The Association of Race and Socioeconomic Status With Cardiovascular Disease Indicators Among Older Adults in the Health, Aging, and Body Composition Study

Ronica N. Rooks,1 Eleanor M. Simonsick,2 Toni Miles,3 Anne Newman,4 Stephen B. Kritchevsky,5 Richard Schulz,6 and Tamara Harris1

Objectives. We hypothesized that older Black adults would have a higher prevalence of cardiovascular disease (CVD) than White adults, as indicated by elevated systolic blood pressure (SBP), low ankle-arm blood pressure index (AAI), and left ventricular hypertrophy (LVH). But, accounting for a broad interpretation of socioeconomic status (SES) (i.e., education, family income, home ownership, and other assets) would reduce these differences.

Methods. Data are from the Health, Aging, and Body Composition study, a longitudinal clinical research study of 3,075 well-functioning adults aged 70–79, in which 46% of women and 33% of men are Black. Logistic regression modeled racial and SES differences in CVD indicators.

Results. Being Black was significantly associated with elevated SBP (men only), low AAI, and LVH, and remained significant after accounting for each SES measure. The racial association with CVD was reduced the most by income for elevated SBP in men, other assets for low AAI in women and men, and other assets for LVH in men.

Discussion. Contrary to the age-as-leveler theory, being Black was strongly associated with CVD indicators, and accounting for SES did not reduce this association. Whether other SES measures, such as access to care, could explain the racial association remains to be explored.

Controversy exists over whether racial disparities in health outcomes are reduced in old age. The “leveling” hypothesis is based on the premise that lower socioeconomic status (SES) and increasing health problems in old age are less disruptive for racial and ethnic minorities, who may have struggled with low SES throughout their lives (Pampel, 1998). If this is true, then racial disparities in health outcomes should be diminished in old age because health problems and SES become more equalized across groups. However, life course theory and the political economy perspective suggest that accumulated exposure to inequalities within educational and economic institutions, such as having fewer years of and poorer quality schooling and not owning a home or having other financial assets, results in greater health disparities, particularly for older Black adults with greater exposure to segregated institutions (Dannefer & Uhlenberg, 1999; Quadagno & Reid, 1999). These SES disadvantages may help explain the persistence of racial disparities in cardiovascular disease (CVD) among Black and White adults into old age, observed in several studies (Manolio et al., 1995; Svetkey, George, Burchett, Morgan, & Blazer, 1993; Williams, Massing, Rosamond, Sorlie, & Tyroer, 1999).

Contrary to the leveling hypothesis, racial disparities in CVD among older adults have been found, using a number of indicators at different stages of CVD development and severity. Svetkey and colleagues (1993) found that older Black adults, compared with older White adults, were 30% more likely to have hypertension, after adjusting for sex, age at 65 years and over, education, income, smoking, obesity, health service use, and comorbid diabetes. Manolio and colleagues (1995) found that older Black adults had more subclinical CVD, measured by thicker common carotid arterial walls and lower ankle-arm blood pressure indices (AAIs), than White adults, even after adjusting for age, education, income, behavioral risk factors, and disease prevalence. (Common carotid arterial wall thickness, a noninvasive measure of atherosclerosis, is defined as the diameter of the major arteries in the neck that supply blood to the right and left sides of the head.) Williams and colleagues (1999) found that coronary heart disease mortality rates decreased for both Black and White adults from 1968 to 1992, but de-
clines were lower for Black adults. In addition, the coronary heart disease mortality rate ratios of Black to White men and women increased over time, showing that racial differences were much greater in older men since the early 1980s and women since the late 1960s.

Most studies of CVD, race, and SES have focused on younger populations (Harburg et al., 1973; James, Keenan, Strogatz, Browning, & Garrett, 1992; James, Strogatz, Wing, & Ramsey, 1987; Krieger, 1990; Krieger & Sidney, 1996; Ren, Amick, & Williams, 1999; Wiist & Flack, 1992; Wilson, Williams, Arheart, Bryant, & Alpert, 1994); therefore, little is known as to whether accounting for differences in SES reduces the greater race-related prevalence of CVD found in older Black adults. In addition, the few studies on CVD, race, and SES in older adults (Svetkey et al., 1993; Winkleby, Fortmann, & Barrett, 1990; Young, Waller, & Kahan, 1991) have examined limited SES measures, such as education and income, which provide a narrow understanding of older adults’ economic status (Hurd, 1989). Few studies consider other SES measures that may be more relevant to older age groups, such as housing and other asset accumulation over the life course (Myers & Chung, 1996; Oliver & Shapiro, 1997; Shea, Miles, & Hayward, 1996). Given that racial minorities are more likely to experience poorer well-being in later life, resulting from marginalized economic and social opportunities (Markides, Liang, & Jackson, 1990) and differential patterns of social integration (Beckett & Dungee-Anderson, 1992), it is critically important to take into account broader indicators of SES to better understand the persistence of racial health disparities in older adults.

We examine the prevalence of CVD indicators in a well-functioning population of Black and White men and women, aged 70–79, participating in the Health, Aging, and Body Composition (Health ABC) study. We propose that the increased prevalence of CVD indicators in Black versus White adults can be explained by a more complete assessment of SES (i.e., education, family income, home ownership, and other financial assets), accounting for various stages in the lives of older adults. Three objective indicators based on the severity of CVD are examined, including systolic blood pressure (SBP), AAI, and left ventricular hypertrophy (LVH). This research tests the following hypotheses:

\[ H_1 \quad \text{Older Black adults will have a higher prevalence of elevated SBP, low AAI, and LVH than older White adults.} \]

\[ H_2 \quad \text{Lower SES will be associated with a higher prevalence of elevated SBP, low AAI, and LVH among older adults.} \]

\[ H_3 \quad \text{A higher prevalence of elevated SBP, low AAI, and LVH in older Black versus White adults will be reduced by adjusting for SES.} \]

**Methods**

**Data**

Health ABC is a 7-year, longitudinal cohort study developed and supported by the Laboratory of Epidemiology, Demography, and Biometry of the National Institute on Aging. Health ABC is designed to gain an understanding of the onset of functional limitations, focusing on declines in performance, strength, and endurance, as they are linked to declining health, from a state of vigor to frailty. In particular, the study examines body composition changes, such as age-related muscle loss, in relation to disability and chronic conditions. Participants were identified from a random sample of White Medicare beneficiaries and all age-eligible Black community residents in designated zip code areas surrounding the Memphis, Tennessee, and Pittsburgh, Pennsylvania, field centers.

