

# GEOGRAPHIC DISPARITIES IN HEART DISEASE AND STROKE MORTALITY AMONG BLACK AND WHITE POPULATIONS IN THE APPALACHIAN REGION

In this paper, we examine geographic and racial/ethnic differences in heart disease and stroke mortality in the Appalachian region. Initial comparisons are made between national rates for heart disease and stroke mortality and those for the Appalachian region. County-level analyses were performed to examine the relative mortality experience of populations in Appalachian counties compared to other counties in the United States and to assess the degree of geographic disparity in mortality from heart disease and stroke among these race/ethnic and gender groups within Appalachia. The Appalachian region exhibits higher rates of both heart disease and stroke mortality for all race/ethnic, gender, and age groups examined. We found that many counties in the Appalachian region endure a considerable burden of the national excess in both heart disease and stroke mortality, and these counties tend to be aggregated in particular areas as opposed to being dispersed regionwide. Finally, we compare 2 groups of counties in Appalachia based on the designation as an "economically distressed county," defined by the Appalachian Regional Commission. As a group, distressed counties in Appalachia exhibit higher rates of both heart disease and stroke mortality than the rest of Appalachia. (*Ethn Dis.* 2002;12[suppl3]:S3-82-S3-91)

**Key Words:** Appalachia, Heart Disease, Stroke, Geographic Disparities, Racial/Ethnic Disparities

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## INTRODUCTION

The Appalachian region was defined as a political entity by the Appalachian Regional Development Act of 1965, which created the Appalachian Regional Commission.<sup>1</sup> Over the years the region has grown and now includes 406 counties in 13 states in the eastern United States (New York, Pennsylvania, Ohio, West Virginia, Maryland, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, and Mississippi). Physiographically, the most dominant feature of the region is the Appalachian mountain chain, which extends from Maine to Alabama. The relatively rugged terrain in many areas within Appalachia contributes to the rural, under-developed nature of much of the region. Appalachia is commonly recognized as a highly rural, under-developed, and impoverished region and, in fact, has lagged behind the rest of the nation on a number of significant indicators.<sup>2,3</sup> However the region is not homogeneous with respect to socioeconomic condition or rurality. While many counties in Appalachia have had significantly lower levels of educational attainment, lower per capita incomes, higher rates of poverty, and reduced access to medical care resources compared to counties outside the region, there are also significant social and economic differences within Appalachia. These differences are evident in the diversity of economic bases among rural communities within Appalachia and among metropolitan areas in the region that typically have more diversified economies, higher per capita incomes, and greater access to medical care than non-metropolitan areas in the region.<sup>2-4</sup>

Since the inception of the Appalachian Regional Commission, many economic and health infrastructure improvements have been made in the region. Despite these improvements, the Appalachian region still has low regional incomes, low levels of urbanization, education deficits, and generally lower standards of living than the nation as a whole.<sup>3</sup> We focused this analysis on the Appalachian region because of its particular vulnerability to chronic diseases that has resulted from a history of economic under-development, high rates of poverty and unemployment, low educational attainment, and reduced access to medical care resources and health insurance. Personal and community incomes can determine, to a large extent, the availability and quality of food, housing, medical care, and other necessities that contribute to health and well-being.<sup>5</sup> The inverse relationship between socioeconomic status and risk of disease has been an enduring observation in public health.<sup>5</sup> Social class, socioeconomic status (SES), real income and income inequality, occupational structure, unemployment, and others, have been directly associated with chronic disease morbidity and mortality.<sup>6-9</sup> In addition, poor socioeconomic conditions limit the effectiveness of traditional public health programs to improve population health at the local level.

Understanding racial/ethnic disparities is important because a history of segregation and discriminatory practices has decreased socioeconomic opportunities for many population subgroups in this country, particularly Blacks. Consequently, some population subgroups are less able to benefit from improvements in public health awareness and

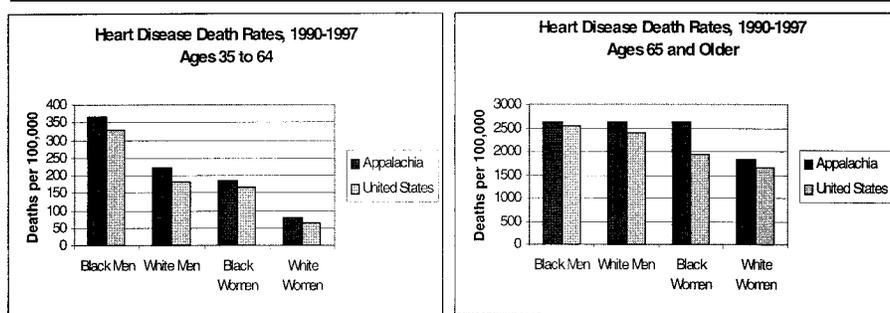


Fig 1. Race/ethnicity and gender-specific heart disease deaths rates, 1990–1997, for Appalachia and the United States, ages 35 to 64 and 65 and older

healthcare delivery, and are more vulnerable to poor health outcomes. In areas such as Appalachia, which already suffer from poor socioeconomic conditions, racial/ethnic disparities may be more pronounced.

