Geographic Disparities in Heart Disease Mortality Among Women
Patterns Vary Within and Between Racial and Ethnic Groups*

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Diseases of the heart are the leading cause of mortality among women of all racial and ethnic groups in the United States. Recently, West Virginia University and the Centers for Disease Control and Prevention completed the first national study of geographic patterns of heart disease mortality among women. This study focused on the heart disease mortality experiences of women ages 35 years and older during the years 1991 to 1995. The research culminated in the publication of a 240-page monograph, "Women and Heart Disease: An Atlas of Racial and Ethnic Disparities in Mortality," that includes national and state maps depicting county-level variation in heart disease mortality for American Indian and Alaska Native women, African American women, Asian and Pacific Islander women, Hispanic women, and white women. In addition, maps of several dimensions of the social environment that are important predictors of cardiovascular health were produced, including local economic resources, social isolation among elderly women, and county medical care resources.

Highlights of the findings from "Women and Heart Disease" are reported in this article. We found substantial geographic disparities in heart disease mortality for women of each racial and ethnic group, and for all women combined. Among African American women, the highest rates of heart disease mortality occurred in counties in the lower Mississippi River valley and Mississippi Delta region. Among American Indian and Alaska Native women, the highest heart disease death rates occurred in counties in South Dakota, Montana, and Minnesota. Adverse social environmental conditions were most prevalent in the rural areas, the South and Appalachia. (CVD Prevention 2000; 3:328-339)

Key Words • heart disease mortality • race • ethnicity • mapping • small area analysis • geographic variation • social environment

Introduction

In the United States there continue to be persistent racial and ethnic disparities in the burden of heart disease mortality among women. While heart disease is the leading cause of death for each racial and ethnic group, data indicate that over time the gap between several racial and ethnic groups has widened. In response to the President's Initiative to Eliminate Racial and Ethnic Disparities in Health, new insights into the determinants of the disparities are needed along with new approaches to alleviate the excess burden of heart disease mortality. The examination of geographic disparities in heart disease mortality by racial and ethnic group provides new and challenging perspectives on

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both the determinants of racial and ethnic disparities and the prevention approaches that can be used to eliminate the disparities. Geographic disparities in heart disease mortality direct attention to the underlying inequalities in local social environments that contribute to the disparities in heart-healthy living and working conditions for residents.

Recently, West Virginia University and the Centers for Disease Control and Prevention released a joint publication, "Women and Heart Disease: An Atlas of Racial and Ethnic Disparities in Mortality," which provides a comprehensive examination of county-level heart disease death rates for women, ages 35 and older, of the five largest racial and ethnic groups in the United States, for the years 1991–1995. National and state-specific maps are presented for American Indian and Alaska Native women, Asian and Pacific Islander women, black women, Hispanic women, white women, and women of all races and ethnicities combined. In addition to the mortality maps, there are national maps of several dimensions of the social environment, including local economic resources, social isolation among elderly women, and medical care resources. Highlights from "Women and Heart Disease" are reported here.

Definition of Racial and Ethnic Groups

Racial and ethnic categories were defined according to Office of Management and Budget, Directive 15 and are not based upon biological or anthropological concepts. The categories were developed in response to needs for collecting standardized data to be used by federal agencies for record keeping, collection and presentation of data. Under the federal data reporting scheme, "Hispanic" is considered a designation of ethnicity, not race. We use the terms "black" and "African American" interchangeably throughout this publication.

An important limitation for examining racial and ethnic disparities in heart disease mortality is the accuracy of race and ethnicity information reported on the death certificate. There are instances when American Indians and Alaska Natives, along with Asian and Pacific Islanders, are mistakenly identified as white, and Hispanics are mistakenly reported as non-Hispanics. A recent report from the National Center for Health Statistics (NCHS) estimates that death rates (for all causes of death combined) corrected for both misreporting of race and ethnicity on the death certificates and population undercounts in census files would be 21% higher than currently reported for American Indians and Alaska Natives, 11% higher for Asians and Pacific Islanders, and 2% higher for Hispanics. No studies to date have evaluated the extent of geographic variation in the accuracy of reporting race and ethnicity on the death certificate and in the degree of population undercounts. While we are aware of these data quality limitations for race and ethnic groups other than whites and blacks, we hope that the results will both highlight the need for improved death certificate and population data quality, and provide useful information to public health agencies and advocacy groups who are working to improve health outcomes in diverse populations.