The study population consists of 3,075 community-dwelling, Black (42%) and White, men and women (52%), between the ages of 70 and 79. This cohort is free of difficulties with activities of daily living and lower-extremity functional limitations. Participants also reported no need to use specialized equipment, such as a cane, walker, or crutches. Freedom from these difficulties defines participants as well-functioning. Baseline data, collected between April 1997 to June 1998, include an in-person interview and a clinic-based examination, with evaluations of body composition, clinical and subclinical diseases, and physical function.

**Measures**

**Cardiovascular disease indicators (dependent variables).**—Cardiovascular diagnoses, based on reports of disease from doctors, may be inaccurate and potentially biased because affected patients may not seek treatment, conditions may be differentially diagnosed on the basis of race or gender, and/or participants may not accurately report diagnoses. To avoid these potential biases, we elected to use objective indicators of CVD. We chose three markers of subclinical risk related to CVD, indicative of increasing severity, including: elevated SBP, an indicator of early-stage CVD risk that is highly prevalent in old age; low AAI, an indicator of one type of CVD known as peripheral arterial disease; and LVH from an electrocardiogram, where the latter two indicators reflect established CVD markers that are indicative of biological disease progression.

Although other measures, such as heart rate and elevated diastolic blood pressure (DBP), are also CVD indicators, heart rate was not examined because it is thought to largely reflect physical activity level rather than CVD; and research suggests that, with increasing age, SBP tends to be a better indicator of CVD risk than DBP (National Heart, Lung, and Blood Institute, 1997). In addition, most people with elevated DBP also have elevated SBP. Within Health ABC, there were only 25 participants who had elevated DBP, but not elevated SBP.

The three CVD indicators we chose reflect different prognostic and structural changes associated with CVD in the body. A diagnosis of elevated SBP is more common than the other conditions (National Heart, Lung, and Blood Institute, 1997), with no visible structural changes to a person’s arteries, and elevated SBP is treatable by diet and exercise, as well as antihypertensive medications. Low AAI and LVH, although less frequent than elevated SBP, have a more severe prognosis and are more difficult to treat. LVH is also one of the major complications of elevated SBP. Visible structural changes exist for low AAI, such as narrowed ar-
teries as a result of atherosclerosis, and LVH, such as thickened ventricular walls, which restrict blood flow to the rest of the body.

Even though elevated SBP, low AAI, and LVH are indicators of cardiovascular disease progression, they do not necessarily represent the same process. In fact, of the 46% of participants with any one of these conditions, 36% had only one, 9% had two (of which 70% had elevated SBP and low AAI), and 1% had all three. Therefore, we did not combine the three outcomes into a single index.

Elevated systolic blood pressure.—SBP is the pressure exerted by blood pumped from the ventricle against the walls of the artery. In this analysis, SBP is an average of the first and second measurements of sitting SBP, using a conventional mercury sphygmomanometer on either arm. Based on recommendations of the American Heart Association, participants with greater than or equal to 140 mm Hg were considered to have elevated SBP. We included all participants in the analysis and created an indicator variable for those who were currently taking antihypertensive medications, including beta- or alpha-adrenergic blockers, central hypertensive medications, angiotensinogen inhibitors, and vasodilating agents, such as calcium channel blockers and diuretics. There were 1,741 people taking antihypertensive medications, including 68% and 50% of Black and White women, as well as 56% and 54% of Black and White men, respectively.

AAI.—AAI is a noninvasive procedure for detecting peripheral arterial disease, a condition in which atherosclerosis obstructs blood flow to the legs. It was measured by a hand-held, 8-MHz Doppler probe placed directly over the artery and a conventional mercury sphygmomanometer on either arm. AAI was defined as the lowest ratio of either the right ankle to the right upper-arm or the left ankle to the right upper-arm artery SBP. Means of the first and second measurements for each leg and arm SBP were used to attain the low-AAI. We used the following classification: 1% had low AAI and normal SBP, 53% had normal to low AAI and normal SBP, 22% had low AAI and low SBP, 24% had normal to low AAI and low SBP, 1% had normal to low AAI and high SBP, 9% had low AAI and high SBP, and 1% had low AAI and very high SBP. We excluded all participants who were currently taking antihypertensive medications, including beta- or alpha-adrenergic blockers, central hypertensive medications, angiotensinogen inhibitors, and vasodilating agents, such as calcium channel blockers and diuretics. There were 1,741 people taking antihypertensive medications, including 68% and 50% of Black and White women, as well as 56% and 54% of Black and White men, respectively.

LVH.—A resting electrocardiogram uses 10 chest and limb electrodes to digitally record electrical conduction in the heart, which directly shows abnormalities of rhythm. Patterns of delayed or accelerated conduction are associated with an underlying structural abnormality of the heart, LVH, meaning enlargement of the left or dominant ventricle of the heart that pumps blood to the periphery of the body, is a measure related to long-standing hypertension, obesity, and coronary artery disease (Benjamin & Levy, 1999; Kannel et al., 1999; Knutsen et al., 1988; Levy, 1988, 1991; Post & Levy, 1994).

