A Rural Socioeconomic Risk and Resiliency Inventory and Associated Health Outcomes

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EXECUTIVE SUMMARY

Background: Social and economic variables are among the strongest predictors of health outcomes [1,2]. However, strong associations between socioeconomic status (SES) and health outcomes do not exist for all diseases and are not uniform for all populations defined by ethnicity, gender, age, and geography. Potential health risks related to socioeconomic conditions of local areas may be mediated by a number of factors including economic diversity and resiliency in times of economic crisis[3,4]. Rural areas generally lag economically from urban counterparts, often have higher rates of unemployment, lower incomes, higher educational deficits, and tend to be less economically diverse and therefore more susceptible in times of economic hardship. Adverse economic conditions result in immediate adversity from unemployment, loss of income, lack of health insurance and also potential cascading effects that may lead to fragmented public infrastructure and social networks.

In this study we relate social and economic variables to population health outcomes among U.S. counties and identify socioeconomic risks, vulnerabilities, and resiliencies that predict both adverse and favorable health outcomes. We have created for each county a socioeconomic risk and resiliency index (VRI) which quantifies the level of exposure to a set of social, economic, and demographic strengths and weaknesses. The VRI is based on combination of socioeconomic variables that have been shown in the literature to influence health outcomes.

Methods: We processed and collated data from a number of secondary sources to create a database that represents key socioeconomic indicators for every county in the U.S. Data sources included the Area Resource File (ARF), Economic Research Service, U.S. Census, and death certificate data obtained from the National Center for Health Statistics. We constructed the Vulnerability and Resiliency Index (VRI) by ranking six socioeconomic indicators among 3,074 counties in the coterminous U.S. The VRI represents the sum of the ranks for each variable.

Both descriptive and regression analyses were conducted using a number of spatial categorizations (national, census region and division, and county, and rural-urban classification) to assess the degree of association between individual and collective socioeconomic indicators and health outcomes using age-adjusted death rate for major causes of death (heart disease, all-site cancers, stroke). For these analyses we use the rural-urban continuum codes developed by the USDA/Economic Research Service [5]. Rural-urban continuum codes provide a 9-part

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classification scheme that distinguishes metropolitan (metro) counties by the population size of their metro area, and nonmetropolitan (nonmetro) counties by degree of urbanization and adjacency to a metro area or areas (Table 1.). Rural counties are those with either no urban populations or urban populations of less than 2,500.

Table 1: Rural-Urban Continuum Code Descriptions.

Rural-Urban Continuum Code	Description
1	County in metro area with 1 million population or more
2	County in metro area of 250,000 to 1 million population
3	County in metro area of fewer than 250,000 population
4	Nonmetro county with urban population of 20,000 or more, adjacent to a metro area
5	Nonmetro county with urban population of 20,000 or more, not adjacent to a metro area
6	Nonmetro county with urban population of 2,500-19,999, adjacent to a metro area
7	Nonmetro county with urban population of 2,500-19,999, not adjacent to a metro area
8	Nonmetro county completely rural or less than 2,500 urban population, adj. to metro area
9	Nonmetro county completely rural or less than 2,500 urban population, not adj. to metro area

Results: The individual variables used to generate the VRI are: unemployment volatility, social capital index, percent of persons living in poverty, persons aged 25 and older who have completed 4 or more years of college, percent employed in white collar occupations, and the percent of the population living in urban areas. These individual variables, in addition to the VRI, perform well as independent predictors of health outcomes at the national level measured by death rates for leading causes of death, particularly heart disease. Analyses at different geographic levels suggest that the VRI performs fairly consistently across geographic regions. However in several cases the VRI is better as a predictor for certain regions and county rural-urban classifications of the U.S. Regression analyses indicate that the high values of the VRI (representing low vulnerability and high resiliency) are associated with lower rates of heart disease, cancer, and stroke deaths across the rural-urban continuum. However, stronger gradients are evident for heart disease and cancer among counties classified in the rural categories suggesting that rural counties with high vulnerability and low resiliency may experience more adverse health effects.

Conclusions: The VRI performs well in predicting health outcomes and is consistent across geographic regions of the U.S. These analyses support theoretical linkages that have been made in the literature between area-level socioeconomic factors and health outcomes and provide evidence to support the development of programs and policies that promote investment in education and infrastructure to support economic diversity and vitality. These data and analyses suggest that significant improvements in health outcomes in rural areas of the U.S. may be realized by improved economic conditions that improve resilience and lower vulnerability to periods of economic volatility.

INTRODUCTION

There has been growing awareness in the public health community over the last several decades that a person's health (both physical and mental) is linked to contextual circumstances and events in addition to individual risks [6]. Context defines social conditions that effect all who share a particular environment. There are a variety of social landscapes in the U.S. which reflect underlying processes that have served to shape the local cultural norms and behaviors, economic, recreational, and health service opportunities, and health outcomes of local populations. Socioeconomic processes are tied to forms of social organization (relationships and infrastructures) that influence the health and well-being of populations [7,8]. Variability in socioeconomic processes and conditions often reflect social inequalities that contribute to adverse health disparities.

Social and economic factors are among the best predictors of health outcomes, [1-2] however strong associations between socioeconomic status (SES) and health outcomes do not exist for all diseases and are not uniform for all populations defined by ethnicity, gender, age, or geographic area. For example, populations classified as 'rural' generally have many characteristics that would pose health risks such as limited access to health care, or limited educational and employment opportunities. However there is also considerable variability in health outcomes for rural areas in the U.S.

Developing an understanding of the underlying factors that contribute to variability in health outcomes is critical in order to develop programmatic and policy interventions to improve health and reduce health disparities and inequities. Our primary proposition in this study is that socioeconomic conditions are a principal underlying factor influencing health disparities in the U.S. among individuals in addition to communities defined by levels of rurality. Rural areas tend to be less economically diverse than urban counterparts and therefore more susceptible/vulnerable to economic adversity in times of economic crisis. Given the relationship between socioeconomic factors and health outcomes, rural areas may experience more adverse health outcomes.

Developing programs and policies that promote investment in education and infrastructure to support economic diversity and vitality may be necessary to improve health outcomes in rural areas of the U.S. and in addition to urban areas that have experienced economic decline.

This study examines the role of several independent variables, measuring various aspects of socioeconomic condition, in shaping the health outcome landscape in the U.S. We then develop an index, derived from these component variables, that reflects collective socioeconomic strengths and weaknesses of U.S. counties and examine association with health outcomes associated with heart disease, cancer, and stroke mortality.

METHODS

Design: The study is a retrospective secondary analysis of existing data sources. We employ a natural field experimental design in the comparison of health outcomes as a function of independent socioeconomic variables and collective socioeconomic strengths and weaknesses. We construct the Vulnerability and Resiliency Index (VRI) by ranking six socioeconomic indicators among 3,074 counties in the coterminous U.S. The VRI represents the sum of the ranks for each variable. The six variables that were selected are : unemployment volatility, social capital index, percent of persons living in poverty, persons aged 25 and older who have completed 4 or more years of college, percent employed in white collar occupations, and the percent of the population living in urban areas.

Data sources: Data are drawn from the Health Resources Services Administration's Area Resource File (ARF), the U.S. Census Bureau, death certificate data obtained from the National Center for Health Statistics (NCHS), and the USDA Economic Research Service

(ERS). Data were collected or derived at the county level. Due to variability in county definitions and coverage differences among the various datasets, a county database was compiled that accounted for 3,074 counties in the coterminous U.S.

VRI Component Variables

Six key variables were identified for inclusion in the VRI. Together these variables represent a broad spectrum of socioeconomic conditions that each have theoretical linkages to health outcomes.

-Unemployment Volatility

Labor Force and Employment/Unemployment data were obtained through the ERS for the years 1990-2007 for U.S. counties. These data were used to generate a measure of volatility in unemployment rates over this time period. Volatility in rates of unemployment was calculated as the Standard Deviation of annual unemployment rates over the period 1990-2007. Volatility in unemployment rates is used in this study as a key indicator of economic resiliency. Although unemployment has been linked to health outcomes [3], large fluctuations in unemployment rates are hypothesized in this study to reflect overall economic instability and may represent a better indicator of economic resiliency than static unemployment rates.

-Social Capital Index

An Index measuring 'Social Capital' was constructed by a group of researchers at the Penn State University [9]. Social Capital is somewhat of an abstract concept that reflects the degree of social cohesion, trust, and reciprocity among a population. There has been increasing interest in social capital as an influence of the economic growth potential of local areas as well as health outcomes. Our proposition in this study is that high levels of social capital lowers vulnerability and increases resiliency to adverse health effects of economic crisis.

-Percent of Person Living in Poverty

Poverty is commonly associated with poor health outcomes and often reflects social inequities that influence population health outcomes through a number of potential pathways including fewer options for living healthier lifestyles and limited access to health care resources. Data on the percent of persons living in poverty were obtained from the Area Resource File [5]. High levels of poverty are indicative of high vulnerability and low resiliency.

-Percent of Persons 25 years and Older who have Completed 4 or more years of College

Educational attainment is a key variable that represents the general knowledge and skill level of the working age population. High levels of educational attainment may also reflect high levels of economic vitality, and therefore low vulnerability/high resilience. Data on the percent of persons with 4 years of college were obtained from the Area Resource File [5].

-Percent of Persons Employed in White Collar Occupations

Occupational structure has also been related to health outcomes [10]. For this analysis we utilize the percent employed in white collar occupations as in indicator of the prevailing occupational type. White collar occupations are typically associated with higher income and benefits and therefore reduced vulnerability. Data on white collar employment were obtained from the Area Resource File [5].

-Percent of Population Living in Urban Areas

Even among rural counties, settlement patterns vary across the U.S. Many urban/metro counties may have significant populations living in rural areas, others may have populations

concentrated in urban areas with rural areas in those counties devoid of population. Varying settlement patterns among counties likely contributes to variations in the socioeconomic milieus of those counties and therefore may also partially explain variations in health outcomes. The rural-urban continuum codes may not fully account for varying settlement patterns in different parts of the country. We have used the percent of the population living in urban areas to aid in differentiating between settlement pattern types. For example, rural counties in the East may have a large proportion of their population widely distributed in relatively isolated, rural areas and in the West greater proportions of the population are more concentrated in urbanized areas. Data on the percent of persons living urban areas were obtained from the Area Resource File [5]. Counties with high percentages of people living in urban areas are viewed in this study as counties with lower vulnerability.

