

Geographic Variation And Socio-Economic Correlates Of Heart Disease Death Rates In West Virginia, 1999-2012

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Abstract

This paper examines the spatial pattern of heart disease death rates in the general population in West Virginia between 1999 and 2012. METHODS: Tertiles of low, medium, and high rates are derived for heart disease death rates for the counties and choropleth maps are created to depict the changes in the spatial distribution of counties with low, medium, and high rates over the study period. Correlation analyses are performed to explore the association between the outcome variable and selected socio-economic variables. RESULTS: Overall, the heart disease death rates declined over time in the state. While the number of counties with high death rates decreased during the study period, the counties with low rates increased in number. The analyses show that the heart disease death rates are significantly associated with educational attainment, household income, and lack of health insurance. CONCLUSION: The between-county differences in the heart disease death rates suggest that the underlying factors and the associated mortality burden have varying impact on West Virginia communities. While the correlation results indicate the significance of the county level socio-economic environment, research is needed to investigate this association at the individual level in the state.

INTRODUCTION

Despite the steady decline in heart disease-related deaths in the United States since the 1960s (Pickle and Gillum 1999; American Heart Association 2010), heart disease remains the leading cause of death in the nation (Miniño et al. 2011). The financial burden of coronary heart disease, the most common type of heart disease, was projected to cost the nation about \$151.6 billion in 2007 (Rosamond et al., 2006) and about \$108.9 billion in 2010 (Heidenreich, et al., 2011). The West Virginia Department of Health and Human Resources (WVDHHR) reports that in 2007, heart disease accounted for 5234 deaths in the state, constituting an age-adjusted mortality rate of 230.2 per 100,000 (WVDHHR, 2011). Although heart disease accounts for the largest proportion of cardiovascular as well as all deaths in the state, little is known about the evolving spatial pattern of its rate of occurrence. Changing patterns of high or low heart disease mortality rates across the state may be telltales for the spatial dynamics of underlying factors. For instance, Peter et al. (1996) find that a north-south trend in cardiovascular and ischemic heart disease mortality in Eurasia mirrors the spatial pattern for body mass index and blood pressure; and Taylor et al (1999) demonstrate that urbanized areas have

higher heart disease mortality rates than remote, rural areas. In recent studies, certain socio-economic factors have also been found to be significantly associated with heart disease mortality. When comparing the mortality experience of Scottish postcode sectors, McLoone and Boddy (1994) found that death rates from ischemic heart disease and carcinoma of the lung and bronchus at ages 40-69 were lower in all deprivation categories in 1990-92, and that more affluent areas experienced greater reduction in the death rates. They also found that the difference in ischemic heart disease death rates between deprived groups and the affluent increased over time. In analyzing the geographic variation in cardiovascular disease morbidity and mortality in public health units in Ontario, Djietror (2003) found that average dwelling value (which, he notes, is an indicator of permanent wealth and social status) is negatively associated with the rate of ischemic heart disease mortality. Djietror and Inungu (2008) analyzed spatial patterns and covariates of heart disease death rates in Michigan counties and show that poverty rate and lack of health insurance is positively associated with heart disease death rates while educational attainment and household income are inversely associated with the death rates. Loughnan et al (2010) demonstrate that

both age and socioeconomic inequality contribute to acute myocardial infarction admissions to hospital in Melbourne during hot weather. Also, analyzing data from the French GAZEL cohort, Silhol et al (2011) reveal that coronary heart disease incidence increased with decreasing socioeconomic position of the residential environment among men from highly urbanized environments. Thus, a geographic analysis of heart disease death rates can inform an effort to characterize the associated societal mortality burden and identify the potential risk factors for possible intervention.

Figure 1

Comparing Heart Disease Death Rates in West Virginia and the USA

The statewide decline in heart disease deaths in West Virginia from 1999 to 2012 is consistent with the overall national decline (Figure 1), although the state level rate was persistently higher than the national average during the study period. Also, West Virginia has one of the ten highest heart disease death rates by state in the nation. Nonetheless, the fairly steady decline suggests that policies and programs aimed at reducing heart disease deaths in the state have been yielding progressively positive results overall. Correspondingly, the changing spatial variation in the rate of heart disease deaths may prove problematic for locational targeting of heart health promotion and intervention policies and programs.

