existing epidemiologic data by race and ethnicity must be recognized.

In interpreting and using the epidemiological data presented in this chapter, the racial and ethnic categories should be viewed as social, not biological constructs (11–13). Although genetics, gene–gene, and the gene–environment interactions are important influences on the data presented (14), racial and ethnic differences seen should not be assumed to be necessarily caused by genetic or biological differences (11–15). Other key determinants of disparities such as access to care, quality of care delivered, systems of care, geographic and environmental influences, income and educational levels, prejudice, discrimination, provider bias, psychosocial stressors, and personal behaviors and lifestyle choices all play important roles in causing disparities (16). Appropriate recognition of these limitations, challenges,

and caveats in the use of these data are important in the contemporary and future considerations in the prevention and control of CVD in racial and ethnic minority populations.

4. LIFE EXPECTANCY AND SUMMARY MEASURES OF POPULATION HEALTH

A summary measure of population health is an epidemiological index that combines mortality and non-fatal health outcomes with functional and quality of life dimensions into a single indicator to measure a population's overall state of health (17–19). Together with life expectancy, these measures provide an important assessment of the first overarching goal of the Healthy People 2010 national health agenda (to increase the years and quality of healthy life), as well as the second overarching goal (to eliminate health disparities) when these measures are examined by race and ethnicity (18–21).

Life expectancy at birth and at age 65 years are two of the most commonly used summary measures of mortality. In 2005, life expectancy at birth for the total US population reached a record high of 77.9 years and was higher in whites by 5.1 years compared with that in blacks (22). Compared with black men and women, life expectancy at birth was higher in white men and women by 6.1 and 4.3 years, respectively (Fig. 1) (22). Although

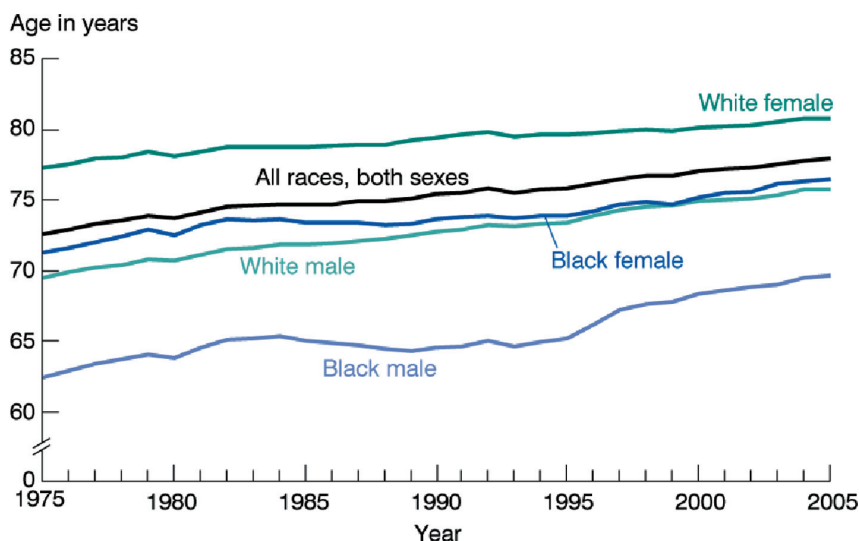


Fig. 1. Life expectancy at birth, by race, and sex: United States, 1975–2004 final and 2005 preliminary.

Source: CDC/NCHS, National Vital Statistics System. From Kung HC, Hoyert DL, Xu J, Murphy SL. Deaths: Preliminary data for 2005. Health E-Stats. Sept 2007. www.cdc.gov/nchs/products/pubs/pubd/hestats/prelimdeaths05/prelimdeaths05.htm (22).

the National Center for Health Statistics does not report life expectancy data for other race or ethnic groups, other sources show marked disparities in life expectancy between Asian Americans who have the highest life expectancy and poor whites living in Appalachia and the Mississippi Valley, Native Americans living on reservations in the West, poor blacks living in the rural South, and other race–county subgroups (Fig. 2) (23). Examination of life expectancy across race–county groups shows even greater disparities (Figs. 3 and 4). For example, Murray et al. showed that Native American males in a cluster of Bennet, Jackson, Mellette, Shannon, Todd, and Washabaugh Counties in South Dakota had a life expectancy of 58 years in 1997–2001, compared to Asian females in Bergen County, New Jersey, with a life expectancy of 91 years, a gap of 33 years. The Eight Americas study confirmed that the largest measurable disparities observed in the United States to-date are those revealed by examining the disparities across race–county groups (23).

Cardiovascular diseases, the leading cause of death in the United States plays an important role in these disparities. In one study of the disparities in life expectancy stratified by race and educational level, Wong et al. showed that cardiovascular diseases account for 35.3% of the black–white difference in potential life-years lost, in large part because of the impact of hypertension (24). African-Americans and American Indians also suffer disproportionate shares of total burden relative to their population size when assessed by the disability adjusted life years as a measure of premature death and disability (Figs. 5 and 6) (25). The marked disparities in burden experienced

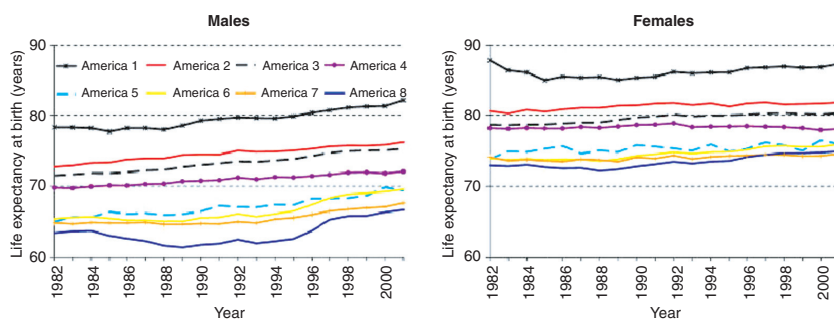


Fig. 2. Life expectancy at birth in the Eight Americas (1982–2001). The “Eight Americas” as used in this study, represent distinct subgroups of the US population where 1 = Asian; 2 = Northland low-income rural white; 3 = Middle America; 4 = low-income whites in Appalachia and the Mississippi valley; 5 = Western Native American; 6 = Black Middle America; 7 = Southern low-income rural black; and 8 = high-risk urban black.

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Source: Murray CJ, Kulkarni S, Ezzati M. Eight Americas: new perspectives on U.S. health disparities. *Am J Prev Med* 2005 December; 29(5 Suppl. 1):4–10 (23).

