Disparities in Highly Preventable Deaths by Rurality and Area Deprivation

Adam R. Roth

Justin T. Denney

Department of Sociology

Washington State University

Corresponding Author: Adam R. Roth, Department of Sociology, 249 Wilson-Short Hall, Washington State University, Pullman, WA, USA 99164-4020. Email: adam.roth@wsu.edu

Acknowledgements: We acknowledge support from the Health Equity Research Center, a strategic research initiative of Washington State University.

ABSTRACT

Advances in place-based analyses suggest the importance of area-level resources for individual mortality but have largely focused on urban spaces. We advance knowledge on rural-urban mortality disparities by focusing on differences for the most preventable causes of death. Using geocoded mortality records from Washington state, we match individual-level attributes with area-level measures of rurality, socioeconomic conditions, healthcare access, and social cohesion to examine whether characteristics of place elucidate the rural-urban mortality divide. We find that rural decedents have higher odds of dying from highly preventable causes. Place-based measures of social and economic disadvantage independently associate with the odds of dying from highly preventable causes. Finally, we find that accounting for markers of social cohesion suppresses the rural mortality penalty from highly preventable causes such that rural decedents would have even higher odds of highly preventable death if not for the relatively high levels of social cohesion present in rural areas.

Keywords: Mortality; Rural; Urban; Place; Social Cohesion

INTRODUCTION

One of the most enduring findings to emerge from the social sciences is the inextricable link between socioeconomic status and mortality. According to fundamental cause theory, high status individuals utilize a host of socioeconomic resources to protect themselves from disease and illness (Link and Phelan 1995). Support for this claim comes from the fact that as the major causes of death (e.g., typhoid fever) are mitigated and replaced by new causes (e.g., heart disease), the underlying relationship between socioeconomic status and mortality persists. This has led social scientists to argue that the physiological deterioration of the body leading to death is a social process.

In addition to the substantial mortality disparities in the United States that are demarcated by personal characteristics such as income, education and race (Olshansky et al. 2012; Singh and Siahpush 2006; Subramanian and Kawachi 2006), there are also appreciable disparities across geographic contexts (Bolin et al. 2015; Cohen et al. 2017; Murray et al. 2006). Although individuals living in urban centers were historically exposed to greater health risks than rural residents, empirical evidence suggests that the trend has reversed since the 1980s (Cossman et al. 2010). Rural residents now suffer from what has been referred to as the 'rural mortality penalty' (Cosby et al. 2008). Popular explanations for the growing rural-urban mortality disparities point to issues of poverty, limited educational opportunities, and unequal health care access, among other things (Burton et al. 2013; Cossman, James, and Wolf 2017).

Despite advances in health disparities research, much of what we know about differences in mortality across groups come from studies that use either aggregate measures to focus on mortality rates or individual-level data via prospective surveys to investigate the association between personal attributes and mortality risk. The former approach points to macro-level mortality trends across rural-urban areas whereas the latter approach highlights specific attributes to explain within-group mortality disparities. More recent studies, however, combine the two perspectives by using individual-level data embedded in an area-based context. In this paper, we extend analyses of rural-urban mortality disparities by using a multilevel framework to assess the odds of dying from a highly preventable cause compared to a less preventable cause. This allows us to account for individual sociodemographic and socioeconomic characteristics that associate with highly preventable deaths and better understand how place-based factors influence the risk of those deaths across rural and urban settings (Phillips and McLeroy 2004).

Our focus on the preventability of causes of death is motivated by fundamental cause theory (Link and Phelan 1995). If high status individuals use their social and economic resources to protect their health through a variety of mechanisms, we would expect them to be less likely to die from highly preventable causes. However, these resources are rendered ineffective against fatalities that we do not know how to prevent or that do not manifest through processes of social and economic inequality. This leads to the proposition that socioeconomic status will be more strongly associated with highly preventable causes of death than with less preventable causes, at least at the individual-level (Phelan et al. 2004). Although fundamental cause theory is commonly viewed as an individual-level process, it acknowledges the importance of contextual factors as individuals tend to geographically segregate along socioeconomic divides which in turn exposes them to unequal community resources (Link and Phelan 2010:6). This notion harmonizes with the rural health literature, which suggests that rural residents are at greater health risks due to the social conditions of their communities. Therefore, we argue that the rural mortality penalty cannot be entirely understood solely through personal characteristics but must take into consideration the characteristics of place.