This paper reports an analysis of the spatial variation in heart disease death rates across West Virginia counties (Figure 2). The study may contribute to the state-wide endeavor "... to adequately define the burden of cardiovascular disease in West Virginia ..." (WVDHHR 2011:4). It may help draw attention to localities in the state that have persistently high rates of heart disease deaths in order to target the planning and implementation of population-based cardiovascular health programs. The findings may also be helpful in identifying local areas with persistently low heart disease death rates with the view to possibly replicating their probable best practices in higher-rate communities.

Figure 2

West Virginia Counties

METHODS

Study area

The State of West Virginia, which is divided into 55 counties (Figure 2) for local government administration, is located in the southeast of the United States. The state

capital, Charleston, is located at Latitude 38.33°N and Longitude 81.58°W. The state is divided into 49 public health departments along county lines, with eight counties being grouped into two public health departments. The analyses in this research, however, are conducted by county in order to reveal details of the changes in heart disease death rates in each county during the study period.

Data

The data for heart disease death rates are obtained from the CDC WONDER database on underlying cause of death. Diseases of heart are defined using International Classification of Diseases, Tenth Revision (ICD-10) codes 100-109, 111, 113, and 120-151. The data are available at three levels of geographic detail: national, state, and county. For this study, heart disease death rates are extracted for the 55 West Virginia counties for the years 1999 through 2012. The death rates are per 100,000 people, and are directly age-standardized to the 2000 total population of the United States (Centers for Disease Control and Prevention 2011).

The data on socio-economic variables come from the 2000 census, which is freely available to the public at the U.S. Census Bureau's website. Seven potential correlates are selected based on a conceptual model for the investigation of underlying causes of geographic variation in cardiovascular disease outcomes (Djietror 2003), and on findings reported in the heart disease risk factor literature. The socio-economic variables included in the analyses are: unemployment (Mattiasson et al. 1990; Brenner 1997; Elliott and Dean 1998; Yarnell et al., 2005; Sundquist et al. 2006), housing tenure (Tunstall-Pedoe et al. 1995); educational attainment (Shestov et al. 1993; Elliott and Dean 1998; Yarnell et al. 2005), poverty rate (Pearson 2003; Balamurugan et al. 2011), median income (Lemstra et al. 2006; Winkleby et al. 2007), income inequality (Kawachi et al. 1997, Sundquist and Johansson 1997; Nilsson et al. 1998; Kucharska-Newton et al. 2011), and lack of health insurance (McWilliams et al. 2004; James et al. 2007).

Although the data on heart disease death rates in the state and the selected socio-economic variables are not collected and maintained by the same institution, the two sets of data are compiled for the same population at the same spatial resolution and can, therefore, be expected to be well-matched.

Analyses

The heart disease death rates are categorized into tertiles of low, medium, and high rates of heart disease mortality per 100,000 people (Table 1), and analyzed for both sexes combined and for males and females separately.

Table 1

Categories of heart disease death rates (per 100,000) in West Virginia, 1999 – 2012

Choropleth maps are prepared to show the spatial distribution of counties with low and high heart disease death rates in the state for the sexes combined, and separately for males and females for the first and last years of the study period. Correlation analyses are also performed to determine if the heart disease death rates are significantly associated with the potential socio-economic variables described above.

