# 2 Reader's Guide to Understanding and Interpreting the Maps

Maps have the potential to convey large amounts of complex information in an efficient and visually appealing format. Several important elements are necessary for creating a well-designed and accurate map, including the *subject matter* or content of the map (in this case, heart disease death rates), the *layout* of the map (i.e., the location and meaning of different items on the page), the *projection* of the map (i.e., the method by which the earth's curved surface is translated onto a flat page), and the *scale* of the map (i.e., the size of features on the map relative to their actual size on the earth). This section describes each element, and provides additional information useful for interpreting and using the maps.

We have designed the maps in *Women and Heart Disease* to provide the reader with easy access to important information on the geographic distribution of heart disease mortality among women of diverse races and ethnicities. One of the attractions of maps is that they enable communication of huge amounts of information. Precisely because so much information is being presented, however, it is important to be aware of the strengths and limitations of map display.

*Women and Heart Disease* includes heart disease death rate maps for the nation as a whole and for each individual state. Our rationale for including both national and state maps was straightforward. The national maps illustrate the broadscale geographic patterns of heart disease mortality for each race and ethnicity group, and enable the reader to compare any region, state, or county with other parts of the country. The state maps allow the reader to identify the high-rate and low-rate areas within each state for all of the race and ethnicity groups.

For each state, the categories for high- and low-rate areas are based only on the county rates for that state. Consequently, the spatial pattern of heart disease death rates for a particular state on the national map will look different than the spatial pattern shown on the state map. With care, it is possible to contrast mortality patterns and rates among states and among the different race and ethnicity groups.

## *Calculation of Heart Disease Death Rates*

Our study population consisted of women aged 35 years and older who resided in the United States during 1991-1995. County maps of heart disease mortality were created for six groups of women: all women, American Indian and Alaska Native women, Asian and Pacific Islander women, black women, Hispanic women, and white women. We calculated heart disease death rates at the county level for each group of women using death certificate data from the National Vital Statistics System and population data collected by the Bureau of the Census. We defined a *heart disease death* as any death for which the underlying cause of death recorded on the death certificate fell into the category "diseases of the heart," as defined by the National Center for Health Statistics. This category included deaths coded 390-398, 402, 404-429 under the Ninth Revision of the International Classification of Diseases (see Appendix B for details).

Important methodological issues had to be resolved before we could map geographic patterns of heart disease mortality for women. Analyses at the county level provide a high degree of spatial specificity but are also subject to potential statistical biases. Specifically, for counties with sparse populations and small numbers of heart disease deaths, the estimated death rates were likely to have large variances which could result in many counties having estimated rates that were either spuriously high or low. The issue of small populations was particularly relevant for examining patterns of heart disease mortality by race and ethnicity, since racial and ethnic populations tend to be concentrated in certain geographic regions and sparse in other regions. For all races and ethnicities, populations are more sparse in rural than urban counties.

Given the assumption that, in general, mortality rates are subject to some random variation,[1] counties with small populations are more likely to exhibit rates that fluctuate considerably from the true, unknown rates. This fluctuation can result in misrepresentations of the true geographic patterns.[2] We employed two approaches to reduce the statistical variability of the county mortality rates for heart disease: 1) temporal aggregation of the data

for the five year period 1991-1995, and 2) application of a statistical procedure known as *spatial smoothing*.

Spatial smoothing involves calculating spatial moving averages for all counties.[2] Heart disease deaths (numerators) and population counts (person-year denominators) for each county were summed together with the deaths and populations of the immediate neighboring counties (i.e. contiguous counties) and then divided to produce an average rate. Stated another way, the rate shown on the map for a single county represents an average of the heart disease mortality experience of that county and all its contiguous neighbors (see Appendix B for complete details).

All rates were age-adjusted using the 1970 United States population as the standard, and are presented as deaths per 100,000 population. On each map, counties were grouped into five categories of approximately equal number (quintiles) based on the county distribution of smoothed heart disease death rates. Counties were first ranked from lowest to highest based on heart disease death rates. The lowest 20% of counties were assigned to the first quintile; counties with death rates within the range from 20% to 39% were assigned to the second quintile; from 40% to 59% to the third quintile; from 60% to 79% to the fourth quintile, and the top 20% of counties were assigned to the highest quintile. The use of quintiles for mapping is appropriate for smoothed death rates and helps the reader to avoid over-interpreting the data.

