Does Socioeconomic Position Moderate the Effects of Race on Cardiovascular Disease Mortality?

Rhonda Jones-Webb, DrPH; Xinhua Yu, MD, PhD; Jennifer O'Brien, BA; Peter Hannan, MStat; Melanie Wall, PhD; John Oswald, PhD

Objective: Cardiovascular disease (CVD) rates differ markedly by minority status, with younger Blacks having some of the highest CVD mortality rates in the United States. A major objective of this study was to assess whether socioeconomic position moderates the effects of race or minority status on CVD mortality.

Design: The sample included 443 Black and 21,182 White men, and 415 Black and 24,929 White women, 45 years and older, who died of CVD from 1992–1998, and who had lived in the Twin Cities 5-county area. Using individual and neighborhood level measures of socioeconomic position, we hypothesized that socioeconomic position would moderate the effects of race on CVD mortality. Test hypotheses were analyzed using Poisson regression analysis.

Results: Socioeconomic position moderated the effects of race on CVD mortality among older men, but not in older women. Older Black men who lived in more impoverished neighborhoods had significantly and disproportionately higher CVD mortality rates than did older White men living in more impoverished neighborhoods; this was not the case among older Black and White men living in less impoverished neighborhoods. Race was independently related to CVD mortality among younger men and women, with younger Black men and women having significantly higher CVD mortality rates than younger White men and women. The Black-White rate for Black women was twice that of White women.

Conclusion: Socioeconomic position as measured by neighborhood poverty can moderate the effects of race on CVD mortality in older Black and White men. This may not have been as apparent had socioeconomic position not been treated as a major variable of interest, and measured at multiple levels. (*Ethn Dis.* 2004;14:489–496)

Key Words: CVD, Mortality, Blacks, Socioeconomic, Position, Race, Age

Introduction

Cardiovascular disease (CVD), which includes diseases of the heart and blood vessels, remains one of the leading causes of death in the United States in the 21st century.[1] Cardiovascular disease (CVD) rates differ markedly by minority status, with younger Blacks having some of the highest CVD mortality rates in the United States.[2–5] For example, younger Blacks are 5 to 6 times more likely than younger Whites to die prematurely from stroke.[2,4]

Race, Socioeconomic Position, and Mortality

Socioeconomic position may be an important variable in understanding Black-White differences in CVD mortality rates. Blacks are disproportionately represented among the poor, and lower socioeconomic position has been shown to be related to poorer health outcomes.[6,7] Socioeconomic position includes various social and economic factors, such as income and education, that influence what position(s) individuals and groups hold within the structure of society.[7]

Despite the importance of socioeconomic position in health research, studies investigating Black-White differences in CVD mortality sometimes treat socioeconomic position as a confounder, rather than a major variable of interest.[8–12] This trend has resulted in 2 important flaws in CVD research. First, when socioeconomic position has been treated as a confounder, the range of hypotheses regarding the relationships between race, socioeconomic position, and CVD mortality has been limited. There are 2 ways in which socioeconomic position can influence Black-White differences in CVD mortality. Socioeconomic position can mediate Black-White differences in CVD mortality. In other words, adjusting for socioeconomic position can reduce or eliminate Black-White differences in CVD mortality.[8,9,12,13] This hypothesis suggests that socioeconomic position is a stronger predictor of mortality than race or minority status. Socioeconomic position can also moderate the effects of race on CVD mortality.[14,15] In the latter case, Black-White differences in CVD mortality vary by race within socioeconomic groups. For example, less affluent Blacks may have higher CVD mortality rates than less affluent Whites; however, this may not be true for more affluent Blacks and Whites with greater access to health care and to better quality healthcare facilities.[16] This hypothesis suggests that both race and socioeconomic position are important in understanding Black-White differences in mortality. Few studies in the published literature have tested the latter hypothesis in Black and White adults, ie, how socioeconomic status may moderate the effects of race or minority status on CVD risk or mortality.[14,15,17]

Second, the measurement of socioeconomic position in studies examining Black-White differences in CVD has been incomplete. Studies investigating Black-White differences in CVD mor-

From the Division of Epidemiology (RJW, PH, JO), Division of Health Services, Research, and Policy (XY), Division of Biostatistics (MW), University of Minnesota, School of Public Health; Minnesota Department of Health (JO), Minneapolis, Minnesota.