Heart Disease Mortality

Variable Definitions and Data Sources

Deaths from heart disease were defined as those for which the underlying cause of death listed on the death certificate was coded according to the International Classification of Disease, 9th Revision (ICD-9) as: 390–398, 402, 404–429. These codes comprise the category "Diseases of the Heart" as defined by the NCHS. Death certificate data for the years 1991–1995 were obtained through the National Vital Statistics System maintained by the NCHS. Population count data for all counties in the United States were obtained from the Bureau of the Census for the years 1991–1995. These intercensal estimates were calculated by the Bureau of the Census through extrapolation of linear trends in population growth and intercounty migration patterns between census years 1980 and 1990.

Calculation of Heart Disease Death Rates

Age-adjusted and spatially smoothed heart disease death rates were calculated separately for each of the racial and ethnic groups and for all racial and ethnic groups combined. The 1970 United States standard population, ages 35 and older, was used for direct age adjustment. Spatial smoothing of the rates was conducted to reduce heteroskedasticity among counties. For counties with sparse populations and small numbers of heart disease deaths, the death rates are likely to have large variances, suggesting that the calculated rate could be spuriously high or low. This situation is particularly prevalent for minority populations, given that historical and social processes have resulted in concentrations of each racial or ethnic group in some regions of the
country and sparse populations in other regions. A spatial moving average was calculated by averaging the heart disease mortality experience of each county with that of all of its neighboring (contiguous) counties. Two constraints were applied to the calculation of county-level heart disease death rates for each racial and ethnic group. A heart disease death rate was not calculated for any county for which the total number of deaths in that county plus its neighbors was fewer than 20 during 1991–1995. To avoid calculating rates for counties that had no population themselves but whose neighbors had significant populations, rates were calculated only for counties that had a population count of 5 or greater for 1991–1995 (i.e., had 5 or greater person-years).

**Guide to National Mortality Maps**

For this report, we present maps of county heart disease death rates for all women combined, for American Indian and Alaska Native women, and for black women. A detailed analysis of the geographic patterns of heart disease mortality among Hispanic women has been published separately.

For each racial and ethnic group, counties were categorized into quintiles based upon the distribution of heart disease death rates for the respective racial or ethnic group. Because the distributions of heart disease death rates varied by race and ethnicity, the quintile cutpoints are different for each of the racial and ethnic groups, and the range of values represented by a given quintile varies from map to map. Therefore, each map indicates the geographic disparity within a given racial or ethnic group. To determine whether the mortality rates were absolutely higher or lower for one racial or ethnic group than for another, the reader must consult the relevant legends and compare the cutpoints.

Counties are labeled as “insufficient data” if there are fewer than 20 deaths in that county and the contiguous counties for the specified racial or ethnic group over the five-year study period. For these areas of very low population and infrequent heart disease deaths, statistically reliable death rates could not be calculated.

For the contiguous 48 states, Albers Equal Area map projection was used to preserve the accurate presentation of relative area and thus enhance comparison of one county with another. Alaska was projected using Miller's Cylindrical projection to provide a suitable orientation on the layout. Hawaii was presented using geographic coordinates (latitude and longitude), for reasons of shape and orientation. New York City and the District of Columbia were also presented using geographic coordinates.

**Racial and Ethnic Disparities in Heart Disease Mortality**

The age-adjusted national heart disease death rates among women ages 35 and older varied considerably among the racial and ethnic groups for the years 1991–1995. The highest death rates were experienced among black women (553 per 100,000), followed by white women (388 per 100,000), Hispanic women (265 per 100,000), American Indian and Alaska Native women (259 per 100,000), and Asian and Pacific Islander women (221 per 100,000). The overall heart disease death rate for all women combined was 401 per 100,000. Annual trend data for this time period indicate that these rankings were consistent throughout the time period, with the rates for Hispanic women and American Indian and Alaska Native women merging over time (figure included in the Atlas).

