Mortality Disparity Analytics in Rural Health: a Trend and Graphical Analysis

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Abstract
Studies in the United States indicate cause-specific mortality rates are often higher in rural counties than in urban counties. We investigate these findings using a health trend analysis aimed at determining whether rural-urban mortality disparities are persistent over time. Our methodology builds upon past studies' findings. We examine absolute and relative changes, and estimate the average annual rate of change using several models fit to National Vital Statistics System (NVSS) age-adjusted mortality data obtained from CDC WONDER. Data visualization techniques are employed to succinctly convey disparity results across various measurement types. Locating increasing rural health disparity gaps allows policy makers the opportunity to tailor rural health policies and programs.

Key Words: Rural Health; Disparity; Trend; Mortality; Data Visualization

1. Background

This project builds off of the recent study titled "Exploring Rural and Urban Mortality Differences by HHS Region" (Rural Health Reform Policy Research, April, 2016) which examined the top ten causes of death by level of rurality (five rural-urban statuses), age, sex, across the US, by region (ten Health and Human Services regions) as well as within Appalachia and Delta.

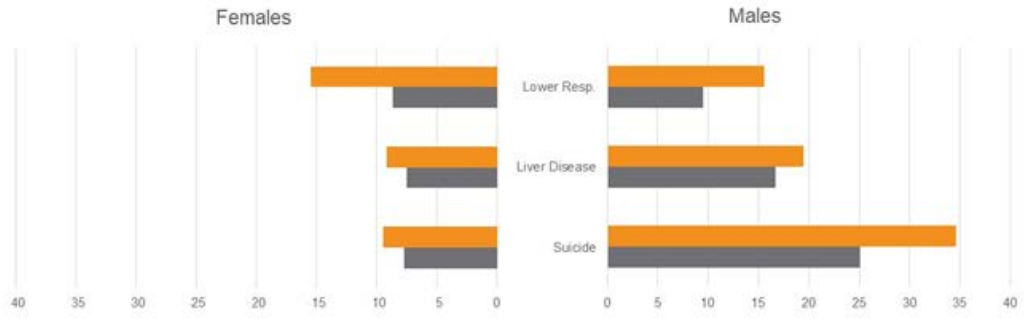

Figure 1: National Cause-Specific Mortality Rates by Gender and Rurality, Ages 25 to 64 Years: US 2011-2013†
† Note: Mortality value are orange for rural rates grey for urban rates.

Within the study, rural-urban cause-specific mortality rates for females and males age 25 to 64 were found statistically different for the majority of causes of death including suicide, liver disease, and chronic lower respiratory disease.

This study examines rural-urban disparities within these three causes of death over time. The study objective is to examine the rural mortality disparity over time instead of for a single point in time.

2. Methods

2.1 Data

We examined annual age-adjusted mortality rates made available by the Centers for Disease Control and Prevention, National Center for Health Statistics for the years 1999 to 2016 on the CDC WONDER Online Database. Multiple cause-of-death data reflect all medical information reported on death certificates not just underlying cause-of-death data.

2.2 Measures

2.2.1 Cause of Death

Multiple cause of death is calculated as the cause-of-death attributed to one or more condition. The cause of death is found on the death certificate and applied based on the International Classification of Diseases (ICD-10). A discontinuity in the cause-of-death trends occurs before and after 1999 as the United States began using the 10th revision of the ICD (ICD–10) in 1999. For this reason, our study only examines mortality rates starting in 1999.

Mortality data are age-adjusted to reduce differences in observed estimates that result from age differences in the population compositions. The projected 2000 U.S. population was used as the standard population. Age groups used for the adjustments include 25 to 34 years old; 35 to 44; 45 to 54; and 55 to 64. For more information see http://wonder.cdc.gov/wonder/help/mcd.html#Age-Adjusted Rates.

2.2.2 Mortality Rate

Mortality rate is calculated by dividing the number of deaths in a population in a year by the midyear resident population and then are expressed as the number of deaths per 100,000 population.

2.2.3 Cause-of-Death

We examined three cases of death: liver disease, chronic lower respiratory disease, and suicide.

Liver disease (ICD-10: K70, K73-K74) includes a range of problems that can cause the liver to fail because of tissue scarring. Alcohol abuse and Hepatitis are the most common causes of liver disease (Johns Hopkins, 2018). Included in liver disease are alcoholic liver disease (K70), chronic hepatitis, liver disease not elsewhere classified (K73), and fibrosis and cirrhosis of liver (K74).

Chronic lower respiratory disease (ICD-10:J40-J47) includes a range of diseases that affect the lungs and airways, making it difficult to breath. Smoking is the largest contributor to chronic lower respiratory disease. Other common causes include air pollutants, genetics,

or infections (CDC, 2017). Included are Bronchitis (J41 – J42) Simple and mucopurulent chronic bronchitis, Emphysema (J43), other COPD (J44), Asthma (J45), Bronchiectasis (J47).

Suicide (ICD-10: U03, X60-X84, Y87.0) is the act of intentionally causing one's own death. Suicide is often caused by one or more factor including substance use, money, health, relationship status, physical health, as well as mental health conditions (CDC, 2018).