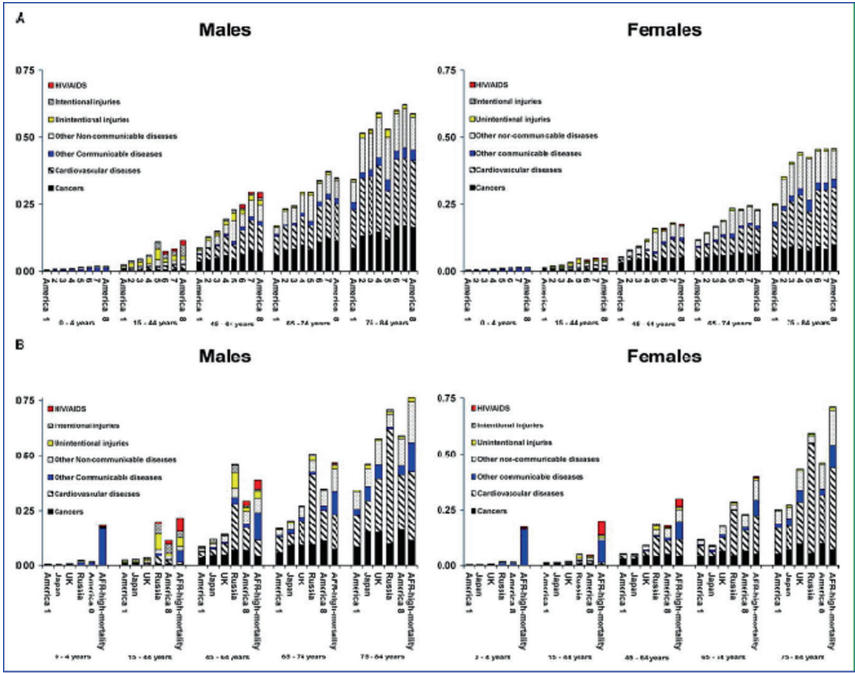


Fig. 3. Probability of dying in specific age ranges in the Eight Americas as defined in Fig. 2. (A) Probability of death by sex, age, and disease for the Eight Americas in 2001. (B) Probability of death by sex, age, and disease for Americas 1 and 8 compared to Japan, United Kingdom, the Russian Federation, and high-mortality countries in sub-Saharan Africa (AFR-high-mortality; made up largely of countries in West Africa and excluding countries with very high mortality due to HIV/AIDS) in 2001. Results are not shown for ages 5–14 year because there are few deaths in this age range in the United States.

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Source: Murray CJ, Kulkarni S, Ezzati M. Eight Americas: new perspectives on U.S. health disparities. *Am J Prev Med* 2005 December; 29(5 Suppl. 1):4–10 (23).

by African-Americans is most evident for cerebrovascular diseases as shown in Fig. 6.

5. CARDIOVASCULAR RISK FACTORS AND BIOMARKERS

An important contributor to population differences in cardiovascular disease events and outcomes is the magnitude of the population-level differences in traditional risk factor levels and emerging biomarkers. For example, in the INTERHEART standardized case–control study of acute myocardial infarction in 52 countries, representing 15,152 cases and 14,820 controls, Yusuf et al. (26) found that collectively, nine risk factors accounted for

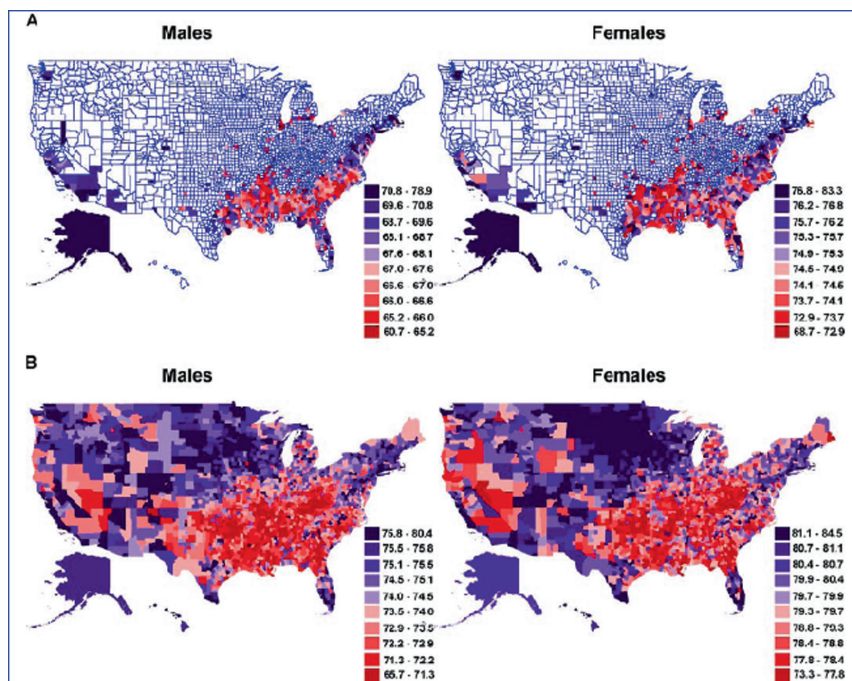
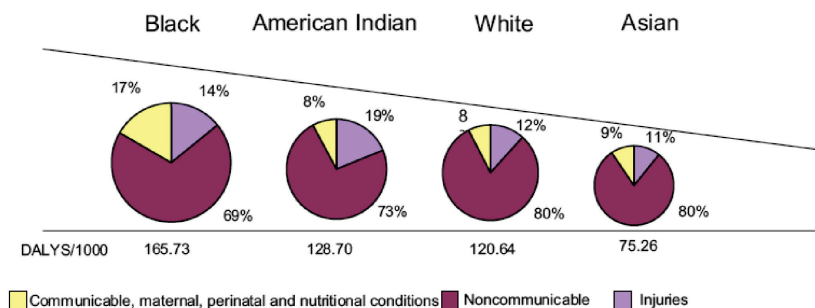


Fig. 4. County life expectancies by race (Fig. 1). Deaths were averaged for 1997–2001 to reduce sensitivity to small numbers and outliers. (A) Life expectancy at birth for black males and females. Only counties with more than five deaths for any 5-year age group (0–85) were mapped, to avoid unstable results. (B) Life expectancy at birth for white males and females.

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Source: Murray CJ, Kulkarni S, Ezzati M. Eight Americas: new perspectives on U.S. health disparities. *Am J Prev Med* 2005 December; 29(5 Suppl. 1):4–10 (23).

90% of the population attributable fraction of acute myocardial infarction in men and 94% in women. These nine risk factors included cigarette smoking, raised ApoB/ApoA1 ratio, history of hypertension, diabetes, abdominal obesity, psychosocial factors, daily consumption of fruits and vegetables, regular alcohol consumption, and regular physical activity. Their significant associations with acute myocardial infarction were noted in men and women, old and young, and in all regions of the world (26). As discussed in the sections below, racial and ethnic differences in these traditional risk factors contribute to the established racial and ethnic disparities in cardiovascular health. In addition to differences in traditional risk factors, differences in cardiovascular biomarkers such as high sensitivity C-reactive protein (CRP), soluble intercellular adhesion molecule, homocysteine, and fibrinogen may contribute to or serve as markers for differences in disease burden and outcomes (27–32).