Construction of the VRI

Each of the component variables was calculated as a proportion to its mean value to generate the individual VRI score. (Descriptive statistics for each component variable are shown in Table 2.) Values for Unemployment Volatility and Percent Living in Poverty were reverse scored to reflect their inverse association with health outcomes (high index scores of Unemployment Volatility and Percent Living in Poverty would be inconsistent with high index scores on the other variables, see Table 2.) Each score was then summed to derive the overall VRI index score. High values of the VRI index reflect high resiliency and low vulnerability and low VRI scores reflect low resiliency and high vulnerability. Descriptive statistics for the VRI component variables are shown in Table 1. Average values for VRI component variables by Rural-Urban classification are presented in Figures 1-6 and the geographic distribution of VRI component variables is shown in Figure 18.

Table 2. Vulnerability and Resiliency Index (VRI) Component Variables.

Variable	Mean (SD)	Maximum	Minimum
Unemployment Volatility	1.4 (.8)	10.28	0.24
Social Capital Index	-.013 (1.3)	7.66	-4.06
Percent 25+ w/4 or more years of College	16.4 (7.7)	60.5	4.9
Percent of Persons Below Poverty Level	13.3 (5.6)	42.2	1.7
Percent White Collar Employment	51.6 (7.7)	83.2	30.7
Percent Urban Population	39.5 (30.5)	100	0

Dependent variables: Three dependent variables representing health outcomes were used in this study. Age-adjusted death rates for heart disease, all-site cancers, and stroke were generated for each U.S. county using individual death certificate data obtained from the NCHS and population denominators from the U.S. Census. Data were aggregated over the period 1995-2001 to improve the likelihood of generating stable and reliable estimates. If a county had

fewer than 20 deaths for any of the three causes of death, a death rate was not calculated and instead was assigned an 'Insufficient Data' value. The geographic distributions of dependent variables are shown in Figures 19-21.

Analysis: Descriptive analyses of VRI component variables was done using urban-rural continuum codes (Table 1, Figures 1-6). The geographic distribution of rural-urban continuum codes are shown in Figure 17. Descriptive analysis was also done to assess rural-urban variations in health disease, cancer, and stroke death rates (Figures 7-9). Rural areas differ in various parts of the country. For example, many rural areas are devoid of human habitation, while others have populations dispersed in relatively isolated areas. Health outcomes are also known to vary by region of the country. Due to potential differences in associations between the VRI score and health outcomes between regions of the U.S., we also analyzed associations by Census Region and Census Division.

Regression analyses were performed to identify general associations between VRI component variables, the VRI, and health outcomes. Regression analyses were performed at the global (all counties) and regional levels to assess the degree of variation in regional associations between the VRI and health outcome variables.

RESULTS

Along the rural-urban continuum, counties towards the rural end of the continuum generally tend to experience more adverse socioeconomic conditions relative to metropolitan counties, however there are exceptions. Average Unemployment Volatility is greater among counties classified as non-metro and those classified as completely rural-adjacent to metro areas, but not completely rural non-adjacent to metro areas (Figure 1). Although the Social Capital Index suggests generally low values among completely rural, non-adjacent counties (Figure 2), the lowest average Social Capital score occurs in metro counties with 250,000 to 1 million population. Counties towards the rural end of the continuum are more represented as socioeconomically disadvantaged in educational attainment, poverty rates, white collar employment, and percent urban population (Figures 3-6).

Overall, the rural U.S. counties fair reasonably well compared to more urban counterparts (Figures 7-9). The peak of the average heart disease death rate distribution occurs among counties which are non-metro with an urban population of 2,500 to 19,000- not adjacent to a metro area. Counties on the rural and metropolitan ends of the continuum tend to have lower heart disease death rates. Average death rates from all-site cancers are lowest among the most rural counties and tend to generally decline with rural status. Average stroke death rates are higher in the non-metropolitan counties but relatively low among the completely rural-non-adjacent counties.

There are significant regional differences in the relationship between health outcomes and rural-urban classification (Figures 10-12). When disaggregated to the Census Division level, both the magnitude and direction of differences is evident. Average heart disease death rates tend to be higher among counties on the rural end of the continuum in the East South Central, South Atlantic, and New England regions, and lower rural counties in the Pacific Region. Other regions suggest minimal differences in average heart disease death rates by rural-urban status. For average cancer death rates, the West North Central region suggests a continuous gradation in death rates with the lowest rates occurring among rural counties. Average stroke death rates tend to be higher in rural counties of the South Atlantic region and higher among major metropolitan counties in the East South Central region.

VRI scores among U.S. counties are generally lower among rural counties and highest in the major metropolitan counties (Figure 13.). This distribution reflects a relative socioeconomic disadvantage in rural counties demonstrated in the individual VRI component variables (Figures 1-6).

Results from individual regression analyses for the VRI component variables and health outcomes are presented in Table 2. Each component variable is independently associated with each health outcome and highly significant, with the exceptions of Percent Urban Population and Cancer death rate and Unemployment Volatility and Stroke. Positive associations are evident for Unemployment Volatility and Percent Living in Poverty (reflecting weaknesses) and negative associations are evident for Social Capital Index, Percent w/4+ Years of College, Percent White Collar Employment, and Percent Urban Population (reflecting strengths). Overall, the VRI is highly significant in predicting all three outcomes.

Regression models examined health outcomes as a function of the VRI by Census Region and Division and results are presented in Tables 3 and 4. Significant associations were demonstrated for all 4 Census regions for health outcomes with the exceptions of Cancer in the Northeast and West, and Stroke in the West. Among Census divisions, significant associations between the VRI and health outcomes were demonstrated for all divisions with the exceptions of cancer in the Middle Atlantic, West South Central, and Mountain divisions, and stroke in the New England, East South Central, West South Central, East North Central, Mountain, and Pacific regions.

Regressions were also performed to assess the associations between the VRI and health outcomes for each rural-urban classification and the results are presented in Table 5. The VRI is a significant predictor for health outcomes at all rural-urban levels with the exceptions of stroke in non-metro counties with a population of 20,000 or more.

DISCUSSION

Rural areas have general characteristics that may render their populations vulnerable to high risk of chronic (and other) diseases. High rates of poverty, undiversified economies, lack of transportation and social infrastructure, and low levels of educational attainment, all contribute to increase risk of poor chronic disease outcomes. Many rural areas in the U.S. demonstrate adverse health outcomes, however not all rural areas exhibit the same level of adversity and many rural areas have very positive health outcomes relative to metropolitan areas. Overall, fundamental factors associated with socioeconomic conditions and individual socioeconomic status are known to influence health outcomes, however variability in population health outcomes (measured by disparities in death rates) are not clearly linked to these factors in every instance.

In this study we examine a number of factors hypothesized to contribute to population health outcome disparities among counties in the U.S. We expect that no one socioeconomic factor is adequate to explain variability in health outcomes, and have derived a Vulnerability and Resiliency Index (VRI) which combines multiple socioeconomic factors. In addition, we introduce in this study a ‘new’ variability (unemployment volatility) which has not yet been examined in relation to health outcomes, but we hypothesize to be an important measure of socioeconomic resilience and vulnerability related to health outcomes.

As an explanatory tool the VRI performs well in explaining overall measures of health outcomes. In several cases the VRI does not explain variability in health outcomes and alternative models need to be developed to account for these discrepancies. From a policy perspective, the findings underscore the need for policies to improve population health by addressing fundamental determinates of health related to socioeconomic conditions such as economic diversification or job creation programs, policies to support education, and anti-poverty programs.

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Figure 1. Average Unemployment Volatility by Rural-Urban Classification