Figure 3

Distribution of Heart Disease Rate Categories by County in West Virginia for Both Sexes Combined - Comparing the Spatial Patterns in 1999 and 2012

RESULTS

Both sexes combined

Figure 3 shows the spatial pattern of high heart disease deaths by county in West Virginia at the beginning and end of the study period (1999 – 2012). At the beginning of the period 46 of the 55 counties had high heart disease death rates. By 2005, this figure dropped to 15 (Table 2) and by 2012 only 3 counties (Lewis, McDowell, and Wyoming) had high death rates. However, the analyses reveal other communities, namely Barbour, Boone, Hancock, Lewis, Lincoln, Logan, Mason, Mingo, Raleigh, Randolph, Ritchie, Tyler, and Wetzel, that experienced a few years of high heart disease death rates, particularly during the first half of the study period. In Mingo, for instance, the high rate persisted till 2010 – decreasing to medium only in 2011 and 2012; and in Logan the high rate did not let up until 2007. While no county experienced an increasing trend in the death rate, the trends of Brooke and Tucker appear to be worsening toward the end of the study period. In 10 counties (Berkeley, Hampshire, Harrison, Jackson, Jefferson, Kanawha, Morgan, Putnam, Summers, and Upshur) the death rates were mainly high in the first half of the study period, but these improved to continuously low death rates during the second part of the period (i.e. 2006 – 2012). Monongalia and Wayne follow closely with continuously low death rates from 2007 to 2012.

At the other end of the high-medium-low scale, no county

had low heart disease death rate at the beginning of the study period. By 2005, however, there were 11 counties with low heart disease death rates (Table 2), and by the end of the period the number of counties with low death rates increased to 39 (Figure 3). Hampshire, Harrison, Morgan, and Summers experienced the longest continuously occurring low heart disease death rates (2005 – 2012) during the study period for both sexes combined. They are followed closely by Berkeley, Jackson, Jefferson, Kanawha, Putnam, and Upshur with low rates occurring continuously from 2006 to 2012.

Males

There were 37 counties in the state that had high male heart disease death rates in 1999. In 2005, 11 counties still had high rates (Table 2), and by 2012 only two counties (McDowell and Wyoming) remained in the high-rate category (Figure 4). In both of these counties, the male death rate was mostly high during the study period, except for Wyoming that had an occasional low rate in 2008. However, there were other communities that had high for many years during the study period. These include Boone, Logan, Mingo, Tyler, and Wood. For instance, Mingo's record high male heart disease death rate from 1999 to 2010 was slightly broken only in 2008 when it dropped to medium. While the pattern of improvement in the male heart disease death rates differed among the counties, all counties experienced decreases in the male death rates during the second half of the study period.

Figure 4

Distribution of Male Heart Disease Rate Categories by County in West Virginia - Comparing the Spatial Patterns in 1999 and 2012

At the beginning of the study period only Putnam County had low male heart disease death rate (Figure 4). The number of counties experiencing low death rate increased to ten by 2005 (Table 2), and to 21 by the end of the study period (Figure 4). During the study period, Jefferson County experienced the longest continuous years of low male heart disease death rate (2005 – 2012), followed by Greenbrier, Jackson, and Putnam (2006 – 2012), and by Morgan and Wayne (2007 – 2012).

Females

Forty counties had high female heart disease death rates in 1999. By 2005 less than a third of that number (13 counties) had high female death rates (Table 2), and only two of those

counties (Lewis and Wood) still had high female heart disease death rates by the end of the study period (Figure 5). The scenario in both of these counties was one of deterioration of the death rate after improvements in their initial high rates during the study period. In Wood County, for instance, the high rate in the initial three years improved to medium rate in 2002 and remained at this level for 8 continuous years and then deteriorated to high rate in 2011 and 2012. Hampshire County experienced the longest continuously occurring low female heart disease death rate (2004 – 2012) with only one year (2008) of missing data. The closest to this were Berkeley and Ohio each with 8 continuous years (2005 – 2012) of low female heart disease death rates; and then by Cabell, Jackson, Kanawha, and Wayne each with 7 continuous years (2006 – 2012) of low death rate. On the other hand, the longest times for which high female death rate was experienced continuously were: eleven years in Lewin (1999 – 2009), nine years in Wyoming (2002 – 2010), eight years in McDowell (1999 – 2006), and five years in Hardy, Jefferson, Lincoln, Mason, Mingo, and Roane (1999 – 2003).

