

Rural Residence Predicts Lower Cardiac Mortality and Better Mental Health Outcomes

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ABSTRACT

Introduction: Previous studies have found higher rates of heart disease and worse mental health outcomes among individuals residing in rural areas. To our knowledge, no research has used county-level data to measure the effect of “ruralness” (the degree to which a county is rural) on heart disease and mentally unhealthy days while controlling for other sociodemographic factors. This study analyzes the effect of ruralness on heart disease death rates and the average number of mentally unhealthy days on a county-level.

Methods: Linear regressions were performed using county-level data to analyze the effect of “Ruralness” on heart disease death rates and mental unhealthiness while controlling for confounding variables. Geographic analysis was also used.

Results: Higher rural-urban continuum codes predict lower rates of cardiac mortality ($\beta = -.075$ deaths per 100,000 people/continuum code, $t = -4.36$, $P < .001$) and fewer mentally unhealthy days ($\beta = -.265$ monthly mentally unhealthy days/continuum code, $t = -16.45$, $P < .001$).

Conclusion: Being from a rural area correlates with lower rates of heart disease death and mental unhealthiness after controlling for sociodemographic confounders. This adds nuance to the previously reported trend of heart disease being more prevalent in rural areas.

INTRODUCTION

Optimal health is often considered a challenge in rural regions. Life expectancy in America’s rural regions is decreasing significantly faster than the national average.¹ Rural Americans are more likely to characterize their health as poor¹ and are more frequently diagnosed with diabetes, asthma, and stroke, amongst other chronic diseases.² They also are more likely to experience heart attacks and heart disease.²

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Heart Disease in Rural Areas

Heart disease risk factors are heightened in modern rural America.³⁻⁶ They include hypertension, hypercholesterolemia, hyperglycemia, smoking, high body mass index (BMI), sedentary lifestyle, family cardiac history, history of preeclampsia, poor diet, and age.⁷ High blood pressure, high cholesterol, diabetes, and prediabetes are more common in rural versus urban areas, which is due in part to increased caloric, fat, and sugar consumption among rural residents.³ The association between rural living and these risk factors has not been explored when controlling for sociodemographic factors.

People in rural areas are more likely to smoke and use other forms of tobacco. Onset of tobacco use tends to be earlier

among rural individuals than those from suburban or urban areas.⁴ Rural citizens also have less access to primary care and other forms of preventive health care,⁸ while access to primary care and other forms of preventive health care have been shown to decrease smoking rates.⁹

Rural Americans tend to have less healthy BMIs than urban Americans, and rural children are more likely to be overweight and less likely to be physically active than their nonrural counterparts.⁵ Rural counties also have fewer resources to support healthy eating and physical activity (eg, nutrition education classes; nutritional services; obesity prevention and weight management programs; physical activities for kids, such as afterschool sports; parks; sidewalks; recreational areas; bike trails; and gyms).⁵ Diet is worse amongst rural adults than urban adults, in that meals tend to have fewer nutrients but are more calorically dense.⁶

Mental Health in Rural Areas

In addition to the heightened rates of coronary health disease, mental health is another health outcome often explored in rural areas. Previously, no difference was found in mental health between rural and urban areas in the US.¹⁰ However, in Great Britain, urban residents were more likely to suffer from psychiatric morbidity, drug dependence, and alcohol dependence than rural residents.¹¹ Time spent in nature has been shown to improve mental health, and people who live in urban areas likely have less access to nature.¹² Rural families also tend to have more social capital than urban families.¹³ From the literature, it is unclear if there is a difference in mental health outcomes between residents of rural versus urban counties.

Research Questions

This study was guided by 2 research questions:

1. Does residing in a rural area increase one's likelihood of death from heart disease?
2. Is residing in a rural area a predictor of good mental health?

Study Objectives

Direct associations of rural living and many health conditions have been widely studied. However, these studies have not thoroughly explored mechanisms behind their associations or controlled for sociodemographic factors. Our study aims to deconstruct associations between rural living and heart disease and mental health by controlling for sociodemographic factors. Mental health was chosen for analysis because of its high prevalence. An average of 8.1% of Americans had depression over any given 2-week period during our investigation.¹⁴ Heart disease was chosen for analysis because it consistently has been the most common cause of death in America.

METHODS

Variables

This study uses county-level data from public sources for every county in the United States. We analyzed 3 main variables. The independent variable was the degree to which a county is rural; the dependent variables were the frequency at which people in that county died from heart disease and the average number of unhealthy days for residents in that county.

Measures

"Ruralness." The degree to which an area is rural can be defined many ways. Acceptable measures include population density, total population, and percentage of gross domestic product based on agriculture. For our study, we defined rural using the 2013 Rural-Urban Continuum Codes, as determined by the US Department of Agriculture.¹⁵ Rural-urban continuity codes range from 1 through 9, with 1 being the most urban and 9 being the most rural.¹⁶ In this study, counties with lower rural-

urban continuity codes were considered urban, and those with higher codes were considered rural.