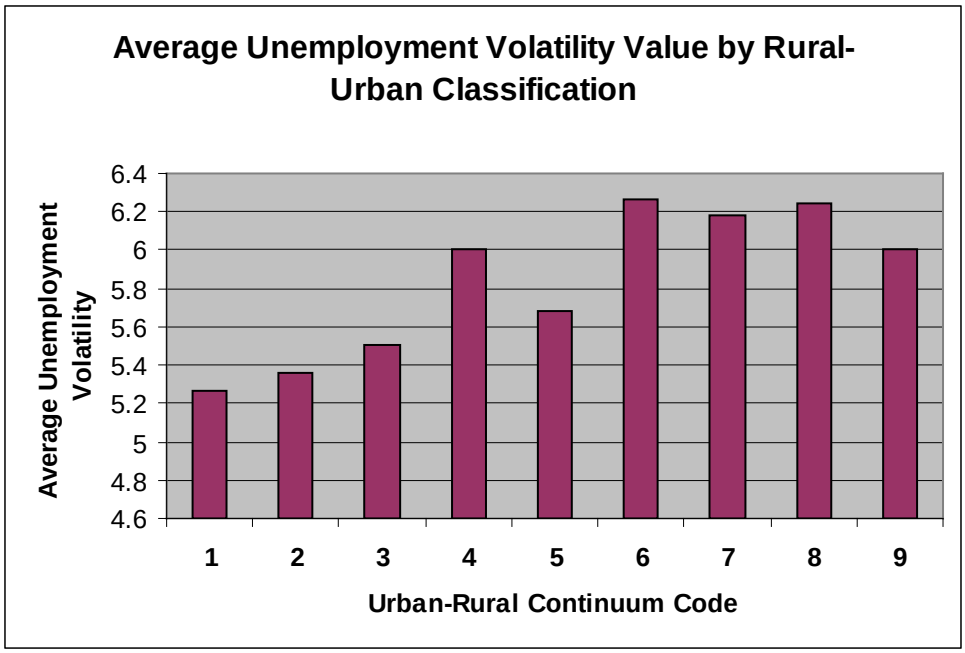


Figure 2. Average Social Capital Index Values by Rural-Urban Classification

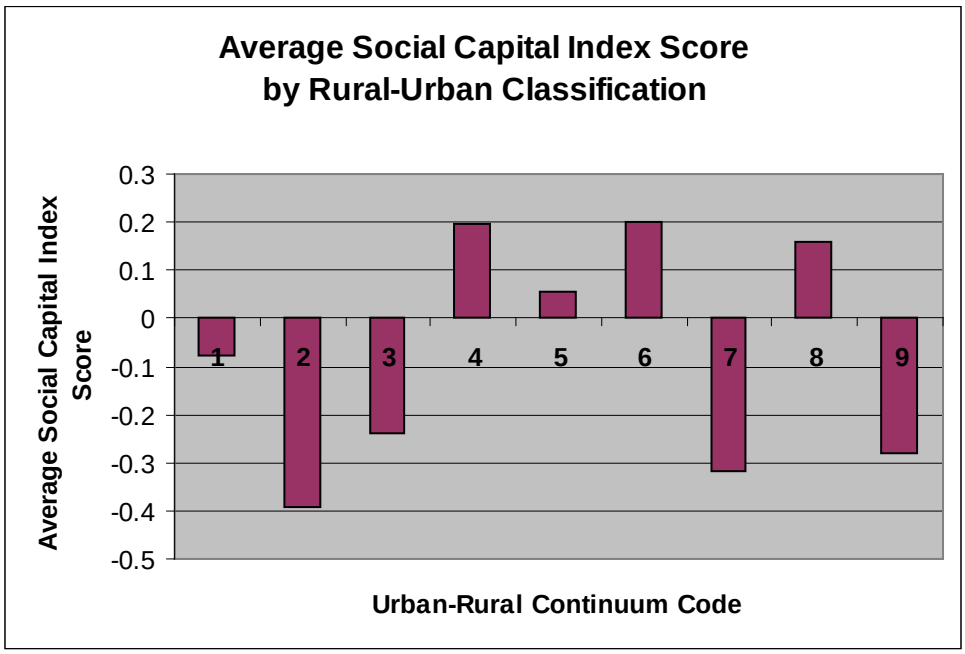


Figure 3. Average Educational Attainment by Rural-Urban Classification

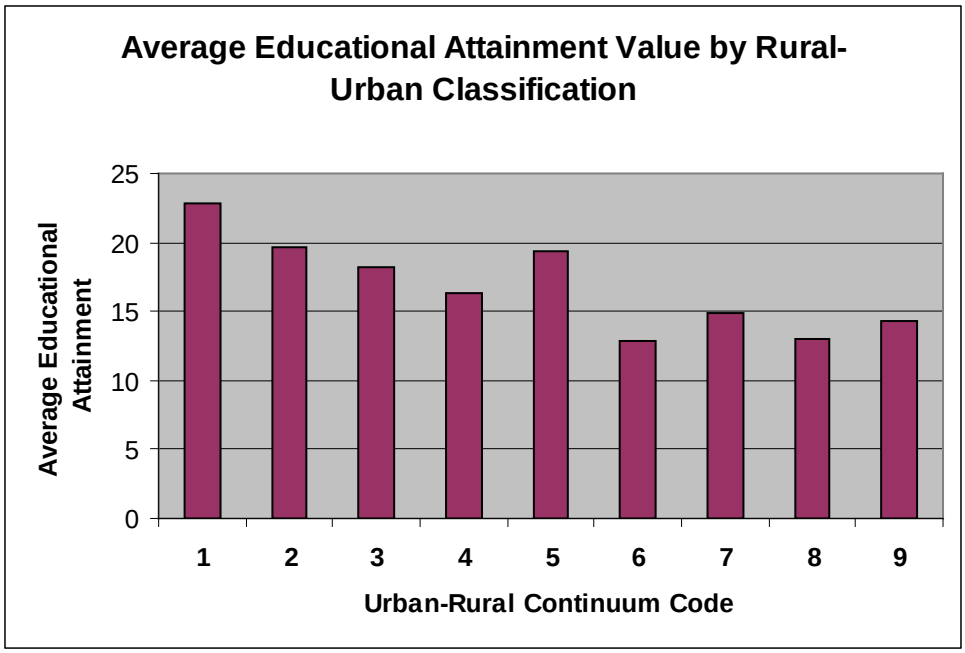


Figure 4. Average Poverty Level by Rural-Urban Classification.

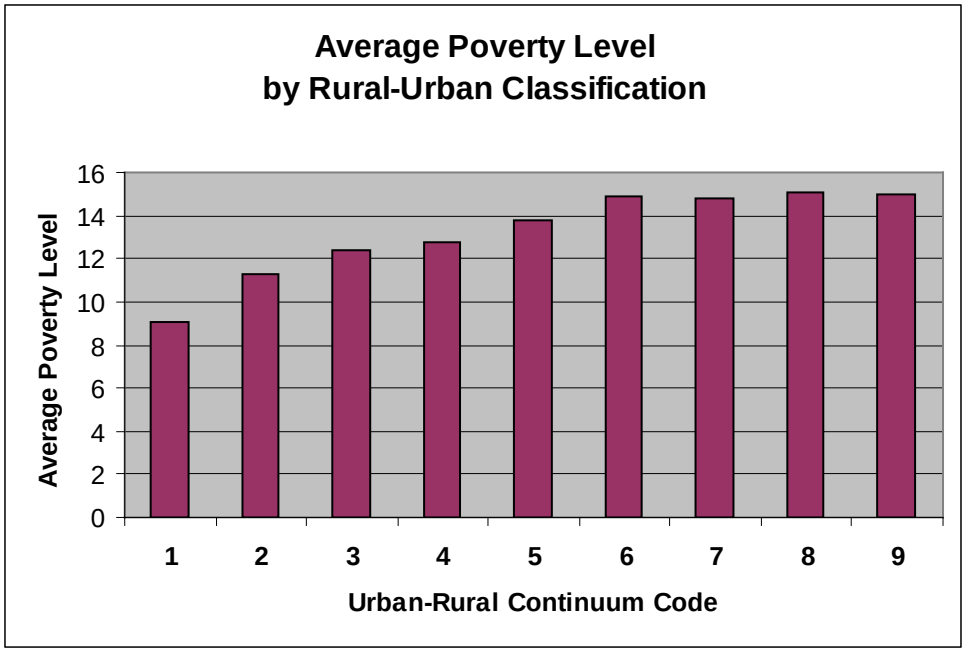


Figure 5. Average Percent White Collar Employment by Rural-Urban Classification.

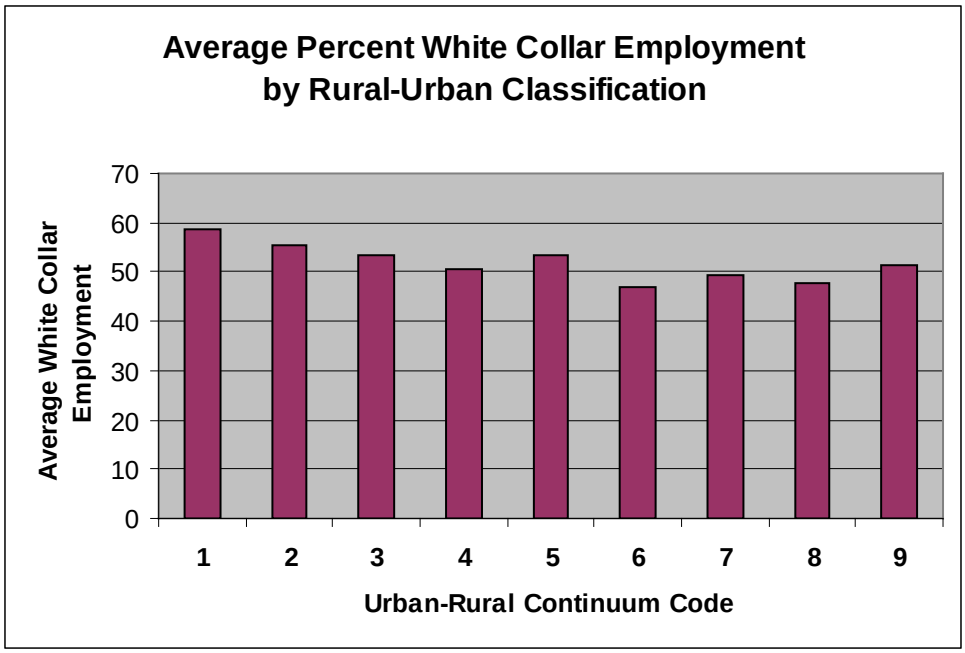


Figure 6. Average Percent Urban Population by Rural-Urban Classification.

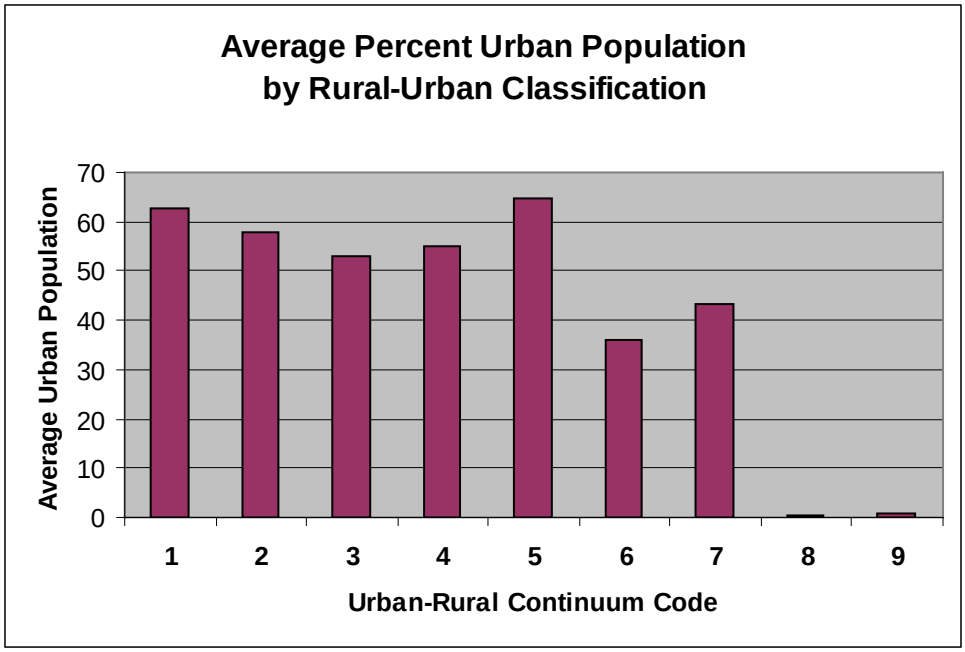


Figure 7. Average Heart DIsease Death Rate by Rural-Urban Continuum Code.