The frequency distributions of heart disease death rates for each of the racial and ethnic groups indicates that there was considerable geographic variation in the level of heart disease death rates among the counties (Fig. 1). The county distributions also highlight the disparities in the burden of heart disease among women of different races and ethnicities. By focusing on the tails of the distributions it is evident that there was very little overlap in the county rates for Asian and Pacific Islander women and the rates for African American women. The highest county heart disease death rates for Asian and Pacific Islander women were lower than almost all of the county rates for black women. For white women, the high end of the tail of the distribution was about midpoint in the distribution of county rates for African American women.

For women of all racial and ethnic groups, ischemic heart disease was the primary specific category of death from diseases of the heart (Fig. 2). Among all women aged 35 years and older, 64% of heart disease deaths were attributed to ischemic heart disease. The contribution varied somewhat according to race and ethnicity, with the largest percentage (67%) occurring among Hispanic women and the smallest percentage (54%) occurring among African American women. The proportion of heart disease deaths from hypertensive disease also varied notably according to race and...
ethnicity. Among black women, 9% of heart disease deaths were a consequence of hypertensive heart disease, compared with only 3% of heart disease deaths for white women and Asian and Pacific Islander women.

**All Women: National Map of Heart Disease Mortality**

Among the 3103 counties for which data on women of all racial and ethnic groups combined were available, the heart disease death rates ranged from 212 to 670 per 100,000. The heart disease death rate at the midpoint of the top quintile (560 per 100,000) was twice as high as the midpoint of the lowest quintile (275 per 100,000).

There was a clear East-West gradient in heart disease mortality among women during 1991–1995 (Fig. 3). Counties in the top two quintiles were located primarily within Appalachia, the Ohio-Mississippi River Valley, the Mississippi Delta, and the eastern Piedmont and coastal regions of Georgia, South Carolina, and North Carolina.

Most counties in the Pacific Northwest and Rocky Mountain areas of Colorado and New Mexico were in the lowest quintile. Another region of counties with low rates was in Wisconsin, North Dakota, and South Dakota. Alaskan and Hawaiian

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**Figure 1.** Frequency distribution of smoothed county heart disease death rates for women 35+, by race and ethnicity, 1991–1995.

**Figure 2.** Specific categories of heart disease deaths among women 35 years of age and older, by race and ethnicity, 1991–1995.
American Indian and Alaska Native Women: National Map of Heart Disease Mortality

Among the 375 counties with sufficient data for American Indian and Alaska Native women, the heart disease death rates for American Indian and Alaska Native women ranged from 97 to 1000 per 100,000. There was nearly a fivefold difference in the heart disease death rate at the midpoint of the top quintile compared with the midpoint of the lowest quintile (784 deaths per 100,000 vs 165 deaths per 100,000).

The map of heart disease death rates among American Indian and Alaska Native women suggests that there is a North-South gradient in heart disease mortality (Fig. 4). High rates of heart disease mortality were located primarily in South Dakota (predominantly Dakota Nation), Montana, and Minnesota (predominantly Chippewa Nation). Low rates of heart disease mortality were found predominantly in Oklahoma (largely Cherokee Nation) and New Mexico (mostly Navajo Nation) and California. In addition, low rates of heart disease mortality were observed in several large metropolitan counties and surrounding areas (New York City, San Francisco, Los Angeles, Seattle, Anchorage). An area of southeastern North Carolina is home to a large group of Lumbee Indians, who are not a federally recognized tribe. American Indian women in this area experienced high rates of heart disease mortality.

Black Women: National Map of Heart Disease Mortality

Among the 1929 counties for which data were available, the heart disease death rates for black women ranged from 218 to 1198 per 100,000. The heart disease death rate at the midpoint of the top quintile (908 per 100,000) was 2.6 times higher than the rate at the midpoint of the bottom quintile (351 per 100,000).