We focused analyses on mortality from cardiovascular diseases because they represent the leading causes of death in the United States. For this analysis, we have separated cardiovascular disease into 2 major components, heart disease and stroke, which represent respectively the first and third leading causes of death in the United States.<sup>10</sup>

We identified several specific goals for this analysis: 1) to compare the mortality experience of the Appalachian region with the United States as a whole; 2) to examine the level of heart disease and stroke mortality disparity within Appalachia; 3) to identify specific areas within the Appalachian region with

high and low rates of mortality; and 4) to examine the relationship between mortality and economically “distressed” counties in Appalachia.

Understanding geographic disparities in health (how and why places differ in health outcomes) provides important insights into the social conditions, structures, and mechanisms that influence disease outcomes. We believe these analyses will help to inform and guide the Appalachian Regional Commission, and other public and private agencies within the region, in their efforts to reduce geographic and racial/ethnic disparities in health outcomes and improve the overall health of the region.

## METHODS

### Mortality Data

Death certificate data for the years 1990–1997 were obtained through the

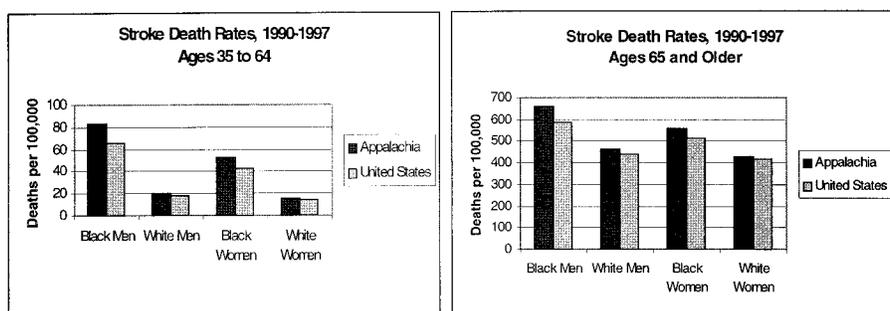


Fig 2. Race/ethnicity and gender-specific stroke deaths rates, 1990–1997, for Appalachia and the United States, ages 35 to 64 and 65 and older

Table 1. Rate ratios for heart disease death rates, 1990–1997, between Appalachia and the United States

	Appalachia/ United States— Rate Ratios	
	Ages 35 to 64	Ages 65 and Older
Black men	1.1	1.0
White men	1.2	1.1
Black women	1.1	1.4
White women	1.3	1.1

National Vital Statistics System maintained by the National Center for Health Statistics. Deaths from heart disease were defined as those deaths for which the underlying cause listed on the death certificate was coded as: 390–398, 402, 404–429, according to the International Classification of Diseases (9th revision). These codes comprise the category *diseases of the heart* as defined by the National Center for Health Statistics. Deaths from stroke were defined as those deaths for which the underlying cause listed on the death certificate was coded as: 430–438, according to the International Classification of Diseases (9th revision). For each decedent, underlying cause of death, age, race, gender, and county of residence at the time of death were abstracted from computerized death certificate files. These death counts were used as the numerators for calculating mortality rates.

Population count data for all counties in the United States, used as de-

Table 2. Rate ratios for stroke death rates, 1990–1997, between Appalachia and the United States

	Appalachia/ United States— Rate Ratios	
	Ages 35 to 64	Ages 65 and Older
Black men	1.3	1.1
White men	1.2	1.0
Black women	1.2	1.1
White women	1.1	1.0

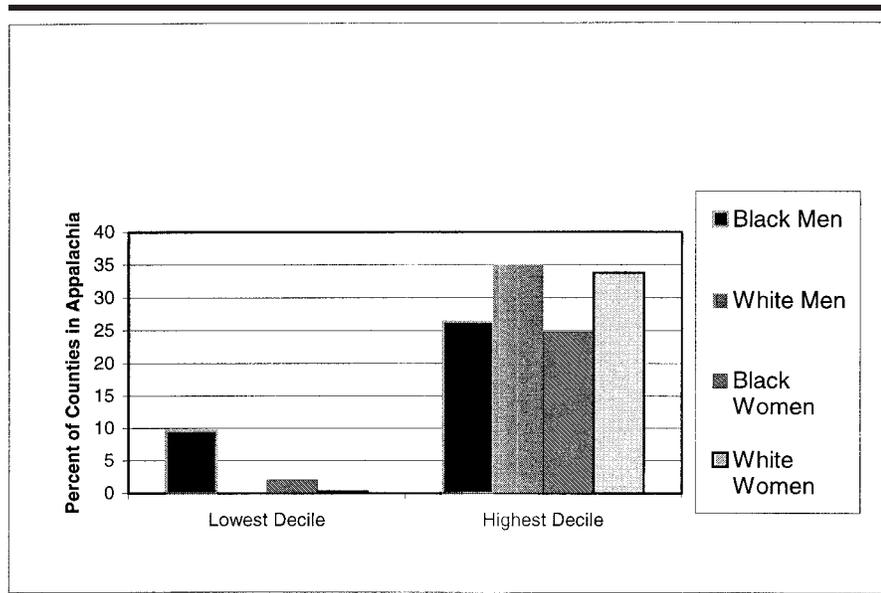


Fig 3. Percentage of Appalachian counties in the lowest and highest decile of the national distribution of heart disease death rates, 1990-1997; ages 35 to 64

nominators in mortality rate calculations, were obtained from the Bureau of the Census for the years 1990-1997. These age, race, ethnicity, and gender-specific estimates between censuses were calculated by the Bureau of the Census through extrapolation of linear trends in

population growth and inter-county migration patterns.

