Health Disparities in Rural Kentucky Counties: Mortality Outcomes and the “Rural Penalty”

Aaron R. Tims

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Health Disparities in Rural Kentucky Counties:
Mortality Outcomes and the “Rural Penalty”

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Scholarship in Medicine Final Report

Abstract

Objective: The object of this paper is to investigate the relationship between rurality and the national top five causes of death in Kentucky counties.

Methods: We used Spearman correlations to quantify the relationship between percent rurality and the crude death rate for heart disease, malignant neoplasia, unintentional injury, chronic lower respiratory disease, and cerebrovascular disease for each Kentucky county. We also used a Spearman correlation to compare and correlate percent rurality and mortality due to heart disease as these two factors changed between data from 2000 and 2010.

Results: Our research demonstrated statistically significant correlations between percent rurality and the crude death rates for all five included means of mortality (heart disease ($r = 0.457, p < 0.001 (5.15 \times 10^{-7})$), malignant neoplasms ($r = 0.518, p < 0.001 (6.65 \times 10^{-9})$), unintentional injury ($r = 0.464, p = 0.001$), chronic lower respiratory disease ($r = 0.757, p < 0.001 (9.72 \times 10^{-12})$), and cerebrovascular disease ($r = 0.561, p = 0.002$)). Further, we found neither correlation nor significance between changes in percent rurality and changes in heart disease as these two factors changed between data from 2000 and 2010 ($r = -0.019, p = 0.843$).

Figures:

Figure 1: Heart Disease vs % Rural
Figure 5: Cerebrovascular Disease vs % Rural

Figure 6: ΔHeart Disease vs Δ% Rural

Figure 7: KY Percent Rurality 2010
Key Words: Kentucky, rural, “rural penalty”, mortality, disparity, heart, lung, stroke, cancer, “unintentional injury”


**Introduction/Literature Review**

Since the mid-1980s, potentially excess deaths* have been worse within rural settings than within their urban counterparts.\(^1\,\text{,}2\) While both groups’ mortality rates have been decreasing, between 1990 and 2004, the rate of decreasing mortality for urban populations and rural populations have been 1.23% and 0.68%, respectively.\(^3\) Research has demonstrated a 75% increase in this gap (the “rural penalty”) between 2004 to 2016.\(^1\) Further analysis revealed that when the outcomes of those in high-poverty in rural areas are considered, the disparity even exceeded that of the established racial disparity suffered by the black population,\(^1\) which is rightly deemed significant enough to warrant intentional action to rectify.

Among the five leading causes of mortality in America (namely, heart disease, cancer, unintentional injury, chronic lower respiratory disease [CLRD], and stroke\(^2\)), rural America exceeds their urban counterparts in all five.\(^2\) While calls to action have sounded from some health organizations,\(^4\) there are still many hurdles in the way. These include the challenges of adequate distribution of resources,\(^1\,\text{,}2\) the economics of the business of rural hospitals,\(^5\) and even the inconsistent definition of “rural” within the literature leading to the unbalanced allocation of Medicare funds to urban centers despite a given rural community’s established need.\(^5\)

The research of Garcia *et al* demonstrated not only this distinction between rural and urban adverse outcomes, but also incidentally demonstrated the American South’s\(^5\) leading position in all but one of these outcomes (in which case it vies for the #2 position).\(^2\) They also point out the need for further analysis to identify ways to “inform the strategic alignment of resources with condition-specific need”.\(^2\) The forthcoming research will investigate some of the relevant data available from County Health Rankings and CDC Wonder in consideration of the counties of Kentucky. We will limit our investigation to one state so that the results might be useful to state-level entities as the distribution of Medicaid and Medicare resources is handled at this level. The state of Kentucky, specifically, was chosen purely at the author’s preference.

**Research Questions**

The impact of rurality on mortality for Kentucky’s 120 counties will be investigated as follows:

- **RQ1**: How do the crude rates for death by heart disease, malignant neoplasms, unintentional injury, chronic lower respiratory disease, and cerebrovascular disease each correlate with percent rurality for each Kentucky county?
- **RQ2**: Does the change in percent rural between the data for 2000 and 2010 correlate with the change in crude rates for mortality due to heart disease between the data for 2000 and 2010 for each Kentucky county?

