

Higher Cardiovascular Disease Prevalence and Mortality among Younger Blacks Compared to Whites

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ABSTRACT

BACKGROUND: Blacks have higher rates of cardiovascular disease than whites. The age at which these differential rates emerge has not been fully examined.

OBJECTIVE: We examined cardiovascular disease prevalence and mortality among black and white adults across the adult age spectrum and explored potential mediators of these differential disease prevalence rates.

METHODS: We conducted a cross-sectional analysis of National Health and Nutrition Examination Survey data from 1999-2006. We estimated age-adjusted and age-specific prevalence ratios (PR) for cardiovascular disease (heart failure, stroke, or myocardial infarction) for blacks versus whites in adults aged 35 years and older and examined potential explanatory factors. From the National Compressed Mortality File 5-year aggregate file of 1999-2003, we determined age-specific cardiovascular disease mortality rates.

RESULTS: In young adulthood, cardiovascular disease prevalence was higher in blacks than whites (35-44 years PR 1.9; 95% confidence interval [CI], 1.1-3.4). The black-white PR decreased with each decade of advancing age (*P* for trend = .04), leading to a narrowing of the racial gap at older ages (65-74 years PR 1.2; 95% CI, 0.8-1.6; ≥75 years PR 1.0; 95% CI, 0.7-1.4). Clinical and socioeconomic factors mediated some, but not all, of the excess cardiovascular disease prevalence among young to middle-aged blacks. Over a quarter (28%) of all cardiovascular disease deaths among blacks occurred in those aged <65 years, compared with 13% among whites.

CONCLUSIONS: Reducing black/white disparities in cardiovascular disease will require a focus on young and middle-aged blacks. © 2010 Elsevier Inc. All rights reserved.

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Reducing racial disparities in health is the stated objective of many public health policies and programs.¹⁻⁴ Insights gained from studies examining differences in prevalence and mortality from various diseases between blacks and whites can inform interventions aimed at reducing these

disparities.^{3,5-9} Despite considerable research, interventions, and policy changes, the magnitude of racial disparities in health appear to be widening and mortality differences remain high.⁹⁻¹¹ Disparities in cardiovascular disease have received particular focus because cardiovascular disease is common and a major contributor to differences in mortality between blacks and whites.^{4,8,12-14}

Most studies of racial cardiovascular disease disparities have noted higher age-adjusted prevalence and mortality among blacks, thought to be attributable to differences in cardiovascular disease risk factors, socioeconomic, and access to health care.^{8,14-17} Few studies have examined in detail the effects of age on differential disease patterns of cardiovascular disease prevalence and mortality across a broad adult age range or explored potential mediators of

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differential disease rates by age, particularly among young to middle-aged adults.¹⁷⁻¹⁹ Understanding potential differences by age in disease rates is important for primary care providers who play a key role in identifying those at risk. It also is important for targeting effective interventions and policies aimed at reducing health disparities.

We examined differences in cardiovascular disease prevalence and mortality between blacks and whites using national population data from over a 7-year time period by defined age categories across an adult age range. We explored potential interactions and trends by age and sex for prevalence and examined whether traditional cardiovascular disease risk factors, socioeconomic factors, and access to health care mediated these differences.

METHODS

National Health and Nutrition Examination Survey

We combined data from the 1999-2006 waves of National Health and Nutrition Examination Survey (NHANES) data, a cross-sectional, nationally representative survey of the noninstitutionalized US civilian population administered by the National Center for Health Statistics.²⁰ Details of recruitment and study procedures are published and available on the website.²⁰ We focused on 2 racial groups, those who self-identified as non-Hispanic black or non-Hispanic white. We included participants who completed the questionnaire portion of the survey and limited our sample to those 35 years of age or older in an attempt to minimize the influence of congenital heart disease.

In the health interview portion of NHANES, participants were asked a series of questions in order to obtain information about their health. We estimated prevalence of self-reported cardiovascular disease by responses to these questions: Has a doctor or other health professional ever told you that you had congestive heart failure? Has a doctor or other health professional ever told you that you had a stroke? Has a doctor or other health professional ever told you that you had a heart attack (also called myocardial infarction)? For our study, we defined cardiovascular disease as a composite measure of self-reported history of heart failure, stroke, or myocardial infarction. We determined the self-reported prevalence of any cardiovascular disease and of each of the 3 cardiovascular conditions separately.

We used the weight, stratum, and primary sampling unit variables provided with the NHANES dataset²⁰ in conjunction with standard analytic methods as implemented in the

complex survey commands in STATA 10.0 (StataCorp, College Station, Tex), to obtain estimates and inferences that correctly account for complex NHANES sampling design. Specifically, the NHANES weights are inversely proportional to the differential sampling rates within the pop-

ulations targeted by NHANES, resulting in estimates that are representative of the noninstitutionalized US population for non-Hispanic blacks and whites. In addition, STATA survey commands use the stratum and primary sampling unit information to calculate standard errors, 95% confidence intervals (CI), and *P*-values that properly reflect the stratification and clustering of observations in NHANES. We used the Zhang method to obtain prevalence ratios (PR) and 95% CIs for the comparisons of blacks and whites.²¹ This method computes the PR from the odds ratio (OR) at the weighted average value of the prevalence in the reference group, p_0 , using the formula $PR = OR / ([1 - p_0] + [p_0 * OR])$; 95% confidence limits for the PR are calculated by applying this formula to the confidence limits for the OR.