In this paper, we use geocoded mortality records from Washington state during the period of 2012-15 to examine disparities of individual mortality across rural-urban settings. Though not a representation of rural and urban disparities outside of the state of Washington, the state is an ideal setting for such a study because of the availability of individual death records, a wealth of publicly-available data on place-based characteristics, and a mix of rural and urban spaces. Indeed, twenty-one of Washington's thirty-nine counties are rural, with less than 100 residents per square mile. By using this unique data source, we attend to the individual- and area-level characteristics that associate with causes of death deemed more and less preventable. The remainder of the paper proceeds as follows. First, we review the existing literature on rural-urban mortality and move into a broader discussion of health and place. Upon articulating our unique focus across the rural-urban context, we introduce our data sources and modelling framework. Finally, we report our findings and conclude with a discussion of the implications of the main results.

RURAL-URBAN MORTALITY DISPARITIES

Mortality disparities between rural and urban populations within the United States are extensively documented (Bolin et al. 2015; Murray et al. 2006). Not only do rural areas have higher all-cause mortality rates than urban areas but there are also cause-specific mortality disparities (Cossman et al. 2010). For instance, whereas coronary heart disease mortality rates decreased in urban areas from 1999 to 2009, they remained consistently higher in rural areas during the same period (Kulshreshtha et al. 2014). Meanwhile, urban life expectancy has outpaced rural life expectancy at an increasing rate over the last several decades (Singh and Siahpush 2014). Given that nearly 20 percent of Americans (and over 10 percent of Washingtonians) reside in rural areas (U.S. Bureau of the Census 2016), it is clear these geographic disparities require special attention.

There are multiple factors that may explain why rural populations are exposed to greater mortality risks than urban populations. According to a national survey of rural health stakeholders, access to quality health services was ranked the top priority of *Rural Healthy People 2020* (Bolin et al. 2015). Indeed, rural residents often have difficulty accessing primary care providers and hospitals as they must travel further for care than their urban counterparts (Arcury et al. 2005). Health care providers and policy makers argue that this lack of care is a direct threat to the health of rural residents (Douthit et al. 2015; Russell et al. 2013).

Moving beyond access to health services, fundamental cause theory suggests there are underlying social conditions that supersede these proximal causes of death and illness. After all, living far from a hospital does not kill people. At a more basic level, broader structural issues such as high poverty and unemployment—which are more prevalent in rural areas—act as barriers to opportunities that can help stave off ill health and preventable death (Burton et al. 2013; Lichter and Brown 2011; Link and Phelan 2010; Smith and Tickamyer 2011). In order to fully understand rural-urban mortality disparities we must attend to the social conditions of the communities in which rural and urban residents live.

Importance of Place

While there is substantial empirical support that socioeconomic status acts as a fundamental cause of mortality (Phelan, Link, and Tehranifar 2010), multiple studies that control for individual measures still find an enduring area-level effect on health outcomes (Auchincloss and Hadden 2002; Lochner et al. 2001; Winkleby, Cubbin, and Ahn 2006). Indeed, extensive research over the past several decades has explored the contextual link between structurally embedded disadvantage within communities and individual health (Boardman et al. 2001; Denney, Saint Onge, and Dennis 2018; Kawachi and Berkman 2003; Macintyre, Ellaway, and Cummins 2002). According to social disorganization theory, socioeconomic markers of disorganization detract from a community's capacity to self-regulate and achieve collective goals such as economic sufficiency, freedom from crime, and a healthy social environment (Sampson, Morenoff, and Gannon-Rowley 2002). Personal attributes such as race and socioeconomic status do not act alone in determining individuals' health outcomes. Rather, the concentration of many socially disadvantaged people living in close quarters also influences individuals' health through a series of community-level processes. The physical and social community resources afforded to residents provide them with opportunities to engage in healthy lifestyles that are guided by normative expectations of behavior and social cohesion (Kawachi and Berkman 2003). For instance, the availability of public spaces (e.g., parks) not only encourages an active lifestyle but also provides potential meeting locations where people can contribute to a larger sense of community (Barrett, Miller, and Frumkin 2014; Hartig et al. 2014).