Address correspondence and reprint requests to Rhonda Jones-Webb; University of Minnesota, School of Public Health, Division of Epidemiology; 1300 South Second Street, Suite 300; Minneapolis, MN 55454; 612-626-8866; 612-624-0315 (fax); jones@epi.umn.edu

This hypothesis suggests that both race and socioeconomic position are important in understanding Black-White differences in mortality.

tality often include individual measures of socioeconomic position, such as income and education levels, and employment status.[9,11,18,19] Socioeconomic position should be measured at multiple levels, individual, household, and neighborhood, to fully evaluate its effects on health status.[20,21] Neighborhood level measures of socioeconomic position are especially important, because they can provide important contextual information about the types of social and economic conditions that can increase risk of CVD mortality among Blacks.[22,23] Some studies have reported that neighborhood poverty or deprivation is related to mortality, independent of individual socioeconomic position.[15,24–26]

The specific objective of this study was to assess whether socioeconomic position moderates the effects of race of CVD mortality among Black and White adults. Using individual and neighborhood level measures of socioeconomic position, we hypothesized that socioeconomic position would moderate the effects of race on CVD mortality in younger and older Black and White adults.

METHODS

Overview

The mortality data analyzed in this study were obtained from the Minnesota Department of Health vital statistics database, which includes information on all causes of death. A total of 887 Black and 94,953 White Minnesotans, aged 45 years and older, died of CVD between 1992 and 1998. Analyses in this paper were limited however to 443 Black and 21,182 White men, and 415 Black and 24,929 White women, aged 45 years and older, who died of CVD, and who had lived in the Twin Cities 5-county area from 1992 to 1998. We focused on Blacks and Whites in the 5-county area because of the very small percentage (6%) of Blacks living outside the metropolitan Twin Cities area.[27] ZIP codes served as our unit of analysis in multivariate models. Therefore, the death rates presented in this paper are based on death counts within ZIP codes for a specific subgroup. There were a total of 128 ZIP codes with a population of 5 or more Blacks from 1992–1998. The total number of ZIP codes across all 4 race-sex-age groups over the 7 years was 896.

Measures

Independent Variables

Race, sex, age, and socioeconomic position served as independent variables, and were treated as dichotomous variables, due to the small number of Blacks in our sample. Data on race, sex, and age were obtained from death records. Race was based on standard categories used by the US Bureau of Census and limited to Blacks and Whites (non-Hispanic and Hispanic). Hispanic Whites and Blacks were not excluded from the sample because their representation in Minnesota in 1990 was very small (1%). Age was dichotomized to permit comparisons of death rates among subjects aged 45 to 64 years, with subjects aged 65 years and older.[28] Subjects 45 to 64 years of age were characterized as being in their middle years.

Individual and neighborhood level measures of socioeconomic position included educational attainment and neighborhood poverty. Data on individual educational attainment ($\leq$high school vs $>$high school) were based on information recorded on death records. For neighborhood poverty, 1990 Census data at the ZIP code level were matched to each geocoded subject's permanent address. This census-derived measure assessed the percentage of persons in a ZIP code who lived below the poverty line in 1990. Impoverished ZIP codes consisted of federally defined areas in which 20% or more of the population lived below the poverty line, which was $12,700 for a family of 4 in 1990.[29] Subjects' addresses were matched with Census data at the ZIP code level, rather than at smaller geographic levels, such as census block groups, due to the number of incomplete addresses on death certificates. Subjects with missing ZIP code information (7%) were randomly assigned to ZIP codes that reflected their race-sex-age-education characteristics using a hot-deck procedure.[30] With most hot-deck procedures, missing values are replaced by values from similar responding units in the sample.[30]

Dependent Variable

Cardiovascular disease (CVD) mortality was the key outcome of interest in this study. Data related to CVD mortality were obtained from information recorded on subjects' death records and then coded according to criteria used by the International Classification of Diseases system (ICD version 9). We used the following ICD 9 codes for our CVD measure: 390–398 (rheumatic heart disease); 401, 403, 405 (hypertension without heart disease); 402, 404 (hypertension with heart disease); 410–414 (ischemic heart disease); 420–423, 425–428, 429.2, 429.9 (other diseases of the heart); 424 (chronic disease of the endocardium); 429.0, 429.1 (other myocardial degeneration); 430–438 (cerebrovascular disease); 415–417, 441–447; 449–459 (diseases of the arteries and veins); and 440 (arteriosclerosis). Total CVD mortality rather than specific CVD outcomes were assessed, due to the small number of Blacks in our sample.