Groups I, II, and III as a percentage of total burden of disease (DALY) by race, US, 1996.

Fig. 5. The main categories of diseases and conditions expressed as a percentage of total burden of disease (DALY) by race, United States, 1996.

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Source: Michaud CM, McKenna MT, Begg S, et al. The burden of disease and injury in the United States 1996. *Popul Health Metr* 2006 October 18;4:11 (25).

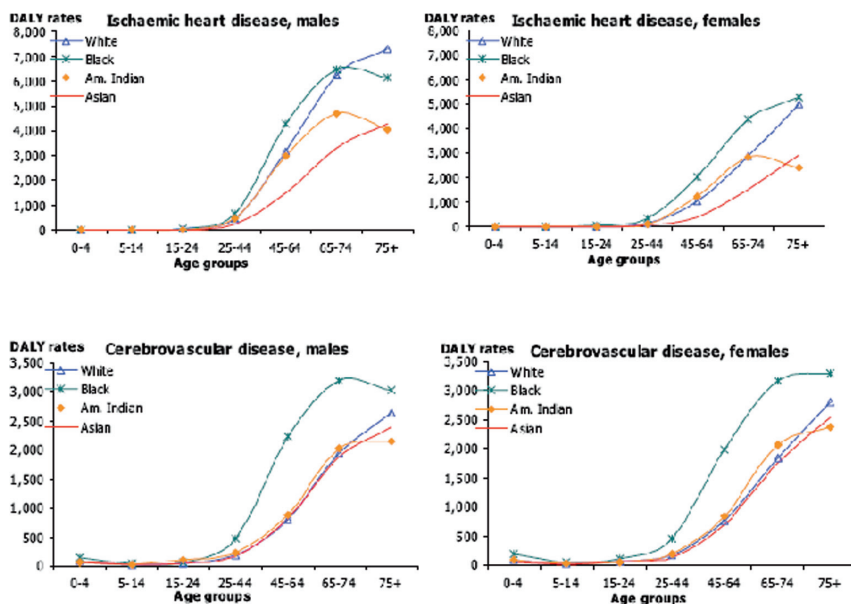


Fig. 6. The burden of ischemic heart disease and cerebrovascular diseases: distribution of DALY rates/100,000 by age, race, and sex, United States, 1996.

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Source: Michaud CM, McKenna MT, Begg S, et al. The burden of disease and injury in the United States 1996. *Popul Health Metr* 2006 October 18;4:11 (25).

5.1. Self-Reported Behavioral and Lifestyle Risks

Self-reported behavioral and lifestyle risk factors for CVD vary by sex, race, ethnicity, and education level and contribute to the established disparities in cardiovascular health (33). In the United States, several national and state-based surveillance systems provide crucial information on self-reported personal behaviors and lifestyle risks such as tobacco use, alcohol intake, consumption of fruits and vegetables, lack of participation in leisure-time physical activity, acceptance of seasonal influenza vaccination, and measures of overweight and obesity (34–37).

In one comprehensive review of the state of disparities in these behavioral and lifestyle risk factors, the prevalence of “no physical activity” was common in all racial and ethnic groups, especially in women with less than high school education (Table 1) (33). Daily intake of five or more servings of fruits and vegetables was low in all groups and lowest in African-American and white men with less than a high school education (33). African-American men and women had the highest self-reported prevalence of diagnosed diabetes and high blood pressure, and African-American men had the highest rate of smoking (33). Importantly, the prevalence of two or more risk factors (among six risk factors for heart disease and stroke: high blood pressure, high cholesterol, diabetes, current smoking, physical inactivity, and obesity) in adults aged 18 years and older was highest among blacks (48.7%) and American Indians/Alaska Natives (46.7%) and lowest among Asians (25.9%) (38).

As shown in Fig. 7, the most recent data on the percentages of adults with selected unhealthy behavior characteristics from the National Health Interview Survey varied by race during 2002–2004, with usually high prevalence in African-Americans, American Indians and Alaska Natives, and Native Hawaiian or other Pacific Islanders (39). Increasingly, the important contextual influences that social networks, social support, social norms, and policy and environmental changes have as modifying factors on these lifestyles and behaviors are increasingly being recognized (40,41)

5.2. Prevalence and Trends in Measured Risk Factors

Since the early 1960s, the National Health and Nutrition Examination Survey (NHANES) has periodically provided health data on the noninstitutionalized civilian US population and designated subgroups, including race and ethnicity (35,42). Among the measured traditional risk factors, the most important in the pathogenesis of CVD include systolic blood pressure; total blood cholesterol, low-density and high-density lipoprotein cholesterol; body mass index; hemoglobin A1c; and the calculated prevalences of persons diagnosed, treated, and controlled for hypertension, diabetes, and dyslipidemia. Important racial and ethnic variations in all of these risks are well

Table 1
Unadjusted Prevalence of Risk Factors for Cardiovascular Diseases Among US Adults ≥ 18 Years of Age, The Behavioral Risk Factor Surveillance System, 2003

	Whites			Blacks			Mexican-Americans					
	<High School		≥High School	<High School		≥High School	<High School		≥High School			
	%	SE	%	SE	%	SE	%	SE	%	SE		
Current smoker												
Men	40.6	1.1	22.9	0.3	41.8	2.7	27.4	1.0	27.3	1.7	22.6	1.1
Women	34.6	0.9	19.9	0.2	25.6	1.6	17.8	0.7	10.6	1.0	12.9	0.7
Total	37.5	0.7	21.4	0.2	33.0	1.5	22.0	0.6	18.6	1.0	17.7	0.7
No physical activity												
Men	40.1	1.0	17.7	0.2	42.1	2.7	24.7	1.0	46.5	1.9	24.9	1.1
Women	45.3	0.9	21.5	0.2	50.7	1.9	32.2	0.8	52.2	1.7	33.3	1.0
Total	42.8	0.7	19.7	0.2	46.8	1.6	28.9	0.6	49.4	1.3	29.1	0.8
≥5 Servings of fruits and vegetables												
Men	13.3	0.7	18.6	0.3	14.6	2.0	18.9	0.9	18.2	1.6	17.4	1.1
Women	20.6	0.7	29.5	0.2	22.5	1.8	25.8	0.8	24.1	1.5	25.3	1.0
Total	17.1	0.5	24.3	0.2	18.9	1.3	22.8	0.6	21.3	1.1	21.4	0.7
Told to have diabetes												
Men	11.9	0.7	7.0	0.2	14.6	1.7	10.1	0.7	9.0	1.0	5.6	0.6
Women	13.3	0.5	5.9	0.1	19.2	1.3	10.6	0.5	11.5	1.0	6.4	0.5
Total	12.6	0.4	6.4	0.1	17.1	1.1	10.4	0.4	10.3	0.7	6.0	0.4

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Source: Mensah GA, Mokdad AH, Ford ES, Greenland KJ, Croft JB. State of disparities in cardiovascular health in the United States. *Circulation* 2005 March 15; 111(10):1233–1241 (33).