#### Calculation of Death Rates

Two types of death rates were calculated for heart disease and stroke in this study. Age-adjusted rates of heart

disease and stroke mortality were calculated for the Appalachian region and the United States as a whole, based on the combined deaths and population counts in each region for 8 population subgroups that resided in the United States during the period 1990-1997: White men aged 35 to 64; White men aged 65 and older; White women aged 35 to 64; White women aged 65 and older; Black men aged 35 to 64; Black men aged 65 and older; Black women aged 35 to 64; and Black women aged 65 and older. Death rates for both heart disease and stroke were standardized using the direct method of standardization, with the 2000 US population as the standard. Direct comparisons were made between the level of the death rates between race/ethnic and gender groups both within and between Appalachia and the United States. Rate ratios were computed to assess the relative difference in death rates in each population subgroup.

County-level, age-adjusted heart disease and stroke death rates were spatially "smoothed" based on a spatial moving average. Spatial smoothing is used in this analysis to reduce the statistical variability of county death rates and to compensate for sparse populations and small numbers of deaths for some population subgroups in certain parts of the country. Spatial smoothing involves calculating the spatial moving averages of county rates. Using this method, a smoothed rate for a single county represents an average of the heart disease mortality experience of that county and all of its neighboring counties.

Specifically, annual deaths (numerators) and population counts (denominators) for 10-year age groups (35-44 years old, 45-54, 55-64, 65-74, 75-84 and 85 years and older) were summed for each county for the 8-year study period 1990-1997. County numerators and denominators were then each summed with the numerators (death counts) and denominators (population counts) for all neighboring counties.

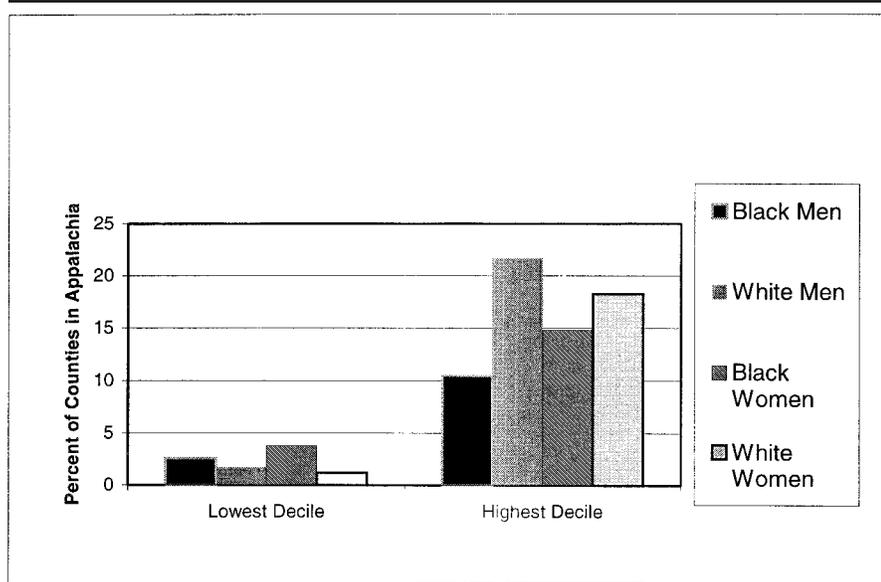


Fig 4. Percentage of Appalachian counties in the lowest and highest decile of the national distribution of stroke death rates, 1990-1997; ages 35 to 64

**Table 3. Black/White differences in heart disease death rates, 1990–1997, for Appalachia and the United States**

	Black/White Disparities			
	Appalachia		United States	
	Rate Ratio	Rate Difference	Rate Ratio	Rate Difference
Ages 35 to 64				
Black/White men	1.6	142.1	1.8	150.5
Black/White women	2.3	107.5	2.6	102.2
Ages 65 and Older				
Black/White men	.9	-8.4	1.1	147.4
Black/White women	1.4	802.0	1.2	295.2

Neighboring counties were defined solely based on contiguity (as opposed to distance). This process produced spatially smoothed, age-specific (by 10-year age group) death rates for both heart disease and stroke for Black and White men and women in two age groups: 35 to 64 and 65 and older.

Two important constraints were applied to the calculation of smoothed county-level death rates. A death rate was not calculated for any county where the total number of deaths in that county plus its neighbors was fewer than 20 during 1990–1997. To avoid calculating rates for counties that had no popula-

tion of a particular subgroup, but whose neighbors had significant populations, rates were calculated only for counties that had a population count of 5 or greater for 1990–1997 (ie, had 8 or more person-years). Counties, which did not meet both of these criteria for rate calculation, were designated as *insufficient data*.