Cardiovascular disease (CVD) rates were calculated by dividing the number of deaths in a given ZIP-race-sex-age-education-poverty stratum by the esti-

mated population at risk in that stratum. Population data were obtained from the 1990 Census, ZIP code, and were race-sex-age- specific. Because neighborhood poverty was available at only the ZIP code level, deaths and populations at risk were allocated proportionately to the percentage of neighborhood poverty in the ZIP code. While death certificates report individual achieved education, Census data do not provide estimates of population at the ZIP code level stratified by race-sex-age-education. In race-sex-age strata, we used state level estimates of percent, with not more than a high school education, to proportionally assign the population at risk in the ZIP-race-sex-age strata and to estimate denominators of rates in educational sub-strata.

Analysis

Data are counts of deaths in each of the 32 cells defined by 5 dichotomous variables: age, race, sex, individual education, and neighborhood poverty. Count data are appropriately modeled as Poisson distributed with the population at risk representing exposure; the Poisson model implies increased variance in the count at higher counts. The alternative, analysis of the rates as approximately Gaussian distributed, would require weighting to allow for the increased rate variation at higher rates. Multiple events (deaths) were modeled within a ZIP code to accommodate possible correlation due to similar health experiences of residents in the same ZIP code. Because the data are collapsed into cells, and because our interest is in group-level effects, the marginal (or population averaged) approach of generalized estimating equations (GEE)[31] is preferred to the subject-specific approach[32,33] of hierarchical linear models such as HLM[34] or SAS MIXED.[35] If the distribution were taken as Gaussian, the marginal and subject-specific approaches are equivalent, but this is not the case under non-Gaussian distributions. In GEE, first the Poisson model is fit assuming independent observations (the marginal model). Then the standard errors of the parameter estimates are empirically re-estimated, starting from a working correlation matrix of specified form and the variance function, which, for the Poisson distribution, says the variance equals the mean. The GEE method is robust to misspecification of the working matrix, as long as the regression model is specified correctly.

Inferences are based on testing the interactive effects of race category with either neighborhood poverty or individual educational level on CVD mortality, stratified by the 4 sex-age strata. Terms that were not statistically significant at the 5% level (2-sided) were excluded from the final models. Analyses were conducted using the GENMOD procedure of the Statistical Analysis System.[35] Test hypotheses were considered supported if interactions of race with economic variables and with CVD mortality were observed.

Table 1. Number of CVD deaths by race, sex, and years

	White		Black	
Year	Male	Female	Male	Female
1992	2971	3610	48	52
1993	3143	3657	75	49
1994	3126	3482	73	65
1995	3089	3647	59	58
1996	3800	3730	55	63
1997	2953	3469	69	71
1998	2820	3334	64	57

RESULTS

Demographic Characteristics

Table 1 describes the number of deaths by year for Black and White men and women. The number of CVD deaths slightly increased for Blacks, but decreased for Whites, from 1992–1998. Blacks who died of CVD were more likely to be younger, male, and to live in more impoverished neighborhoods (Table 2). Blacks and Whites who died of CVD had similar education levels (Table 2).

Bivariate Analyses

The mean crude death rate across all 896 ZIP codes was 604 deaths per 10,000 population. Blacks were more likely than Whites to have higher crude CVD mortality rates, regardless of age (Figures 1 and 2). Older Black men had the highest CVD mortality rates of the 5 race-sex-age groups. Black-White differences were most striking between younger Black and White women, with younger Black women having a CVD mortality rate 3 times that of younger White women (197 deaths per 10,000 population vs 59 deaths per 10,000 population, respectively).