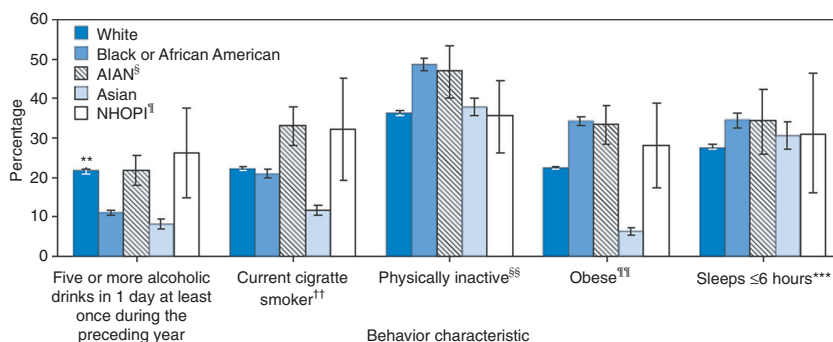


Fig. 7. The percentage of adults with selected unhealthy behavior characteristics varied by race during 2002–2004.

Source: Centers for Disease Control and Prevention. QuickStats: Prevalence of Selected Unhealthy Behavior Characteristics Among Adults Aged 18 Years, by Race* — National Health Interview Survey, United States, 2002–2004. *MMWR Morb Mort Wkly Rep* 2007 February 2;56(04):79 (39).

*Racial categories include persons who indicated a single race only and are consistent with the 1997 Office of Management and Budget federal guidelines for race reporting.

[†]Estimates are age adjusted using the 2000 projected US population as the standard population and using three age groups: 18–44, 45–64, and >65 years. Estimates are based on household interviews of a sample of the civilian, noninstitutionalized US adult population. Denominators for each percentage exclude persons with unknown health-behavior characteristics. [§] American Indian or Alaska Native;

[¶] Native Hawaiian or other Pacific Islander;

** 95% confidence interval;

^{††} smoked at least 100 cigarettes in lifetime and currently smoked;

^{§§} Never engaged in any light, moderate, or vigorous leisure-time physical activity;

^{¶¶} Defined as a body mass index (weight [kg]/height [m²]) of >30.

known and so contribute to the well-recognized disparities in CVD burden and outcomes (33).

Generally, the prevalence of hypertension is highest among African-Americans regardless of sex or educational status. The prevalence of hypercholesterolemia is usually highest among white and Mexican American men and white women in both education level groups. The prevalence of low concentrations of high-density lipoprotein cholesterol and hypertriglyceridemia is most favorable among African-Americans, although among the most educated women, whites and African-Americans have a similar prevalence of low concentration of high-density lipoprotein cholesterol. The prevalence of measured levels of hemoglobin A1c $\geq 7\%$ is highest in African-American men and women (Table 2).

These racial and ethnic differences have also held up in more recent surveillance data. For example, in 2005–2006, the NHANES data showed that non-Hispanic blacks had a significantly higher prevalence of hypertension than the non-Hispanic white and Mexican American populations

Table 2
Prevalence of Measured Traditional Risk Factors for Cardiovascular Diseases Among US Adults ≥18 Years of Age, NHANES, 1999–2002

	Whites			Blacks			Mexican Americans					
	<High School			<High School			<High School					
	%	SE	%	SE	%	SE	%	SE	%	SE		
Obesity (BMI ≥30 kg/m ²)												
Men	28.4	2.0	27.2	1.1	25.1	1.8	26.9	2.2	22.3	1.7	29.2	2.5
Women	36.8	2.6	29.6	1.5	47.7	3.2	47.1	2.3	37.8	3.0	32.8	2.8
Men and women	32.8	1.7	28.5	1.1	37.2	1.8	38.4	1.6	29.5	1.7	31.0	1.9
Large waist												
(men >102 cm; women >88 cm)												
Men	44.9	2.6	39.6	1.2	29.4	1.8	27.2	1.7	25.2	1.7	34.2	2.0
Women	68.0	3.3	52.9	1.8	71.9	2.3	67.0	1.6	62.2	2.6	53.9	2.9
Men and women	56.8	2.2	46.4	1.4	51.9	1.6	49.8	1.4	42.3	1.2	43.9	1.6
Hypertension												
Men	39.3	2.5	29.8	1.2	45.9	2.8	31.8	1.7	21.1	2.2	16.5	2.1
Women	47.4	2.6	31.3	1.3	51.2	2.8	37.0	1.9	24.2	2.4	15.5	1.8
Men and women	43.5	1.9	30.6	1.0	48.7	2.4	34.7	1.3	22.6	1.8	16.0	1.3
Total cholesterol ≥200 mg/dl												
Men	45.5	3.0	49.2	1.5	37.7	2.8	41.7	2.3	49.2	2.7	45.5	2.8
Women	56.9	2.5	52.4	1.2	45.8	3.0	42.6	2.2	38.7	2.2	37.9	2.2
Men and women	51.4	2.0	50.8	1.0	41.9	2.0	42.2	1.8	44.4	2.0	41.7	1.6

Table 2
(Continued)

Glycosylated hemoglobin ≥ 7%												
Men	7.5	1.3	3.8	0.4	10.1	1.4	3.7	0.7	4.9	0.8	4.3	0.9
Women	6.2	1.2	2.2	0.3	10.9	1.9	6.7	0.9	7.8	1.2	3.6	0.7
Men and women	6.8	0.9	3.0	0.3	10.5	1.5	5.4	0.6	6.3	0.7	4.0	0.6
NHANES 1999–2000												
Low HDL cholesterol												
(men < 40 mg/dl; women < 50 mg/dl)												
Men	41.2	3.1	35.9	2.2	27.0	4.3	23.8	3.4	35.6	3.5	25.6	4.6
Women	54.8	4.3	38.8	2.4	33.8	3.9	39.7	3.4	47.4	2.5	45.7	3.6
Men and women	48.0	3.1	37.4	1.9	30.4	2.9	33.0	2.4	41.1	2.4	36.2	3.0
LDL-cholesterol ≥ 130 mg/dl												
Men	49.5	7.0	46.7	2.9	27.2	5.4	31.0	5.8	46.7	4.6	54.3	7.0
Women	33.6	7.5	42.3	2.8	36.3	7.4	25.1	4.3	30.1	4.8	28.0	4.9
Men and women	41.9	5.8	44.4	2.0	31.9	5.0	27.5	4.1	38.8	2.8	41.0	5.2
Triglycerides ≥ 150 mg/dl												
Men	38.3	7.7	35.7	3.2	...	...	...	...	40.5	4.2	40.2	9.1
Women	39.2	6.2	33.2	3.3	14.0	4.2	11.5	3.0	40.9	5.2	30.0	5.8
Men and women	38.7	4.6	34.4	2.4	15.4	4.2	10.4	2.6	40.7	3.7	35.2	6.6

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Source: Mensah GA, Mokdad AH, Ford ES, Greenlund KJ, Croft JB. State of disparities in cardiovascular health in the United States. *Circulation* 2005 March 15; 111(10):1233–1241 (33).