Independent variables.—Race was determined by participant self-identification as either Black or White. Race is used as a social, economic, and cultural construct, which often determines social identity and has been linked to access to societal rewards and resources in the United States (Williams, 1997).

We use the following SES measures as proxies for social class. These expanded measures represent SES across various stages of the life course for older adults (Robert & House, 1996; Smith & Kington, 1997). Education represents an early stage in the life course, because people generally complete their education by age 25. However, family income is measured currently, representing a later stage in the life course. Home ownership and ownership of other financial assets, as proxies for wealth, capture financial resources over the greatest part of the life course, from young to middle adulthood and old age.

Education was defined as years of school completed. Participants with less than 12 years of school, including those who did not complete high school or receive their GED, represent the lowest group. Participants with a high school degree, including those who attended vocational or trade school after high school, represent the middle group, whereas those with any college represent the highest group. Data on education were missing for 8 participants.

Given the known difficulty in collecting information about income (Brock, Manton, & Woodbury, 1990; Guralnik, Fried, Simonsick, Bandeen-Roche, & Kasper, 1995), we elected to adapt questions from the Health and Retirement Survey (Moon & Juster, 1995). We used nested income categories that allowed participants to indicate their general range of income and then more specifically, how high or low their income was relative to that range.

Four categories of family income from the year prior to interview were designated: less than $10,000, between $10,000–$25,000, between greater than $25,000 to less than $50,000, and greater than or equal to $50,000. Family income includes wages, salaries, Social Security or retirement benefits, help from relatives, rent from property, and any other source of income. Use of the nested income categories reduced missing data on family income to about 12% of the cohort, or 374 participants. But, to maintain the largest possible sample size, we created a fifth category for the missing cases.

Home ownership was ascertained by asking participants if they or their husbands, wives, or partners owned a house, condo, or apartment and the land immediately surrounding it. Seventy-nine percent of workers aged 60 and over cite home ownership and equity in the home as their most important source of wealth, representing 48% of total household wealth for this age group (Summer, O’Neill, & Shirey, 2000). Data on home ownership were missing for 52 participants.

To minimize nonresponse, Health ABC asked participants for the number of other assets they owned rather than the values of these assets. Although the number of other assets owned is not as good an SES measure as value of assets owned, it reflects the type of access households have to assets over the greatest part of the life course, from young to middle adulthood and old age.

We used the following SES measures as proxies for social class. These expanded measures represent SES across various stages of the life course for older adults (Robert & House, 1996; Smith & Kington, 1997). Education represents an early stage in the life course, because people generally complete their education by age 25. However, family income is measured currently, representing a later stage in the life course. Home ownership and ownership of other financial assets, as proxies for wealth, capture financial resources over the greatest part of the life course, from young to middle adulthood and old age.

Education was defined as years of school completed. Participants with less than 12 years of school, including those who did not complete high school or receive their GED, represent the lowest group. Participants with a high school degree, including those who attended vocational or trade school after high school, represent the middle group, whereas those with any college represent the highest group. Data on education were missing for 8 participants.

Given the known difficulty in collecting information about income (Brock, Manton, & Woodbury, 1990; Guralnik, Fried, Simonsick, Bandeen-Roche, & Kasper, 1995), we elected to adapt questions from the Health and Retirement Survey (Moon & Juster, 1995). We used nested income categories that allowed participants to indicate their general range of income and then more specifically, how high or low their income was relative to that range.

Four categories of family income from the year prior to interview were designated: less than $10,000, between $10,000–$25,000, between greater than $25,000 to less than $50,000, and greater than or equal to $50,000. Family income includes wages, salaries, Social Security or retirement benefits, help from relatives, rent from property, and any other source of income. Use of the nested income categories reduced missing data on family income to about 12% of the cohort, or 374 participants. But, to maintain the largest possible sample size, we created a fifth category for the missing cases.

Home ownership was ascertained by asking participants if they or their husbands, wives, or partners owned a house, condo, or apartment and the land immediately surrounding it. Seventy-nine percent of workers aged 60 and over cite home ownership and equity in the home as their most important source of wealth, representing 48% of total household wealth for this age group (Summer, O’Neill, & Shirey, 2000). Data on home ownership were missing for 52 participants.

To minimize nonresponse, Health ABC asked participants for the number of other assets they owned rather than the values of these assets. Although the number of other assets owned is not as good an SES measure as value of assets owned, it reflects the type of access households have to assets over the greatest part of the life course, from young to middle adulthood and old age.

We use the following SES measures as proxies for social class. These expanded measures represent SES across various stages of the life course for older adults (Robert & House, 1996; Smith & Kington, 1997). Education represents an early stage in the life course, because people generally complete their education by age 25. However, family income is measured currently, representing a later stage in the life course. Home ownership and ownership of other financial assets, as proxies for wealth, capture financial resources over the greatest part of the life course, from young to middle adulthood and old age.

Education was defined as years of school completed. Participants with less than 12 years of school, including those who did not complete high school or receive their GED, represent the lowest group. Participants with a high school degree, including those who attended vocational or trade school after high school, represent the middle group, whereas those with any college represent the highest group. Data on education were missing for 8 participants.

Given the known difficulty in collecting information about income (Brock, Manton, & Woodbury, 1990; Guralnik, Fried, Simonsick, Bandeen-Roche, & Kasper, 1995), we elected to adapt questions from the Health and Retirement Survey (Moon & Juster, 1995). We used nested income categories that allowed participants to indicate their general range of income and then more specifically, how high or low their income was relative to that range.

Four categories of family income from the year prior to interview were designated: less than $10,000, between $10,000–$25,000, between greater than $25,000 to less than $50,000, and greater than or equal to $50,000. Family income includes wages, salaries, Social Security or retirement benefits, help from relatives, rent from property, and any other source of income. Use of the nested income categories reduced missing data on family income to about 12% of the cohort, or 374 participants. But, to maintain the largest possible sample size, we created a fifth category for the missing cases.