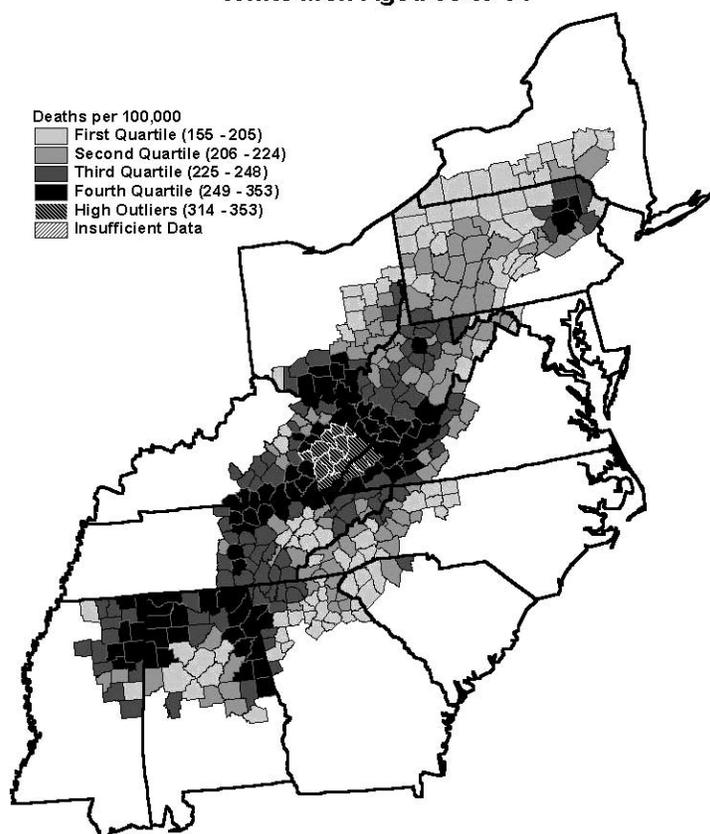
To enable a comparison of the regional mortality experiences between Appalachian and other US counties, the national distributions of heart disease and stroke death rates were divided into deciles. Within each decile, the total number of Appalachian vs non-Appalachian counties were calculated. This allowed us to assess the relative position of high-rate and low-rate counties in Appalachia with respect to other US counties.

To analyze the distribution of heart disease and stroke death rates within Appalachia, smoothed county-level death rate distributions were divided into quartiles and mapped. Within each distribution, we identified both *low outliers* and *high outliers*. Outliers are counties that had statistically unusually low or high death rates relative to the majority of counties. Low outliers were identified as counties with death rates lower than the 25th percentile minus 1.5 times the interquartile range (25th–75th percentile) and high outliers were identified as counties with death rates higher than the 75th percentile plus 1.5 times the interquartile range. The distributions for all population subgroups for both heart disease and stroke were mapped and analyzed. The identification of outliers allows a quick visual assessment of the counties in Appalachia most likely to contribute to the excess in mortality indicated by the national distribution of death rates.

### Distressed County Designations

The Appalachia Regional Commission (ARC), began a “distressed county” program in 1983 to provide funds for the region’s poorest counties.<sup>11</sup> The

**Smoothed Heart Disease Death Rates, 1990–1997  
White Men Aged 35 to 64**



**Fig 5. Smoothed heart disease death rates, 1990–1997-White men aged 35 to 64**

**Table 4. Black/White differences in stroke death rates, 1990–1997, for Appalachia and the United States**

	Black/White Disparities			
	Appalachia		United States	
	Rate Ratio	Rate Difference	Rate Ratio	Rate Difference
Ages 35 to 64				
Black/White men	4.1	63.0	3.7	47.3
Black/White women	3.4	36.0	3.0	28.6
Ages 65 and Older				
Black/White men	1.4	198.0	1.3	146.9
Black/White women	1.3	127.5	1.2	97.3

ARC defines distressed counties as those identified as having a 3-year average unemployment rate that is at least 1.5 times (150%) the US average *and* have a per capita market income that is less than two-thirds (67%) of the US average and have a poverty rate that is at least 1.5 times (150%) of the US aver-

age. The distressed county program originally focused on providing public facilities infrastructure, such as clean water systems and waste disposal, as well as human resource projects such as literacy training. Today the distressed county program has a much broader focus, which includes economic develop-

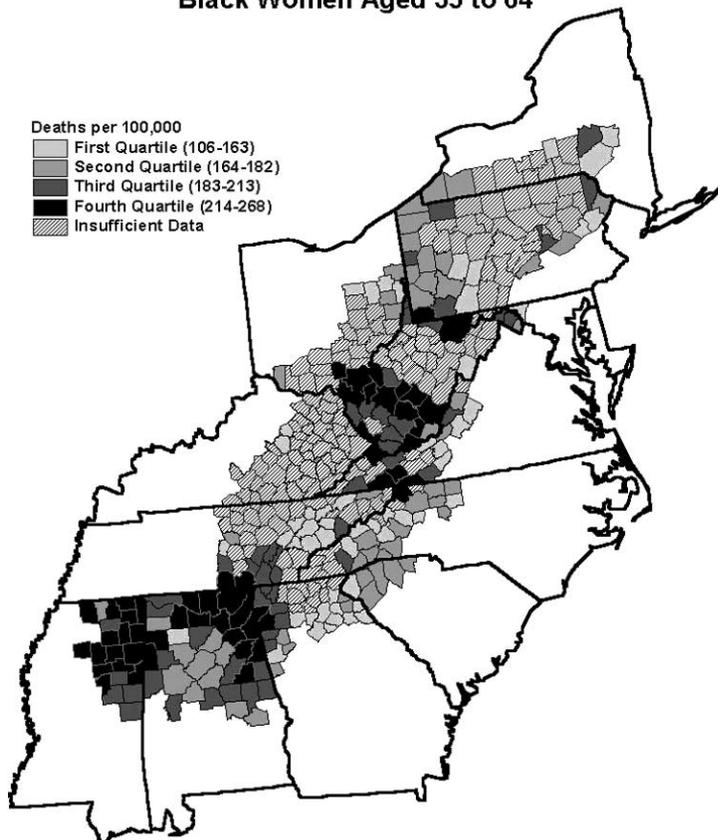
ment, improving access and infrastructure, education and training, and a new focus on technology sector job creation. For our purposes, the ARC's distressed counties designation provides a potentially useful measure linking county-level socioeconomic condition to health outcomes. In addition, the distressed county designation has considerable political significance because it is used to target money and resources to specific areas. Annual distressed county designations were obtained from the ARC for the period 1983–2002. Due to some changes and temporality in the data sources used for this designation, we have analyzed the 1994 distressed county designations. The 1994 distressed county designation is based on 3-year average unemployment for 1989–1991, 1990 per capita market income, and 1990 poverty level. Therefore, the 1994 distressed county designation represents the baseline year for our mortality data analysis, 1990–1997.