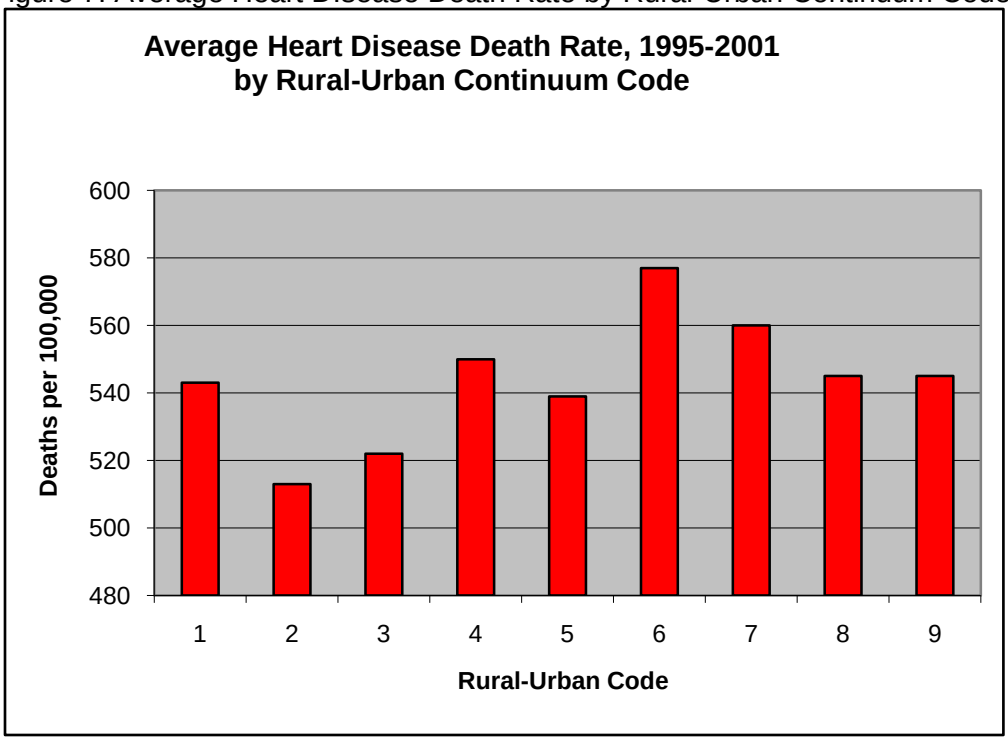


Figure 8. Average All-Site Cancer Death Rate by Rural –Urban Continuum Code.

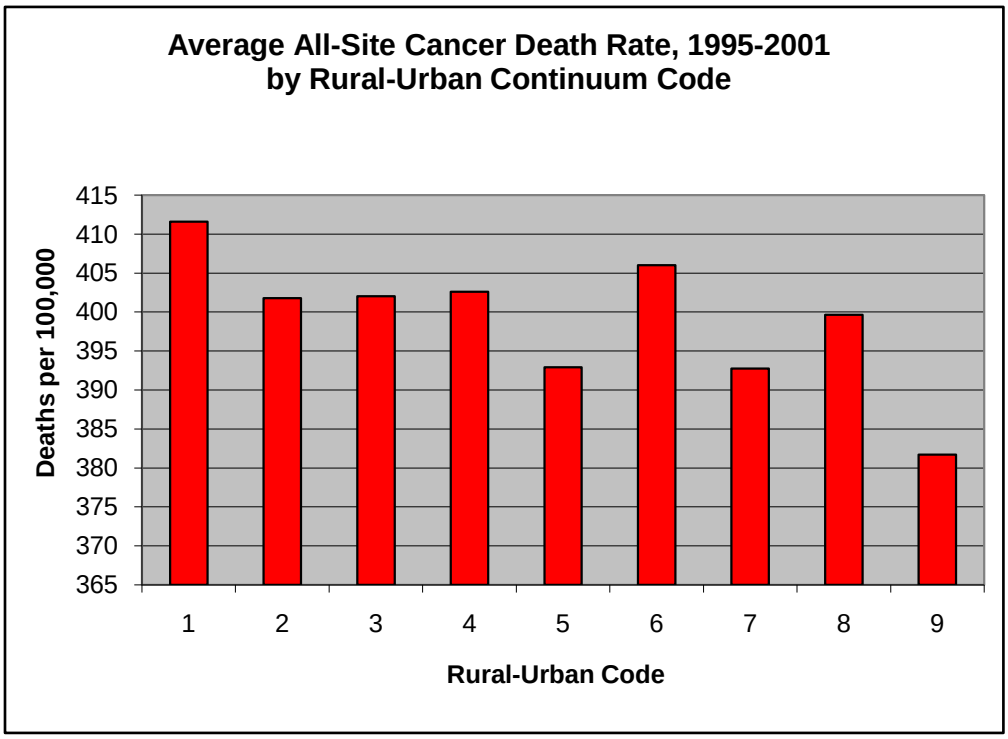


Figure 9. Average Stroke Death Rate by Rural-Urban Continuum Code.

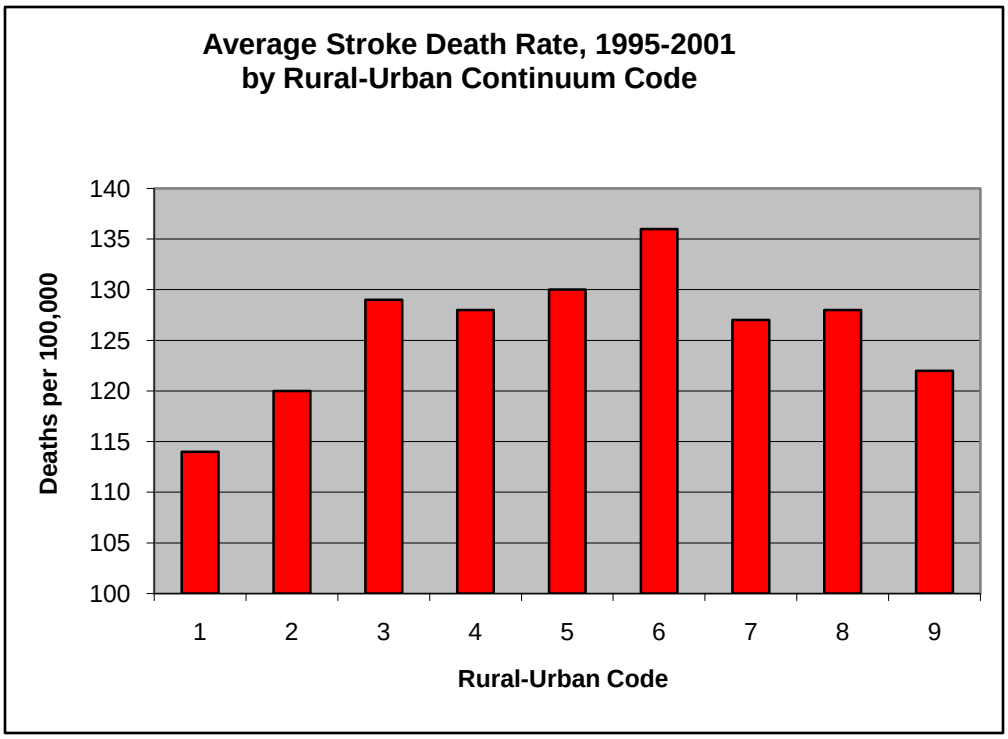


Figure 10. Regional Variations in Average Heart Disase Death Rate by Rural-Urban Continuum Code.

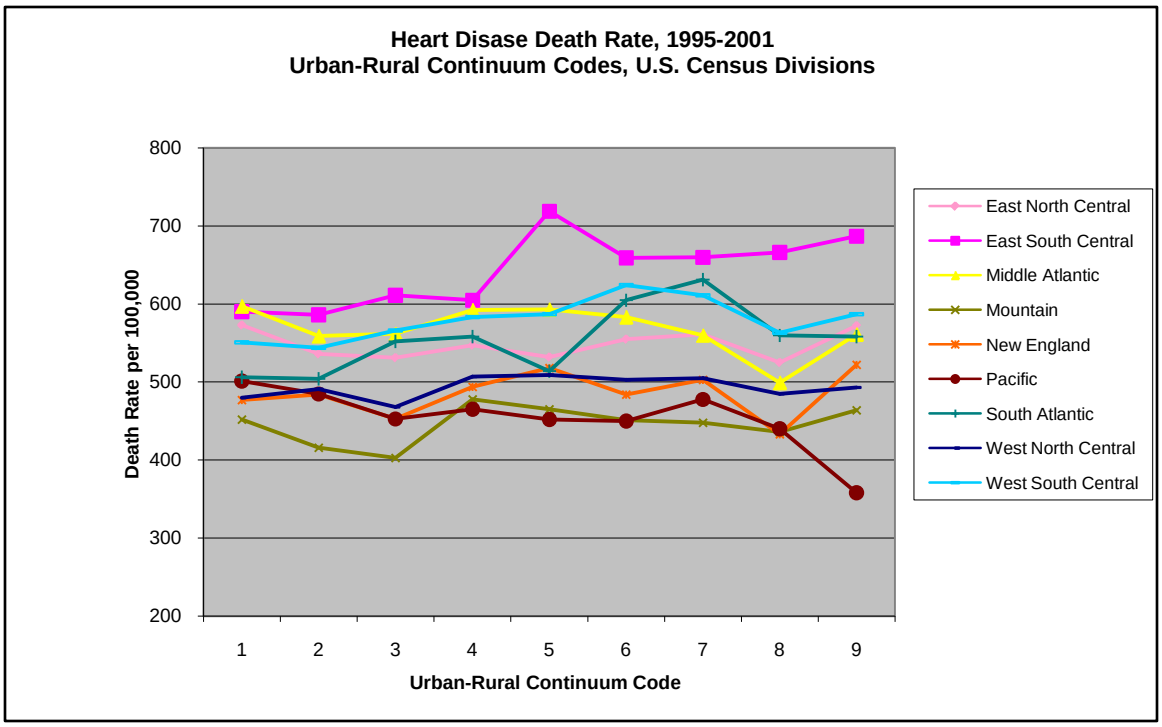


Figure 11. Regional Variations in Average Cancer Death Rate by Rural-Urban Continuum Code.