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We estimated prevalence ratios for blacks versus whites unadjusted and age-adjusted, with age as a continuous variable. We then categorized age by decade (35-44, 45-54, 55-64, 65-74, and ≥ 75 years), and estimated the association of race with our cardiovascular disease outcomes within each resulting age and sex category, using Wald tests to assess heterogeneity in the effects of race across these strata.²² We tested for race/sex interactions within each age stratum. We then tested for race/age interactions within each sex, in particular for heterogeneity and trend across age strata, using standard orthogonal contrasts. Lastly, we tested for 3-way interaction, as measured by between-sex difference in the trends across age strata.

We selected a priori several potential mediators of racial differences in cardiovascular disease rates by age, and examined their effects in multivariable logistic regression models. We examined traditional cardiovascular disease risk factors, including self-reported history of high blood pressure, high cholesterol, being overweight, current smoking, or diabetes. We also examined 2 socioeconomic factors: highest educational attainment (less than a high school education vs high school graduate)^{16,23,24} and annual household income level ($< \$20,000$ vs $\geq \$20,000$).²⁴ Finally, we examined 2 measures of access to health care: having health insurance and having a usual source of outpatient health care.^{20,25}

CLINICAL SIGNIFICANCE

- Blacks are more likely than whites to manifest clinical cardiovascular disease, including heart failure, stroke, and myocardial infarction, in their 30s, 40s, and 50s.
- Deaths from these conditions also are higher in blacks than whites in these age groups.
- Clinical programs and policies to address racial disparities in cardiovascular disease should recognize the age at which these disparities are most evident and focus attention on these high-risk groups.

CDC WONDER Compressed Mortality File

We used mortality data from the Centers for Disease and Control and Prevention (CDC) Wide-ranging On-line Data for Epidemiologic Research (WONDER) program.²⁶ CDC WONDER contains a Compressed Mortality File (CMF), a county-level and national population-level database that contains data on race (black, white, and other), underlying cause of death (4-digit International Classification of Disease, Tenth Revision [ICD-10] code or group of codes), and defined age groups.²⁶ Cause of death in CMF is the underlying cause of death, which is defined by the World Health Organization as “the disease or injury which initiated the train of events leading directly to death, or the circumstances of the accident or violence which produced the fatal injury.”²⁷ Data for the years 1999-2003 were available for this analysis. Within CMF, we focused on the 2 racial groups, blacks and whites, as identified per death certificate protocol by funeral directors or family members.²⁶ Age at death was categorized into 4 groups: 35-44, 45-54, 55-64, and ≥65 years of age.

To obtain mortality rates for the cardiovascular disease conditions of interest, we used primary underlying cause of death per the World Health Organization regulations by ICD-10 codes.²⁷ From the CDC WONDER CMF file for the years 1999-2003, we categorized these as death due to heart failure (I11.0, I13.0, I13.2, I25.5, I42.0-2, I42.5, I42.8, I50.0-1), stroke (I60.0-7, I60.9, I61.0-6, I61.8-9, I62.9, I63.0-6, I63.8-9, I64, I65.0-3, I65.8-9, I66.0-4, I66.8-9, I67.8, I68.8, I69.0-4, I69.8), or myocardial infarction (I21.0-4, I121.9, I22.0-1, I22.8-9, I23.0-6, I23.8, I24.1).

We used SAS version 9.2 (SAS Institute Inc., Cary, NC) to calculate the 5-year aggregated (1999-2003) population-level average annual mortality rates and their corresponding Poisson 95% CIs due to heart failure, stroke, or myocardial infarction as the underlying cause of death per 100,000 persons for blacks and whites. Similar to NHANES, we defined a composite measure of cardiovascular disease death as underlying cause of death due to heart failure, stroke, or myocardial infarction and calculated mortality rates and their corresponding Poisson 95% CIs. We calculated the percentage of all deaths due to cardiovascular disease for each of the age categories among blacks and whites and the proportion of all deaths from cardiovascular disease within each age decade and in those over age 65 years for blacks and whites.

Institutional review board approval was obtained from the University of California at San Francisco.

RESULTS

Blacks had higher age-adjusted prevalence of cardiovascular disease compared with whites (PR 1.5; 95% CI, 1.1-2.0) (Table 1). We observed a significant interaction between age and race ($P = .04$ for linear trend in the log odds ratio for blacks versus whites across 10-year age categories) (Figure 1). The black-white ratio decreased with each successive decade, with no prevalence differences in cardiovascular disease observed in the older decades.