Social Cohesion

If the relationship between the social conditions of a community and individual health exist above and beyond personal characteristics, there must be an underlying mechanism operating at the community level. A prevailing theme across the health and place literature points to the collective aspects of community life. This has led many scholars to turn to social capital theory to explain the link between health and place (Browning and Cagney 2002; Kawachi et al. 1997; Sampson 2003; Yang, Jensen, and Haran 2011). Although there are varying definitions of social capital, most macro-level accounts direct attention to the norms and mutual trust between citizens that operate via social networks and civic engagement (Coleman 1990; Kawachi and Berkman 2000; Putnam 2000).

Drawing on the core principles of social capital, we devote attention to the social cohesion among community residents and their expectations for civic engagement. Living in a socially cohesive community enhances individual health through multiple pathways. First, the social control exercised by community members can lower rates of crime and social malfeasance (e.g., violence, drug/alcohol abuse, reckless behavior) (Sampson, Raudenbush, and Earls 1997). This not only reduces the odds of dying from otherwise preventable causes (e.g., homicide, accidents) but also alleviates the harmful psychosocial effects of living in a constant state of fear-induced stress (Browning, Cagney, and Iveniuk 2012; Klinenberg 2002). Second, living in a socially cohesive community invokes a sense of belonging which facilitates joint participation in a healthy lifestyle (e.g., local community gatherings, recreational sports leagues) and overall life satisfaction (Gattino et al. 2013). Finally, civically engaged communities can address problematic public health concerns (e.g., poorly maintained infrastructures, health-compromising public policies) thereby benefitting all members of the community (Browning and Cagney 2002).

Extending Beyond Urban Settings

Despite the appeal of using place-based theories to test health outcomes, few contemporary studies compare communities across rural and urban settings. This omission may stem from the fact that these theories (e.g., social disorganization theory) are widely considered urban theories (Sampson 2003). Indeed, urban neighborhoods have been the dominant focus of theoretical development and empirical research for the study of community influence on health. However, there is convincing reason to suggest that such a framework should be extended to rural settings given that social processes occurring in response to poverty and disadvantage look quite similar in rural and urban areas (Lichter and Brown 2011).

Like the urban areas that are of wide interest to health scholars, rural areas frequently exhibit spatial inequalities marked by poverty, residential segregation, and stigma (James 2014; Lichter et al. 2008). Indeed, Albrecht, Albrecht, and Albrecht (2000) explain how in recent decades rural America has mirrored the urban economic transformations described by Wilson (1987) in *The Truly Disadvantaged*. This has led to the development of what certain scholars refer to as 'rural ghettos' (Burton et al. 2013; Eason 2012). Although rural ghettos take multiple forms (e.g., dilapidated homes in small rural towns, subsidized housing projects, degraded trailer parks), their high levels of poverty and social disorganization limit their capacity to realize shared values and collectively solve social problems (Burton, Garrett-Peters, and Eason 2011; MacTavish and Salamon 2001; Sherman 2018). As evidenced by the health and place literature, this can have meaningful consequences for the well-being of community residents. Therefore, we argue that there is justification in extending place-based analyses beyond urban settings.