The map of heart disease mortality among African American women indicates that the counties in
the top two quintiles are concentrated primarily in the southern portion of the Mississippi River Valley and Delta region (Fig. 5). Pockets of high-rate counties are also located in the southern states of Alabama, Georgia, and South Carolina, parts of the Midwest, and areas within Texas, Oklahoma, California, and Nevada. Counties in the lower quintiles are located primarily in the western and southwestern states of Washington and New Mexico but are also scattered throughout communities in the Midwest, Northeast, Mid-Atlantic states, and Florida.

**Discussion of National Heart Disease Mortality Maps**

These maps of county-level heart disease mortality rates highlight the pronounced geographic disparity in the burden of heart disease that exists among women in the United States. For women of all racial and ethnic groups combined, the heart disease death rates in the top quintile are on average two times higher than the rates in the lowest quintile. For American Indian and Alaska Native women the gap is fivefold, and for African American women the gap is threefold. These findings highlight the fact that each racial and ethnic group is not a monolithic group. Instead, these maps stress the importance of the local social environment and local historical circumstances on the observed burden of heart disease for each group. The magnitude of variation in the burden of heart disease within each racial and ethnic group also points to the potential for prevention efforts within each of the racial and ethnic groups.

Furthermore, these maps portray the differences in the geographic patterns of heart disease mortality among racial and ethnic groups. Among American Indian and Alaska Native women there is a North-South gradient, with the high rates of heart disease mortality primarily in the northern regions of the United States and low rates primarily in the Southwest. Among black women, however, there is no clear gradient. The highest rates are predominantly in the Southeast and the low rates are scattered throughout the Northeast, Midwest, and West. The patterns for these two minority populations are also very different than the geographic pattern observed for women of all racial and ethnic groups com-
bined, in which there is a very strong East-West gradient with the highest rates concentrated in Appalachia, the Mississippi Delta and the rural Cotton Belt counties in the South.

These findings have important implications for directing and tailoring prevention resources and policy initiatives to specific counties. If agencies with a focus on the heart health of African American and/or American Indian women were to use only the map of heart disease mortality for women of all racial and ethnic groups combined, their resources would be ineffectively distributed since they would miss the pockets of high rate areas for those two minority populations.

Local Economic Resource Index

Variable Definitions and Data Sources

The geographic distribution of local economic resources among all counties in the United States was examined using a summary index based on the following three dimensions of the local socioeconomic infrastructure: median family income, occupational structure, and unemployment rate. Occupational structure was defined as the percent of all employed persons who were engaged in white collar jobs (i.e., managerial and professional specialty occupations and technical, sales, and administrative support jobs).

Data for the Index of Local Economic Resources were obtained from the Area Resource File (February 1996 edition)—a compilation of health-related data that have been abstracted from multiple data sources by the Bureau of Health Professions, Department of Health and Human Services. The three variables that were used to create the index were abstracted from the 1990 Census of Population and Housing, STF3A data files.

The index was calculated by ranking all counties separately for each variable. For each variable, the counties were then categorized into deciles, and each decile was assigned a score ranging from zero to nine. Counties in the decile with the poorest economic conditions (lowest median income, lowest occupational structure, highest unemployment rate) were assigned a zero and counties in the decile with the most advantaged economic conditions were assigned a nine. For each county, the scores from the three variables were added together to arrive at the index score. Values of the local economic resource index score ranged from zero.
(counties that were in the lowest decile for all three dimensions of the index) to 27 (counties that were in the top decile for all three dimensions of the index).

Counties were divided into five groups with roughly equal ranges of index values on the map. Dark colors represent counties with the least favorable local economic resource profiles, and light colors represent counties with the most favorable profiles.

Results and Discussion of Local Economic Resource Map

A distinctive pattern was apparent for the geographic distribution of local economic resources in 1990 (Fig. 6). Clusters of counties with very unfavorable local economic resource profiles were found in several rural, underdeveloped regions of the country. These regions included Appalachia, the Mississippi Delta, the Texas border counties, and the Cotton Belt counties of the South. Unfavorable local economic resource profiles were found in many other counties as well, mostly in rural areas.

Clusters of counties with the most favorable local economic resource profiles were found in the metropolitan areas of the eastern seaboard from the District of Columbia, and north through the New York City metropolitan area to Boston. Metropolitan and surrounding counties in southern Florida, the San Francisco Bay Area, and southern California also had very favorable local economic resource profiles in 1990.