Table 1 Prevalence per 100,000 Population of Self-reported Cardiovascular Disease, among Adult Blacks and Whites by Age Categories, 1999-2006

By age category (years)	Cardiovascular Disease		Heart Failure		Stroke		Myocardial Infarction	
	White n (95% CI)	Black n (95% CI)	White n (95% CI)	Black n (95% CI)	White n (95% CI)	Black n (95% CI)	White n (95% CI)	Black n (95% CI)
Overall	9666 (8790-10,541)	10,397 (8985-11,808)	3391 (2978-3804)	4135 (3253-5019)	3563 (3083-4043)	4890 (4125-5656)	5359 (4761-5957)	4297 (3426-5167)
35-44	1959 (1199-2719)	3718 (2121-5316)	462 (127-797)	956 (204-1709)	1009 (427-1590)	1479 (589-2368)	811 (369-1253)	1430 (450-2410)
45-54	4844 (3507-6182)	6915 (4349-9481)	1395 (743-2046)	3344 (1689-5000)	1490 (815-2165)	3515 (1798-5233)	2533 (1636-3431)	2487 (1139-3836)
55-64	9842 (7868-11,817)	15241 (11,719-18,763)	3190 (2124-4257)	6112 (4300-8924)	2870 (1835-3906)	6197 (4190-8204)	6711 (5034-8387)	7053 (4559-9547)
65-74	17,120 (14,462-19,778)	19,738 (16,393-23,085)	6637 (5029-8246)	7648 (5615-9681)	6033 (4755-7310)	10,483 (7949-13,017)	10,102 (7907-12,298)	7020 (4797-9244)
≥75	29042 (26,384-31,700)	29,707 (24,210-35,205)	11,114 (9404-12,824)	11,082 (7500-14,665)	12,213 (10,460-13,966)	14,721 (10,464-18,978)	14,614 (12,721-16,507)	14,106 (9933-18,278)

CI = confidence interval.

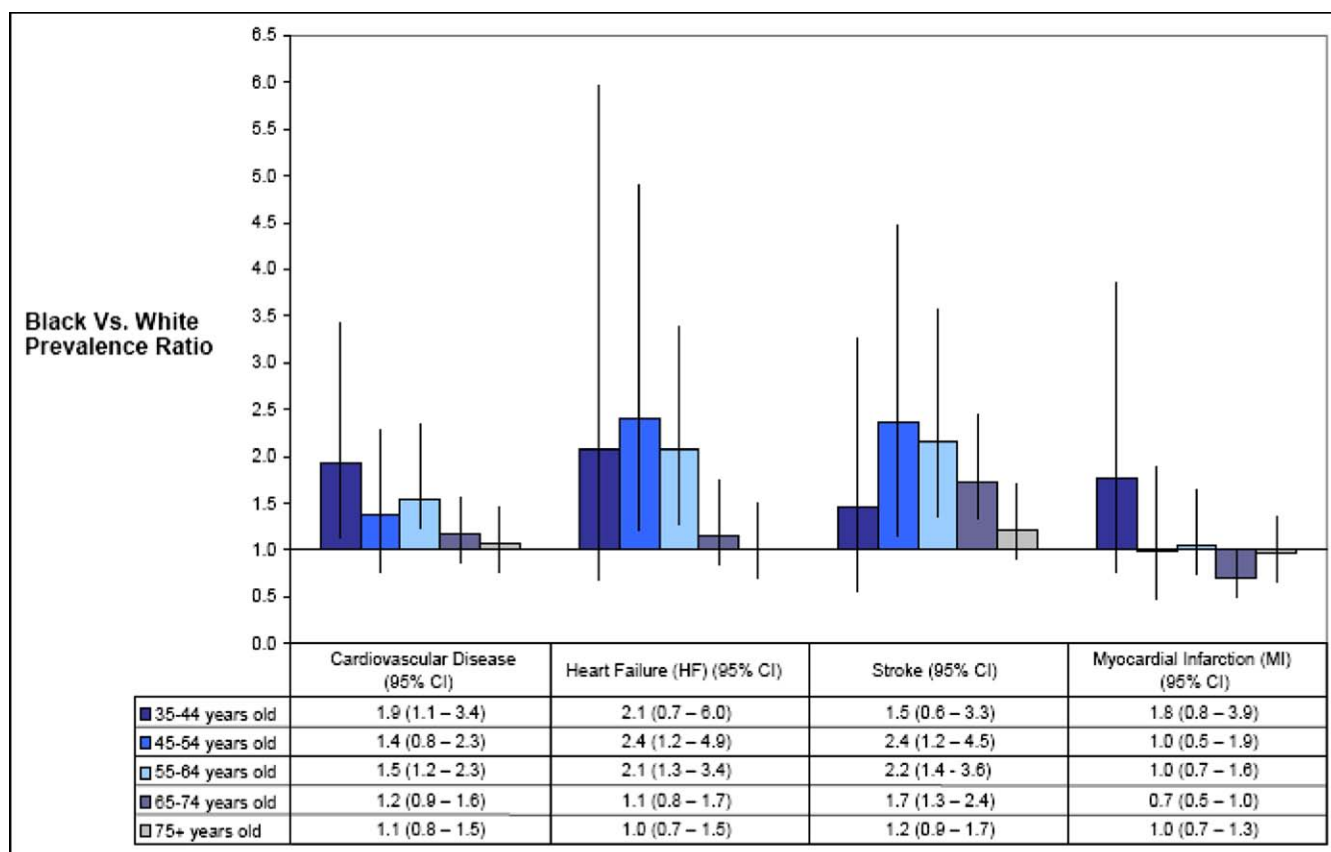


Figure 1 Prevalence ratios of self-reported cardiovascular disease, congestive heart failure, myocardial infarction, and stroke for black versus white adults by age categories, National Health and Nutrition Examination Survey, 1999-2006.