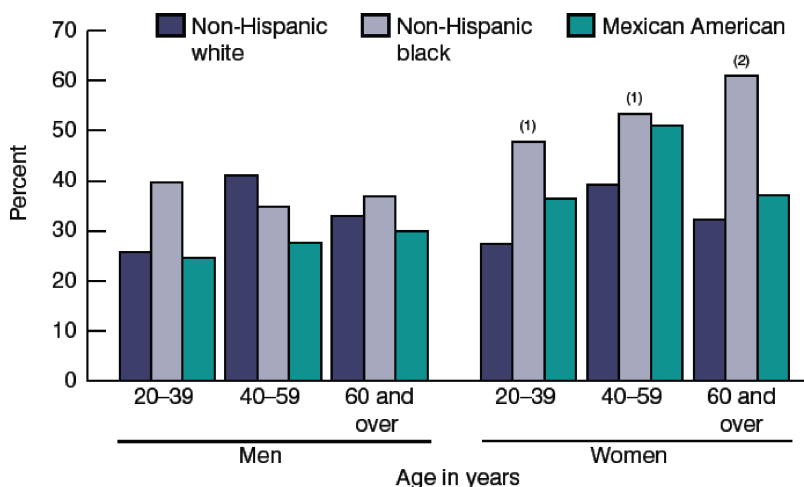
(41% vs. 28% and 22%, respectively) (43). No statistically significant differences were noted by race/ethnicity in the prevalence of prehypertension (defined as systolic BP 120–139 mmHg or diastolic BP 80–89 mmHg, and not pharmacologically treated for high BP) (43). Hypertension awareness and treatment were highest in non-Hispanic blacks compared to non-Hispanic whites and Mexican Americans. However, no statistically significant differences were noted in control rates among persons treated for hypertension (64% overall) (43).

Although glycemic control improved between 1999 and 2004 (44), Mexican Americans and non-Hispanic Blacks were less likely to achieve good control (35.4 and 36.9%, respectively) compared with non-Hispanic Whites (48.6%) (45). These racial and ethnic differences persisted even after multivariable adjustment for measures of socioeconomic status, obesity, health-care access and utilization, and diabetes treatment (45). Similarly, although the awareness, treatment, and control of high LDL-cholesterol among US adults increased significantly in 1999–2004, control rates remain significantly lower in non-Hispanic blacks and Mexican Americans compared with non-Hispanic whites (17.2% and 16.5% vs. 26.9%, respectively; $p = 0.05$ and $p = 0.008$) (46). The 2005–2006 NHANES data again demonstrate the continuing epidemic of obesity in the United States, and especially the marked racial and ethnic disparities in the prevalence of obesity in women but not in men (Fig. 8) (47).

5.3. Emerging Risk Factors and Biomarkers of Cardiovascular Risk

The NHANES also provides data on the prevalence of emerging risk factors for CVD stratified by sex, race/ethnicity, and education level (Table 3) (33). Among men who had not completed a high school education, the prevalence of elevated concentrations of CRP is high among whites. Among men who had completed high school, the prevalence of elevated concentrations of C-reactive protein was high among African-American and Mexican American men. Among women who had not completed high school, the prevalence was variable among the three racial or ethnic groups, whereas among women who had completed high school, African-American, and Mexican American women tended to have a high prevalence of elevated concentrations of C-reactive protein. Similar patterns were observed for the prevalence of elevated concentrations of fibrinogen. Mexican American men and women had low prevalence of elevated concentrations of homocysteine regardless of educational status. Albuminuria was highest in African-Americans and was nearly twice the prevalence observed in Mexican Americans (33).

In one systematic review of 20 studies that were unadjusted or adjusted for demographic variables, 19 found inverse associations between CRP levels and socioeconomic position. Of 15 similar studies, 14 found differences



¹Significantly different from the non-Hispanic white population.

²Significantly different from the non-Hispanic white and Mexican-American populations.

NOTE: Obesity is defined as body mass index ≥ 30 .

SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey.

Fig. 8. Prevalence of obesity, by age, race/ethnicity, and sex, adults aged 20 years and older: United States, National Health and Nutrition Examination Survey, 2005–2006.

Source: Ogden CL, Carroll MD, McDowell MA, Flegal KM. Obesity among adults in the United States – no change since 2003–2004. NCHS data brief no 1. Hyattsville, MD: National Center for Health Statistics. 2007. Available from: www.cdc.gov/nchs/data/databriefs/db01.pdf (47).

between racial/ethnic groups such that whites had the lowest, while blacks, Hispanics, and South Asians had the highest CRP levels (30). In a large multiethnic cohort study of four American racial/ethnic groups (Caucasian, Black, Hispanic, and Chinese), significant differences in hemostatic and endothelial markers were found (32). Blacks had the highest levels of factor VIII, D-dimer, plasmin–antiplasmin (PAP), and von Willebrand factor, among the highest levels of fibrinogen and E-selectin (women only), but among the lowest levels of intercellular adhesion molecule 1 (ICAM-1), and, in men, the lowest levels of plasminogen activator inhibitor-1 (PAI-1) (32). Whites and Hispanics tended to have intermediate levels of factors and markers, although they had the highest levels of ICAM-1, and Hispanics had the highest mean levels of fibrinogen and E-selectin (women only) (32). Chinese participants had among the highest levels of PAI-1, but the lowest, or among the lowest, of all other factors and markers.