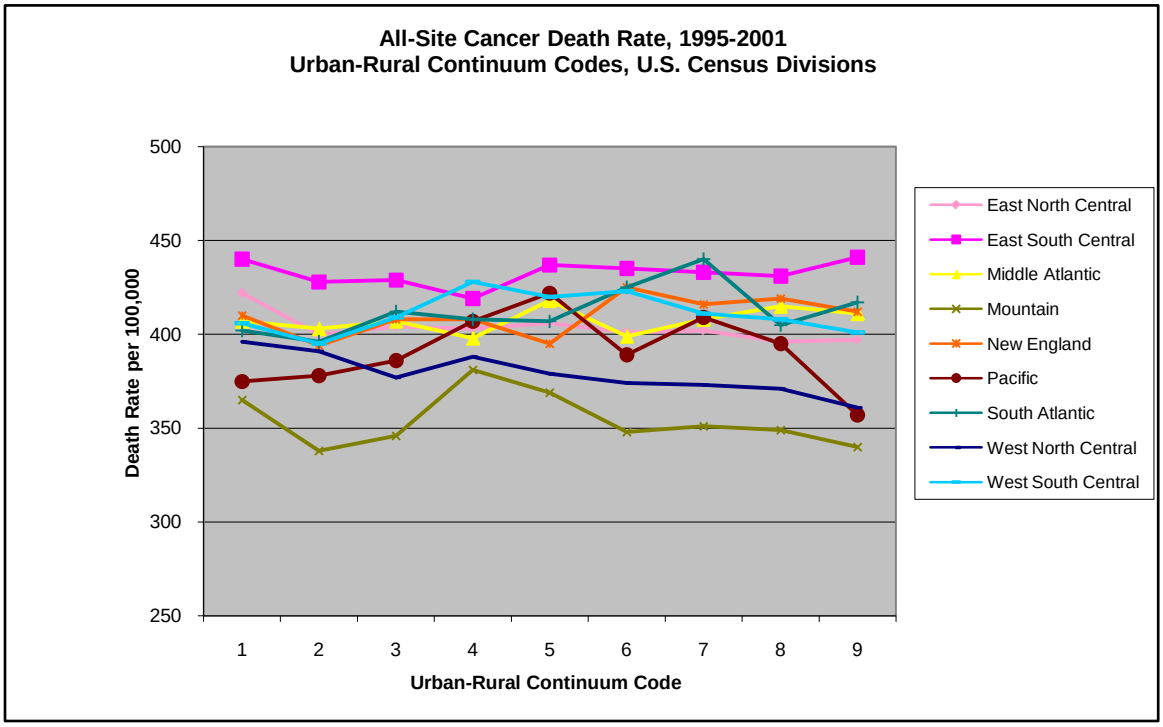


Figure 12. Regional Variations in Average Stroke Death Rate by Rural-Urban Continuum Code.

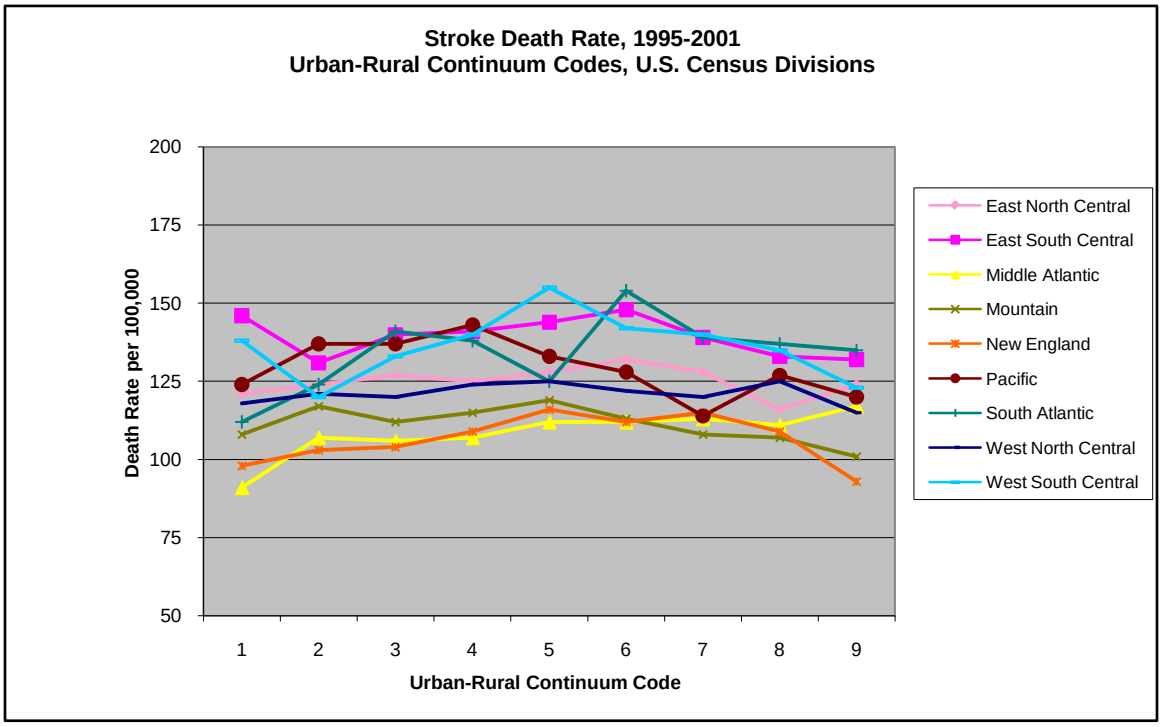


Figure 13. Average Vulnerability and Resiliency Index Score by Rural-Urban Continuum Code.

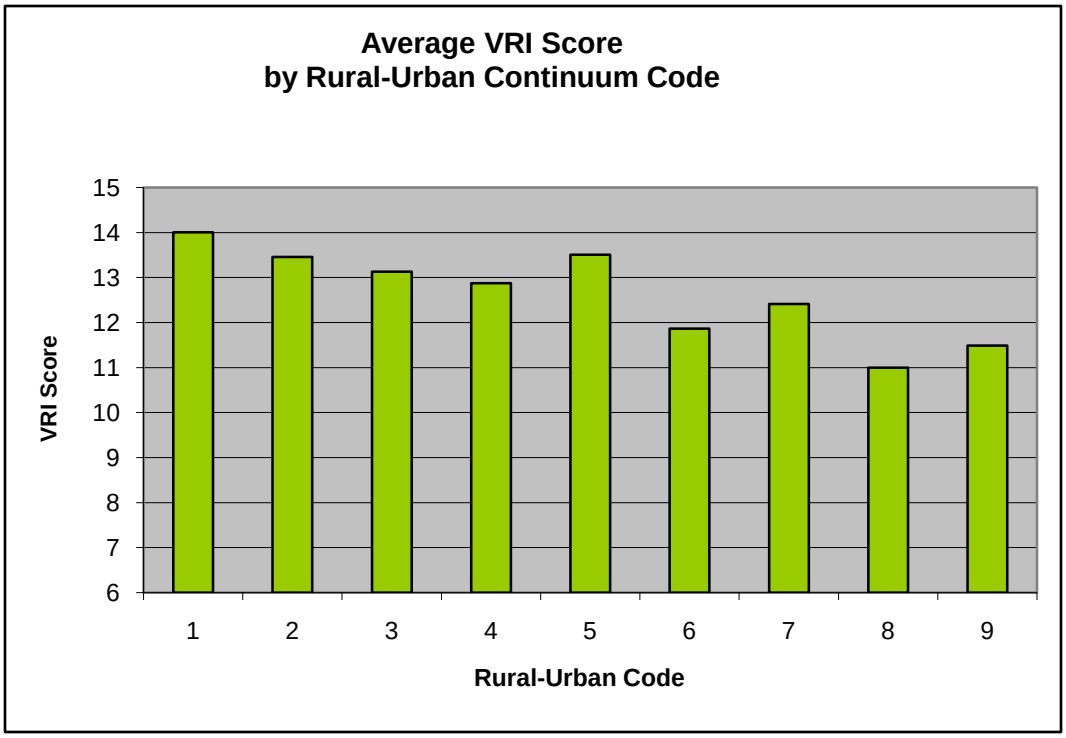


Figure 14. County-Distributions, Vulnerability and Resiliency Index (VRI)– Component Variables.