Multivariate Analyses

Table 3 presents the final Poisson regression model for younger Black and White men and women. No interaction effects were observed for race with socioeconomic position variables and with CVD mortality, but race was independently related to CVD mortality. Younger Black men and women exhibited significantly higher mean CVD mortality rates compared to younger White men and women, regardless of their personal educational or neighborhood poverty levels (271 deaths per 10,000 population vs 185 deaths per 10,000 population for males, and 163 deaths per 10,000 population vs 71 deaths per 10,000 population for females, respectively). In fact, the Black-

Table 2. Demographic Characteristics of the Sample

		Whites		Blacks			
		Deaths	%	Deaths	%	Total	%
Total		46111	98.17%	858	1.83%	46969	100.00%
Age	45–64	4994	10.83%	274	31.93%	5268	11.22%
	65+	41117	89.17%	584	68.07%	41701	88.78%
Sex	Male	21182	45.90%	443	51.63%	21586	46.00%
	Female	24929	54.10%	415	48.37%	25339	54.00%
Neighborhood poverty*	<20%	40895	88.69%	438	51.05%	41333	88.00%
	≥20%	5216	11.31%	420	48.95%	5636	12.00%
Education	≤HS	33084	71.75%	634	73.89%	33718	71.79%
	>HS	13027	28.25%	224	26.11%	13251	28.21%

* Neighborhood poverty was defined as an annual income of $12,700 in 1989.

White rate ratio for younger Black women was twice that of younger White women.

Table 4 presents the final Poisson model for older Black and White men and women. Interaction effects were observed of race with neighborhood poverty and with CVD mortality among older Black and White men ($P \leq .006$). Older Black men living in impoverished neighborhoods were significantly more likely to die of CVD than were their White counterparts (2,478 deaths per 10,000 population vs 1,841 deaths per 10,000 population, respectively). There were no significant differences in CVD mortality rates among Black and White men living in less impoverished neighborhoods. Among older women, no interactions were observed for race with socioeconomic variables and with CVD mortality (Table 4). Additionally, race was not significantly related to CVD mortality among older Black and White women (data not shown).

To assess biases that may have occurred due to our restricting the sample to urban Whites, additional GEE models were conducted on the statewide sample of Whites for each sex-age group (data not shown). These analyses assessed whether being in the urban sample or being in the statewide sample was related to CVD mortality. We found no significant differences in CVD mortality rates between Whites in the 2 samples.

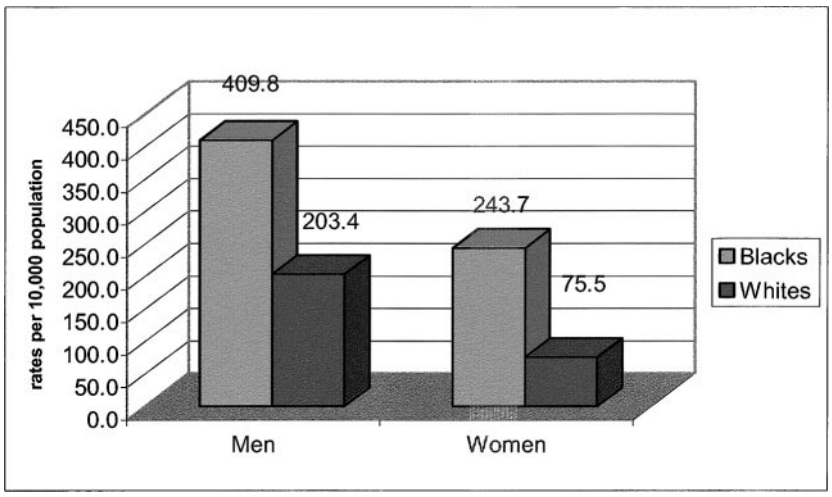

Fig 1. CVD mortality rrates for men and women, 45–64 years of age

DISCUSSION

Summary

To summarize, socioeconomic position did not moderate the effects of race on CVD mortality among younger Black and White men and women in their middle years (45 to 64 years). Race was independently related to CVD mortality, with younger Black men and women having higher CVD mortality rates compared to younger White men and women. Socioeconomic position moderated the effects of race on CVD mortality among older men; thus, our hypothesis was supported in older men only. Older Black men who lived in more impoverished neighborhoods had significantly and disproportionately higher CVD mortality rates than did older White men living in more impoverished neighborhoods; this was not the case among older Black and White men living in less impoverished neighborhoods. The latter may not have been as apparent had socioeconomic position not been treated as a major variable of interest, and measured at multiple levels.