Broader themes of social cohesion, meanwhile, have been readily employed in the rural literature. Whether under the guise of social capital, collective efficacy, social solidarity, or civic engagement, rural scholars consistently point to the fact that the social life of a community is imperative for the well-being of its residents (Beggs, Haines, and Hurlbert 1996; Castle 2002; Hofferth and Iceland 1998; MacTavish and Salamon 2001). More to our point, these concepts have been dovetailed with the rural health literature to explain a host of outcomes, including mortality (Beaudoin, Wendel, and Drake 2014; Yang et al. 2011). In the present paper, we acknowledge the importance of social and economic conditions of communities to better understand rural-urban mortality disparities.

METHODS

Data sources

This study uses geocoded mortality data (2012-15) from the Washington State Department of Health. This resource links all individual deaths in the state to the decedent's residential address at their time of death. There were 207,121 recorded deaths from 2012 to 2015. These records are matched with the United States Census Bureau's 2010 tract boundaries (N=1456). Twenty-six tracts were removed due to limited number of deaths (<10 deaths). Census tracts are a commonly used measure in area-based studies, however, this is an imperfect measure as tracts do not necessary align with the concept of a community, especially in rural areas (De Marco and De Marco 2010). Nevertheless, our use of census tracts is necessitated by the availability and reliability of data and motivated by a wealth of literature linking residential census tracts to health and mortality.

Variables

Our outcome variable distinguishes between the most highly preventable causes of death and other, less preventable, causes. Specifically, we follow Phelan et al. (2004) and code deaths according to their level of preventability. Less preventable causes—those arguably less influenced by socioeconomic resources—differ importantly from highly preventable deaths which can be avoided or delayed through access to resources and the avoidance of being put at "risk of risks" (Link and Phelan 1995). To establish measures of preventability, we use a numeric scale to code cases according to the underlying cause of death as categorized by the International Classification of Diseases, 10th revision (ICD-10). This preventability ranking system uses a combination of two criteria. First, the preventability of the cause itself is based on factors such as vaccination availability and lifestyle. Second, preventability of death is evaluated upon onset of disease based on the availability and means of treatment. For example, death from multiple sclerosis is nearly impossible to prevent, while tuberculosis is one of most preventable causes of death. If rural residents are more likely to die from the most preventable causes, that sheds light on the conditions influencing mortality and may provide more targeted solutions to begin to understand and alleviate differences. Deaths that are considered least preventable (e.g., gallbladder cancer) receive a score of 1.0 and deaths that are considered most preventable (e.g., acute respiratory infections) receive a score of 5.0 (see Phelan et. al 2004, Appendix A for details). Using this coding scheme and aligning the original Phelan et al. (2004) study using ICD-9 codes with the new ICD-10 codes, we were able to include 258 specific causes of death and account for nearly 86% of all deaths in the data set. Following Phelan et al. (2004), we dichotomize all coded cases into "high preventability" (4.0 rating or higher) and "low preventability" (less than 4.0). As part of supplementary analyses, we followed Masters, Link, and Phelan (2015) by separating heart disease deaths from other preventable causes. This did little to change the findings (results are available upon request).

Individual-level variables

The individual mortality records include a set of sociodemographic variables including the decedents' race/ethnicity (non-Hispanic white, non-Hispanic black, Native American, Asian, Hispanic) and education (less than HS, HS, some college, college or more). Due to potential for incomplete education, we limit our analyses to individuals who were aged 25 or over at the time of their death. We also include controls for the decedents' age at time of death, sex, and marital status.

Community-level variables

Using the residential geocodes for all decedents, we link individual deaths to residential census tract data. Following the Washington State Department of Health's Rural-Urban Classification System for Community Health Assessment, we use the Rural Urban Commuting Area (RUCA) to classify tracts based on their degree of rurality. Due to the distribution of the data, we collapse codes into a rural-urban dichotomy. We also control for population density of the tract.

Next, we assign each tract with its respective concentrated disadvantage (CD) score. Concentrated disadvantage is a composite index that consists of the following five measures: percent of individuals below poverty line; percent of individual on public assistance; percent of female-headed households; percent unemployed; percent under 18 years of age (Sampson et al. 1997). Each variable was standardized with mean equal to zero and standard deviation equal to one. Our final measure of CD is calculated by taking the mean of these standardized variables. Higher values indicate higher levels of concentrated disadvantage.