Patterns were similar for each of the specific cardiovascular conditions examined. No black-white differences were observed for heart failure in those in the oldest 2 age groups examined ($P = .10$ for heterogeneity, $P = .07$ for linear trend), or for stroke in those aged 75 years and older ($P = .21$ for heterogeneity, $P = .52$ for linear trend). For myocardial infarction, black-white differences in prevalence were observed only in the 35- to 44-year-olds.

Traditional cardiovascular disease risk factors, socioeconomic factors, and access to care each appeared to mediate part of the black-white difference in disease prevalence ratios in the youngest adults (Table 2). In our final model, adjusting for sex, self-reported hypertension, diabetes, and elevated cholesterol, obesity, smoking, education, income, health insurance, and a usual source of health care, cardiovascular disease prevalence remained higher in blacks ver-

Table 2 Prevalence Ratios for Cardiovascular Disease among Adult Blacks versus Whites, Accounting for Potential Mediators of Difference in Risk

Age Category (Years)	Prevalence Ratios for Blacks versus Whites (95% CI)			
	Unadjusted	Adjusted for Cardiovascular Disease Risk Factors*	Adjusted for Cardiovascular Disease Risk Factors Plus Socioeconomic Factors†	Adjusted for Cardiovascular Disease Risk, Socioeconomic Factors, and Access to Health Care‡
35-44	1.9 (1.1-3.4)	1.8 (1.0-3.0)	1.6 (0.9-2.7)	1.6 (0.9-2.7)
45-54	1.4 (0.8-2.2)	1.1 (0.6-1.7)	0.9 (0.6-1.5)	0.9 (0.6-1.5)
55-64	1.6 (1.2-2.1)	1.2 (0.9-1.6)	1.1 (0.7-1.5)	1.1 (0.8-1.5)
65-74	1.2 (0.8-1.6)	1.0 (0.8-1.2)	0.8 (0.7-1.1)	0.9 (0.7-1.1)
≥75	1.0 (0.7-1.4)	0.9 (0.7-1.2)	0.8 (0.6-1.1)	0.8 (0.6-1.1)

CI = confidence interval.

*Sex and self-reported history of hypertension, diabetes, elevated cholesterol, obesity, current smoking.

†Self-reported highest educational attainment (less than high school or high school grad or higher), annual household income (<\$20 K, ≥\$20 K).

‡Self-report of having health insurance; self-report of usual source of outpatient health care.

Table 3 Prevalence Ratios of Self-reported Cardiovascular Disease Stratified by Age and Sex among Adult Blacks and Whites

	Prevalence per 100,000 Population		Prevalence Ratio (95% CI)	
	White n (95% CI)	Black n (95% CI)	Black vs White	P Value
Female				
Unadjusted	8747 (7680-9813)	10,708 (8712-12,703)	1.2 (1.0, 1.5)	
Age-adjusted			1.6 (1.2, 2.0)	
By age category (years)				<i>P</i> for heterogeneity* .30 <i>P</i> for linear trend† .14
35-44	1694 (683-2706)	4196 (1809-6584)	2.5 (1.1, 5.3)	
45-54	4707 (2999-6415)	6799 (3397-10,200)	1.5 (0.8, 2.6)	
55-64	7616 (5365-9868)	14,596 (10,989-18,203)	1.9 (1.3, 2.8)	
65-74	12,646 (9914-15,378)	18,629 (14,142-23,115)	1.5 (1.1, 2.0)	
≥75	26,848 (23,470-30,227)	30,499 (22,955-38,043)	1.1 (0.9, 1.5)	
Male				
Unadjusted	10,661 (9447-11,874)	9992 (8107-11,877)	0.9 (0.8, 1.1)	
Age-adjusted			1.2 (0.9, 1.4)	
By age category (years)				<i>P</i> for heterogeneity* .33 <i>P</i> for linear trend† .11
35-44	2224 (1209-3239)	3131 (749-5512)	1.4 (0.5, 3.4)	
45-54	4980 (3340-6620)	7064 (3775-10,353)	1.4 (0.8, 2.4)	
55-64	12,201 (9073-15,329)	16,044 (10,039-22,049)	1.3 (0.9, 2.0)	
65-74	22,381 (18,455-26,307)	21,126 (1516-26,635)	0.9 (0.7, 1.3)	
≥75	32,344 (28,811-35,877)	27,993 (21,097-34,890)	0.9 (0.6, 1.1)	

CI = confidence interval.