Findings are consistent with those of other studies comparing CVD mortality rates among Black and Whites, which have also reported that Blacks are more likely than Whites to die prematurely from CHD and stroke.[2–5]

Our finding that neighborhood poverty has more deleterious consequences

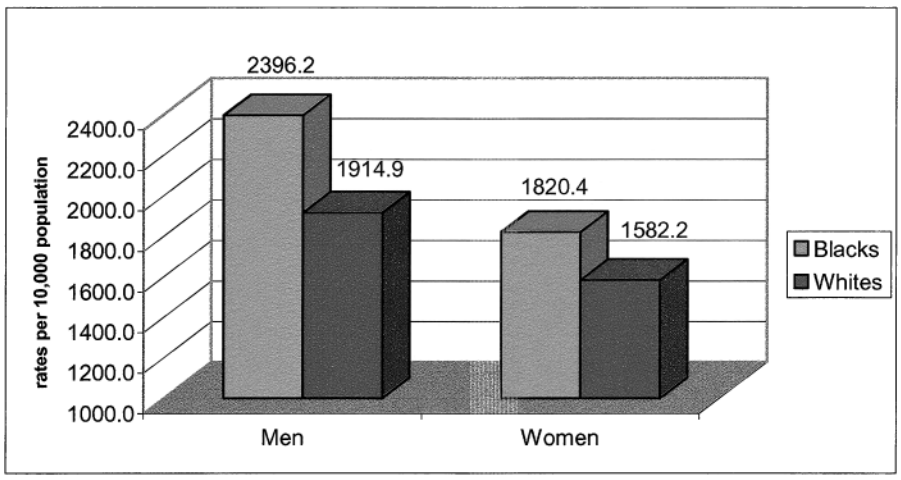

Fig 2. CVD mortality rates for men and women, 65+ years of age

on CVD mortality in older Black men, compared to their White counterparts, has not been reported previously. In American society, neighborhoods remain racially segregated in many parts of the country.[36] Thus, poverty may look very different in predominately Black impoverished neighborhoods than in equally impoverished White neighborhoods. Black impoverished neighborhoods may have fewer health and other community resources than White impoverished neighborhoods; this may in turn result in higher CVD mortality rates for older Black men.[37,38] For example, there are fewer grocery stores in predominately Black neighborhoods in the Twin Cities, and the price of food is markedly higher in these areas than in other parts of the city.[39]

Although Black-White differences in CVD mortality varied by neighborhood poverty level, they did not vary by level of individual educational attainment. Bivariate analyses indicated that Blacks and Whites had similar levels of education. Given that Blacks and Whites did not differ in their educational levels, we would not expect Black-White differences in CVD mortality to vary by education.

In contrast to older Black and White men, race or minority status was independently associated with CVD mortality among younger Black and White men and women. For example, younger Black women were more than twice as likely as younger White women to die prematurely of CVD in adjusted analyses. These findings suggest that race continues to matter. Younger Black men and women may be exposed to higher levels of socioecologic stress (eg, crime, poverty) than younger White men and women, because of their minority status. Exposure to high levels of stress may lead to more hypertension at an early age, which, in turn, may lead to more premature CVD deaths in younger Black men and women.[40,41] Additionally, previous experiences with discrimination may cause some Black men and women in their middle years to distrust health professionals and delay seeking medical assistance for hypertension and other health problems.

Race was not associated with CVD mortality among older Black and White women. Older Black women may be more likely than older Black men to have more developed social networks and sources of social support, making them better able to cope with socioecologic stress in their environment. In general, women are more central to receiving and giving social support than are men.[42–44]

Our study has 5 limitations that can inform future research. First, our sample included only urban Blacks and Whites; therefore, findings are generalizable only to urban settings. Future studies may wish to include both urban and rural samples of Blacks and Whites to confirm study findings. Our findings, while limited in their generalizability, highlight some of the challenges of using vital statistics data in states where Blacks represent a small proportion of the state population, and reside largely in the metropolitan area.

Table 3. CVD Mortality Rates Per 10,000 Population for Black and White Men and Women Age 45–64 Years Old

Sex		Deaths	Unadjusted Rate*	Adjusted Rate†
Male	Blacks	175	248.7	270.7
	Whites	3592	158.9	184.5
	Black-White rate ratio‡		1.57 (1.28–1.92)§	1.47 (1.18–1.82)
Female	Blacks	99	171.9	162.5
	Whites	1402	63.3	71.0
	Black-White rate ratio		2.72 (2.13–3.46)	2.29 (1.71–3.06)

* Unadjusted rate was based on GEE model without adjustment for individual educational attainment or neighborhood poverty.
† Adjusted Rate was adjusted for individual educational attainment and neighborhood poverty.
‡ P-value for rate ratios are all equal to 0.001.
§ Numbers in parentheses represent confidence intervals.