In addition to the CD measure, we used the following tract-level variables from the Washington Tracking Network (Washington State Department of Health 2016)—health professional shortage areas, availability of parks, and percent of non-voters. Finally, we include measures of residential instability and home ownership from the 2011-2015 American Community Survey five-year estimates. These variables capture multiple dimensions of community that may be important predictors of mortality. Given the concerns over access to health services, the health professional shortage areas (HPSA) variable provides an account of lack of primary health care (25 points possible), mental health care (25 points possible), and dental health care (26 points possible) within each census tract. Values are summed across sectors such that possible HPSA scores range from zero to 76 with higher values indicating that a tract is lacking health care access.

Availability of parks, measured as the percent of children in the census tract that live near a park, is used to mark the contribution to physical health through recreational opportunities as well as a broader contributor to mental health (Barrett et al. 2014). Percent of non-voters, residential instability and home ownership, meanwhile, all serve as proxies for social cohesion. Although each measure captures a different dimension of social cohesion, collectively the three variables signal an overall connectedness and investment in community. For instance, in their study on social capital, Kawachi and Kennedy (1997) found a moderate relationship between voter turnout and commonly accepted measures of social capital ($r = -0.46$, $p < 0.05$). Because there was relatively low interitem reliability between percent of non-voters, residential instability and home ownership ($\alpha = 0.42$), we treat each variable as a separate predictor of highly preventable mortality.

Analytic Strategy

Many rural health studies use aggregate measures of mortality rates to study rural-urban differences. While this approach draws attention to geographic disparities, such an approach is unable to distinguish between compositional and contextual contributors to differences. That is, it may not be the characteristics of an area that explain variation in mortality outcomes but merely that there happens to be a high concentration of "at-risk" residents living in that area. These residents might be more likely to die from a highly preventable cause regardless of whether they lived in rural or urban areas. Thus, any conclusion made about rural-urban mortality disparities might be speaking to characteristics that are unique to individuals rather than areas (Meijer et al. 2012). In order to appropriately address the differences between urban and rural areas, a contextual approach is needed—one that controls for individual-level and area-level factors (Macintyre and

Ellaway 2000). Therefore, we employ a multi-level approach in which we nest individuals within residential census tracts.

We conduct multilevel logistic regressions and present odds ratios (OR) to explore the associations between rurality, community indicators of disadvantage, social cohesion, healthcare availability, and availability of parks with death from a highly preventable cause while accounting for important individual-level characteristics (Guo and Zhao 2000). Because all cases in the data are deaths, the associations can be interpreted as the odds of dying from the most preventable causes versus dying from less preventable causes. Because we use population data, we do not include p-value indicators of statistical significance.

We present an initial unadjusted model to examine the association between living in a rural census tract and death from a highly preventable cause. Then we adjust for individual characteristics that have strong established associations with mortality. Next, we add the other tract characteristics one at a time to assess each independent community-level association and to examine whether community characteristics explain any mortality gaps between rural and urban residents or whether any suppression associations exist. Finally, we include a fully adjusted model to assess the adjusted community-level associations and the fully adjusted relationship between rurality and highly preventable mortality.

RESULTS

Table 1 provides proportions and means of all decedents in the data and separately by whether the individual lived in an urban or rural census tract. Looking first at the total population of deaths, although we dichotomized all deaths above the midpoint of our 5-point classification scale (i.e., preventable death $\geq$ 4.0), more than half of all deaths (59%) were considered highly preventable. This aligns with previous studies that use a similar measure of preventability (Phelan et al. 2004) and is partly the result of causes such as ischemic heart disease falling into the high preventability category. The individual-level characteristics show that the average age at death was 76 years (SD=15.17). Decedents were overwhelming white (91%) and there was an even proportion of men and women who died over the study period. About 55% of all deaths occurred for individuals with a high school education or less. Over 38% of all decedents were married at the time of their death and 35% were widowed.