Theoretically we would expect that those counties identified as economically distressed would exhibit higher death rates from both heart disease and stroke.<sup>12–16</sup> We examined this relationship by dividing Appalachian counties into 2 groups, distressed and non-distressed. Separate death rates were calculated in each group for both heart disease and stroke mortality for each ethnic, gender, and age-group.

**RESULTS**

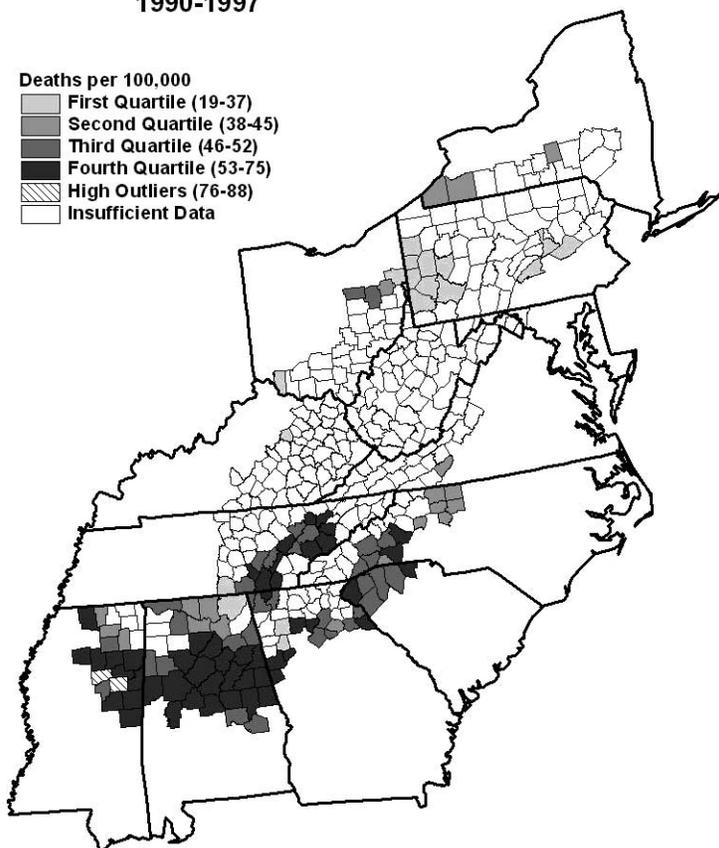
Figures 1 and 2 show the heart disease and stroke death rates for the Appalachia region and the United States, with calculations for Black and White men and women for 2 age groups, ages 35 to 64 and 65 and older. Death rates for both heart disease and stroke are consistently higher among Appalachian population groups compared with US rates. Death rates for Black men and women are also consistently higher than their White counterparts, with one ex-

**Smoothed Heart Disease Death Rates, 1990-1997  
Black Women Aged 35 to 64**



**Fig 6. Smoothed heart disease death rates, 1990–1997: Black women aged 35 to 64**

**Smoothed Stroke Death Rates  
Black Women Ages 35 to 64  
1990-1997**



**Fig 7. Smoothed stroke death rates, Black women ages 35 to 64. 1990–1997**

ception. Elderly White men (ages 65 and older) in Appalachia have a slightly higher heart disease death rate than elderly Black men (2641.1 deaths per 100,000 for elderly White men vs 2632.7 deaths per 100,000 for elderly Black men).

To determine the relative difference between the rates for the Appalachian region and the United States, we examined rate ratios shown in Tables 1 and 2. Table 1 shows the Appalachian/US rate ratios for heart disease mortality calculated for the period 1990–1997. In general, it appears that for all race/ethnic, gender groups there is a slightly elevated risk in Appalachian populations aged 35 to 64, with the largest difference in risk occurring among White men and women. Among Appalachian

subgroups aged 65 and older the most elevated risk occurs among Black women. Table 2 shows the Appalachian/US rate ratios for stroke mortality. The largest difference in risk of stroke mortality for Appalachian subgroups occurs among Black men aged 35 to 64.