Table 4. CVD Mortality Rates per 10,000 Population by Race and Neighborhood Poverty Level for Men and Women Age 65 Years and Older

				Percentage Below Poverty Level†			
Sex	**Race**	**Deaths**	**Unadjusted Rate***	**<20%**	**Deaths**	**≥20%**	**Deaths**
Male	Blacks	268	1580.3	1283.2	139	2477.8	129
	Whites	17590	1543.6	1595.3	15848	1840.6	1699
Black-White Rate Ratio			1.02 (0.76–1.37)	0.80 (0.63–1.03)		1.35‡ (1.03–1.76)§	
Female	Blacks	316	1122.3	948.0	157	1456.7	159
	Whites	23527	1267.9	1212.7	20553	1463.1	2962
Black-White Rate Ratio			0.89 (0.70–1.11)	0.78 (0.57–1.08)		1.0 (0.72–1.37)	

* Unadjusted rate was based on GEE model without adjustment for individual educational attainment or neighborhood poverty.
† Rates were adjusted for individual educational attainment.
‡ P-value is equal to .03 for this Black-White rate ratio.
§ Numbers in parentheses represent confidence intervals.

Second, neighborhood poverty was assessed at the ZIP code level, because of the number of incomplete addresses. Studies have shown that smaller geographical census units, such as census block group numbers, are more highly associated with health outcomes than are larger geographic units, such as ZIP codes.[20,21] Future studies on CVD mortality using neighborhood level measures of socioeconomic position would greatly benefit from more systematic and rigorous methods of collecting vital statistics information at the state level.

Third, about 7% of our sample had missing ZIP code information. Cases with missing values were first randomly assigned once to ZIP codes that reflected their race-sex-age-education characteristics. As a more reliable method of imputation, we also performed multiple imputation (5 times), and then pooled the resultant statistics. Study findings did not differ substantially from our original results using this approach.

Fourth, the socioeconomic characteristics of some of the neighborhoods may have changed, and some individuals in our sample may have moved over the 7-year study period. We do not expect these to be important biases, because it generally takes several years for the socioeconomic characteristics of neighborhoods to change significantly.[26] Also, as people grow older they become less mobile, which may be especially true among the elderly poor, who have fewer resources to assist them in relocating.

Finally, our study did not control for behavioral risk factors that are known to be related to CVD mortality, such as smoking and obesity.[45,46] We controlled for individual education level, which is related to a number of behavioral risk factors associated with CVD.[47,48]

Race was independently related to CVD mortality, with younger Black men and women having higher CVD mortality rates compared to younger White men and women.

Implications

Despite these limitations our findings have practical implications for those working to reduce health disparities in CVD mortality rates. First, our findings have implications for those who wish to design interventions to reduce health disparities. Our findings suggest that public health professionals need to take into account the socioeconomic conditions of the neighborhoods in which minorities and the poor live and die when designing health interventions. For example, health workers who are interested in designing programs to increase hypertension screening will need to understand the 'opportunity costs' of participating in such programs for elderly Black men living in impoverished neighborhoods where public transportation and safety may present significant barriers to participation. "Opportunity costs" refers to what one gives up in order to have a specific opportunity or gain in another area.[17]

Second, our findings have implications for public health initiatives for cultural competency training in Minnesota and elsewhere.[49,50] Cultural competency training may help increase trust and reduce cultural barriers that may exist between health providers and Black men and women in their middle years.

Finally, our findings have implications for policy advocacy. The disparities in CVD mortality rates observed in this study mirror social and economic inequalities in society as a whole. Therefore, health policy advocates will need to be able to work effectively with policy advocates in other public policy areas that address broader social and economic inequities in our society.

ACKNOWLEDGMENTS
This study was supported by a grant (UR6/CCU517477-John Oswald, PI) from the Centers for Disease Control and Prevention.