**P* for heterogeneity, or interaction, tests the hypothesis that the black versus white prevalence ratio differs across the 5-age strata. This test is more sensitive to arbitrary patterns in the prevalence ratio than the test for trend.

†*P* for linear trend tests the hypothesis that the black versus white prevalence ratio increases or decreases across the 5-age strata. This test is more sensitive to approximately linear patterns in the prevalence ratio than the test for heterogeneity.

sus whites in the 35-44 years age category (PR 1.6; 95% CI, 0.9-2.7).

We observed high rates of cardiovascular disease among young to middle-aged black women (Table 3). The estimated prevalence for cardiovascular disease among black women aged 35-44 years exceeded that of white women and black and white men of the same age. This racial difference in disease rates was only partially mediated by differences in cardiovascular disease risk factors (adjusted PR among black women vs white women 35-44 years old = 2.1; 95% CI, 1.0-4.5) and for socioeconomic factors and access to health care (final adjusted PR 1.8; 95% CI, 0.8-4.0).

Using CDC WONDER data, we also examined annual average cardiovascular disease mortality rates by age category. We found that cardiovascular disease mortality was higher among blacks compared with whites at younger ages (Table 4). Over a quarter (28%) of all deaths from cardiovascular disease among blacks occur in those aged <65 years, while only 13% of all deaths from cardiovascular disease among whites occur in those aged <65 years (Figure 2).

DISCUSSION

Racial differences in cardiovascular disease prevalence vary by age, with the largest black-white disparities observed in young to middle age. These racial differences in disease rates across the age spectrum are masked in the traditional

age adjustment of disease rates. Our results highlight the importance of understanding the current epidemiology of disease patterns for research, clinical, and public health efforts aimed at reducing cardiovascular disease health disparities.

Prior studies have noted higher age-adjusted prevalence, incidence,^{12,28} or mortality rates^{14,17,29} of cardiovascular disease among blacks compared with whites. A smaller number of studies have commented on the differential disease rates between blacks and whites by age or statistical interactions between age and race.^{12,30} We found that the higher burden of cardiovascular disease among blacks compared with whites occurs at younger ages in adulthood than previously described.^{15,17,19} The higher rates of cardiovascular disease begin in the 30s and 40s.

We observed a similar pattern of higher cardiovascular disease mortality in blacks compared with whites in young to middle age. Cardiovascular disease processes appear to have similar outcomes at young to middle age as they do in older ages, and a higher prevalence of nonfatal cardiovascular disease events among blacks is unlikely to account for the differential disease prevalence that we report. Another explanation of the higher cardiovascular disease prevalence among young to middle-aged blacks compared with whites is the higher burden of traditional cardiovascular disease risk factors and lower socioeconomic status. Our analyses do suggest that these factors account for much of the black-

Table 4 Annual Average Mortality Rates per 100,000 Population for Cardiovascular Disease, Heart Failure, Stroke, and Myocardial Infarction, CDC WONDER, 1999-2003

Age Category (Years)	Cardiovascular Disease		Heart Failure		Stroke		Myocardial Infarction	
	White n (95% CI)	Black n (95% CI)	White n (95% CI)	Black n (95% CI)	White n (95% CI)	Black n (95% CI)	White n (95% CI)	Black n (95% CI)
35-44	14.8 (14.7-15.0)	36.7 (36.0-37.4)	3.8 (3.7-3.9)	13.3 (12.9-13.8)	4.2 (4.1-4.3)	13.4 (13-13.9)	6.9 (6.8-7.0)	10 (9.6-10.3)
45-54	46.8 (46.5-47.2)	110.6 (109.3-112.0)	8.6 (8.4-8.7)	30.5 (29.7-31.2)	11.4 (11.2-11.5)	41 (40.1-41.8)	26.9 (26.6-27.1)	39.2 (38.4-40.0)
55-64	133.7 (133.0-134.4)	265.1 (262.3-267.9)	23.9 (23.7-24.2)	63.9 (62.5-65.3)	31.5 (31.2-31.8)	90.4 (88.8-92.1)	78.2 (77.7-78.8)	110.8 (109-112.7)
≥65	1099.7 (1098.1-1101.4)	1196.8 (1191.2-1202.4)	264.3 (263.5-265.1)	285.4 (282.7-288.1)	403.9 (402.9-404.9)	460.1 (456.7-463.6)	431.5 (430.5-432.5)	451.3 (447.9-454.7)

CDC WONDER = Centers for Disease and Control and Prevention Wide-ranging On-line Data for Epidemiologic Research program; CI = confidence interval.

white differences in disease prevalence, although excess cardiovascular disease prevalence remained in the 35- to 44-year age group even after accounting for these factors. We cannot rule out the possibility that excess variation observed among blacks might still be due to differences in traditional cardiovascular disease risk factors or socioeconomic factors that cannot be fully accounted for in our adjustment.