5.4. Markers of Subclinical Cardiovascular Disease

Another established biomarker of atherosclerotic plaque burden or sub-clinical coronary atherosclerosis is coronary artery calcium score (CACS) (48). In a large, multi-center, ethnically diverse cohort of 14,812 patients,

Table 3
Prevalence of Emerging Risk Factors for CVD Among US Adults ≥ 18 Years of Age, NHANES, 1999–2002

	Whites			Blacks			Mexican Americans					
	<High school		≥High school	<High school		≥High school	<High school		≥High school			
	%	SE	%	SE	%	SE	%	SE	%	SE		
C-reactive protein >3 mg/L												
Men	37.9	2.9	26.2	1.1	31.7	2.0	32.0	2.2	22.3	2.1	25.6	2.1
Women	53.8	2.6	42.6	1.2	50.1	2.3	50.3	2.5	54.0	2.8	48.9	2.5
Men and women	46.1	1.6	34.6	0.9	41.4	1.5	42.6	1.9	37.0	1.9	37.2	1.8
Fibrinogen >3 g/L												
Men ≥40 year	89.5	2.2	76.2	1.8	84.3	3.6	78.1	2.4	68.8	2.9	73.0	3.5
Women ≥40 year	91.6	1.9	81.7	1.7	95.1	1.7	88.9	2.2	84.5	1.7	87.3	2.5
Men and women ≥40 year	90.6	1.6	79.1	1.5	90.1	2.1	84.3	1.6	76.6	2.1	80.3	2.1
Homocysteine >10 μmol/L												
Men	34.4	2.4	25.2	1.2	31.9	3.4	23.0	1.7	17.7	1.7	15.2	2.2
Women	25.1	2.2	13.7	0.8	22.5	1.9	11.5	1.5	7.9	1.4	4.7	1.4
Men and women	29.6	1.8	19.3	0.8	26.9	1.8	16.4	1.3	13.1	1.2	10.0	1.4
Microalbuminuria ≥30 to <300 mg/g or macroalbuminuria ≥300 mg/g												
Men	12.0	1.6	7.8	0.6	16.5	1.7	9.2	1.3	8.1	0.9	8.9	1.7
Women	16.2	1.5	8.7	0.8	19.6	1.4	10.5	1.0	12.0	1.6	9.6	1.6
Men and women	14.2	1.0	8.2	0.5	18.2	1.0	9.9	0.8	9.9	0.8	9.3	1.0

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Source: Mensah GA, Mokdad AH, Ford ES, Greenlund KJ, Croft JB. State of disparities in cardiovascular health in the United States. *Circulation* 2005 March 15; 111(10):1233–1241 (33).

Nasir et al. (49) examined the prognostic value of CACS in African-Americans ($n = 637$), Asians ($n = 1,334$), Hispanics ($n = 1,334$), and non-Hispanic whites ($n = 11,776$). The prevalence of CAC scores ≥ 100 was highest in non-Hispanic whites (31%) and lowest for Hispanics (18%) ($p < 0.0001$). However, as also shown in previous studies, lower the CAC score, the better the prognosis, and the higher the CAC score, the worse the prognosis regardless of race or ethnicity. Importantly in this study, the finding of mild or more CAC in African-Americans conferred an all-cause mortality of nearly twice that documented for non-Hispanic whites and Hispanics, with the least all-cause mortality seen in Asians (Fig. 9) (49). In fact, in the 10-year follow-up, the overall survival was 96, 93, and 92% for Asians, non-Hispanic whites, and Hispanics, respectively, as compared with 83% for African-Americans (Fig. 10; $p < 0.0001$) (49). In the accompanying editorial, Rumberger pointed out the importance of underlying traditional risk

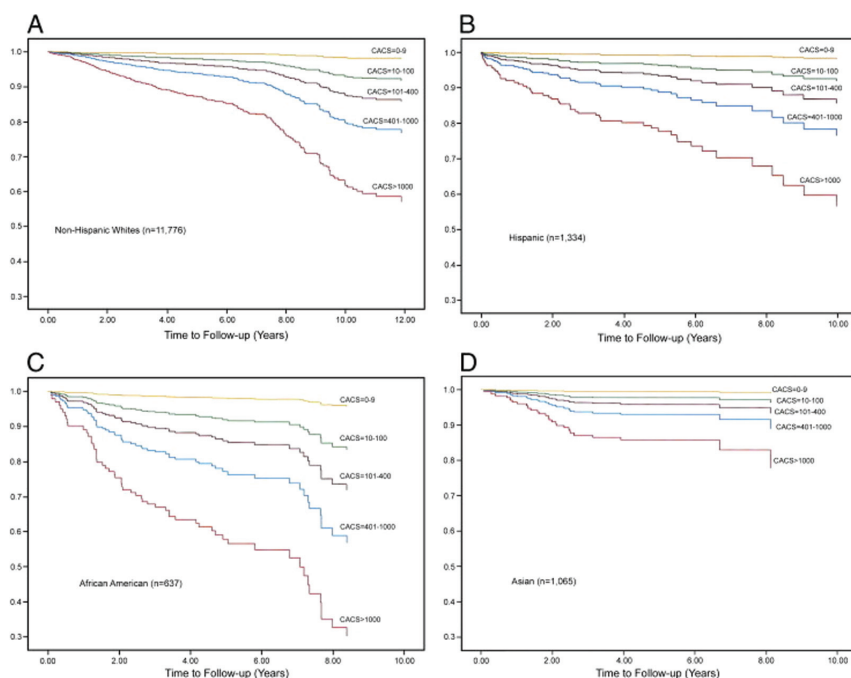


Fig. 9. Cumulative Survival By Coronary Artery Calcium Score (CACS) in ethnic subsets. (A–D) Using risk-stratified Cox proportional hazard survival analyses, the survival ranged from 98 to 57% in non-Hispanic whites, 97 to 30% in African-Americans, 99 to 60% in Hispanics, and 100 to 80% in Asians for CACS of 0–10 to 1,000.

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Source: Nasir K, Shaw LJ, Liu ST, et al. Ethnic differences in the prognostic value of coronary artery calcification for all-cause mortality. *J Am Coll Cardiol* 2007 September 4;50(10):953–960 (49).

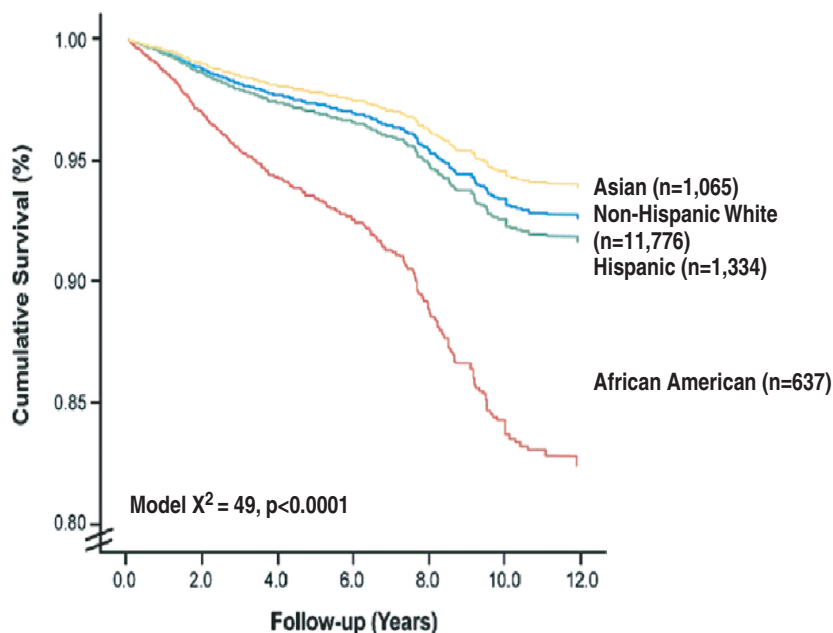


Fig. 10. Long-term survival in ethnic subsets ($n = 14,812$). Overall survival was 96, 93, and 92% for Asians, non-Hispanic whites, and Hispanics as compared with 83% for African-Americans, respectively, ($p = 0.0001$). Among all ethnic groups, the lowest survival was observed in African-Americans (83%, $p < 0.0001$).