Home ownership was ascertained by asking participants if they or their husbands, wives, or partners owned a house, condo, or apartment and the land immediately surrounding it. Seventy-nine percent of workers aged 60 and over cite home ownership and equity in the home as their most important source of wealth, representing 48% of total household wealth for this age group (Summer, O’Neill, & Shirey, 2000). Data on home ownership were missing for 52 participants.
their husbands, wives, or partners owned any of the following: a money market account, certificates of deposit, savings bonds or treasury bills, investment property or housing other than their current residence, a business or farm, stock or stock mutual funds, an IRA or a Keogh account, and other investments. Because about 95% of participants had a checking or savings account, with little variation across the sample, this item was not counted as part of the previous total number of assets. Checking and/or savings accounts were also not considered stable, long-term assets, due to frequent use and monthly balance changes. The following categories were used to divide participants by ownership of other assets: none, one to two, and three to seven. Rather than use a dichotomous variable of any versus no assets, categories were used because the literature has shown that various SES gradients have significant effects on health outcomes (Adler et al., 1994; Smith & Kington, 1997). Data on other assets were missing for 281 participants, or about 9% of the cohort; but, to maintain the largest possible sample size, we created a fourth category for the missing cases.

**Control variables**—Considering the association between positive family social networks, particularly being married, and lower morbidity and mortality (Murray, 2000; Pienta, Hayward, & Jenkins, 2000; Taylor, Repetti, & Seeman, 1997; Wilson, 2001), we controlled for household family size and marital status. In addition, these controls adjusted participants’ family income based on other relatives within their households.

Family size was defined from a summary of questions asking participants to give the number of spouses, parents, siblings, children or children-in-law, grandparents, or other relatives living in their household. Because there were 851 cases who were missing, we cross-referenced family size with a question asking participants how many other people lived in their household besides themselves. Of the previous cases, 849 were coded as having no other people living in participants’ households. The remaining two cases had one other person in each household, but we could not determine whether they were relatives or not. Thus, they were left as missing cases.

Marital status was defined as either being never married, married, widowed, divorced, or separated. We coded marital status into a dichotomous variable, including never or previously married and married.

**Statistical Analysis**

Descriptive and multivariate analyses were used to compare the prevalence of CVD indicators, using SAS for Windows, version 6.12. Bivariate cross-tabulations were calculated for SES and the various CVD indicators across combined racial and sex groups and two sites. Sex-specific logistic regression models were run to obtain odds ratios and 95% confidence intervals for the association between elevated SBP, low AAI, and LVH and the previous predictor variables. Sex-specific analyses were performed because of differences in heart disease prevalence.

We ran 10 models for each outcome by sex, including a model for race only, each SES measure separately without race, each SES measure with race, and a race and combined SES model, each with controls for use of antihypertensive medications, age, site, household family size, and marital status. This approach allowed us to evaluate whether: (a) race was associated with CVD, (b) any SES measures were associated with CVD, (c) certain SES measures were more strongly associated with CVD than others, (d) specific SES measures effectively reduced racial disparities in CVD, and (e) all SES measures combined in a model produced more equal racial outcomes in CVD than any single SES measure.

To ensure the feasibility of running combined models for each outcome, a Pearson correlation analysis was performed between each SES measure. All correlations between each variable were below 17%, except between family income and other assets at 58%. For purposes of brevity, the combined SES models will only be discussed in terms of their influence on the racial association with the CVD indicators.

**RESULTS**

**Descriptive Analysis**

Table 1 shows the distribution of SES by race, sex, and study site. The average age of the sample was about 74 years, with little variation by sex, race, or site. For all SES measures, there were wide disparities by race, with Black adults having lower SES than White adults. Black women were generally at the lowest SES levels, except for education, whereas White men were at the highest SES levels (p < .001). SES differences also existed by site, where participants in Memphis were less educated, had lower family incomes, and owned fewer assets than those in Pittsburgh; however, participants in Memphis were more likely to own their homes (p < .001).

Table 2 shows the distribution of CVD indicators by race, sex, and study site. Black men and women had a higher prevalence of elevated SBP (p < .001 and p = .002, respectively), low AAI (p < .001), and LVH (p < .001), compared with White men and women, despite there being a greater percentage of Black adults on antihypertensive medications (p = .471 for men and p < .001 for women). Pittsburgh residents had a significantly higher prevalence of elevated SBP but a borderline significant, lower prevalence of LVH compared with those in Memphis. There were no site differences in those taking antihypertensive medications or those who had low AAI.

**Multivariate Analysis**

Table 3 shows the association of SES with elevated SBP, low AAI, and LVH by sex, without race included in each model. Education and other assets for women showed an association with elevated SBP and LVH with sex differences, whereas race was generally at the lowest SES levels, except for education. Black women were generally at the highest SES levels, except for education, whereas White men were at the lowest SES levels, except for education. SES differences also existed by site, where participants in Memphis were less educated, had lower family incomes, and owned fewer assets than those in Pittsburgh; however, participants in Memphis were more likely to own their homes (p < .001).

Table 2 shows the distribution of CVD indicators by race, sex, and study site. Black men and women had a higher prevalence of elevated SBP (p < .001 and p = .002, respectively), low AAI (p < .001), and LVH (p < .001), compared with White men and women, despite there being a greater percentage of Black adults on antihypertensive medications (p = .471 for men and p < .001 for women). Pittsburgh residents had a significantly higher prevalence of elevated SBP but a borderline significant, lower prevalence of LVH compared with those in Memphis. There were no site differences in those taking antihypertensive medications or those who had low AAI.