Our findings suggest that studies examining the causes for racial differences in cardiovascular disease rates should focus on young to middle-aged adults. To date, most of the cardiovascular disease disparities literature has examined older populations,³¹⁻³⁵ both because cardiovascular disease is more common with advancing age and because administrative data (ie, Medicare) and cohort data are more readily available on older adults. Our study suggests that a reliance solely on data from older adults may miss opportunities to explore the root causes of the high burden of cardiovascular disease in blacks presenting in adulthood at young to middle age. Comprehensive data collection across the age spectrum, not just the elderly, of the population, is needed to understand the epidemiology of cardiovascular disease. Research on how biological susceptibility, environmental factors, early life events, and social determinants of health may together play a role in increasing cardiovascular disease risk among young to middle-aged blacks are needed.

Because traditional, modifiable cardiovascular disease risk factors likely account for some of the excess risk among blacks at younger ages,^{8,16,17,36,37} clinicians and public health programs should target the prevention and treatment of conditions such as hypertension, diabetes, smoking, and obesity at younger ages in order to reduce the burden of disease in young to middle-aged adults. Programs aimed at cardiovascular disease risk factor reduction or prevention do not generally target young to middle-aged adults. This group may be more challenging to reach with these programs, as they are more likely to be uninsured and therefore less likely to have access to medical care, and less likely to be able to afford medications.³⁸⁻⁴⁵ Adherence to medications also may be lower in young and middle-aged adults. These difficulties may be exacerbated by lower awareness among young to middle-aged adults of their cardiovascular disease risk, and reluctance on the part of clinicians to treat cardiovascular disease risk factors at younger ages.^{46,47}

Although focusing on young to middle-aged adults for disease prevention may be challenging, interventions in this group also could yield significant benefits. Older populations have experienced a substantial decrease in cardiovascular disease mortality because of improvements in the prevention and treatment of this disease; the same magnitude of benefits has not been observed among younger adults, partly because of unfavorable trends in cardiovascular disease risk factors.⁴⁸ This pattern may continue to be exacerbated as the high prevalence of overweight among today's adolescents will likely mean record obesity rates among future young to middle-aged adults.⁴⁹

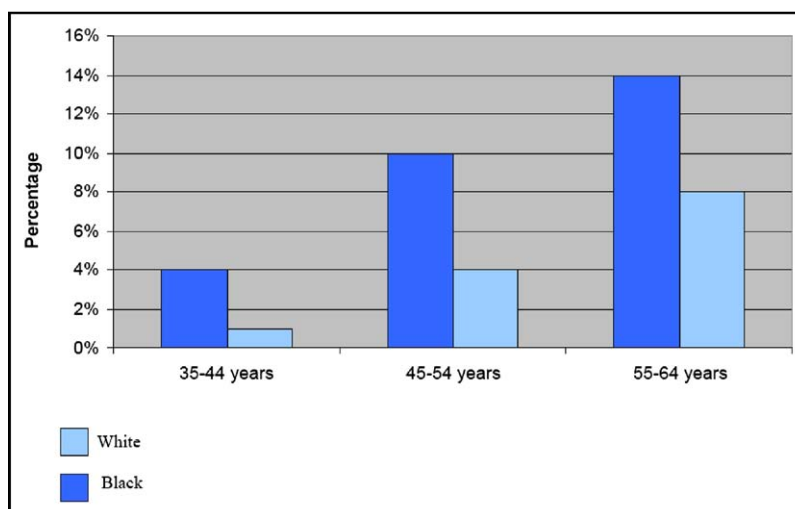


Figure 2 Percentage of all deaths from cardiovascular disease among adult Blacks and Whites that occur within particular age categories, Centers for Disease and Control and Prevention Wide-ranging On-line Data for Epidemiologic Research program, 1999-2003.

Our study has several limitations to note. This is a cross-sectional study, and therefore, we cannot determine causality nor account for changes in our outcome or covariates over time. Specifically, we do not know whether the disparity described for 35- to 44-year-olds in 1999-2006 will close as that cohort ages, which would require prospective confirmation. Disease status was determined by self-report in NHANES and thus may not accurately reflect true prevalence; prior studies, however, have shown self-report of these conditions to be reliable.^{50,51} Although NHANES was designed to be representative of the noninstitutionalized population, and specific groups, such as blacks, were oversampled, our population prevalence estimates may not reflect true prevalence. Racial misclassification in CDC WONDER CMF is possible, although vital statistics administrative coding of race was found to be reliable for blacks and whites in a prior study.⁵² Racial misclassification is not likely to be different across age or age and sex categories and therefore is unlikely to affect the results of our study. ICD-10 codes for the underlying cause of death were used to capture mortality from the cardiovascular conditions of interest and thus, miscoding also is possible. However, it is unlikely that miscoding would be differential between whites and blacks, and prior work has shown the codes to be reliable.⁵²

We describe a high burden of cardiovascular disease among young and middle-aged blacks. Continued work is needed to better understand the causes of excess cardiovascular disease morbidity and mortality in blacks in young and middle age. Policy-makers, public health officials, and clinicians aimed at reducing health disparities should focus on the period when these black-white cardiovascular disease disparities appear to emerge among those over age 35 years who are young to middle-aged.