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Source: Nasir K, Shaw LJ, Liu ST, et al. Ethnic differences in the prognostic value of coronary artery calcification for all-cause mortality. *J Am Coll Cardiol* 2007 September 4;50 (10):953–960 (49).

factors, with a much higher frequency of “no risk factors” in Asians across ethnic subgroups and greater frequency of 3 or more risk factors in African-Americans (50).

6. CARDIOVASCULAR MORBIDITY

Nearly 81 million Americans, about one in three live with one or more forms of CVD (51). The most common of these include hypertension, coronary heart disease, chronic heart failure, and stroke. Among persons aged 18 years and older in 2005, the age-adjusted percentage of heart disease was highest in American Indians or Alaska Natives (13.0%) and lowest in Asian Americans (6.7%) (52). Stroke was, however, most prevalent in American Indians or Alaska Natives (5.8%) and African-Americans (3.4%) and least prevalent in Asian Americans (2.0%) (52). African-Americans also had the highest age-adjusted percentage of hypertension (31.2%), while the lowest percentages were seen in Hispanics (20.3%) and in whites (21%) (52).

Hospitalizations, especially for chronic heart failure, acute myocardial infarction, and stroke, constitute an important cause of morbidity from cardiovascular diseases. Among Medicare enrollees aged 65 years and older, whites had the highest prevalence of hospitalization for acute myocardial infarction (53,54). In fact, for the period of 1999–2004, the prevalence of acute myocardial infarction was higher in whites than in blacks for persons aged 55 years and older but in younger patients aged 35–54 years, the prevalence was higher in blacks (55). Overall the prevalence of the prevalence of hospitalizations for congestive heart failure was higher in African-Americans, Hispanics, and American Indian/Alaska Natives than among whites (53,54).

The overall prevalence of stroke and stroke hospitalizations Medicare population was highest in African-Americans (53–55).

7. ACCESS TO CARE AND THE QUALITY OF HEALTH CARE DELIVERED

Several publications, including an Institute of Medicine summary of the literature (56–63), and one review, conducted jointly by the American College of Cardiology Foundation and Kaiser Family Foundation (64), concluded (after examining the most rigorous studies investigating racial/ethnic differences in angiography, angioplasty, coronary artery bypass graft surgery, and thrombolytic therapy) that disparities in the quality of medical care are pervasive and they persist even after adjustment for potentially confounding factors. In addition, data from recent national health-care surveys and national health-care reports on disparities and health-care quality provide compelling evidence of the pervasiveness of disparities in quality of health care (65–67).

For example, the third annual *National Healthcare Disparities Report* published by the Agency for Health Research and Quality showed that disparities were observed in almost all aspects of health care and across all dimensions of quality of health care including effectiveness, patient safety, timeliness, and patient centeredness (65). In addition, these disparities were present across many levels and types of care including preventive care, treatment of acute conditions, and management of chronic diseases including cardiovascular diseases (65). Overall in that report, Hispanics received poorer quality of care than whites in 53% of the most important measures; blacks received poorer quality of care in 43% of these measures; and American Indians and Alaska Natives received poorer quality of care in 38% of the key measures (65).

In fact, the subsequent report for 2006 showed that for most core quality measures, Blacks (73%), Hispanics (77%), and poor people (71%) received worse quality care than their respective reference groups (66). Blacks and Asians had worse access to care than Whites for a third of core measures

and Hispanics had worse access than non-Hispanic Whites for 83% of core measures (66). Importantly, for most measures in racial and ethnic minorities, significant changes in disparities were not observed, although disparities were increasing for most (80%) measures for Hispanics (66).

The Fifth National Health-Care Report on disparities observed that overall disparities in quality and access for minority groups and poor populations have not been reduced since publication of the first report 5 years earlier (68). In addition, the report concluded that comparing data from 2000 to 2001 with those from 2004 to 2005, the number of measures on which disparities have significantly worsened or have remained unchanged since the first report is higher than the number of measures on which disparities have significantly improved for Blacks, Hispanics, American Indians and Alaska Natives, Asians, and poor populations (68).

8. PROGRESS MADE IN THE ELIMINATION OF HEALTH DISPARITIES

Healthy People 2010 is the US national health promotion and disease prevention framework with the overarching goals of increasing the quality and years of healthy life (Goal-1) and eliminating health disparities (Goal-2) (69). Periodic reviews are conducted to assess progress in achieving objectives for these goals (69,70). Nineteen objectives and subobjectives established for heart disease and stroke were examined at the mid-course review to gauge progress made in addressing the two overarching goals and the 19 objectives and subobjectives (71). This review observed numerous disparities in access to health care for several objectives and subobjectives (specific objective numbers in parentheses) (71).

Overall, significant progress was made during the first half of the decade in improving cardiovascular health. The death rate from coronary heart disease and stroke declined to their lowest levels; hospitalizations due to heart failure declined; the proportion of adults with high blood pressure under control increased; and the target for reducing the proportion of persons with high blood cholesterol levels was met by the 1999–2002 period (71–73). However, hypertension prevalence moved in the wrong direction, away from the 2010 target (71,72). Of the 19 national objectives and subobjectives, 3 have met their respective targets, 7 others have moved toward their target, 1 has moved in the wrong direction away from the target, and 7 others could not be evaluated because the appropriate data were not available at the time of the review or have only recently become available (72).

Most importantly, however, significant disparities persist by race/ethnicity, gender, educational level, and disability. For example, the summary index of disparity (SID) by race/ethnicity was <10% or not statistically significant for 6 objectives; however, it exceeded 10–49% for 7 objectives (71). In particular, racial/ethnic disparities associated with coronary heart

disease and stroke mortality increased. Similarly, the SID by education showed statistically significant disparities in seven of eight objectives (71). In persons with less than a high school education, significant disparities were present in seven of eight objectives and in five, disparities exceeded 100% in comparison to persons with at least some college education (71). As shown in Fig. 11, the Healthy People 2010 targets for coronary heart disease (Fig. 11) and stroke (Fig. 11) mortality rates were met by 2004 for whites, Hispanics, American Indians, and Asian Americans but not for blacks (72).