Looking across the columns for rural and urban decedents reveals a few individual-level differences in the proportion who died. First, just over 64% of all deaths in rural tracts were classified as highly preventable, compared to 59% of urban deaths. A greater proportion of deaths in rural tracts were male and Native American and the proportion of non-Hispanic black and Asian deaths were greater in urban tracts. Over 62% of deaths in rural tracts occurred for individuals with a high school education or less, compared to about 55% in urban tracts. There were also more married decedents in rural areas than in urban.

Table 1 also shows at the census-tract level, there are larger differences between rural and urban decedents. Rural decedents lived, on average, in tracts with higher concentrated disadvantage, worse healthcare access, and fewer parks. However, rural decedents also lived in tracts with fewer non-voters, less residential instability, and greater home ownership. We turn to Table 2 for multiple regression results characterizing the odds of dying from a highly preventable cause, versus death from a less preventable cause.

Model 1 shows that those decedents who lived in rural census tracts had 1.25 times higher odds of death from a preventable cause relative to their urban counterparts (Table 2). Model 2 includes the individual-level covariates and shows that a proportion of the higher odds for rural decedents to die from a highly preventable cause are due to differences in characteristics such as individual educational attainment. Indeed, the odds that a college or greater educated adult died from a highly preventable cause were 0.65 times the odds of a less than high school educated adult. Importantly, even after including the individual-level covariates, the odds of rural death from a highly preventable cause were 1.18 times higher than that of urban death.

Models 3-6 add the census-tract characteristics one at a time (Table 2). Model 3 shows that the odds of death from a highly preventable cause are 1.07 times higher for every standard deviation increase in concentrated disadvantage (CD). Including CD does little to impact the odds of dying from a preventable cause for rural adults. Model 4 swaps out the CD measure with healthcare access and shows that for a one standard deviation increase in healthcare shortage, the odds of death from a highly preventable cause multiply by 1.03. Importantly, the inclusion of the healthcare indicator reduces the OR for rural by 28% ((1.18-1.13) / (1.18-1.00)). Model 5 shows that a one standard deviation increase in park access in the census tract is associated with lower odds of highly preventable death. Similar to CD, the inclusion of park access does little, however, to influence the higher odds of preventable death for rural decedents.

Model 6 includes the three proxies for social cohesion. First, for a one standard deviation increase in residents who do not vote, odds of death from a highly preventable cause multiply by 1.05. Residential stability does not impact the odds of highly preventable death in Model 6 but a greater proportion of home ownership associates with lower odds of highly preventable death. In addition, the odds of rural decedents dying from highly preventable death increases with the inclusion of the social cohesion covariates in Model 6, from 1.18 in Model 2 to 1.21 in Model 6.

Finally, Model 7 provides results from a fully specified model. The odds of highly preventable death for rural decedents are 1.14 times higher than for urban decedents in this full model. In addition, more CD, worse healthcare access, and higher proportions of non-voters are associated with higher odds of death from a highly preventable cause. Greater access to parks and greater proportions of home ownership associate with lower odds of death from a highly preventable cause.

Tables 3 and 4 replicate the results in Table 2 but separately for rural decedents (Table 3) and urban decedents (Table 4). For many of the level-2 covariates, the ORs are similar. For example, rural decedents have 9% higher odds of dying from a highly preventable cause for each standard deviation increase in CD. Similarly, for urban decedents, each standard deviation increase in CD is associated with 7% higher odds of death from a highly preventable cause. Looking between rural and urban decedents for the rest of the area-based predictors reveals similar odds but larger standard errors for rural decedents. This was consistent with interaction terms we estimated on all decedents between rurality and the level 2 predictors. All of the interaction ORs included 1.0 in the 95% confidence intervals (results available upon request).

