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

Socioeconomic position and CVD mortality

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. 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. 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 (≥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. 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. With most hot-deck procedures, missing values are replaced by values from similar responding units in the sample.

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 (atherosclerosis). 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 code by the population at risk in that ZIP code. Mortality rates were calculated using the age-standardized method of direct standardization. We calculated rates for age groups, race-sex, and education-poverty stratum by the esti-
estimated 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) is preferred to the subject-specific approach of hierarchical linear models such as HLM or SAS MIXED. 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. Test hypotheses were considered supported if interactions of race with economic variables and with CVD mortality were observed.

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-
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Table 2. Demographic Characteristics of the Sample

<table>
<thead>
<tr>
<th></th>
<th>Whites</th>
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<tbody>
<tr>
<td></td>
<td>Deaths (%)</td>
<td>%</td>
<td>Deaths</td>
<td>%</td>
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<td>%</td>
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</tr>
<tr>
<td>Total</td>
<td>46111</td>
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<td>858</td>
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<td>46969</td>
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<td>4994</td>
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<tr>
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<td>21182</td>
<td>45.90%</td>
<td>443</td>
<td>51.63%</td>
<td>25339</td>
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<tr>
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<td>24929</td>
<td>54.10%</td>
<td>415</td>
<td>48.37%</td>
<td>21586</td>
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<td>Neighborhood poverty*</td>
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<tr>
<td>&lt;20%</td>
<td>40895</td>
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<td>420</td>
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<td>5636</td>
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<td>≤HS</td>
<td>33084</td>
<td>71.75%</td>
<td>634</td>
<td>73.89%</td>
<td>33718</td>
<td>71.79%</td>
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<tr>
<td>&gt;HS</td>
<td>13027</td>
<td>28.25%</td>
<td>224</td>
<td>26.11%</td>
<td>13251</td>
<td>28.21%</td>
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</table>

* 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 = .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.

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...
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. 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. 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.

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. 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.

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

<table>
<thead>
<tr>
<th>Sex</th>
<th>Race</th>
<th>Deaths</th>
<th>Unadjusted Rate*</th>
<th>Percentage Below Poverty Level†</th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;20% Deaths</td>
<td>≥20% Deaths</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;20% Deaths</td>
<td>≥20% Deaths</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Blacks</td>
<td>268</td>
<td>1580.3</td>
<td>1283.2</td>
<td>139</td>
<td>2477.8</td>
</tr>
<tr>
<td></td>
<td>Whites</td>
<td>17590</td>
<td>1543.6</td>
<td>1595.3</td>
<td>15848</td>
<td>1840.6</td>
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<tr>
<td>Black-White Rate Ratio</td>
<td></td>
<td>1.02 (0.76–1.37)</td>
<td>0.80 (0.63–1.03)</td>
<td>1.35† (1.03–1.76)‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Blacks</td>
<td>316</td>
<td>1122.3</td>
<td>948.0</td>
<td>157</td>
<td>1456.7</td>
</tr>
<tr>
<td></td>
<td>Whites</td>
<td>23527</td>
<td>1267.9</td>
<td>1212.7</td>
<td>20553</td>
<td>1463.1</td>
</tr>
<tr>
<td>Black-White Rate Ratio</td>
<td></td>
<td>0.89 (0.70–1.11)</td>
<td>0.78 (0.57–1.08)</td>
<td>1.0 (0.72–1.37)</td>
<td></td>
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</tr>
</tbody>
</table>

* 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.

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.

Second, neighborhood poverty was assessed at the ZIP code level, because of the number of incomplete addresses. Studies have shown that smaller geographica...
REFERENCES

47. Dressler WW. Education, lifestyle, andarte-


**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