2.2.4 Rural-Urban Status

Counties are classified into two urbanization levels metropolitan (metro) and nonmetropolitan (nonmetro) using the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme. Urban includes counties in metropolitan statistical areas. Rural includes counties in micropolitan statistical areas and nonmetropolitan counties.

Geographic location of death is classified by place of residence unless stated as by place of occurrence. Deaths of nonresidents (e.g. nonresident aliens, nationals living abroad, residents of the U.S. territories) are not included.

2.2.5 Gender

Life expectancy varies based on ones' gender (Kochanek, 2016) where males typically die earlier than females. As such, mortality rates are frequently presented by sex to allow policy makers, patients, and practitioners easy access to sex-specific rates.

2.3 Methods

We examined trends in age-adjusted, multiple cause of death mortality estimates between 1999 and 2016. Trends were compared visually as well as analytically to answer two key questions. First: is the mortality rate consistently higher in rural areas compared with urban? Next, how are rural-urban differences changing over time?

After visual inspections, we calculated the average annual percent change (APC) using a log-linear model of the age-standardized rates. Next, absolute and relative measures of disparity were calculated between 1999 and 2016.

3. Results

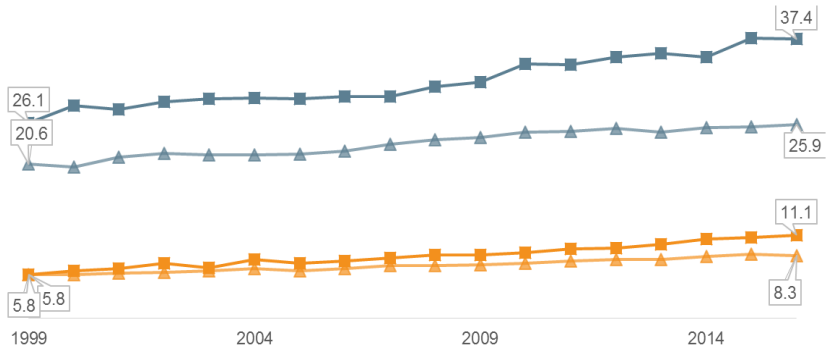

Figure 2: Suicide Rates by Gender, Rurality, and Year, Ages 25 to 64 Years: US 1999-2016†

† Note: Orange trends (bottom) represent female mortality rates and blue trends (top) represent male. Darker shades with square symbols are rural mortality rates whereas lighter shades with triangle symbols are urban.

Figure 2 presents working age suicide trends in urban and rural areas from 1999 through 2016. The suicide mortality rate is steadily increasing for urban and rural men and women. Across all years, rural gender-specific mortality rates exceed urban rates.

The average annual percent change for men in urban and rural areas are 1.5 and 2.0%, respectively. The absolute measure of disparity between rural and urban suicide rates is large and increased over time, from a rural-urban difference 5.5 to 11.5 or an average change of 3.4% annually. The relative measure of disparity is also large and steadily increasing over time at an average rate of 0.6% per year.

For women, a similar story exists. The average annual percent change in urban and rural areas is 2.3% and 3.6% respectively. The average annual change in the absolute measure of disparity faced challenges as the disparity was original close to zero thus leading to an overestimate in 2016. With the removal of 1999, we see an average increase over time at 2.9% annually. The relative measure of disparity is also increasing over time at an average rate of 1.4% per year.

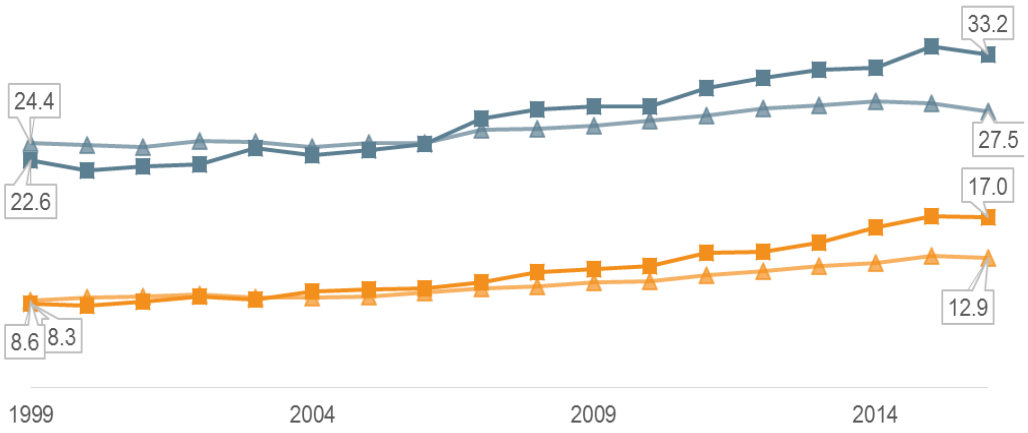

Figure 3: Liver Disease Mortality Rate by Gender, Rurality, and Year, Ages 25 to 64 Years: US 1999-2016†

† Note: Orange trends (bottom) represent female mortality rates and blue trends (top) represent male. Darker shades with square symbols are rural mortality rates whereas lighter shades with triangle symbols are urban.