References

1. US Department of Health and Human Services. *Healthy People 2010*, 2nd edition. Washington DC: US Government printing office; 2000. Available at: <http://www.healthypeople.gov/document/tableofcontents.htm>. Accessed September 12, 2007.
2. Institute of Medicine. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. Washington, DC: National Academies Press; 2003.
3. Mensah GA. Eliminating disparities in cardiovascular health: six strategic imperatives and a framework for action. *Circulation*. 2005;111:1332-1336.
4. Lillie-Blanton M, Maddox TM, Rushing O, Mensah GA. Disparities in cardiac care: rising to the challenge of Healthy People 2010. *J Am Coll Cardiol*. 2004;44:503-508.
5. Yancy CW, Benjamin EJ, Fabunmi RP, Bonow RO. Discovering the full spectrum of cardiovascular disease: Minority Health Summit 2003: executive summary. *Circulation*. 2005;111:1339-1349.
6. Liao Y, Tucker P, Okoro CA, et al. REACH 2010 Surveillance for Health Status in Minority Communities—United States, 2001-2002. *MMWR Surveill Summ*. 2004;53:1-36.
7. Levine RS, Foster JE, Fullilove RE, et al. Black-white inequalities in mortality and life expectancy, 1933-1999: implications for healthy people 2010. *Public Health Rep*. 2001;116:474-483.
8. Cooper R, Cutler J, Desvigne-Nickens P, et al. Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. *Circulation*. 2000;102:3137-3147.
9. Murray CJ, Kulkarni SC, Michaud C, et al. Eight Americas: investigating mortality disparities across races, counties, and race-counties in the United States. *PLoS Med*. 2006;3:e260.
10. Centers for Disease Control and Prevention (CDC). Disparities in premature deaths from heart disease—50 States and the District of Columbia, 2001. *MMWR Morb Mortal Wkly Rep*. 2004;53:121-125.
11. U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality. *2007 National Healthcare Disparities Report; February 2008* (AHRQ Publication No. 08-0041). Available at: <http://www.ahrq.gov/qual/nhdr07/nhdr07.pdf>. Accessed on June 29, 2008.