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* Potentially excess deaths is defined as the number of deaths of individuals under the age of 80 in excess of the expected amount as determined by the average death rate set by the three states with the lowest mortality rate for a given cause of mortality.\(^2\)

\* “The South” is region #4 in their research.
Methods

Context & Data Collection

Data was retrieved from two separate sources and then combined using county name as the key linking the two databases’ tables. Percent rural (both the 2020 and 2011 data, representing the state in 2010 and 2000, respectively) was downloaded from County Health Rankings. This number is calculated by the Census Bureau’s Population Estimates Program (PEP) and represents the percent of a county’s population who is rural. It is calculated by taking the county’s population living within census tracts with a population under 2,500 and dividing by the total county population.6

The remaining data was sourced from CDC Wonder’s Compressed Mortality Data. Specifically, from the available “Mortality for 1999 - 2016 with ICD 10 codes” data. The raw data used was that data that corresponded to 2010 (and 2000 for RQ2) which gave the crude death rates for heart disease, malignant neoplasms, unintentional injuries, chronic lower respiratory disease, and cerebrovascular disease for all 120 of Kentucky counties. This number is calculated by taking count of a given kind of deaths in each county, divided by the county’s population, times 100,000 (making it represent the number of relevant deaths per 100,000 people).7

This Compressed Mortality Data was produced by the Center for Disease Control’s (CDC) National Center for Health Statistics (NCHS) Office of Analysis and Epidemiology (OAE). The information contained therein is sent to the CDC by state registries via the National Vital Statistics System. Total population data is supplied by Bureau of the Census’ modified census counts.

The data had to be manipulated as follows:

The ICD-10 definitions of heart disease, malignant neoplasms, unintentional injuries, chronic lower respiratory disease, and cerebrovascular disease derived from the National Vital Statistics Reports.8

- Heart Disease – (I00-I09, I11, I13, I20-I51)
- Malignant Neoplasms – (C00-C97)
- Accidents (unintentional injuries) – (V01-X59, Y85-Y86)
- Chronic lower respiratory diseases – (J40-J47)
- Cerebrovascular diseases – (I60-I69)

By the nature of working with populations defined as “rural” by their smallness, some data were marked “Unreliable” or “Suppressed” by CDC Wonder due to statistical and ethical (privacy) concerns, respectively. When a county’s data was so marked, it was not considered in the given calculation. Death rates are flagged as unreliable when the numerator counts 20 or fewer. County-level data with fewer than 10 persons were suppressed for the dates we examined. As demonstrated in Table 1 and Table 2, this had an impact on sample size and no correlation was able to include data from all 120 counties, though some sample sizes were less effected than others. The resulting sample sizes ranged from 28 to 110 out of the 120 Kentucky counties studied.

When investigating the impact of change (Δ) in percent rural on heart disease, each county in Kentucky was looked at separately and change in percent rural and change in mortality due to heart disease between 2000 and 2010 were calculated by subtracting year 2000 value data from the 2010 value data. The resulting difference was our value for Δ%rural and Δmortality heart disease.
\[
\Delta_{value} = 2010_{value} - 2000_{value}
\]

A Spearman correlation was then made by comparing \(\Delta\)\text{\%rural} and \(\Delta\)\text{mortality heart disease} for each Kentucky county.

Data Analysis

All research questions were answered using Spearman correlations after checking for normality by visual inspection of each data’s histograms.

Results

The results of our research aligned with the national-level data found in the research.

Using a Spearman correlation to investigate the correlation between percent rural and the crude rate for the top five main causes of death in the nation (RQ1), we found statistically significant correlations for all five. Mortality due to heart disease \((r = 0.457, p < 0.001 (5.15 \times 10^{-7}))\) and unintentional injury \((r = 0.464, p = 0.001)\) demonstrate a weak, though significant, correlation. Mortality due to malignant neoplasms \((r = 0.518, p < 0.001 (6.65 \times 10^{-9}))\) and cerebrovascular disease \((r = 0.561, p = 0.002)\) were moderately correlated with statistical significance. Mortality due to chronic lower respiratory disease \((r = 0.757, p < 0.001 (9.72 \times 10^{-12}))\) was strongly correlated with high statistical significance (Table 1).

<table>
<thead>
<tr>
<th>Table 1: Spearman correlation of mortality data and percent rural</th>
</tr>
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<tbody>
<tr>
<td>Category(^a)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Heart Disease</td>
</tr>
<tr>
<td>Malignant neoplasm</td>
</tr>
<tr>
<td>Unintentional injury</td>
</tr>
<tr>
<td>CLRD</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
</tr>
</tbody>
</table>

Abbreviations: CLRD=Chronic lower respiratory disease
\(^a\) As mentioned, these categories come from National Vital Statistics Reports\(^8\)

These results attest to an increase in percent rurality correlating to an increase in crude rates for mortality from heart disease, malignant neoplasms, unintentional injury, chronic lower respiratory disease, and cerebrovascular disease (Figures 1-5).
We also used a Spearman correlation to investigate a possible relationship between the calculated change in county-level crude rate mortality due to heart disease and percent rural as the data evolved between 2000 and 2010. These calculations demonstrated neither correlation nor statistical significance ($r = -0.019$, $p = 0.843$).