The contrast in levels of local economic resources between rural and metropolitan counties was most apparent in Appalachia and the South. In Kentucky, the cities of Lexington and Louisville had favorable local economic resource profiles, but rural counties to the east had very unfavorable profiles. The same contrast was evident for Nashville, Tennessee, and Jackson, Mississippi, and the surrounding rural counties.

Several studies have shown that in the United States, areas with fewer local economic resources (as measured by income, occupation, and education profiles) had higher rates of heart disease mortality from the 1960s to the 1980s and were slower to experience the onset of decline in heart disease mortality in the 1960s and 1970s.\textsuperscript{6,7} Per capita
government expenditures for employment, social, and health services were lower in these areas than in high economic resource areas. One of the fundamental processes contributing to the uneven distribution of resources is economic underdevelopment. Underdevelopment is an historical, political, and economic process by which wealth generated within a region (by the labor of its residents) is exported outside the region (by owners of firms, factories, and mines) rather than being reinvested within the region to benefit local communities. Developed economic centers, including many large metropolitan areas, typically enjoy high levels of economic activity and economies of scale that result in increased median incomes and greater availability of public, social, cultural, and health services than in smaller urban and rural areas. The pattern of economic underdevelopment is observed in the map of local economic resource index.

The uneven distribution of local economic resources within the United States poses significant barriers to the development of standardized community-wide programs and policies to reduce the burden of heart disease. While many contemporary heart disease prevention efforts focus on changing individual behaviors (e.g., dietary habits, leisure-time physical activity, and tobacco use), a more holistic approach recognizes that the local economic infrastructure provides the context within which individuals are exposed to structural risk factors (poverty, social isolation, stressful working environments) and that there are direct implications for the adoption of detrimental health behaviors. Differences in the local economic infrastructure should be considered when community-based programs and policies to prevent heart disease are being designed. Primary prevention of heart disease can be achieved through broad improvements in local social environments, including full employment in healthy work environments, access to affordable healthy foods and recreational facilities, freedom from bigotry and discrimination, and opportunities for social interaction and participation in civic life.

Social Isolation

Variable Definitions and Data Sources

In the publication "Women and Heart Disease," two indicators of social isolation among women were mapped: percentage of women living alone, and the percentage of women with either mobility or self-care limitations. For this manuscript we highlight the findings for mobility or self-care limitations among women ages 60 years or older. A mobility limitation was defined as a health condition, either physical or mental, that lasted for 6 or more months and which made it difficult to go outside the home alone. A self-care limitation was defined as a health condition, either physical or mental, that lasted for 6 or more months and which made it difficult to take care of personal needs, such as dressing, bathing, or getting around inside the home.

The data were obtained from the 1990 Special Tabulation on Aging compiled by the Bureau of the Census. This data set contains summary statistics for elderly women and men abstracted from the 1990 Census of Population and Housing.

Counties with fewer than 100 women over the age of 60 years old in 1990 were excluded (n = 32). The distribution of county values was divided into quintiles. Dark colors on the maps indicate high prevalence of mobility or self-care limitations among women; and light colors on the map indicate a relatively low prevalence.

Results and Discussion of Mobility and Self-Care Limitations Map

In the United States in 1990, 19.8% of elderly women suffered from a mobility or a self-care limitation. Substantial geographic variation in the prevalence of mobility and self-care limitations was observed, with county values ranging from 2.4% to 40.4% (Fig. 7). The midrange of the highest quintile (33.9%) was approximately four times higher than the midrange of the lowest quintile (7.8%).

Low proportions of women living with mobility or self-care limitations were found in counties in upper New England, the upper Midwest, and most of the West, including Hawaii. An exception to this pattern was the Four Corners region of Arizona, New Mexico, Colorado, and Utah, a region with a large American Indian population, where high proportions of women living with mobility or self-care limitations were observed.

The highest proportions of elderly women living with mobility or self-care limitations were found in counties in the South, Central Appalachia, and the lower Midwest; in these regions, high proportions were found in rural and urban counties. Both New York City and Washington, DC, had high propor-
tions of elderly women living with mobility or self-care limitations.