DISCUSSION

Rural residents tend to experience worse health and mortality outcomes than urban residents. By examining all deaths in Washington state, we find that the odds of dying from a highly preventable cause are higher for rural than for urban decedents, even after considering important individual- and tract-level characteristics. Our decision to analyze highly preventable causes of death in comparison to less preventable causes was motivated by fundamental cause theory, which has been a predominant perspective used by sociologists, epidemiologists, and demographers to explore the social determinants of health. Fundamental cause theory is frequently noted for the enduring associations between individual-level sociodemographic and socioeconomic characteristics and mortality (Link and Phelan 1995). Consistent with previous accounts (Masters et al. 2015; Phelan et al. 2004), we find empirical support for this claim. Furthermore, we extend this line of inquiry and find that area-level social and economic conditions relate to death from highly preventable causes.

We report on two important contributors to the rural-urban differences in death from highly preventable causes. One important contributor is the well-documented shortages in access to healthcare (Bolin et al. 2015; Russell et al. 2013). The second contributor is the idea that measures of area-level social cohesion may suppress the relationship between rurality and highly preventable death. Though rural areas suffer disproportionately from many social and economic disadvantages, we also show that they may have more residents that participate in the political process and greater home ownership, both signs of investment and devotion to community life. These results suggest that strong social ties in rural communities may help buffer other risks and discourage death from highly preventable causes that may otherwise be even more likely.

This study has two limitations. First, we use death records from a single state in the Pacific Northwest region of the United States. Scholars have pointed to the considerable variation across rural places and called for the need to understand such heterogeneity in the causes and consequences of rurality for health and mortality (Bolin et al. 2015; Murray et al. 2006). Second, although we use comprehensive death records which provide impressive coverage of rural and urban places throughout the state and include valuable individual-level characteristics of the decedent at time of death, these are not survey records with which we could estimate the association of preventable death relative to survival. Nor do we have data on the life course of the decedents (e.g., marriage duration, residential history), which could provide useful insights into their risk of death.

Nevertheless, our results shed light on rural and urban mortality and suggest that future policy efforts could help stave off death from highly preventable causes, decrease disparities in health by rurality, and increase longevity for all. Increasing access to healthcare and improving area-level socioeconomic conditions are more than warranted, as is alleviating poverty and providing equal educational opportunities. These conclusions lend further support to fundamental cause theory and place-based theories of health, which both argue that the social conditions of individuals' residential environments actively shape their health outcomes. In addition to these staple ingredients to eliminating health disparities, supporting community development and opportunities to foster social cohesion among residents remains important, perhaps especially so in rural areas. Moving forward, research should consider the dual importance of individual-level and contextual-level effects on mortality when addressing rural-urban disparities.

REFERENCES

Albrecht, Don E., Carol M. Albrecht, and Stan L. Albrecht. 2000. "Poverty in Nonmetropolitan America: Impacts of Industrial, Employment, and Family Structure Variables." *Rural Sociology* 65(1):87–103.

Arcury, Thomas A., John S. Preisser, Wilbert M. Gesler, and James M. Powers. 2005. "Access to Transportation and Health Care Utilization in a Rural Region." *The Journal of Rural Health* 21(1):31–38.

Auchincloss, Amy H. and Wilbur Hadden. 2002. "The Health Effects of Rural-Urban Residence and Concentrated Poverty." *The Journal of Rural Health* 18(2):319–336.

Barrett, Meredith A., Daphne Miller, and Howard Frumkin. 2014. "Parks and Health: Aligning Incentives to Create Innovations in Chronic Disease Prevention." *Preventing Chronic Disease* 11.

Beaudoin, Christopher E., Monica L. Wendel, and Kelly Drake. 2014. "A Study of Individual-Level Social Capital and Health Outcomes: Testing for Variance between Rural and Urban Respondents." *Rural Sociology* 79(3):336–354.

Beggs, John J., Valerie A. Haines, and Jeanne S. Hurlbert. 1996. "Revisiting the Rural-Urban Contrast: Personal Networks in Nonmetropolitan and Metropolitan Settings 1." *Rural Sociology* 61(2):306–325.