The three sig-
significant SES measures, men with less than $10,000 family income, compared with $50,000 or more, had the highest odds of elevated SBP (Models 1–4).

Lower SES was associated with low AAI for women, such that women with less than 12 years of school, less than $50,000 family income, missing income levels, less than or equal to one to two other assets, or missing asset levels had higher odds of low AAI than women on the higher end of these SES groups. Men with less than 12 years of school, with less than or equal to $25,000 family income, who did not own a home, or who owned no other assets had higher odds of low AAI than men on the higher end of these SES groups. The largest associations were for women with less than $10,000 family income or missing income levels and men with no other assets, who had about four and three times higher odds of low AAI, respectively, than those with $50,000 or more income and three or more assets (Models 1–4).

There were no significant associations between the SES measures and LVH among women. However, men with less than 12 years of school or less than $10,000 family income had greater than two times the odds of having LVH, compared with those who had more than 12 years of school or more than $50,000 family income. Men with no assets had the highest odds of having LVH, almost three and half times that of men with three or more assets (Models 1–4).

Table 1. Distribution of Socioeconomic Status Measures by Race, Sex, and Sitea–c

<table>
<thead>
<tr>
<th>Variables</th>
<th>Women</th>
<th></th>
<th>Men</th>
<th></th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>White</td>
<td>Black</td>
<td>White</td>
<td>Pittsburgh, PA</td>
</tr>
<tr>
<td>n</td>
<td>729</td>
<td>855</td>
<td>552</td>
<td>939</td>
<td>1,527</td>
</tr>
<tr>
<td>Age, mean ± SD, years</td>
<td>73.4 ± 3.0</td>
<td>73.6 ± 2.8</td>
<td>73.5 ± 2.8</td>
<td>73.9 ± 2.9</td>
<td>73.7 ± 2.9</td>
</tr>
<tr>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>25.7</td>
<td>25.9</td>
<td>18.1</td>
<td>30.3</td>
<td>—</td>
</tr>
<tr>
<td>Memphis, TN</td>
<td>21.8</td>
<td>29.7</td>
<td>17.8</td>
<td>30.8</td>
<td>—</td>
</tr>
<tr>
<td>Education, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;12 years</td>
<td>38.5</td>
<td>10.2</td>
<td>50.3</td>
<td>14.1</td>
<td>18.2</td>
</tr>
<tr>
<td>12 years</td>
<td>35.4</td>
<td>42.9</td>
<td>24.1</td>
<td>26.1</td>
<td>37.5</td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>26.1</td>
<td>47.0</td>
<td>25.6</td>
<td>59.8</td>
<td>44.3</td>
</tr>
<tr>
<td>Family income, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$10,000</td>
<td>27.6</td>
<td>6.4</td>
<td>17.2</td>
<td>1.3</td>
<td>9.0</td>
</tr>
<tr>
<td>$10,000–$25,000</td>
<td>42.5</td>
<td>31.0</td>
<td>44.0</td>
<td>24.7</td>
<td>34.9</td>
</tr>
<tr>
<td>&gt;$25,000–$50,000</td>
<td>13.7</td>
<td>32.8</td>
<td>22.6</td>
<td>37.3</td>
<td>28.9</td>
</tr>
<tr>
<td>≥$50,000</td>
<td>1.9</td>
<td>15.1</td>
<td>7.6</td>
<td>26.4</td>
<td>14.3</td>
</tr>
<tr>
<td>Missing (n = 374)</td>
<td>14.3</td>
<td>14.7</td>
<td>8.5</td>
<td>10.3</td>
<td>13.0</td>
</tr>
<tr>
<td>Home ownership, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does not own home</td>
<td>38.3</td>
<td>27.0</td>
<td>25.9</td>
<td>18.8</td>
<td>31.9</td>
</tr>
<tr>
<td>Other assets, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>58.3</td>
<td>12.8</td>
<td>50.7</td>
<td>9.9</td>
<td>25.8</td>
</tr>
<tr>
<td>1–2</td>
<td>22.6</td>
<td>30.9</td>
<td>29.9</td>
<td>29.0</td>
<td>27.6</td>
</tr>
<tr>
<td>3–7</td>
<td>9.5</td>
<td>45.5</td>
<td>12.0</td>
<td>52.9</td>
<td>36.7</td>
</tr>
<tr>
<td>Missing (n = 281)</td>
<td>9.6</td>
<td>10.9</td>
<td>7.4</td>
<td>8.2</td>
<td>9.9</td>
</tr>
</tbody>
</table>

Source: National Institute on Aging; Laboratory of Epidemiology, Demography, and Biometry; Health, Aging, and Body Composition Study, 1997.
aPercentages may not total to 100% because of rounding.
bMissing cases are not shown as values for education (8) and home ownership (52), because the numbers were too small to be analyzed by both race and gender.
cChi-square statistics were significant at $p < .001$, except for racial and sex differences by site ($p = .03$).

Table 2. Distribution of Cardiovascular Disease Indicators by Race, Sex, and Sitea