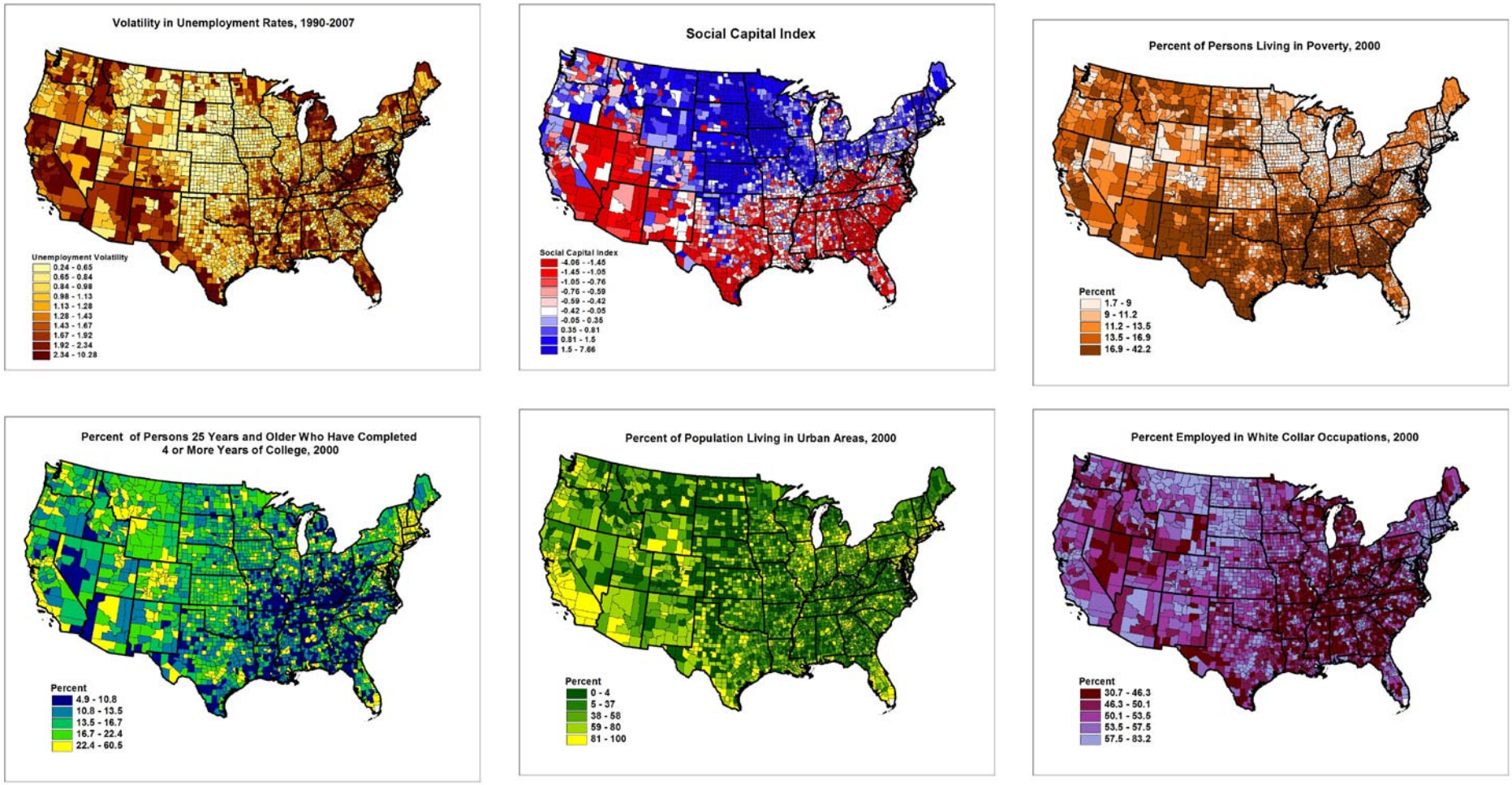


Table 3. Regression results for *all* counties (N=3,074).* Cells are unstandardized regression coefficients with standard errors

	Heart Disease		Cancer		Stroke	
	Estimate (SE)	**P<**	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**
Unemployment Volatility	31.95 (2.5)	0.0001	11.49 (1.2)	0.0001	1.2 (.8)	0.12
Social Capital Index	-36.05 (1.4)	0.0001	-13.66 (.7)	0.0001	-5.17 (.5)	0.0001
Percent w 4+ yrs College	-6.39 (.23)	0.0001	-1.8 (.1)	0.0001	-.075 (.1)	0.0001
Percent Living in Poverty	8.60 (.3)	0.0001	2.68 (.2)	0.0001	1.22 (.1)	0.0001
Percent White Collar Employment	-6.29 (.2)	0.0001	-1.68 (.1)	0.0001	-.92 (.08)	0.0001
Percent Urban Population	.-41 (.07)	0.0001	.05 (.03)	0.143	-.10 (.02)	0.0001
VRI	-26.9 (1.0)	0.0001	-7.26 (.52)	0.0001	-3.44 (.33)	0.0001

Table 4. Regression results for VRI – Death Rate Models, U.S. Census Regions. *Cells are unstandardized regression
coefficients with standard errors.

	Heart Disease		Cancer		Stroke	
Vulnerability and Resiliency Index	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**
U.S. Census Regions						
Northeast	-16.43 (2.9)	0.0001	-1.57 (1.2)	0.21	-2.61 (.7)	0.0004
South	-22.74 (1.4)	0.0001	-4.87 (.7)	0.0001	-1.50 (.54)	0.005
Midwest	-23.21 (1.9)	0.0001	-5.65 (.9)	0.0001	-1.69 (.57)	0.0028
West	-13.19 (2.1)	0.0001	-2.03 (1.4)	0.15	.86 (.8)	0.28

Table 5. Regression results for VRI – Death Rate Models, U.S. Census Divisions. *Cells are unstandardized regression coefficients with standard errors.

	Heart Disease		Cancer		Stroke	
Vulnerability and Resiliency Index	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**
U.S. Census Divisions						
New England	-14.56 (3.1)	0.0001	-5.45 (1.9)	0.0065	-1.28 (1.26)	0.31
Middle Atlantic	-13.19 (3.3)	0.0001	-0.39 (1.6)	0.81	-3.29 (.9)	0.0003
South Atlantic	-23.83 (1.8)	0.0001	-5.18 (.98)	0.0001	-3.78 (.8)	0.0001

East South Central	-20.45 (2.8)	0.0001	-6.03 (1.4)	0.0001	1.18 (1.0)	0.25
West South Central	-13.78 (3.1)	0.0001	-0.49 (1.7)	0.77	.65 (1.07)	0.55
East North Central	-21.39 (2.2)	0.0001	-5.51 (1.25)	0.0001	-0.46 (.77)	0.55
West North Central	-22.56 (2.7)	0.0001	-4.46 (1.30)	0.0007	-2.4 (.8)	0.004
Mountain	-14.50 (2.66)	0.0001	-2.42 (1.7)	0.16	0.85 (1.0)	0.41
Pacific	-12.27 (3.1)	0.0001	-4.72 (1.8)	0.012	0.17 (1.03)	0.87

Table 6. Regression results for VRI – Death Rate Models, Rural-Urban Continuum Codes.
*Cells are unstandardized regression coefficients with standard errors.

	Heart Disease		**Cancer**		**Stroke**	
Vulnerability and Resiliency Index	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**	**Estimate (SE)**	**P<**
Rural-Urban Continuum Code						
1	-26.43 (2.1)	0.0001	-8.67 (1.1)	0.0001	-4.72 (.7)	0.0001
2	-23.81 (3.1)	0.0001	-6.03 (1.5)	0.0001	-3.04 (.9)	0.0006
3	-31.55 (2.8)	0.0001	-7.13 (1.3)	0.0001	-3.37 (.92)	0.0003
4	-25.17 (4.4)	0.0001	-5.17 (2.1)	0.017	-2.48 (1.7)	0.14
5	-43.83 (7.8)	0.0001	-15.20 (3.3)	0.0001	-1.01 (2.1)	0.63
6	-38.68 (3.1)	0.0001	-15.99 (1.6)	0.0001	-5.11 (1.2)	0.0001
7	-45.97 (2.9)	0.0001	-16.14 (1.4)	0.0001	-4.33 (.9)	0.0001
8	-45.53 (5.3)	0.0001	-14.18 (3.1)	0.0001	-4.11 (1.9)	0.0377
9	-46.47 (3.9)	0.0001	-20.30 (2.1)	0.0001	-3.41 (1.3)	0.009

Figure 15. U.S. Census Regions.

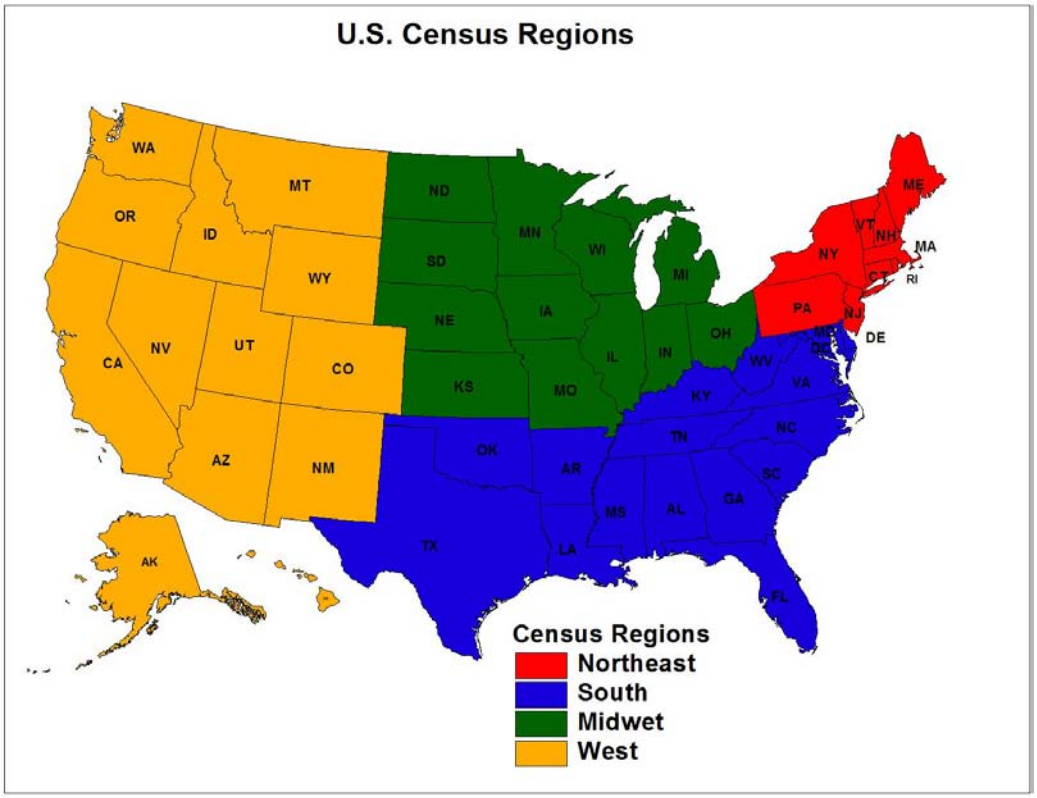


Figure 16. U.S. Census Divisions

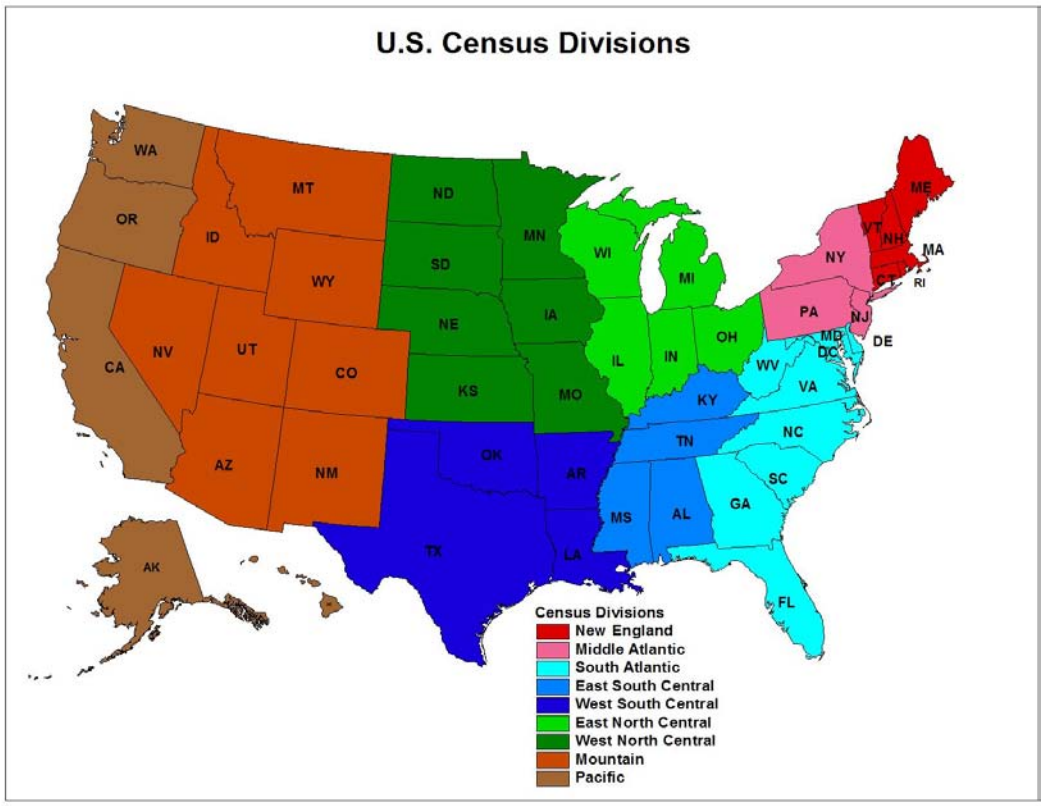


Figure 17. County Distributions of Rural-Urban Continuum Codes.