Figure 3 presents working age liver disease mortality trends in urban and rural areas from 1999 through 2016. The mortality rate is slowly increasing for urban and rural men and

women. Starting in 2004, rural female mortality rates exceed urban rates. Whereas for men rural mortality rates exceed urban rates starting in 2007.

The average annual percent change for male liver disease mortality in urban and rural areas are 1.1 and 2.9%, respectively. The absolute measure of disparity between rural and urban mortality rates shifts from urban rates exceeding rural by a difference of 1.8 to rural rates surpassing urban by a difference of 5.7. Starting in 2008, we see an average absolute disparity change of 18.8% annually. The relative measure of disparity is also steadily increasing over time at an average rate of 1.8% per year.

For female liver disease mortality, a similar story exists. The average annual percent change in urban and rural areas is 2.6% and 4.7% respectively. The absolute measure of disparity between rural and urban mortality rates shifts from urban rates equaling rural in 1999 to rural rates surpassing urban by a difference of 4.1. Starting in 2004, we see an average absolute disparity change of 19.6% annually. The relative measure of disparity is also increasing over time at an average rate of 2.2% per year.

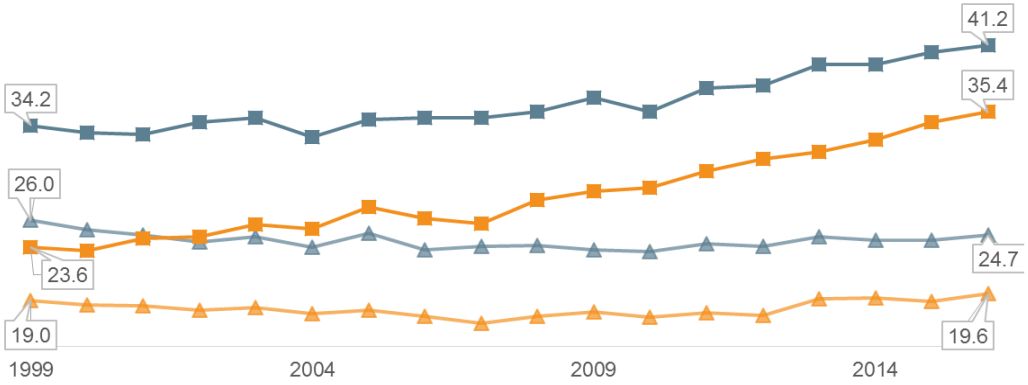

Figure 4: Chronic Lower Respiratory Disease Mortality Rate by Gender, Rurality, and Year, Ages 25 to 64 Years: US 1999-2016†

† Note: Orange trends (bottom) represent female mortality rates and blue trends (top) represent male. Darker shades with square symbols are rural mortality rates whereas lighter shades with triangle symbols are urban.

Figure 4 presents working age chronic lower respiratory trends in urban and rural areas from 1999 through 2016. The mortality rate is steadily increasing for rural men and women while the rate is steadily decreasing for urban men and women. Across all years, rural gender-specific mortality rates exceed urban rates.

The average annual percent change for men in urban and rural areas are -0.2 and 1.2%, respectively. The absolute measure of disparity between rural and urban suicide rates is large and increased over time, from a rural-urban difference 8.2 to 16.5 or an average change of 4.2% annually. The relative measure of disparity is also large and steadily increasing over time at an average rate of 2.1% per year.

For women, remarkably the rural chronic lower respiratory mortality rate exceeds urban males starting in 2002, a feature that is unique to this particular analysis of the three causes

of death. In addition, the female average annual percent change in urban and rural areas is -0.2% and 2.4% respectively. The absolute measure of disparity between rural and urban suicide rates is large and increased over time, from a rural-urban difference 4.6 to 15.8 or an average change of 7.4% annually. The relative measure of disparity is also increasing over time at an average rate of 3.4% per year.

4. Discussion

This analysis indicates a consistently increasing rural–urban disparity in suicide, liver disease, and chronic lower respiratory disease by examining absolute and relative disparities. Other US analyses have found similar widening disparities over time amongst a number of different causes of mortality (Singh, 2002; Singh, 2011; Singh, 2012; Singh, 2013) including suicide (prior to 1997), cancer, and HIV/AIDs.

A number of risk factors contribute to high mortality rates in rural communities. The prevalence of smoking, obesity, physical inactivity, poverty, and high school dropout rate is higher in rural when compared to urban. In addition, access to healthcare is lower.

Our study does have limitations. For example, the death certificate process is state-specific, allowing for a degree of variability between states. Additionally, interpretation of the procedures may differ by physician as well as points in time. In addition, various definitions of rurality exist. Another definition may paint a different picture.

In conclusion, our results indicate that rural disease-specific mortality rates are consistently higher as compared to urban. There is a critical need to improve rural America's health and to continue to monitor mortality rates.

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