<table>
<thead>
<tr>
<th>Table 2: Spearman correlation of changes in mortality due to heart disease and percent rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation coefficient ($r$)</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>-0.019</td>
</tr>
</tbody>
</table>

Figure 6: Change in Heart Disease vs Change in Percent Rural from 2000 to 2010
Discussion

The existence of a “rural penalty” in the realm of population health is becoming increasingly supported. The data reviewed in this research further supports this construct. This rural penalty appears to be impacting in the American South in particular in regard to mortality outcomes. Kentucky’s 120 counties have a mean rurality of 71.6% and a median rurality of 76% with 28 of the 120 counties’ population being less than 50% rural in the 2010 data. Figure 7 summarizes the data on percent rurality in choropleth form derived from Microsoft Excel’s “Filled Map” functionality.

![Figure 7: KY Percent Rurality 2010](image)

Crude death rates per 100,000 was also mapped to Kentucky counties in separate Excel-derived choropleth maps (Figures 8-12) to illustrate the distribution of these rates, allowing for visual comparison to Figure 7 above. Any county that was excluded from this study due to unreliability or privacy concerns as explained previously were also excluded in the choropleths and show up as a light grey.

Mortality due to heart disease, alongside cancer, allowed for the involvement of the most counties in this study (only 10 counties were excluded for each), likely due to the overall prevalence of mortality due to heart disease and cancer nation-wide. Due to this increased completeness of the data, we can look at Figures 8 and 9 and expectedly find lower crude mortality rates near the urban center of Lexington (Fayette County). Rates within Louisville (Jefferson County) are near average for the state; however, this may be due to the locally-attested-to stark socioeconomic discrepancy between those living in West Louisville (urban poverty) versus East Louisville (suburban wealth), neither of which are rural. This suggestion may be supported by decreased crude rates being found in Oldham County which neighbors northeast Louisville.

As expected from consideration of the work done by Garcia et al., both correlation and significance were found when considering the relationship between crude death rates and percent rural for Kentucky’s 120 counties. This work helps to support their hypothesis on a smaller scale that factors that unevenly impact the rural population (such as access) may result in measurable and detrimental health outcomes. These factors may include distance to adequate acute or chronic treatment or even the simply availability of physicians to provide care as only 9% of physicians wind up serving the 20% of patients in rural areas as described by Bolin et al.
Though the results of our investigation into changes in percent rurality and their effect in changing mortality due to heart disease were unexpected, they still may make sense when considering them from a certain perspective. Heart disease, while it may strike acutely, is due to chronic processes leading to either acute or chronic presentations. It is likely that due to the short, 10-year span between these data points that we were unable to assess the impact on these kinds of chronic diseases. It is also possible that despite changes in percent rurality, the surrounding infrastructure (hospitals, for example) have not had adequate time to establish themselves within the communities or otherwise their patient’s outcomes. Similarly, when a population lacks access to care for so long, it is not unthinkable for a culture of self-sufficiency to develop as a coping mechanism. Now having access, they may not immediately make use of it due to their own cultural biases.

With all things remaining as they are (geographical lack of access, ineffective Medicaid/Medicare funding distribution to rural counties, cultural difficulties, etc), patients living in rural counties throughout the state of Kentucky may expect both a decrease in overall life expectancy from 79.1 to 76.7 per Singh\textsuperscript{10} as well as a statistically significant increased crude rate of the top five causes of mortality nationwide.
Conclusion

This study had the statistically and ethically necessary limitation of being unable to retrieve data from counties who may have been most significantly “rural”. This most notably impacted cerebrovascular disease mortality as seen in Figure 12 where only 28 of Kentucky’s 120 counties could be included in the study.

Additionally, as many of the studied mortality causes are the result of chronic processes, it would have been beneficial to know where the deceased had spent the majority of their lives (it’s possible one might move to the city for better care or more to the country to live out their final days). Such data would be difficult as well as potentially insensitive to attain from the grieving family as well as risk compromising the deidentification of the deceased.

Most importantly, while “percent rural” is helpful, it would be more helpful if we had access to data that looked specifically at whether each of the deceased was rural as opposed to simply living in a county with a high percent rural. This would be a monumental undertaking, however.

Future studies should consider examining change in percent rural and more likely to be acute mortality events like unintentional injury or otherwise increasing the spread of data to look at a subsequent generation. Also, further studies of the American South outside of Kentucky may help to identify areas of need that may otherwise be overlooked in our current context which often prioritizes urban health outcomes due to sheer incidence.

Work must be done to reduce the inequities between urban and rural communities. We must incentivize the creation of hospitals or multispecialty medical centers to reach these rural communities. In addition, an adequate number of physicians (and/or physician-supervised mid-level providers) must be drawn to these rural areas. Further, appropriate distribution of Medicaid and Medicare funding must be implemented to best address these observable and measurable healthcare inequities.
References