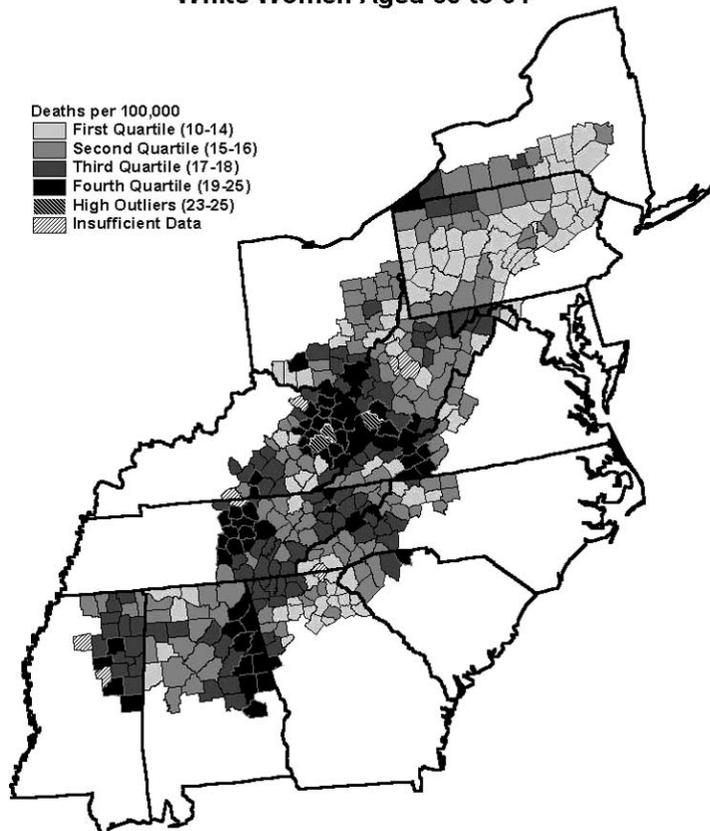
Rate ratios and rate differences between race/ethnic gender groups are shown in Tables 3 and 4. While Blacks ages 35 to 64 have substantially higher risk of heart disease mortality in Appalachia compared to Whites, the disparity does not appear as great as the disparity at the national level. For elderly population subgroups in Appalachia, the mortality rates for Black women are substantially high than the rates for White women. This difference is reflected in a very large rate difference. In con-

trast to the rate ratios observed for heart disease mortality, the rate ratios for stroke mortality among Appalachian subgroups (Table 4) indicate a substantially higher risk for Blacks compared to Whites in both age groups, when compared with the United States. While the greatest rate differences between Black and White gender groups occur in the elderly, the greatest difference in risk appears in the 35 to 64 age group.

For county-level analyses, we focused on premature mortality (deaths in the 35 to 64 age group). To assess the relative position of high-rate and low-rate counties in Appalachia with respect to other US counties, we divided the county-level distributions of heart disease and stroke death rates for the entire United States into deciles. Within each decile, the total number of Appalachian vs non-Appalachian counties were determined. Figures 3 and 4 show the percentage of Appalachian counties in the lowest (lowest death rate) and highest (highest death rate) deciles in the distributions of county-level death rates from heart disease and stroke for the entire United States. Both Figure 3 and 4 indicate that the Appalachian region endures a considerable amount of the national excess in mortality, although this varies by race/ethnicity and cause of death. Nearly 35% percent of the US counties in the highest decile of heart disease mortality for White men and women are within Appalachia, and about 25% for Black men and women. While few Appalachian counties are represented in the lowest decile of heart disease mortality for White men and women, nearly 10% are represented for Black men. The distribution of county-level stroke death rates (Figure 4) shows a similar pattern to that of the heart disease death rates. However, it appears that Appalachian region experiences less of the national excess for stroke mortality than heart disease mortality, especially for Black men.

Representative maps showing the distribution of death rates within Ap-

**Smoothed Stroke Death Rate, 1990-1997  
White Women Aged 35 to 64**



**Fig 8. Smoothed stroke death rates, 1990–1997. White women aged 35 to 64**

palachian are presented in Figures 5–8. Figure 5 shows the distribution of heart disease death rates for White men ages 35 to 64. The most striking feature of this distribution is the large cluster of “high outliers” in eastern Kentucky and western Virginia. Counties designated as high outliers represent death rates which are unusually high, relative to other death rates in the Appalachian region. As shown in Figure 3, these counties represent an area that experiences national level excess in heart disease mortality. In general, the fourth quartile (highest rates) occurs in the central part of the region, although high rate counties also appear in northeastern Mississippi, northern Alabama, and northeastern Pennsylvania. Counties with low heart disease death rates occur primarily in the northern part of the region and

along the fringes in the south. Figure 6 shows the distribution of heart disease death rates for Black women, ages 35 to 64. Small populations of Black women in the region result in an inability to calculate reliable death rates. However, a pattern roughly similar to that of White men is evident. While there are no high or low outliers in the distribution of heart disease death rates for Black women, counties in the fourth quartile tend to cluster in the central part of the region in southern West Virginia, and in the southern part of the region in northeastern Mississippi and northern Alabama. Geographic patterns of heart disease death rates for White women and Black men were similar to those for White men and Black women, respectively.

Figure 7 shows the distribution of

stroke death rates for Black men, ages 35 to 64. Again, due to small populations of Black men in the region, we cannot calculate reliable stroke death rates for many counties. High rate counties, however, do appear in the southern fringes of the region in western North Carolina and South Carolina, central Alabama, and northeastern Mississippi. A few high outlier counties occur in northeastern Mississippi. This geographic pattern for stroke death rates is consistent with the historical distribution of the “Stroke Belt.”<sup>17,18</sup> Counties with low stroke death rates for Black men occur primarily in northern Alabama and southeastern Pennsylvania around the Pittsburgh area. Figure 8 shows the distribution of stroke death rates for White women, ages 35 to 64. High rates of stroke deaths for White women occur in the central part of the region in eastern Kentucky, southern West Virginia, and western Virginia. Several high outlier counties occur in this area. Additional high rate areas appear in central Tennessee and eastern Alabama.