<table>
<thead>
<tr>
<th>Variables</th>
<th>Women</th>
<th></th>
<th>Men</th>
<th></th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>White</td>
<td>Black</td>
<td>White</td>
<td>Pittsburgh, PA</td>
</tr>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP, mean ± SD, mm Hg</td>
<td>139 ± 23</td>
<td>134 ± 20</td>
<td>139 ± 22</td>
<td>133 ± 20</td>
<td>138 ± 21</td>
</tr>
<tr>
<td>Elevated SBP, &gt;140 mm Hg, %</td>
<td>43.1</td>
<td>35.3</td>
<td>44.0</td>
<td>32.8</td>
<td>43.4</td>
</tr>
<tr>
<td>Taking antihypertensive medications, %</td>
<td>67.9</td>
<td>49.6</td>
<td>56.3</td>
<td>54.4</td>
<td>56.4</td>
</tr>
<tr>
<td>AAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAI, mean ± SD</td>
<td>1.0 ± 0.2</td>
<td>1.1 ± 0.2</td>
<td>1.0 ± 0.2</td>
<td>1.1 ± 0.2</td>
<td>1.0 ± 0.2</td>
</tr>
<tr>
<td>Low AAI, ≤0.9, %</td>
<td>21.0</td>
<td>9.0</td>
<td>21.4</td>
<td>10.1</td>
<td>14.5</td>
</tr>
<tr>
<td>LVH, %</td>
<td>9.2</td>
<td>2.5</td>
<td>9.0</td>
<td>3.2</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Note: SBP = systolic blood pressure; AAI = ankle-arm blood pressure index; LVH = left ventricular hypertrophy.
Source: National Institute on Aging; Laboratory of Epidemiology, Demography, and Biometry; Health, Aging, and Body Composition Study, 1997.
Chi-square statistics were significant at $p < .001$, except for racial differences in SBP for women ($p = .002$), racial differences in antihypertensive medications for men ($p = .796$), low AAI ($p = .642$), and LVH ($p = .56$).
Table 3. The Association of Socioeconomic Status with Elevated Systolic Blood Pressure (SBP), Low Ankle-Arm Index (AAI), and Left Ventricular Hypertrophy (LVH) by Sex, Odds Ratios (95% Confidence Intervals)

<table>
<thead>
<tr>
<th>Models</th>
<th>Elevated SBP</th>
<th>Low AAI</th>
<th>LVH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>1: Education&lt;sup&gt;a&lt;/sup&gt;</td>
<td>&lt;12 years</td>
<td>1.43* (1.08, 1.89)</td>
<td>1.50** (1.16, 1.95)</td>
</tr>
<tr>
<td></td>
<td>12 years</td>
<td>1.18 (0.93, 1.50)</td>
<td>1.13 (0.87, 1.47)</td>
</tr>
<tr>
<td>2: Family income&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;$10,000</td>
<td>1.32 (0.83, 2.10)</td>
<td>2.12** (1.31, 3.44)</td>
</tr>
<tr>
<td></td>
<td>$10,000–$25,000</td>
<td>1.05 (0.70, 1.58)</td>
<td>1.86*** (1.34, 2.57)</td>
</tr>
<tr>
<td></td>
<td>&gt;$25,000–&lt;350,000</td>
<td>0.97 (0.64, 1.46)</td>
<td>1.41* (1.03, 1.94)</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1.08 (0.69, 1.69)</td>
<td>1.45 (0.95, 2.23)</td>
</tr>
<tr>
<td>3: Does not own a home&lt;sup&gt;c&lt;/sup&gt;</td>
<td>None</td>
<td>1.04 (0.82, 1.30)</td>
<td>0.77 (0.59, 1.01)</td>
</tr>
<tr>
<td></td>
<td>1–2</td>
<td>1.14 (0.86, 1.52)</td>
<td>1.18 (0.91, 1.54)</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1.73** (1.19, 2.51)</td>
<td>1.17 (0.77, 1.77)</td>
</tr>
</tbody>
</table>

Note: All models were adjusted for antihypertensive medications, age, site, household family size, and marital status.

Source: National Institute on Aging; Laboratory of Epidemiology, Demography, and Biometry; Health, Aging, and Body Composition Study, 1997.

*p ≤ .05; **p ≤ .01; ***p ≤ .001.

<sup>a</sup>The comparison group was owning a home.
<sup>b</sup>The comparison group was greater than or equal to $50,000 family income.
<sup>c</sup>The comparison group was a home.
<sup>d</sup>The comparison group was owning a home.

Table 4 shows the association of race with elevated SBP, low AAI, and LVH by sex, with each SES measure included in the models. After adjustments for antihypertensive medications, age, site, household family size, and marital status, Black men had 70% higher odds of elevated SBP than White men. However, race was only borderline significant in women (Model 1). When race and each or all SES measures were included in this analysis, there were no racial differences in elevated SBP between Black and White women, except the borderline significance of race with family ownership. Unlike women, the racial effect on elevated SBP for men was more important than the SES effect. None of the SES measures, including all of the SES measures combined, markedly reduced the odds ratios associated with race (Models 2–6).

Black women and men had about two and half times higher odds of low AAI than White women and men, with slightly greater racial disparities among women than men (Model 1). In both women and men, when race and each or all SES measures were controlled, the racial association remained significant and mostly unchanged for low AAI. For women, adjusting for other assets and family income reduced the racial effect slightly. For men, other assets reduced the racial effect the most, such that Black men had 78% higher odds of low AAI than White men (Models 2–6).

Black women and men had more than three times higher odds of LVH than White women and men, with greater racial disparities among women than men (Model 1). In both women and men, controlling for race and each or all SES measures did not reduce the association of race on LVH. For women, no measure reduced the racial effect on LVH, and controlling for SES modestly increased its effect. For men, whereas other assets reduced the racial effect on LVH more than the other SES measures, it did not markedly reduce the greater odds of Black men having LVH, compared with White men (Models 2–6). Overall, comparisons by sex...
show greater racial differences in elevated SBP among men, but there were greater racial differences in low AAI and LVH among women.

Table 5 shows the association of SES with elevated SBP, low AAI, and LVH by sex, with race included in each model. After controlling for race, education, and assets for women and family income for men were the only remaining SES associations with elevated SBP. The remaining SES associations with low AAI were family income for women, and education, home ownership, and other assets for men. Although other assets were significantly associated with LVH after considering race for women, SES was not important for men (Models 1–4).