Figure 5

Distribution of Female Heart Disease Rate Categories by County in West Virginia - Comparing the Spatial Patterns in 1999 and 2012

No county had a persistent low female heart disease death rate throughout the study period. The closest to this scenario is Ohio County, which began with a high rate in 1999 that improved to the low-rate category for the rest of the study period, except in 2001 and 2004 when the rate deteriorated slightly to medium. Berkeley and Hampshire also lowered their initial high female heart disease death rates to the low-rate category in 2005 and 2006 respectively, and maintained the low rate till the end of the study period.

Across the state, the spatial pattern in the temporal trend in heart disease death rates is that, for males high rates tended to persist in the southern part of the state, particularly in the southwest, while low rates tended to be maintained for longer times in the northern part of the state. The experience of female high heart disease death rates is more evenly spread across the state, involving mainly Raleigh, McDowell, Mingo, Logan, and Wyoming in the southern part of the state, and Lewis, Wetzel, Randolph, Jefferson, and Hardy in the northern part. The data in Table 2 shows that overall, the areas in West Virginia that experienced low heart disease death rates expanded steadily over time while the areas characterized by high rates have been shrinking.

Table 2

Number of counties with low, medium, and high heart disease death rates in West Virginia, 1999-2012

Table 3

Correlates of heart disease death rates in West Virginia The correlation analyses (Table 3) show that education, income, and lack of health insurance are significantly correlated with heart disease mortality. All the significant correlation coefficients take on the expected sign. When the correlation results are compared for males and females, educational attainment has the strongest association with heart disease deaths for both sexes separately, and it is the only correlate that remained significant when they are combined. Income is a significant correlate of female heart disease deaths, but not for males; and lack of health insurance is only marginally insignificant ($p = .059$) for male heart disease deaths.

DISCUSSION AND CONCLUSION

This county-level analysis depicts spatial patterning of heart disease deaths in West Virginia. Overall, the rate of heart disease death rates declined during the fourteen-year period. During the study period there was an increase in the number of West Virginia counties that experienced low heart disease death rate. On the other hand, the number of counties characterized by high heart disease death rates decreased considerably. Many counties with medium rates in the earlier part of the study period improved their death rate to the low-rate category in the latter years. These shifts indicate spatial dynamism in the general decline of heart disease death rates in the counties over time.

While the general decline in heart disease deaths in the state is consistent with the falling rates of cardiovascular deaths in the nation in recent times (Pickle and Gillum, 1999; McCarron et al. 2006; Ezzati et al. 2008), this study reveals that the decline is uneven across West Virginia counties. There are few counties where the death rate seemed to have stabilized either at a low level (e.g. Berkeley, Hampshire, Harrison, Jackson, Jefferson, Kanawha, Morgan, Monongalia, Putnam, Summers, Taylor, Upshur, and Wayne) or at the medium level somewhat (e.g. Brooke, Fayette, and Wood). The analyses revealed groupings of the counties in the state (Table 4) that fit into four distinct scenarios of the temporal trend of the heart disease death rates.

Table 4

Counties in scenarios of heart disease death rate trends in West Virginia, 1999-2012

The increase in the number of counties with low heart disease death rates (shown in Table 2 and depicted in Figures 3, 4, and 5) and the concurrent persistent or nearly persistent high rates in some of the counties during the study period (see Table 3) suggest that the factors driving the declining rates are not impacting West Virginia communities equally. Thus, they flag spatial unevenness in the burden of heart disease deaths, as well as morbidity, and the associated underlying causes in the state.

The rate scenarios identified in Table 4 may serve as tell-tales of either underlying causes of persisting high heart disease death rates that warrant detailed study, or localized best practices that may be replicated to help lower the death rates in high-rate counties. The scenarios may also have utility in targeting heart health promotion and/or intervention, as well as the evaluation of program activities in the state.

The findings from the spatial analyses in this study are consistent with previous studies (Wing et al 1992; Barnett and Halverson 2000; Gillum et al 2012) that show significant spatial variability in the rates of decline in cardiovascular disease mortality. The correlation results are also consistent with published literature on the association of education, income, and lack of health insurance with heart disease death rates (Djietror and Nnungu, 2008). The correlation results suggest fronts at which underlying socio-economic components of heart disease deaths in the state may be tackled.

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