With some exceptions, some fairly clear patterns emerge from these county-level distributions of death rates. Primarily, a clustering of high death rates in the central part of the region and also in the southern-most states can be found. Next, we examined an indicator of county-level socioeconomic condition, the distressed county designation. A map of counties designated “distressed” in 1994 is shown in Figure 11. As explained earlier, the 1994 designation was determined based on data from 1990, and therefore represents the baseline to our mortality data analysis (1990–1997). We aggregated counties into 2 groups, distressed and not distressed, and calculated separate rates for heart disease and stroke mortality. Figures 9 and 10 show the heart disease and stroke mortality rates among Black and White men and women ages 35 to 64 living in distressed vs not distressed counties in Appalachia. As a group, dis-

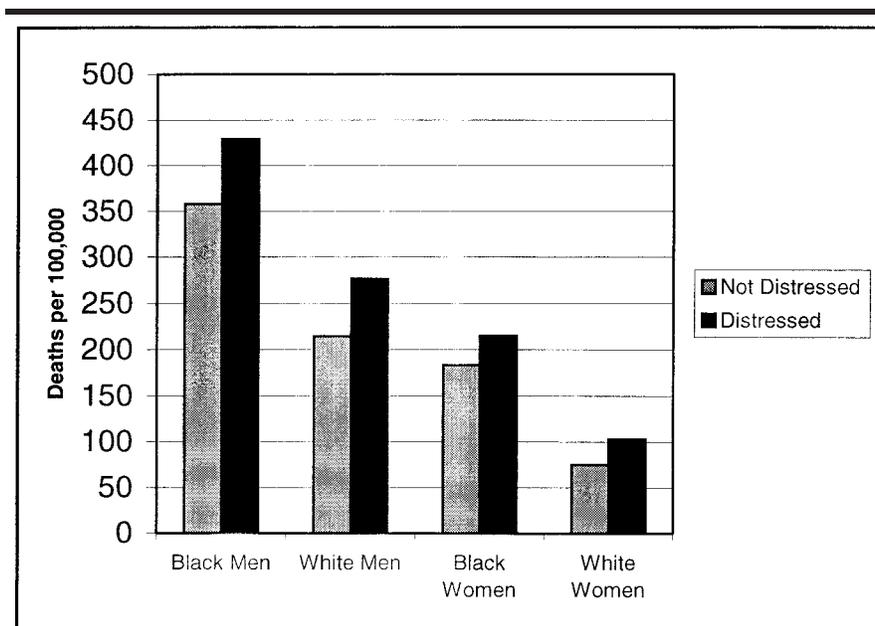


Fig 9. Age-adjusted heart disease death rates, 1990–1997. Distressed and non-distressed Appalachian counties; ages 35 to 64

tressed counties exhibit higher rates for both heart disease and stroke mortality among all race/ethnic and gender groups. By visually comparing the map of distressed counties with the maps of

death rates (Figures 5–8) we can see some level of correspondence between distressed counties and counties with high death rates, particularly in the central part of Appalachia. However, there

are many cases (counties) where high death rates do not appear to correspond to distressed counties.

## DISCUSSION

A number of conclusions are suggested by the results of these analyses. As a region, Appalachia experiences consistently higher rates of health disease and stroke mortality than the nation as a whole. More detailed county-level analyses revealed that many counties in Appalachia carry a significant portion of the national excess in heart disease and stroke mortality. However, there is also considerable geographic variation in the distribution of county-level rates of heart disease and stroke mortality within the region. The extent of the geographic variation within Appalachia, in terms of the level of the rates, is dependent to a certain degree by the population subgroups for which the rates are calculated. Counties with high death rates for all population subgroups appear, in general, to cluster in particular areas and sub-regions within Appalachia. In addition to identifying specific areas within the region that are in need of interventions to reduce the burden of excess mortality from both heart disease and stroke, we believe these analyses partially reveal the heterogeneous nature of the region. The Appalachian region represents a multitude of socioeconomic, cultural, political, and physical landscapes. While there appears to be some level of correspondence between economically distressed counties and high death rates from heart disease and stroke, additional analyses are required to help explain the determinants of geographic disparities in health outcomes within the region. The apparent lack of agreement in some areas, between distressed counties and high rates of mortality, may reflect several limitations of these analyses. Temporal changes in the measures used to construct the distressed county index need to be examined to determine how