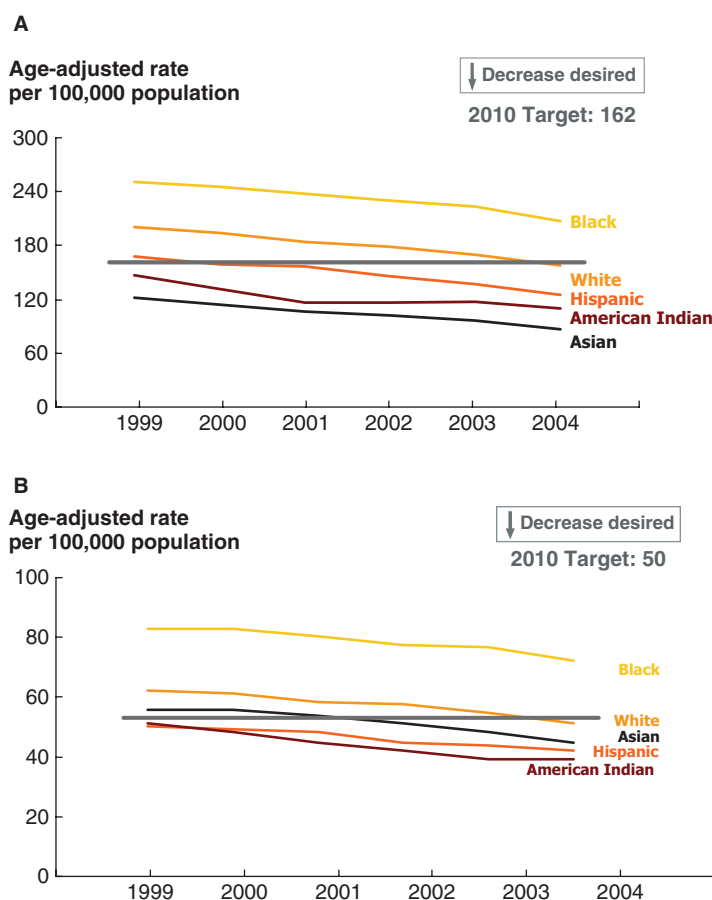


Fig. 11. Age-adjusted death rates for coronary heart disease (A) and stroke, by race and ethnicity, United States, 1999 – 2004. Note: Coronary heart disease deaths (A) are defined by ICD-10 codes I11, I20–I25 and stroke deaths (B) are defined by ICD-10 codes I60–I69. Data are age adjusted to the 2000 standard population. Asian includes Pacific Islander. The black and white categories exclude persons of Hispanic origin. Persons of Hispanic origin may be of any race.

Source: National Vital Statistics System—Mortality (NVSS-M), NCHS, CDC.

Additionally, among racial and ethnic groups, the white non-Hispanic population had the best group rate for the following specific Healthy People 2010 objectives: health insurance (1–1), counseled about smoking cessation (1–3c), a source of ongoing care (1–4a, b, and c), usual primary-care provider (1–5), difficulties or delays in obtaining needed health care (1–6), and delay or difficulty in getting emergency care (1–10) (71). The black non-Hispanic population had the best rate for only two of the sub-objectives: persons counseled about physical activity (1–3a) and diet and nutrition (1–3b). The percentages of the American Indian or Alaska Native population and the Hispanic population that did not have health insurance (1–1) in 2003 were more than twice that of the white non-Hispanic population (71). Similarly, despite a decline in disparity between the poor and the middle/high-income populations, lack of health insurance coverage among the poor and near-poor populations was more than three times that of the middle/high-income population.

Disparities were also noted in the percentage of persons who had a source of ongoing care (1–4). The disparity between the Hispanic population and the white non-Hispanic population exceeded 100% for all age groups. The review noted that the level of disparity has been increasing for all ages and for persons aged 18 years and older (1–4a and c). A similar level of disparity was observed among the Asian and non-Hispanic black populations for persons under 18 years of age (1–4b). Between 1998 and 2003, the disparity between the black non-Hispanic and the white non-Hispanic populations increased by 65 percentage points. Disparities of over 50% were also observed for objective 1–4 between the best income group (middle/high income) and the poor and near-poor populations (71). Persons of two or more races were three times as likely as white non-Hispanic persons to experience delay or difficulty in getting emergency care (1–10). Similarly, the poor and near-poor populations were about twice as likely as the middle/high-income population to have difficulty in obtaining emergency care. Although these measures are not specific for cardiovascular care, the crucial role that they play in overall cardiovascular health is indisputable.

9. SUMMARY AND CONCLUSIONS

Despite its known limitations, epidemiology provides compelling evidence of the pervasiveness of racial and ethnic disparities in cardiovascular health and outcomes. While the most recent evidence documents some progress, stroke and coronary heart disease mortality rates remain high in African-Americans and disparities associated with these rates have increased (Table 4). A higher prevalence of lifestyle and behavioral risks, together with a greater prevalence of multiple traditional cardiovascular risk factors and adverse socioeconomic and environmental conditions especially in African-Americans, American Indians/Alaska Natives, contributes to these health

Table 4

a)

Population-based objectives	Race and ethnicity							Summary index
	American Indian or Alaska Native	Asian	Native Hawaiian or other Pacific Islander	Two or more races	Hispanic or Latino	Black non-Hispanic	White non-Hispanic	
12-1. Coronary heart disease (CHD) death rate (1999, 2002) *		B ¹				↑		
12-2. Knowledge of heart attack symptoms: 20+ years (2001) *							B	
12-3a. Receipt of artery-opening therapy within 1 hour of heart attack symptoms (2000-04) †	B	1				2	2	
12-3b. Receipt of percutaneous intervention within 90 minutes of heart attack symptoms (2000-04) †		1				2	B ²	
12-4. Cardiopulmonary resuscitation (CPR) training (2001) *				B				
12-6a. Congestive heart failure hospitalizations: 65-74 years (1997, 1999) *							B ²	
12-6b. Congestive heart failure hospitalizations: 75-84 years (1997, 1999) *						2	B ²	
12-6c. Congestive heart failure hospitalizations: 85+ years (1997, 1999) *						2	B ²	
12-7. Stroke death rate (1999, 2002) *	B	↑ ¹				↑	↑	
12-8. Knowledge of stroke symptoms: 20+ years (2001) *							B	
12-9. High blood pressure: 20+ years (1988-94, 1999-2002) *					B ³			
12-10. Controlled blood pressure: 20+ years with high blood pressure (1988-94, 1999-2002) *					3		B	
12-11. Taking action to help control high blood pressure: 18+ years with high blood pressure (1998, 2003) * ⁴								
12-12. Blood pressure monitoring: 18+ years with high blood pressure (1998, 2003) *						B		
12-13. Mean total blood cholesterol levels: 20+ years (1988-94, 1999-2002) *					3	B		
12-14. High blood cholesterol levels: 20+ years (1988-94, 1999-2002) *					3	B		
12-15. Blood cholesterol screening within past 5 years: 18+ years (1988, 2003) * ⁴		B		b				

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