Heart Disease. County-level data on the frequency at which people die from heart disease was taken from the Centers for Disease Control and Prevention (CDC).¹⁷ For this data, the number of people older than 35 who died from heart disease in a county from 2012-2015, as determined by autopsies, was divided by the county's population per 100,000.

Mental Health. County-level mental health data in 2016 were gleaned from the Behavioral Risk Factor Surveillance System, in which participants were asked, "Thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?"¹⁸ The CDC then used this data to create a discrete variable for the number of mentally unhealthy days per year experienced by individuals.

Sociodemographic Factors. We controlled for education, unemployment, income, race, marriage, and divorce rates. For education, we used county-level percentages of the population with a bachelor's degree or higher from 2012 through 2016.¹⁹ For unemployment, we used county-level data on the size of the labor force, number employed, number unemployed, and percent unemployed each year during 2012-2016.¹⁹ For income, we used median household income of each county and median county household income as a percentage of median state household income.¹⁹ The percentage of people who identify as White, Black, American Indian, Asian, Native Hawaiian, Pacific Islander, or 2 or more races was taken from the US Census. County-level divorce and marriage rates were shared by the National Center for Family and Marriage Research at Bowling Green State University.²⁰ These data were prepared by aggregating marriage and divorce legal records at the county level and dividing the number of people who have gotten married/divorced by the total county population.

Analysis

To answer our first research question, we used linear regressions to correlate incidence of death from heart disease with the "ruralness" of a county while controlling for education, income, unemployment rate, sex, and race. We then mapped heart disease death incidence to visualize the geographical distribution. To create this map, a blank map of US counties was downloaded from Wikimedia Commons.²¹ Data was then converted to comma delimited (CSV) format. This data was mapped by parsing the Wikimedia Commons map (svg file) using Python, the parsing program BeautifulSoup, and a process detailed by Nathan Yau, PhD.²²

To respond to the second research question, linear regressions were used to correlate the number of mentally unhealthy

days with the “ruralness” of a county, while controlling for the same variables mentioned above. The mental health measure was mapped to visualize the geographical distribution. For reference, the distribution of rural counties was also mapped.

RESULTS

Geographic Distribution of Rural Areas and Heart Disease

The geographical distribution of rural counties, according to 2013 rural-urban continuity codes, is mapped in Figure 1. Highly rural areas are located primarily in the center of the country and in Alaska. The geographical distribution of incidence of death by heart disease per 100,000 people per year—averaged 2012-2016—is mapped in Figure 2. The highest level of heart disease was present mostly in the South and in Appalachia. The average number of mentally unhealthy days is mapped in Figure 3; many Midwestern counties had low averages for mentally unhealthy days while many southern counties had high averages.

Simple Linear Regressions

One of the main goals of this study was to measure the effect of the “ruralness” of counties on county-level heart disease death rates and on the average number of mentally unhealthy days in 2016 for residents of counties. To measure these effects, we ran 2 regressions.

The first regression measured the effect of 2013 rural-urban continuity codes on the average number of mentally unhealthy days in 2016, controlling for the percent of residents who have a bachelor’s degree or higher (averaged 2012-2016), the unemployment rate in 2016, median household income in 2016, the proportion of males and females in 2016, marriage rates, and the proportion of Black, American Indian, Asian, and Hispanic residents in 2016 (Table 1). All betas were statistically significant except the proportion of Asian residents and male residents. As was the case in 2015 with mentally unhealthy days, higher 2013 rural-urban continuity codes predicted lower levels of mentally unhealthy days in 2016 in a statistically significant way ($\beta = -.265$, $t[3140] = -16.45$, $P < .001$).

The second regression measured the effect of 2013 rural-urban continuity codes on heart disease death rates per 100,000 people per year (averaged 2012-2015), controlling for the same variables as the first regression (Table 2). All betas had statistically significant, except the proportion of American Indian, Asian, White, and Black residents. 2013 rural-urban continuity codes were found to predict heart disease death rates in a similar way to mentally unhealthy days: higher 2013 rural-urban continuity codes predicted lower rates of heart disease deaths ($\beta = -.075$, $t[3141] = -4.36$, $P < .001$).