Because the severity of heart disease mortality varied by race and ethnicity, the quintile cutpoints are different for each of the national maps, and the range of values represented by a given quintile varies from map to map. Therefore, comparisons of the spatial patterns of heart disease mortality across the maps should be limited to comparing relative differences among different groups of women. To determine whether the mortality rates were absolutely higher or lower for one race and ethnicity group than for another, the reader must study the relevant legends and compare the cutpoints. It is well worth making a mental note of the range of county heart disease death rates for each group when comparing geographic patterns across maps.

## National Heart Disease Mortality Map Layouts

Each national heart disease mortality map follows a standard layout (Figure 2.1). The title in the upper left hand corner identifies the subject. The upper right hand title identifies the race or ethnicity of the women represented in the map. Most of the page is devoted to a map of the continental United States. We followed the common convention of displaying Alaska and Hawaii as insets in the lower left hand corner of the layout. Two cities with very large populations, New York City and the District of Columbia, are very small in area and hence difficult to see on the continental map. Therefore, these two areas are also displayed as insets. County boundaries are displayed with a thin black line, and state boundaries are displayed with a thick black line.

The legend, located beneath the map, indicates the range of county heart disease death rates in each quintile, and the number of counties in each quintile. For example, among black women (see Figure 2.1) the cutpoint for the lowest quintile is 484, indicating that black women in 20% of counties experienced heart disease death rates less than or equal to 484 deaths per 100,000 population. Counties in each quintile are displayed in a different color on the map. Counties in the highest rate quintile are the darkest color, while counties in the lowest rate quintile are the lightest color. Counties for which there was insufficient data to calculate a heart disease death rate are shaded gray.

## National Map Projections

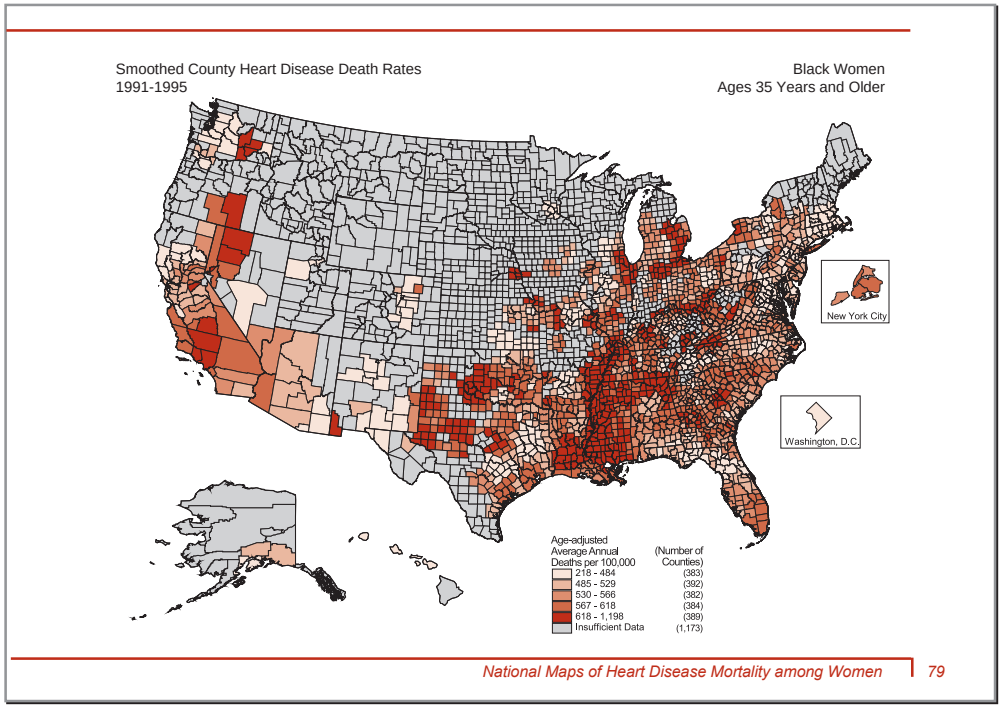
Although no flat map can be a perfect representation of the curved surface of the earth, use of a suitable map projection preserves essential characteristics such as relative size, shape, and orientation. For the national heart disease mortality maps, the three map projections we used maximize the visibility of spatial information. For the contiguous 48 states, we chose Albers Equal Area, a map projection that preserves the accurate presentation of relative area and thus enhances comparison of one county with another. Alaska was projected on

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.