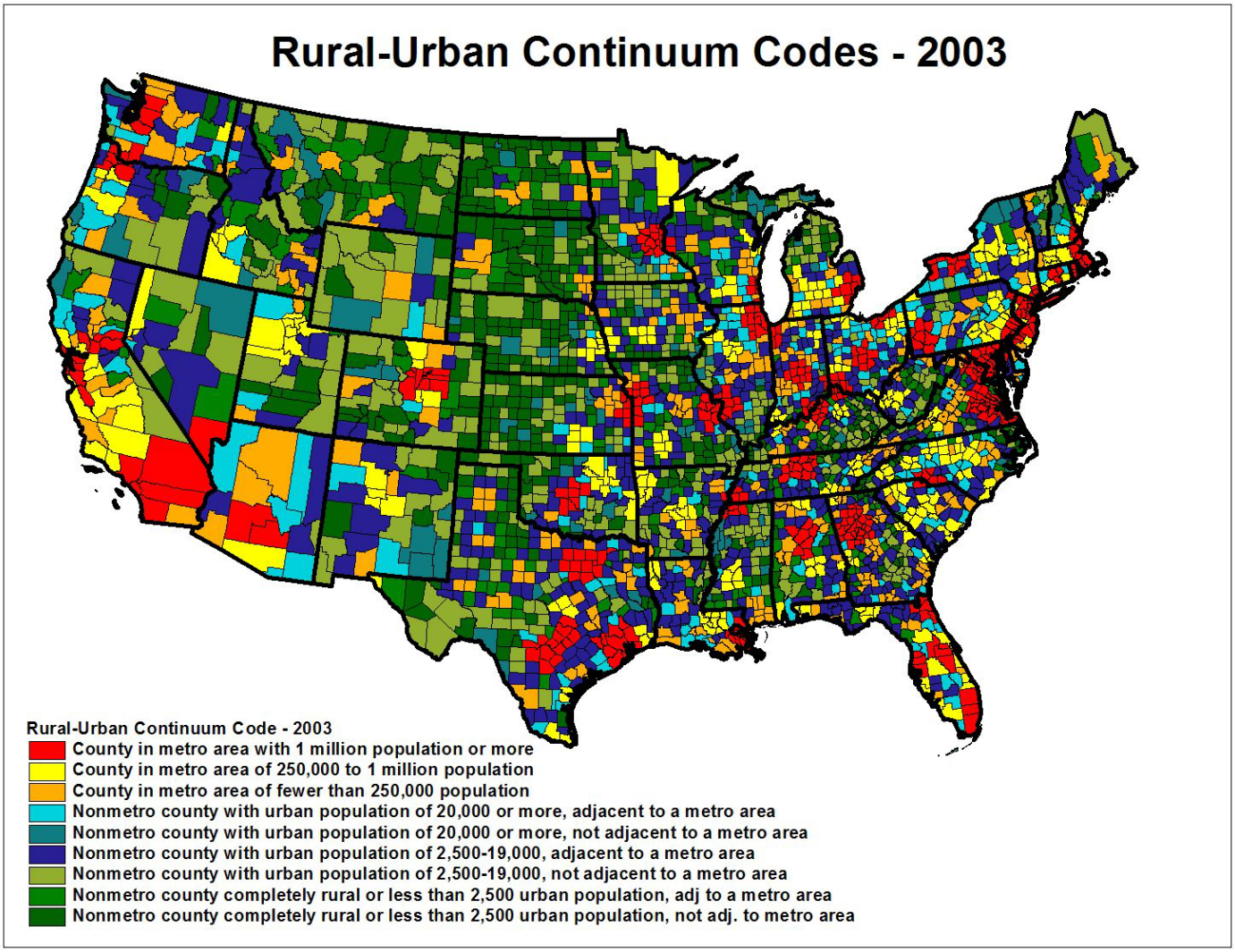


Figure 18. County Distribution, Vulnerability and Resiliency Index.

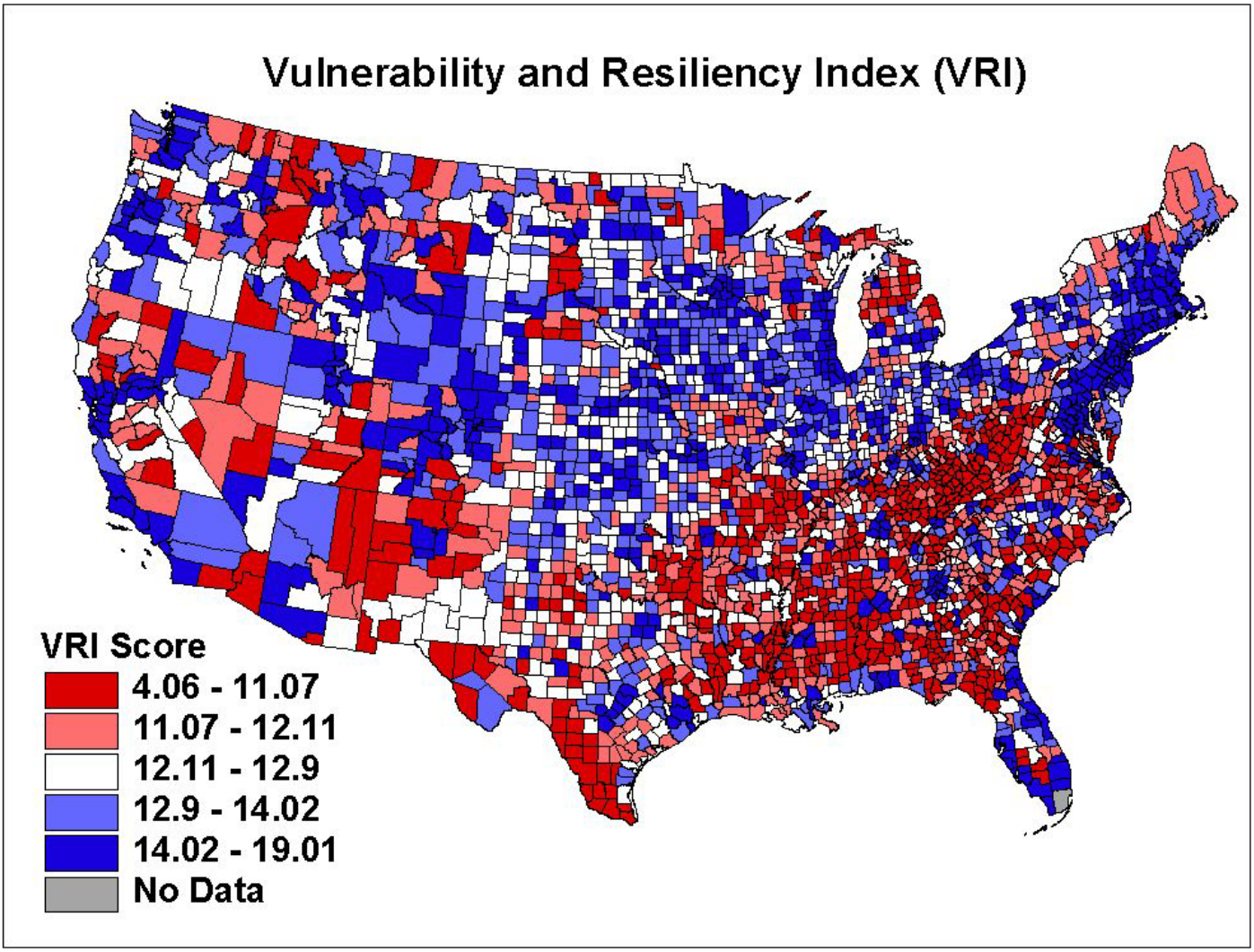


Figure 19. Age-adjusted Heart Disease Death Rates.