DISCUSSION

The purpose of this study was twofold: to explore congruence among previous findings that rural residents are more likely

Figure 1. Map of Rural Counties in the United States

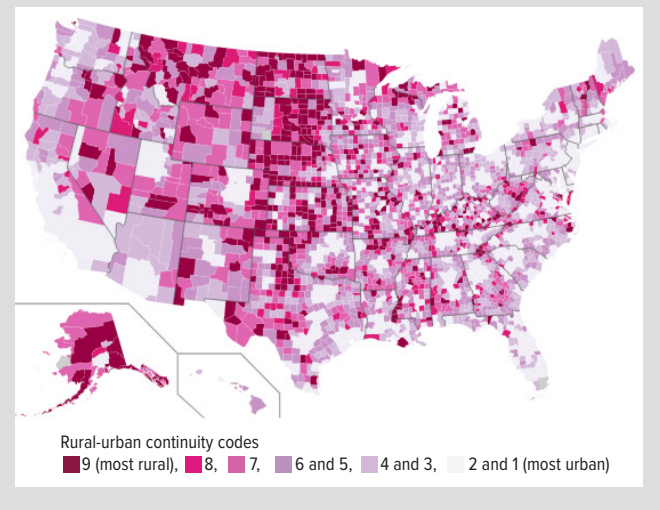


Figure 2. Map of US Counties Based on Incidence of Death by Heart Disease per Year, per 100,000; Averaged 2012-2016

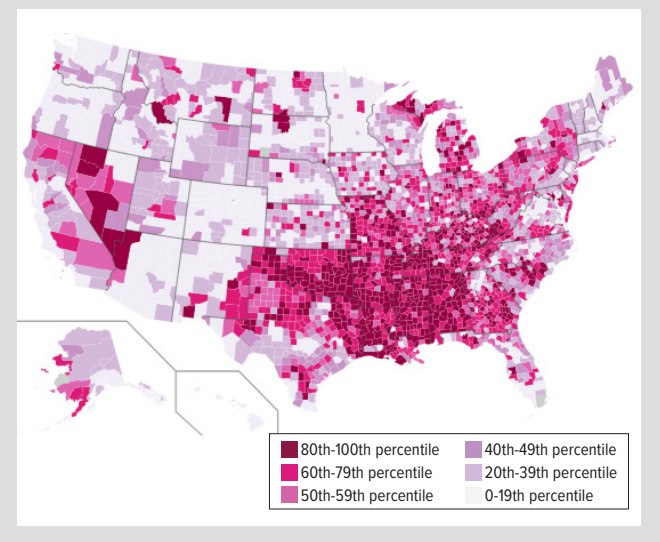
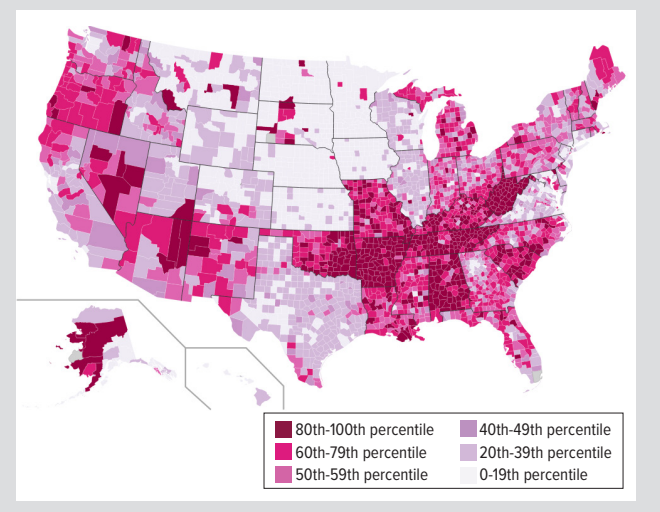


Figure 3. Map of US Counties Based on Average Number of Mentally Unhealthy Days in 2016



to die from heart disease and to clarify ambiguous findings regarding the impact of being from a rural area on mental health. After controlling for several demographic factors, being from a more rural county predicted lower rates of death from heart disease. Similarly, after controlling for the same factors, being from a more rural county predicted fewer mentally unhealthy days.

A key finding of this study was that a county's "ruralness" predicted mental health, with residents of more rural counties having fewer mentally unhealthy days. This finding supported prior research in the United Kingdom wherein people in urban areas had higher rates of psychiatric morbidity and certain mentally unhealthy behaviors than those in rural areas.¹¹ This may be a result of the relative ease of access to green space for rural individuals compared to their urban counterparts. Proximity to green spaces has been associated with good mental health.¹² This also may be a result of people from rural areas having more support from their family compared to their urban counterparts. Previous studies have highlighted this as important social capital that is positively associated with emotional health.¹³ Also, a higher proportion of rural residents are religious, and religion has been associated with good mental health.²³ Both regressions yielded negative relationships between "ruralness" and mentally unhealthy days. We also found that being from a rural area was a predictor of better mental health. However, even though this finding was in line with previous research, it is important to note that seeking mental health care is more highly stigmatized in rural areas, and rural individuals may be more likely to underreport mentally unhealthy days.²⁴