## Scale of the National Maps

Scale is the number of distance units on the earth represented by one distance unit on a map. Scale is a dimensionless ratio and can therefore be expressed in any set of distance units (e.g. miles, kilometers, inches, centimeters). Every national map of heart disease mortality actually contains five separate maps, each displayed at a different scale. To display the entire United States on one page, we had to compromise by displaying Alaska and Hawaii as insets. Alaska is displayed at a smaller scale than the map of the contiguous 48 states, because it is large in land area. Hawaii, New York City, and the District of Columbia are displayed at larger scales than the contiguous 48 states because these areas are relatively smaller in land area. Since these maps are thematic in nature and were not designed for displaying or measuring distances, we have chosen not to provide the exact linear scale for each map.

*Figure 2.1*
*Example of layout for national heart disease mortality maps*




## Guide to National Maps of Local Social Environment

An emerging body of research has recently emphasized the importance of the social environment in influencing population patterns of heart disease mortality. Local social environments provide the context within which individuals live and work, and can create both barriers and incentives to the maintenance of healthy homes, work environments, social networks, and individual lifestyles.[3,4,5] We created several maps that represent four dimensions of the social environment relevant to geographic patterns in heart disease mortality.

The first dimension was *population distribution.* In a series of five maps, the residential location of women aged 35 years and older during 1991-1995 was portrayed separately for each race and ethnicity group. The second dimension was *local economic resources.* Using data on median family income, occupational structure, and unemployment rates for counties, an index of local economic resources was created and mapped. The third dimension of the social environment we examined was *social isolation of elderly women.* We mapped two indicators of women's social isolation for women aged 60 years and older: prevalence of living alone and prevalence of mobility or self-care limitations. Finally, the fourth dimension was *medical care resources.* Maps of county distributions of cardiovascular specialty physicians, coronary care unit beds, and cardiac rehabilitation units were produced. Detailed information on data sources and indicator definitions can be found in Appendix B.

Evaluation of the maps of the social environment in conjunction with the heart disease mortality maps may suggest hypotheses about the determinants of geographic disparities in heart disease death rates among women. These maps also provide important information useful for developing programs and policies to reduce the burden of heart disease among women.

## National Population Distribution Map Layouts

One set of maps in this section, the population distribution maps, display two indicators on the same map and use a legend that may be unfamiliar to many readers. In the example shown in Figure 2.2, the first indicator is the percent of all women in each county who were black, and the second indicator is the number of black women in each county. Values of each indicator were divided into three categories. The cutpoints for the categories were chosen to best display the range of variation in population distribution across counties. Consequently, an unequal number of counties fell into each of the three categories for each variable. The categories for the percent of all women who were black were 1) less than 10%, 2) 10%-34%, and 3) greater than or equal to 35%. The categories for the number of black women were 1) fewer than 5000, 2) 5000-49,999, and 3) greater than or equal to 50,000. The same cutpoints were used for the maps of all the race and ethnicity groups.

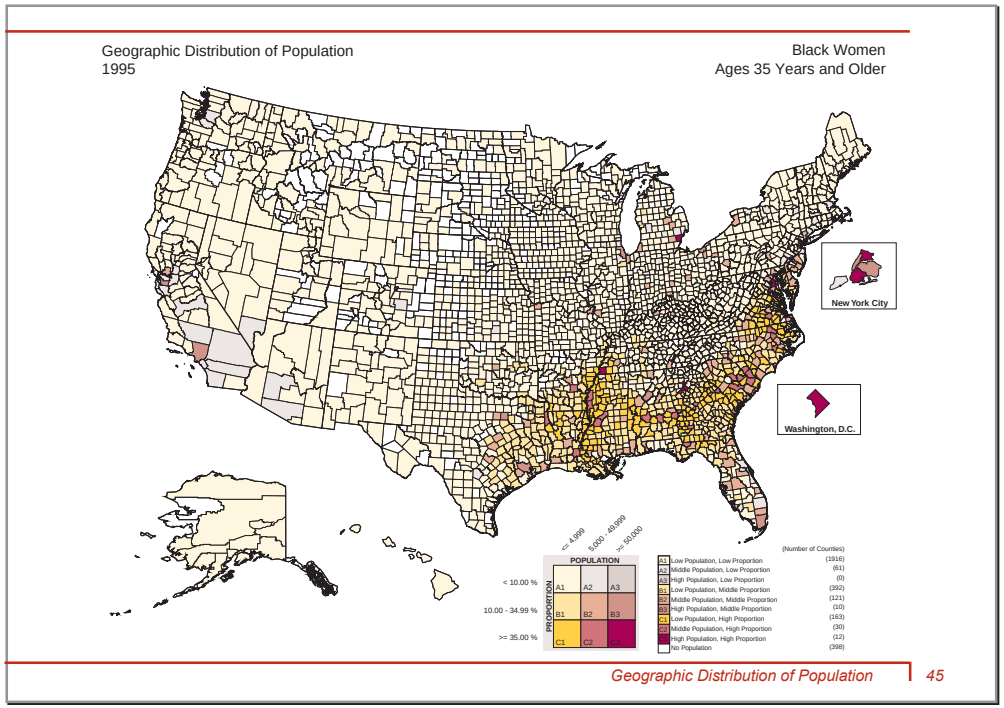
Combining the two indicators resulted in a total of nine categories for mapping which are displayed in a grid format in the legend. There are two color axes on this grid which correspond to the two indicators. Shades of yellow-gray are used for the population number indicator, and shades of yellow-orange are used for the population percent indicator. Categories at the top and left of the grid show low values of the indicators, while categories at the bottom and right of the grid show high values of the indicators. Numbers of counties in each category are also shown in the legend.