REFERENCES

1. Minino AM, Smith BL. Deaths: preliminary data for 2000. *National Vital Stat Rep.* 2001; 49(12):1–5.
2. Gillum RF. Stroke mortality in Blacks: disturbing trends. *Stroke.* 1999;30(8):1711–1715.
3. Jones DW, Sempos CT, Thom TJ, et al. Rising levels of cardiovascular mortality in Mississippi, 1979–1995. *Am J Med Sci.* 2000; 319(3):131–137.
4. Morgenstern LB, Spears WD, Goff DC, Grotta JC, Nichaman MZ. African Americans and women have the highest stroke mortality in Texas. *Stroke.* 1997;28(1):15–18.
5. Sekikawa A, Kuller LH. Striking variation in coronary heart disease mortality in the United States among Black and White women aged 45–54 by state. *J Womens Health Gender Based Med.* 2000;9(5):545–558.
6. Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. *Health Aff.* 2002;21(3):60–76.
7. Lynch J, Kaplan G. Socioeconomic position. In: Berkman L, Kawachi I, eds. *Social Epidemiology.* New York, NY: Oxford University Press; 2000:13–35.
8. Corti MC, Guralnik J, 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(3):308–314.
9. Escobedo LG, Giles WH, Anda RF. Socioeconomic status, race, and death from coronary heart disease. *Am J Prev Med.* 1997; 13(2):123–130.
10. Howard G, Russell G, Anderson R, Evans G, Morgan T, Howard VBGL. Role of social class in excess Black stroke mortality. *Stroke.* 1995;26(10):1759–1763.
11. Howard G, Anderson RT, Russell G, Howard VJ, Burke GL. Race, socioeconomic status, and cause-specific mortality. *Ann Epidemiol.* 2000;10(4):214–223.
12. Ng-Mak DS, Dohrenwend BP, Abraido-Lanza AF, Turner JB. A further analysis of race differences in the National Longitudinal Mortality Study. *Am J Public Health.* 1999;89(11): 1748–1751.
13. LeClere FB, Rogers RG, Peters K. Neighborhood social context and racial differences in womens heart disease mortality. *J Health Soc Behav.* 1998;39:91–107.
14. Ethnic and socioeconomic differences in cardiovascular disease risk factors: findings from women from the Third National Health and Nutrition Examination Survey, 1988–1994. *Nurs Res.* 2002;51(3):140–147.
15. Diez Roux A, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. *N Engl J Med.* 2001; 345(2):99–106.
16. Smedley BD, Stith AY, Nelson AR. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care.* Washington, DC: The National Academies Press; 2002.
17. Appel SJ, Harrell JS, Deng S. Racial and socioeconomic differences in risk factors for cardiovascular disease among southern rural women. *Nurs Res.* 2002;51(3):140–147.
18. Gorelick PB. Cerebrovascular disease in African Americans. *Stroke.* 1998;29(12):2656–2664.
19. Casper ML, Barnett EB, Armstong DL, Giles WH, Blanton CJ. Social class and race disparities in premature stroke mortality among men in North Carolina. *Ann Epidemiol.* 1997;7:146–153.
20. Krieger N, Williams DR, Moss NE. Measuring social class in US public health research: concepts, methodologies, and guidelines [review]. *Annu Rev Public Health.* 1997;18:341–378.
21. Krieger N, Chen JT, Waterman PD, Soobader MJ, Subramanian SV, Carson R. Geocoding and monitoring of US socioeconomic inequalities in mortality and cancer incidence: does the choice of area-based measure and geographic level matter? *Am J Epidemiol.* 2002;156(5):471–482.
22. Macintyre S, Ellaway A. Ecological approaches: rediscovering the role of the physical and social environment. In: Berkman LF, Kawachi I, eds. *Social Epidemiology.* New York, NY: Oxford University Press; 2000:332–347.
23. Mincy RB, Sawhill IV, Wolf DA. The underclass: definition and measurement. *Science.* 1990;248:450–453.
24. Borrell C, Rodríguez M, Ferrando J, et al. Role of individual and contextual effects injury mortality: new evidence from small area analysis. *Inj Prev.* 2002;8:297–302.
25. Cubin C, LeClere FB, Smith GS. Socioeconomic status and injury mortality: individual and neighborhood determinants. *J Epidemiol Community Health.* 2000;54:517–524.
26. Winkleby MA, Cubbin C. Influence of individual and neighborhood socioeconomic status on mortality among Black, Mexican-American, and White women and men in the United States. *J Epidemiol Community Health.* 2003;57:444–452.