Social isolation among elderly women is an important aspect of the social environment. Elderly women are more likely to live in poverty, to live alone, to suffer from physical disabilities, and to lack adequate social support, compared with other demographic groups. Longer life expectancy among women than among men results in many women surviving longer than their spouses. Widowed, divorced, and single elderly women are particularly vulnerable to social isolation resulting from inadequate economic resources and from living alone. Elderly women with mobility or self-care limitations are more likely to be socially isolated and less able to maintain the regular preventive health care visits to hospital or physicians offices which can reduce their risk of heart disease. Furthermore, these limitations may prevent elderly women from taking prescribed medications, eating regular meals, and following a physician’s advice for mental and physical treatment. The geographic disparities in the map of the prevalence of elderly women with mobility or self-care limitations mimics the map of heart disease death rates for all women combined. Community programs and policies dedicated to reducing the risk of heart disease among older women would be well advised to take into consideration the degree of social isolation among women.

Medical Care Resources

Variable Definitions and Data Sources

Three indicators of medical care resources relevant to secondary prevention of heart disease mortality were included in “Women and Heart Disease”: population per cardiovascular disease specialty physician, population per coronary care unit bed, and number of cardiac rehabilitation units. Here we present the map for number of cardiac rehabilitation units per county.

Data on medical care resources were obtained from the Area Resource File (February 1996 edition), a compilation of health-related data abstracted from multiple data sources by the Bureau of Health Professions, Department of Health and Human Services. The primary source for the data
Results and Discussion of Cardiac Rehabilitation Map

In 1993, a majority (60%) of U.S. counties did not have a cardiac rehabilitation unit (Fig. 8). Counties with no availability of cardiac rehabilitation services were clustered in the South, the West, and rural areas throughout the country. Most counties in or near major metropolitan areas, such as New York, Chicago, Los Angeles, and Miami, had three or more cardiac rehabilitation units. Many metropolitan areas throughout the country had at least one cardiac rehabilitation unit.

The availability and accessibility of medical care resources are aspects of the local social environment that play an important role in the secondary prevention of heart disease. The American Heart Association defines secondary prevention as “identifying and treating persons with established disease and those at very high risk of developing disease, and treating and rehabilitating patients who have had a heart attack to prevent a second cardiovascular event.”15 For many women in the United States, however, there are substantial barriers to receiving needed medical care. These barriers include poverty, lack of health insurance, rural isolation, social isolation, and absence of cardiac care physicians and facilities in their communities. Women of minority race or ethnic groups may be particularly disadvantaged in their access to medical care resources, given the geographic distribution of these populations, indicating these areas may be underserved. The distinct metropolitan: nonmetropolitan pattern observed for the distribution of cardiac rehabilitation units means that rural residents are faced with traveling long distances to receive rehabilitative care. Efforts to establish cardiac rehabilitation units in the 60% of U.S. counties that were without such units in 1993 would increase the opportunities for women (and men) with heart disease to develop tailored exercise programs to increase their strength and aerobic fitness, reduce their blood pressure and cholesterol levels, and maintain weight loss.

Summary

It is our hope that these county-level maps of heart disease mortality and the social environment...
will assist health researchers in developing new hypotheses regarding the determinants of the geographic patterns of heart disease for each racial and ethnic group and will also enable health professionals in local, state, and national health agencies to design new programs and policies tailored to the needs of the communities with the highest rates of heart disease mortality. Given the current emphasis on the global economy and global health, it is increasingly important for public health professionals to think globally and act locally. Maps are effective tools for facilitating decision-making that incorporates both the larger context and the local burden of disease—in this case, heart disease among women. This perspective is especially important when addressing racial and ethnic disparities in heart disease. The differences in the geographic patterns between racial and ethnic groups and the pronounced geographic disparities that exist within each racial and ethnic group focus attention on the importance of local social environments and local historical circumstances. These are important perspectives for public health researchers, policy and program analysts, and community activists to maintain as we work towards reducing the burden and eliminating the racial disparities of heart disease among women.

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