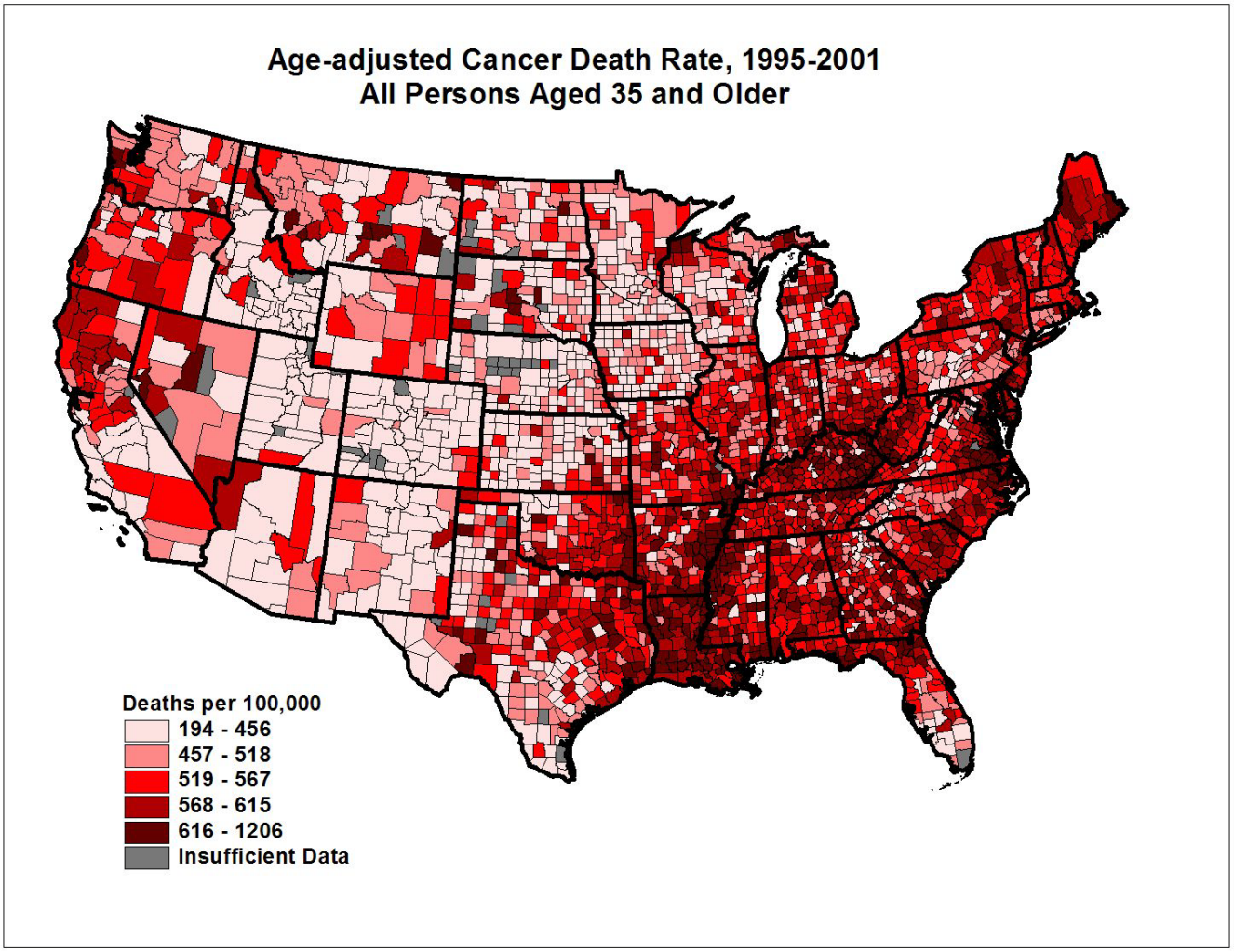


Figure 20. Age-adjusted All-site Cancer Death Rate

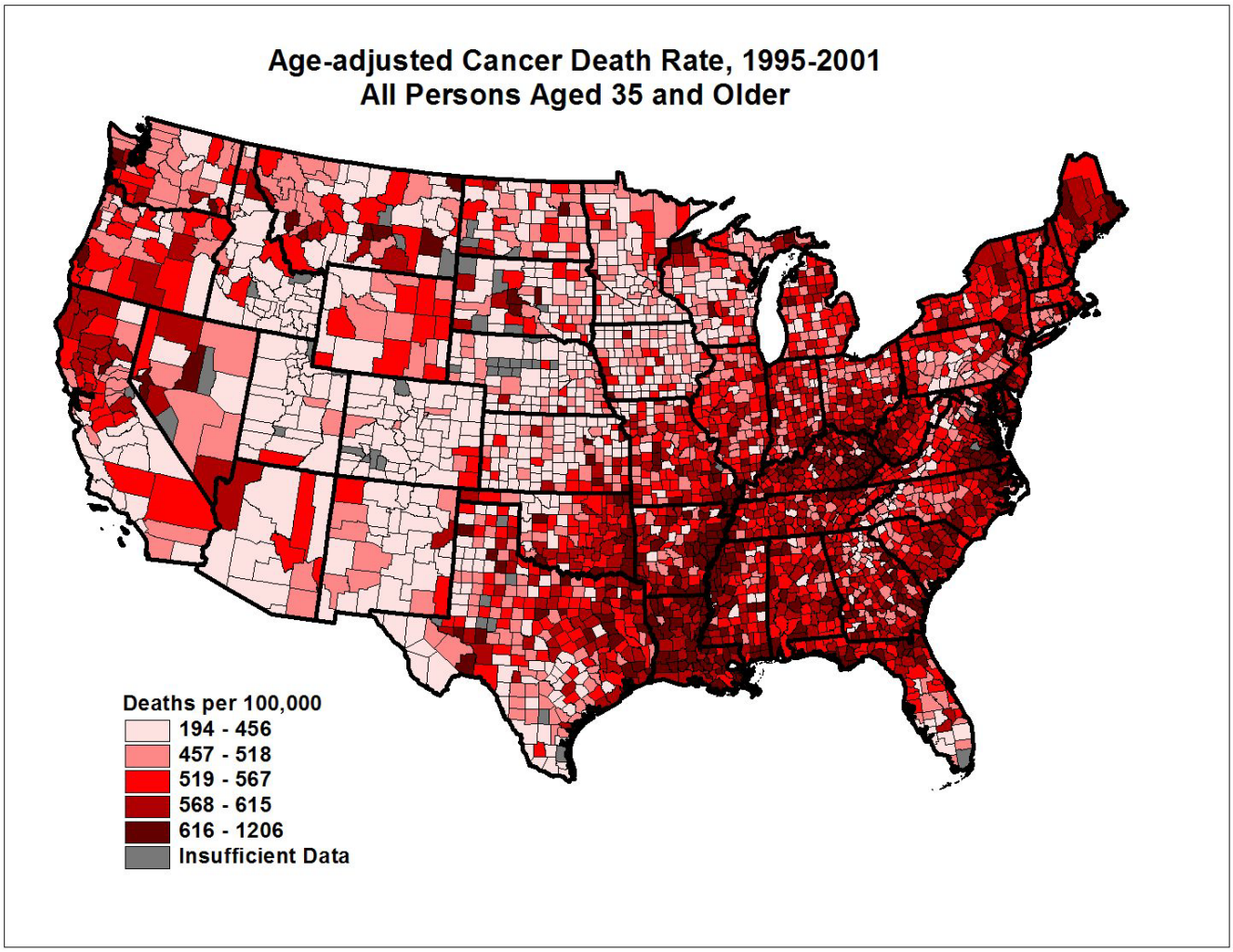
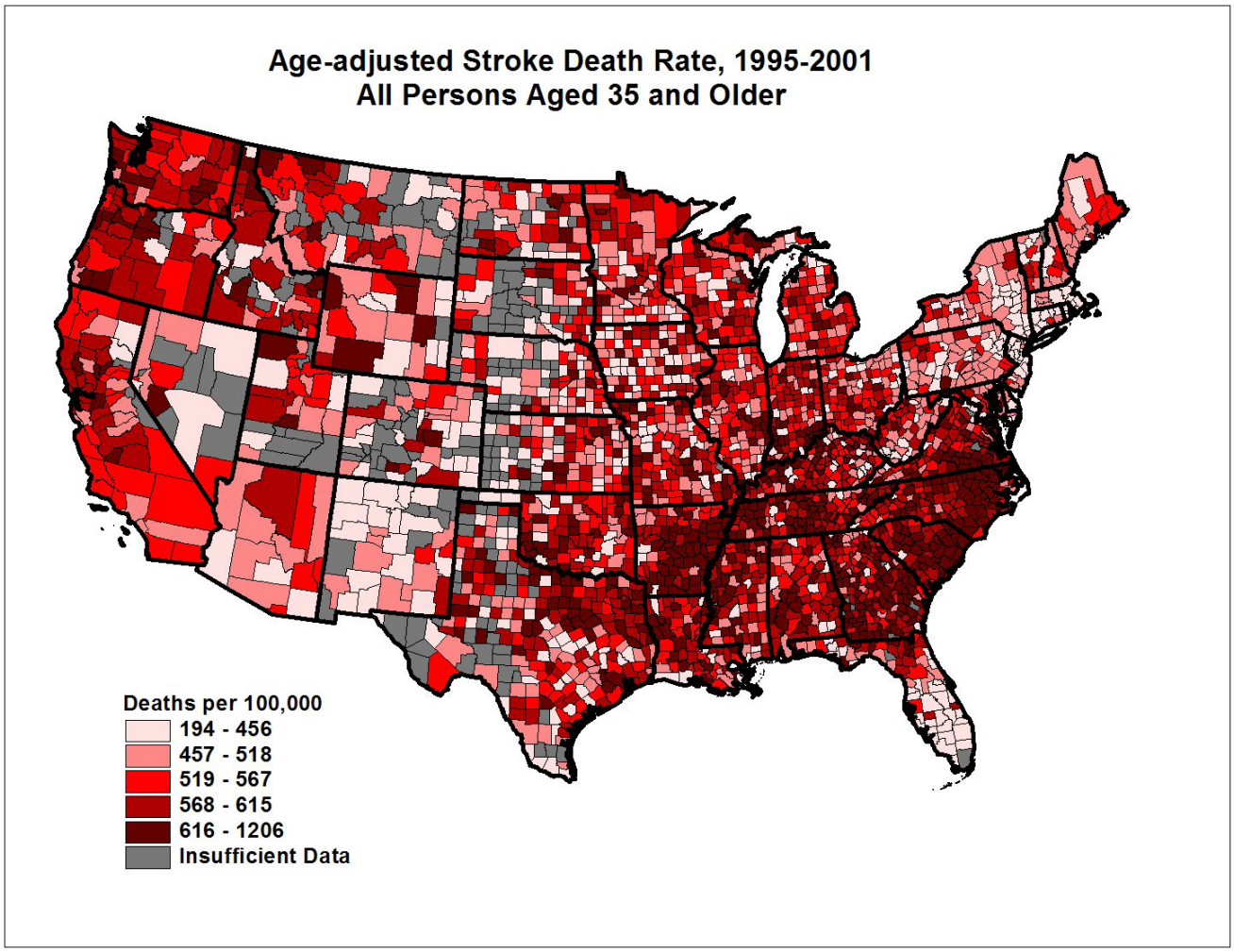


Figure 21. Age-adjusted Stroke Death Rate



Additional Information

See the Full Report that corresponds to this Brief for more detailed methods and findings from this study at: http://wvrhrc.hsc.wvu.edu/projects/2009/halverson/