To ensure that we handled the number of missing cases for the SES measures in the best way possible, we also conducted a sensitivity analysis (data not shown). We imputed missing data for family income, home ownership, and other assets with mean substitutions based on race, gender, and site. Our imputed results varied slightly, with similar trends by race and sex in Tables 1 and 2, and generally larger odds ratios in Tables 3 through 5.

To address the possibility that the association between the CVD indicators, race, family income, home ownership, and other assets may be driven by the lower educational attainment of some participants, we reran four models showing associations among race and each SES measure with elevated SBP by sex, holding education constant at greater than 12 years (data not shown). Results for Black and White women did not show either a racial or SES difference in elevated SBP. However, a significant racial effect remained for Black men when controlling for each of the SES measures in separate models. Better-educated Black men had between 63 to 69% higher odds of elevated SBP than White men, across each SES measure. Moreover, our results show that Black men, and even better-educated Black men, were possibly undertreated for elevated SBP because those treated with antihypertensive medications had higher SBP than those without treatment, regardless of SES controls.

We also examined interactions of race with education, family income, home ownership, and other assets, in four separate models, for each CVD indicator by sex, as well as separate models for each CVD indicator with interactions between race and site by sex (data not shown). No interactions were significant in women. Only two interactions were significant for men, including being Black and living in Memphis associated with elevated SBP and being Black and having a family income of less than $10,000 with low AAI, but these involved minor differences in the pattern of the relationships by race.

### DISCUSSION

Previous research has explored the relationships among race, SES, and health in younger populations. However, few of these studies focused on older adults (Weinrich, Weinrich, Keil, Gazes, & Potter, 1988) and CVD, the leading cause of death for people aged 65 and older (National Center for Health Statistics, 1999). Contrary to the age-as-leveler theory, and supporting our first hypothesis, results showed older Black adults had a higher prevalence of CVD as indicated by elevated SBP, low AAI, and LVH than older White adults. Women with elevated SBP were the exception, where there were no racial differences associated with elevated SBP in either the entire cohort or the restricted sample of better-educated women. This may reflect gender differences in hypertension treatment, which tends to be higher in women (Shea, Cook, Kannel, & Goldman, 1985).

Results for SES were less consistent than race, providing only partial support for our second hypothesis. When SES

### Table 5. Socioeconomic Status Effects in the Association of Race and Socioeconomic Status with Elevated Systolic Blood Pressure (SBP), Low Ankle-Arm Index (AAI), and Left Ventricular Hypertrophy (LVH) by Sex, Odds Ratios (95% Confidence Intervals)

<table>
<thead>
<tr>
<th>Models</th>
<th>Elevated SBP</th>
<th>Low AAI</th>
<th>LVH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>1: Education&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;12 years</td>
<td>1.36* (1.01, 1.83)</td>
<td>1.23 (0.93, 1.63)</td>
<td>1.12 (0.74, 1.70)</td>
</tr>
<tr>
<td>12 years</td>
<td>1.17 (0.92, 1.49)</td>
<td>1.06 (0.81, 1.38)</td>
<td>1.29 (0.91, 1.83)</td>
</tr>
<tr>
<td>2: Family income&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$10,000&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.21 (0.75, 1.95)</td>
<td>1.58 (0.95, 2.63)</td>
<td>2.51 (0.98, 6.41)</td>
</tr>
<tr>
<td>$10,000–$25,000</td>
<td>1.00 (0.66, 1.51)</td>
<td>1.61** (1.15, 2.26)</td>
<td>2.36 (0.98, 5.71)</td>
</tr>
<tr>
<td>&gt;$25,000&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.95 (0.63, 1.43)</td>
<td>1.35 (0.98, 1.86)</td>
<td>2.54* (1.05, 6.16)</td>
</tr>
<tr>
<td>&gt;$50,000</td>
<td>1.03 (0.66, 1.62)</td>
<td>1.36 (0.89, 2.10)</td>
<td>3.07* (1.23, 7.67)</td>
</tr>
<tr>
<td>3: Does not own a home&lt;sup&gt;e&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>1.02 (0.81, 1.29)</td>
<td>0.74* (0.56, 0.98)</td>
<td>1.17 (0.85, 1.62)</td>
</tr>
<tr>
<td>1–2</td>
<td>1.11 (0.81, 1.53)</td>
<td>1.20 (0.87, 1.67)</td>
<td>1.52 (0.95, 2.45)</td>
</tr>
<tr>
<td>Missing</td>
<td>1.66** (1.14, 2.42)</td>
<td>1.05 (0.80, 1.38)</td>
<td>1.49 (0.95, 2.34)</td>
</tr>
</tbody>
</table>

<sup>a</sup>The comparison group was greater than 12 years of education.
<sup>b</sup>The comparison group was greater than or equal to $50,000 family income.
<sup>c</sup>The comparison group was owning a home.
<sup>d</sup>The comparison group was greater than or equal to three other assets.
<sup>e</sup>The comparison group was greater than 12 years of education.

Note: All models were adjusted for antihypertensive medications, age, site, household family size, and marital status.

Source: National Institute on Aging; Laboratory of Epidemiology, Demography, and Biometry; Health, Aging, and Body Composition Study, 1997.

*<i>p</i> < .05; **<i>p</i> < .01; ***<i>p</i> < .001.
was examined without race, lower family income had the strongest association with the CVD indicators for women, whereas home ownership had the weakest. However, for men, owning few other assets had the strongest association with the CVD indicators, whereas home ownership had the weakest.

When we controlled for race and SES, the most striking finding was the consistent association between race and all CVD indicators. For both women and men, race was still significantly associated with elevated SBP (men only), low AAI, and LVH. In addition, regardless of SES controls, racial differences increased with decreased prevalence (but increased severity) of the CVD indicators in both sexes. Although the racial associations remained similar to earlier models without SES, they were reduced the most by family income for elevated SBP in men, by other assets for low AAI in women and men, and by other assets for LVH in men. No SES measures, either separately or in the combined model, reduced the racial association for LVH in women. Therefore, our third hypothesis was partially supported by slight reductions in the racial associations with elevated SBP in men, low AAI in women and men, and LVH in men, but it was not supported for elevated SBP and LVH in women. Overall, no SES measure totally explained racial differences in any CVD indicator.