12. Giles WH, Kittner SJ, Hebel JR, et al. Determinants of black-white differences in the risk of cerebral infarction. The National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Arch Intern Med.* 1995;155:1319-1324.
13. Wong MD, Shapiro MF, Boscardin WJ, Ettner SL. Contribution of major diseases to disparities in mortality. *N Engl J Med.* 2002;347:1585-1592.
14. Mensah GA, Mokdad AH, Ford ES, et al. State of disparities in cardiovascular health in the United States. *Circulation.* 2005;111:1233-1241.
15. Corti MC, Guralnik JM, Ferrucci L, et al. Evidence for a black-white crossover in all-cause and coronary heart disease mortality in an older population: the North Carolina EPESE. *Am J Public Health.* 1999;89:308-314.
16. Kanjilal S, Gregg EW, Cheng YJ, et al. Socioeconomic status and trends in disparities in 4 major risk factors for cardiovascular disease among US adults, 1971-2002. *Arch Intern Med.* 2006;166:2348-2355.
17. Ferdinand KC. Coronary artery disease in minority racial and ethnic groups in the United States. *Am J Cardiol.* 2006;97(2A):12A-19A.
18. Ayala C, Greenlund KJ, Croft JB, et al. Racial/ethnic disparities in mortality by stroke subtype in the United States, 1995-1998. *Am J Epidemiol.* 2001;154:1057-1063.
19. Mohtashemi M, Levins R. Qualitative analysis of the all-cause black-white mortality crossover. *Bull Math Biol.* 2002;64:147-173.
20. Centers for Disease Control and Prevention (CDC). National Health and Nutrition Examination Survey: Questionnaires, Datasets, and Related Documentation. Available at: http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm. Accessed May 17, 2009.
21. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA.* 1998;280:1690-1691.
22. Vittinghoff E GD, Shiboski S, McCulloch CE. *Regression Methods in Biostatistics.* New York: Springer-Verlag; 2004.
23. Yan LL, Liu K, Daviglius ML, et al. Education, 15-year risk factor progression, and coronary artery calcium in young adulthood and early middle age: the Coronary Artery Risk Development in Young Adults study. *JAMA.* 2006;295:1793-1800.
24. Muennig P, Sohler N, Mahato B. Socioeconomic status as an independent predictor of physiological biomarkers of cardiovascular disease: evidence from NHANES. *Prev Med.* 2007;45:35-40.
25. Kamalesh M, Shen J, Tierney WM. Stroke mortality and race: does access to care influence outcomes? *Am J Med Sci.* 2007;333:327-332.
26. United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Office of Analysis and Epidemiology (OAE). Compressed Mortality File (CMF) compiled from CMF 1999-2003, Series 20, No. 2I 2006 on CDC WONDER On-line database available at: <http://wonder.cdc.gov/wonder/help/cmfile.html>. Accessed August 24, 2007.
27. World Health Organization. *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision. Geneva, Switzerland: World Health Organization; 1992.
28. Jones DW, Chambless LE, Folsom AR, et al. Risk factors for coronary heart disease in African Americans: the atherosclerosis risk in communities study, 1987-1997. *Arch Intern Med.* 2002;162:2565-2571.
29. African Americans and Cardiovascular Diseases. *American Heart Association Statistical Fact Sheet—Populations*, 2007 update. Available at: <http://www.americanheart.org>. Accessed August 24, 2007.
30. Bibbins-Domingo K, Pletcher MJ, Lin F, et al. Racial differences in incident heart failure among young adults. *N Engl J Med.* 2009;360:1179-1190.
31. Popescu I, Vaughan-Sarrazin MS, Rosenthal GE. Differences in mortality and use of revascularization in black and white patients with acute MI admitted to hospitals with and without revascularization services. *JAMA.* 2007;297:2489-2495.
32. Rathore SS, Berger AK, Weinfurt KP, et al. Race, sex, poverty, and the medical treatment of acute myocardial infarction in the elderly. *Circulation.* 2000;102:642-648.
33. Skinner J, Chandra A, Staiger D, et al. Mortality after acute myocardial infarction in hospitals that disproportionately treat black patients. *Circulation.* 2005;112:2634-2641.
34. Smith GL, Shlipak MG, Havranek EP, et al. Race and renal impairment in heart failure: mortality in blacks versus whites. *Circulation.* 2005;111:1270-1277.
35. Jha AK, Fisher ES, Li Z, et al. Racial trends in the use of major procedures among the elderly. *N Engl J Med.* 2005;353:683-691.
36. Winkleby MA, Robinson TN, Sundquist J, Kraemer HC. Ethnic variation in cardiovascular disease risk factors among children and young adults: findings from the Third National Health and Nutrition Examination Survey, 1988-1994. *JAMA.* 1999;281:1006-1013.
37. Din-Dzietham R, Liu Y, Bielo MV, Shamsa F. High blood pressure trends in children and adolescents in national surveys, 1963 to 2002. *Circulation.* 2007;116:1488-1496.
38. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med.* 1996;335:791-799.
39. Gornick ME. The association of race/socioeconomic status and use of Medicare services. A little-known failure in access to care. *Ann N Y Acad Sci.* 1999;896:497-500.
40. Murray LA. Racial and ethnic differences among Medicare beneficiaries. *Health Care Financ Rev.* 2000;21:117-127.
41. Weinick RM, Zuvekas SH, Cohen JW. Racial and ethnic differences in access to and use of health care services, 1977 to 1996. *Med Care Res Rev.* 2000;57(Suppl 1):36-54.
42. Ayanian JZ, Weissman JS, Schneider EC, et al. Unmet health needs of uninsured adults in the United States. *JAMA.* 2000;284:2061-2069.
43. Holmes JS, Arispe IE, Moy E. Heart disease and prevention: race and age differences in heart disease prevention, treatment, and mortality. *Med Care.* 2005;43(3 Suppl):I33-I41.
44. Levine DA, Kiefe CI, Houston TK, et al. Younger stroke survivors have reduced access to physician care and medications: National Health Interview Survey from years 1998 to 2002. *Arch Neurol.* 2007;64:37-42.
45. Fronstin P. Sources of health insurance and characteristics of the uninsured: analysis of the March 2006 Current Population Survey. *Employee Benefit Research Institute Issue Brief, No. 298, October 2006.* Social Science Research Network. Available at: <http://ssrn.com/abstract=938130>. Accessed September 12, 2007.
46. Ong KL, Cheung BM, Man YB, et al. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999-2004. *Hypertension.* 2007;49:69-75.
47. Centers for Disease Control and Prevention (CDC). Racial/ethnic disparities in prevalence, treatment, and control of hypertension—United States, 1999-2002. *MMWR Morb Mortal Wkly Rep.* 2005;54:7-9.
48. Ford E, Capewell S. Coronary heart disease mortality among young adults in the U.S. from 1980 through 2002: concealed leveling of mortality rates. *J Am Coll Cardiol.* 2007;50:2128-2132.
49. Bibbins-Domingo K, Coxson P, Pletcher MJ, et al. Adolescent overweight and future adult coronary heart disease. *N Engl J Med.* 2007;357:2371-2379.
50. Okura Y, Urban LH, Mahoney DW, et al. Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. *J Clin Epidemiol.* 2004;57:1096-1103.
51. O'Mahony PG, Dobson R, Rodgers H, et al. Validation of a population screening questionnaire to assess prevalence of stroke. *Stroke.* 1995;26:1334-1337.
52. Rosenberg HM, Maurer JD, Sorlie PD, et al. Quality of death rates by race and Hispanic origin: a summary of current research, 1999. *Vital Health Stat 2.* 1999(128):1-13.