## Guide to State Maps of Heart Disease Mortality

To create the state heart disease mortality maps, we used the same heart disease death rates that were generated for the national heart disease mortality maps. A description of the methods used to calculate the rates can be found on pages 28-29. It is important to remember that each county rate is based on a spatial moving average of that county and its neighbors. Therefore, for a county in a given state, neighboring counties that are part of adjacent states contributed to the smoothed rate for that county, even though those neighboring counties are not displayed on the state map.

There is one important difference between the national maps and the state maps. The five categories (quintiles) into which all counties are grouped on the national maps were derived

*Figure 2.2*
*Example of layout for national population distribution maps*



from the range of heart disease death rates experienced by women in counties across the nation. Consequently, all the counties in a particular state could fall into the same quintile and be the same color on a national map. At the state level, we derived quintiles based only on the smoothed heart disease death rates for counties in each state. Therefore, each state has counties that fall into five different quintile categories.

In addition, separate quintile cutpoints were generated for each race and ethnicity group within each state. Our rationale for having separate cutpoints by race and ethnicity was the same as for the national heart disease mortality maps, namely, we wanted to display the full range of geographic variability for each racial or ethnic group of women. Therefore, comparisons of the spatial patterns of heart disease mortality across the maps should be limited to comparisons of the relative differences among different groups of women. In order to determine whether the mortality rates were absolutely higher or lower for one race or ethnicity group compared to another, the reader must study the relevant legends and compare the cutpoints. It is well worth making a mental note of the range of county heart disease death rates for each group when comparing geographic patterns across maps.

### State Map Layouts

As with the national maps, for ease of use we have standardized the map layouts at the state level. The page layout for the state maps is presented in Figure 2.3, and uses Arizona as an example. The number of maps produced for each state varies, depending on the number of race and ethnicity groups that had sufficient population sizes to permit mapping of heart disease death rates. The number of maps per state ranges from a minimum of two (maps for all women and maps for white women are displayed for all states) to a maximum of six. States for which there are two or three maps have a single-page layout, and states for which there are four to six maps have a double-page layout.

For single-page layouts, the map title, the first point of reference for the reader, appears at the top right with the state name at top left. On double-page layouts, the title appears at top right on even numbered pages and top left on odd numbered pages. The state name can also be used as a quick tab index. The label for race and ethnicity appears at top right on all maps. The legend appears at either the bottom right or bottom center on each map. Counties in the highest rate quintile are the darkest color, while counties in the lowest rate quintile are the lightest color. Counties for which there was insufficient data to calculate a heart disease death rate are shaded gray.

For each state, a table is displayed on the bottom left hand side of the first page of the layout. This table includes summary data for the state as a whole. State population counts for 1995 are provided for each of the racial and ethnic groups. Since all Hispanic women were also included in one of the four race categories, the population count for all women represents the sum of the four race groups only. Heart disease death rates for women of each race and ethnicity are presented in this table. For some states, a particular race and ethnicity group may not have a county map displayed but will have an overall heart disease death rate presented in the table. This is not an error but simply reflects the fact that there were not two counties with sufficient data to generate rates (the minimum necessary for a map) but that there were sufficient data for the state as a whole to calculate a rate for that race or ethnicity group.