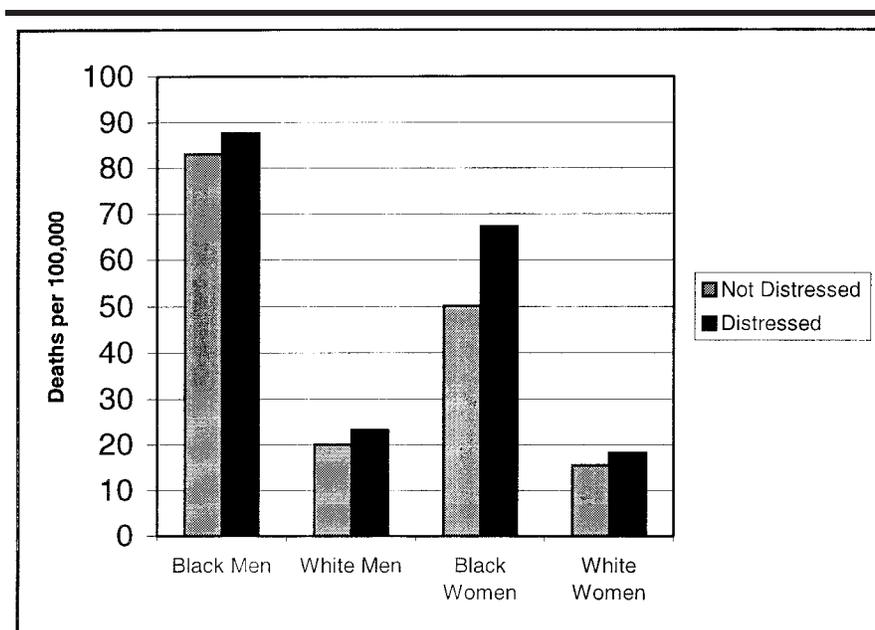


Fig 10. Age-adjusted stroke death rates, 1990–1997. Distressed and non-distressed Appalachian counties; ages 35 to 64

## Distressed Appalachian Counties - 1994

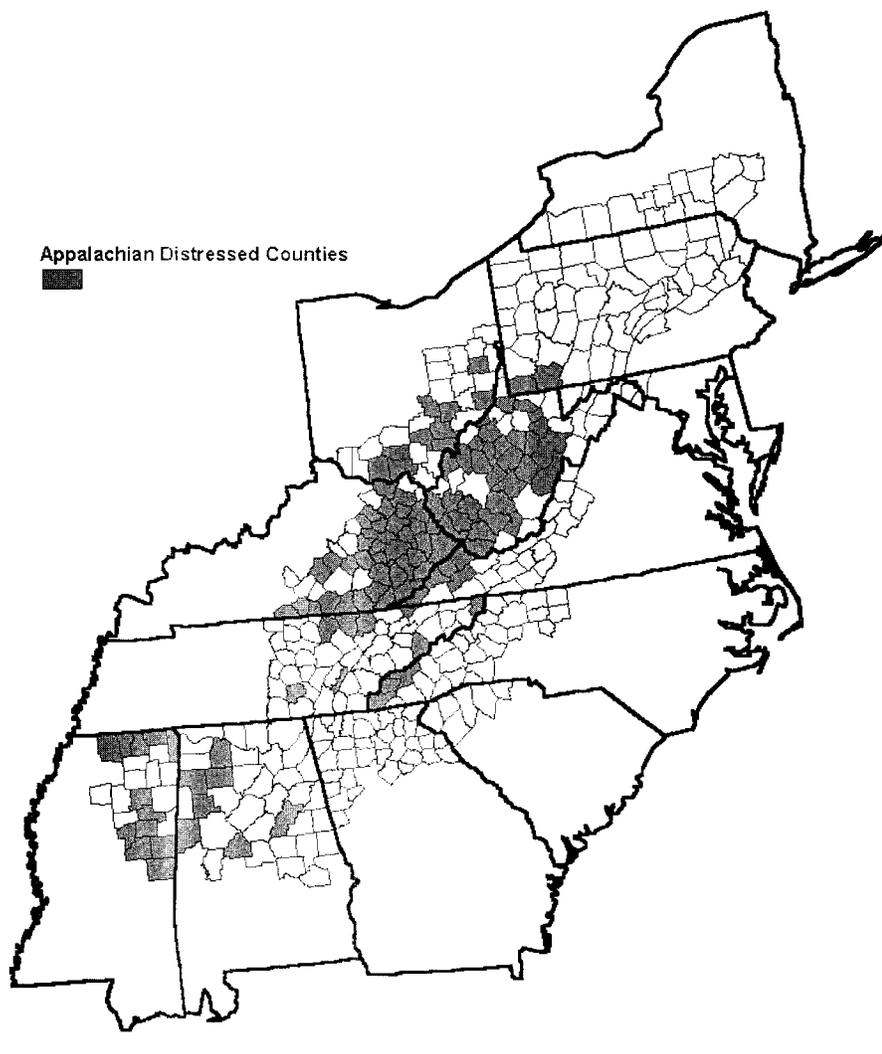


Fig 11. Distressed Appalachian Counties—1994

economic changes have affected this designation over time. In addition individual components of the distressed county designation need to be analyzed to examine how different combinations of the economic measures used to construct this index, might be associated with local health outcomes. There are a number of potential implications for linking economically distressed counties and the health experiences of those counties. If distressed county designations are used to direct money and resources to these areas, then this measure will influence policy decisions at the lo-

cal level and thus, may improve health outcomes. In addition to examining distressed county indicators, more detailed analyses are required to identify other indicators of socioeconomic conditions as they relate to health outcomes in these areas. Levels of income inequality within counties, for example, may be an important factor in geographic disparities in health among racial/ethnic and gender groups in Appalachia.

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#### AUTHOR CONTRIBUTIONS

*Design and concept of study:* Halverson, Barnett, Casper

*Acquisition of data:* Halverson, Barnett, Casper

*Data analysis and interpretation:* Halverson

*Manuscript draft:* Halverson, Barnett, Casper

*Statistical expertise:* Halverson, Barnett, Casper

*Acquisition of funding:* Halverson

*Administrative, technical, or material assistance:* Halverson, Barnett, Casper

*Supervision:* Halverson