Perhaps the most remarkable finding of this study was that being from a rural county predicted lower rates of heart disease death. This adds nuance to research that has found rural areas to have higher levels of heart disease than urban areas.² More unemployment in rural areas—coupled with less education and income—can be contributing factors to the higher rates of heart disease.²⁵ These characteristics likely mediate the relationship between being from a rural area and dying from heart disease. However, controlling for these factors leads to the intriguing finding that some fundamental aspect of rural coun-

Table 1. Linear Regression, Mentally Unhealthy Days, 2016

ANOVA	Sum of Squares	df	Mean Square	F	P value	Adjusted R ²
Regression	540.706	14	38.622	192.167	.000	.465
Residual	616.809	3069	.201			
Total	1157.515	3083				
Coefficients	Beta	t	P value			
Rural-urban continuum code	-.265	-16.451	.000			
Unemployment rate	.290	17.794	.000			
Income	-.474	-21.617	.000			
Male	.008	.161	.871			
Percent college educated	-.056	-2.782	.005			
Female	1.486	6.368	.000			
White	-1.627	-6.917	.000			
Black	-.404	-5.849	.000			
American Indian	-.129	-4.300	.000			

Table 2. Linear Regression, Heart Disease Death Rates (per 100,000), 2013-2015, Adults Ages 35+ by County

ANOVA	Sum of Squares	df	Mean Square	F	P value	Adjusted R ²
Regression	9239883.23	14	659991.659	145.133	.000	.396
Residual	13956283.1	3069	4547.502			
Total	23196166.3	3083				
Coefficients	Beta	t	P value			
Rural-urban continuum code	-.075	-4.358	.000			
Unemployment rate	.169	9.754	.000			
Income	-.190	-8.167	.000			
Male	-.574	-10.361	.000			
Percent college educated	-.310	-14.575	.000			
Female	.820	3.306	.001			
White	-.269	-1.078	.281			
Black	.117	1.598	.110			
American Indian	-.044	-.118	.906			
Asian	-.005	-.127	.899			
Hispanic	-.268	-11.043	.000			
Marriage	.196	3.714	.000			

ties may be protective against heart disease. Rural communities have been shown to offer more social support than urban communities, and social support downregulates the hypothalamus-pituitary-adrenal axis, which decreases the risk of heart disease.¹³ Regardless, this finding suggests that some characteristic of rural counties, not controlled for in this study, predicts lower rates of heart disease.

Additionally, without controlling for sociodemographic factors, rural living has been associated with higher rates of heart disease mortality. After controlling for sociodemographic factors, this study finds rural living to predict lower rates of cardiac mortality. This means that certain sociodemographic characteristics of rural areas controlled for in this study account for increased heart disease death rates, including unemployment, income, and college education. Rural areas have higher levels of unemployment

and lower income and education, which all are associated with increased cardiac mortality. These 3 factors also predict increased number of mentally unhealthy days. These results imply that cardiac mortality and mental health could be improved in these areas by decreasing unemployment and increasing income and college education.

Limitations

Data was taken from a county rather than individual level. County-level data is not ideal because it does not account for all variation within counties. Data from people of all sexes, races, backgrounds, and experiences were grouped together to form generalized “snapshots” of each county. For the sake of this study, perhaps the most important intracounty variation that was disregarded was the degree to which an individual lived in either an urban or rural area. For example, San Bernardino County is given a rural-urban continuum code of 1 (the most urban); however, San Bernardino County extends from the eastern edges of the Los Angeles metropolitan area across the Mojave Desert to the Nevada border; the vast majority of land in San Bernardino County is unambiguously rural. So, many people in San Bernardino county—and other counties—live in rural areas but are grouped as urban residents in this study. In addition, some people who live in urban areas are grouped as living in rural areas, but this phenomenon is less common. Also, this analysis does not account for migration between rural and urban areas.

The following limitations are also important to consider. The proportions of men and women consistently added up to more than 1.0; this happened because a different population survey was used to estimate sex than was used to estimate population statistics. Also, data was taken from different years; it would be most effective for all data to be taken from the same years.

Future Directions

A logical next step is to extend this study by controlling for additional factors in measuring the effect of “ruralness” on heart disease incidence. Further investigation of religion, family support, and green spaces may help explain the connection between rural living and heart disease and mental health. Additionally, analyzing the effect of our controlled sociodemographic factors can be helpful in identifying targetable interventions to improve outcomes of rural residents.

CONCLUSION

People from rural counties have decreased cardiac mortality and better mental health than their urban counterparts after controlling for sociodemographic factors, such as education and income. Although overall heart disease death rates are higher in rural counties, this trend reverses after accounting for relevant confounders. Being from a rural area appears to be protective against cardiac mortality and mental illness through unknown

mechanisms. This further emphasizes the impact of social determinants of health and the need for further investigation.

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