27. *Populations of Color in Minnesota: Health Status Report.* St. Paul, Minn: Minnesota Department of Health; 1997.
28. Cooper RS, Kennelly JF, Durazo-Arvzu R, Oh HJ, Kaplan G, Lynch J. Relationship between premature mortality and socioeconomic factors in Black and White populations of US metropolitan areas. *Public Health Rep.* 2001;116(5):464–473.
29. Annual update of the poverty income guidelines. *Federal Register.* 1990;55:5664.
30. Little RJA, Rubin DB. *Statistical Analysis with Missing Data.* 2nd ed. Hoboken, NJ: John Wiley and Sons, 2002:66.
31. Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika.* 1986;73:13–22.
32. Breslow NE, Clayton DG. Approximate inference in generalized linear mixed models. *J Am Stat Assoc.* 1993;88(421):9–25.
33. Lindsey JK, Lambert P. On the appropriateness of marginal models for repeated measurements in clinical trials. *Stat Med.* 1998; 17(4):447–469.
34. Bryk AS, Raudenbush SW. *Hierarchical Linear Models: Applications and Data Analysis Methods.* 2nd ed. Newbury Park, Calif: Sage Publications; 2001.
35. Statistical Analysis System (SAS). *SAS/STAT Software Release 8.2.* Cary, NC: SAS, Inc; 2001.
36. Parker KF, Pruitt MV. Poverty, poverty concentration, and homicide. *Soc Sci Q.* 2000; 81(2):555–570.
37. Carter-Edwards L, Bynoe MJ, Svetkey LP. Knowledge of diet and blood pressure among African Americans: use of focus groups for questionnaire development. *Ethn Dis.* 1998; 8(2):184–197.
38. Schulz AJ, Williams DR, Israel BA, Lempert LB. Racial and spatial relations as fundamental determinants of health in Detroit. *Milbank Q.* 2002;80(4):677–705.
39. Chung C, Myers SL Jr. Do the poor pay more for food? An analysis of grocery store availability and food price disparities. *J Consumer Aff.* 1999;33(2):276–296.
40. Anderson NB, Myers HF, Pickering T, Jackson JS. Hypertension in Blacks: psychosocial and biological perspectives. *J Hypertens.* 1989; 79(3):161–172.
41. Manton KG, Poss SS, Wing S. The Black/White mortality crossover: investigation from the perspective of the components of aging. *Gerontologist.* 1979;19(3):291–300.
42. Ajrouch KJ, Antonucci TC, Janevic MR. Social networks among Blacks and Whites: the interaction between race and age. *J Gerontol.* 2001;56B(2):S112–S118.
43. Lincoln KD, Taylor RJ, Chatter LM. Correlates of emotional support and negative interaction among older Black Americans. *J Gerontol.* 2003;58B(4):S225–S233.
44. Krieger N, Chen JT, Waterman PD, Rehkopf DH, Subramanian SV. Race/ethnicity, gender, and monitoring socioeconomic gradients in health: a comparison of area-based socioeconomic measures—The Public Health Disparities Geocoding Project. *Am J Public Health.* 2003;93(10):1655–1670.
45. Fagerstrom K. The epidemiology of smoking: health consequences and benefits of cessation. *Drugs.* 2002;62(2):1–9.
46. Must A, Spandano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA.* 1999;282(16):1523–1529.
47. Dressler WW. Education, lifestyle, and arterial blood pressure. *J Psychosom Res.* 1990; 34(5):515–523.
48. Feldman RHL, Fulwood R. The three leading causes of death in African Americans: barriers

to reducing excess disparity and to improving health behaviors. *J Health Care Poor Underserved.* 1999;10(1):45–71.
49. Geiger HJ. Racial stereotyping and medicine: the need for cultural competence. *CMAJ.* 2001;164(1):1699–1700.
50. Williams DR. Race and health: trends and policy implications. Auerbach JA, Krimgold BK, eds. *Income, Socioeconomic Status, and Health: Exploring the Relationships.* Washington, DC: National Policy Association; 2001: 67–85.

AUTHOR CONTRIBUTIONS

Design and concept of study: Jones-Webb, Yu, O'Brien, Hannan, Wall
Acquisition of data: Oswald
Data analysis and interpretation: Jones-Webb, Yu, O'Brien, Hannan, Wall, Oswald
Manuscript draft: Jones-Webb, O'Brien, Wall
Statistical expertise: Yu, Hannan, Wall
Acquisition of funding: Jones-Webb, Oswald
Administrative, technical, or material assistance: O'Brien, Oswald
Supervision: Jones-Webb, Wall