The literature shows a consistent, inverse relationship between SES and CVD (Kaplan & Keil, 1993). This trend was apparent in older adults, even after adjustments for sex and time of survey (Winkleby et al., 1990). However, Svetkey and colleagues (1993) found that interactions between race and SES produced some variation in this inverse relationship, where fewer years of education among White women and Black men, in contrast to higher education among Black women, was associated with increased hypertension prevalence in older adults. In addition, lower income among Black women, but higher income among White men, was also associated with increased hypertension prevalence. Similarly, Young and colleagues (1991) found that, among older myocardial infarction patients, Black adults with less than or equal to 9 years of formal education were less likely to recover and receive preventive medical care, and more likely to die from this event than White patients with greater than or equal to 10 years of education. Although lower-educated Black patients had the worst cardiovascular outcomes, they were followed by higher educated Black and then lower educated White patients.

This study contributes to the literature in gerontology by examining a large and unique cohort of approximately equal numbers of older Black and White adults at similar ages. We focused on a more holistic view of health in old age by combining social environment and biomedical measures. We also focused on cumulative measures of SES over the life course, using several objective subclinical CVD indicators as outcomes. Moreover, unlike previous research, we were able to test the “age-as-leveler” hypothesis on a well-functioning cohort of adults and use a more complete definition of SES. From this healthy cohort, we find that race alone seems to have life-long disadvantages, in that it is a consistent, powerful predictor of negative health outcomes; however, SES does not seem to have this same disadvantage.

We find it possible that, instead of SES potentially reducing racial disparities in the CVD indicators at one point in time, it may play a role in older adults’ health deterioration over time. In particular, limited wealth, health insurance, and access to care, which could lead to underdiagnosis and undertreatment, may advance development of the CVD indicators and thus make a greater contribution longitudinally.

A second possible explanation as to why SES did not reduce the racial association to a greater extent in this study could be the cross-sectional nature of baseline Health ABC data. Outcomes were difficult to assess in this analysis because we were unable to determine whether they were the cause or effect of the predictor variables. In other words, SES and/or racial differences may contribute to CVD problems at different points in time, or CVD problems may magnify any existing SES and/or racial differences. Thus, the possibility exists that instead of trying to reduce the racial effect in the CVD indicators by controlling for SES over time, we should try to reduce the SES effects in the CVD indicators by controlling for race.

A third explanation may be due to limitations posed by large amounts of missing SES data. However, using imputed data for missing cases in family income, other assets, and home ownership in our sensitivity analysis did not alter existing trends in the results. Even though separate categories were created for the missing cases in family income and other assets, we were unable to examine realistic distributions on these variables because the missing cases may represent various gradients of family income and asset ownership.

By comparison, in the Duke Established Populations for Epidemiologic Studies of the Elderly, 20.0% of the sample was missing on annual personal income (Brock et al., 1990), and in the Women’s Health and Aging Study, 20.0% was missing on annual household income (Guralnik et al., 1995). In addition, asking about the value of assets owned was also difficult in studies specifically focusing on wealth, such as the Health and Retirement Survey, resulting in a range of 4.3%–38.7% missing data for conditional nonresponses on the value of a number of assets (Smith, 1995).

A fourth explanation may be that SES had less influence on CVD indicator risk in an older, well-functioning cohort, where those who were sicker and possibly poorer were ineligible in this study. Therefore, it is likely that our results underestimate the significance of the association between race and the CVD indicators, and the strength of SES to reduce racial disparities in this relationship. However, even in this well-functioning cohort, there were meaningful differences in CVD indicator risk, as shown in Table 2.

A final explanation as to why SES did not reduce the racial association to a greater extent could be the lack of occupation data. Occupation is a less commonly used SES measure in biomedical research, but it could be a better measure of long-term economic status than current family income, particularly in research on older adults (Smith & Kington, 1997). Perhaps other variables used in the literature to predict health outcomes, such as asset value, net wealth, access to care, current work status, type of health insurance, and income adequacy, might be better SES proxies for older adults (Hurd, 1989). Some of these variables were not available in Health ABC, but others will be explored in future research.
The results of this study reflect greater racial differences with each more serious CVD indicator. Whether common (i.e., family income and education) or more encompassing (i.e., home ownership and other financial assets) SES measures were used as predictors, these variables did little to reduce the association of race with elevated SBP, low AAI, and LVH. Even after considering antihypertensive medications, racial differences across CVD indicators remained. Furthermore, for elevated SBP, the outcome for which we had sufficient power, racial differences persisted even among a higher educated sample, with adjustments for the other SES measures. In conclusion, this study rejected the age-as-leveler theory, because distributions of education, family income, home ownership, and other assets were not similar across racial and gender groups and racial differences in most of the CVD indicators still exist in old age.

ACKNOWLEDGMENTS

This work was supported by the National Institute on Aging contracts (N01-AG-6-2106; N01-AG-6-2102; and N01-AG-6-2103) and by a grant from the American Aging Research Training Network (NIA AG-98-002) at the Michigan Center for Urban African American Aging Research.

Address correspondence to Ronica N. Rooks, University of Michigan, Institute for Social Research, Social Environment and Health, 426 Thompson Street, Room 2211, Ann Arbor, MI 48106. E-mail: rrooks@umich.edu

REFERENCES


Smith, J. F., & Kington, R. S. (1997). Race, socioeconomic status, and


Received February 27, 2001
Accepted August 8, 2001
Decision Editor: Fredric D. Wolinsky, PhD