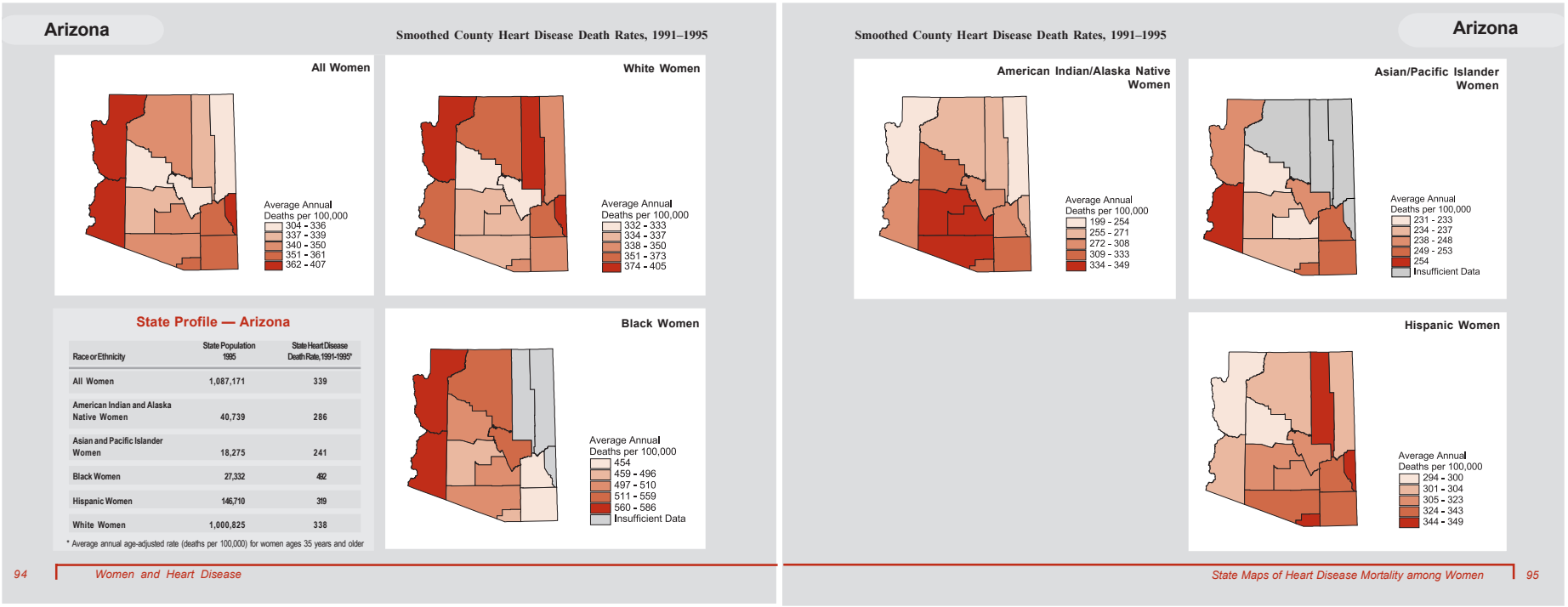
### State Map Projections

All states were projected using the State Plane system. Every state has a separate, official State Plane system of map projection based on the shape and orientation of the state. Each State Plane system has a standard projection or series of projections based on the Transverse Mercator or Lambert's Conformal projection. In the case of states with multiple State Plane zones, we used the central zone, or the zone that caused minimum distortion to the state as a whole. The benefit of using the State Plane projection is that other geographic information for each state is likely to be available in the same projection, which makes comparison with external data more convenient.

## Scale of the State Maps

For each state, the scale is consistent across the maps for different racial and ethnic groups. However, each state is mapped at a different scale compared with other states because we used the largest scale that would fit the layout, in order to maximize the size of the state image. Therefore, states with a small land area were mapped at a larger scale than states with a larger land area. Comparisons among states should be performed recognizing that, for different states, a unit length on the page will not represent the same distance on the ground. It is useful to use the national map as a point of reference when comparing individual state maps. Because these maps are thematic and were not designed for displaying or measuring distances, we have not provided the exact linear scale for each map.

*Figure 2.3*
*Example of layout for state heart disease mortality maps*




[1] Chiang CL. Standard error of the age-adjusted death rate. Vital Statistics - Selected Reports. Washington DC: U.S. Government Printing Office 1961: 47(9).

[2] Cressie N. *Statistics for spatial data*. New York: Wiley, 1991.

[3] Armstrong D, Barnett E, Casper M, Wing S. Community occupational structure, medical and economic resources, and coronary mortality among U.S. blacks and whites, 1980-1988. *Annals of Epidemiology* 1998; 8(3):184-191.

[4] Robert SA. Community-level socioeconomic status effects on adult health. *Journal of Health and Social Behavior* 1998; 39:18-37.

[5] Wing S, Casper M, Hayes C, Dargent-Molina P, Riggan W, Tyroler HA. Changing association between community occupational structure and ischaemic heart disease mortality in the United States. *Lancet* 1987; 11(7):1067-1070.