Boardman, Jason D., Brian Karl Finch, Christopher G. Ellison, David R. Williams, and James S. Jackson. 2001. “Neighborhood Disadvantage, Stress, and Drug Use among Adults.” *Journal of Health and Social Behavior* 151–165.

Bolin, Jane N., Gail R. Bellamy, Alva O. Ferdinand, Ann M. Vuong, Bita A. Kash, Avery Schulze, and Janet W. Helduser. 2015. “Rural Healthy People 2020: New Decade, Same Challenges.” *The Journal of Rural Health* 31(3):326–333.

Browning, Christopher R. and Kathleen A. Cagney. 2002. “Neighborhood Structural Disadvantage, Collective Efficacy, and Self-Rated Physical Health in an Urban Setting.” *Journal of Health and Social Behavior* 383–399.

Browning, Christopher R., Kathleen A. Cagney, and James Iveniuk. 2012. “Neighborhood Stressors and Cardiovascular Health: Crime and C-Reactive Protein in Dallas, USA.” *Social Science & Medicine* 75(7):1271–1279.

Burton, Linda M., Raymond Garrett-Peters, and John Major Eason. 2011. “Morality, Identity, and Mental Health in Rural Ghettos.” Pp. 91–110 in *Communities, Neighborhoods, and Health*. Springer.

Burton, Linda M., Daniel T. Lichter, Regina S. Baker, and John M. Eason. 2013. “Inequality, Family Processes, and Health in the ‘New’ Rural America.” *American Behavioral Scientist* 57(8):1128–1151.

Castle, Emery N. 2002. “Social Capital: An Interdisciplinary Concept.” *Rural Sociology* 67(3):331–349.

Cohen, Steven A., Sarah K. Cook, Trisha A. Sando, and Natalie J. Sabik. 2017. “What Aspects of Rural Life Contribute to Rural-Urban Health Disparities in Older Adults? Evidence From a National Survey.” *The Journal of Rural Health*.

Coleman, James S. 1990. “Foundations of Social Capital.” *Cambridge: Belknap*.

Cosby, Arthur G., Tonya T. Neaves, Ronald E. Cossman, Jeralynn S. Cossman, Wesley L. James, Neal Feierabend, David M. Mirvis, Carol A. Jones, and Tracey Farrigan. 2008. “Preliminary Evidence for an Emerging Nonmetropolitan Mortality Penalty in the United States.” *American Journal of Public Health* 98(8):1470–1472.

Cossman, Jeralynn, Wesley James, and Julia Kay Wolf. 2017. “The Differential Effects of Rural Health Care Access on Race-Specific Mortality.” *SSM-Population Health* 3:618–623.

Cossman, Jeralynn S., Wesley L. James, Arthur G. Cosby, and Ronald E. Cossman. 2010. “Underlying Causes of the Emerging Nonmetropolitan Mortality Penalty.” *American Journal of Public Health* 100(8):1417–1419.

De Marco, Allison and Molly De Marco. 2010. “Conceptualization and Measurement of the Neighborhood in Rural Settings: A Systematic Review of the Literature.” *Journal of Community Psychology* 38(1):99–114.

Denney, Justin T., Jarron M. Saint Onge, and Jeff A. Dennis. 2018. "Neighborhood Concentrated Disadvantage and Adult Mortality: Insights for Racial and Ethnic Differences." *Population Research and Policy Review* 1–22.

Douthit, N., S. Kiv, T. Dwolatzky, and S. Biswas. 2015. "Exposing Some Important Barriers to Health Care Access in the Rural USA." *Public Health* 129(6):611–620.

Eason, John M. 2012. "Extending the Hyperghetto: Toward a Theory of Punishment, Race, and Rural Disadvantage." *Journal of Poverty* 16(3):274–295.

Gattino, Silvia, Norma De Piccoli, Omar Fassio, and Chiara Rollero. 2013. "Quality of Life and Sense of Community. A Study on Health and Place of Residence." *Journal of Community Psychology* 41(7):811–826.

Guo, Guang and Hongxin Zhao. 2000. "Multilevel Modeling for Binary Data." *Annual Review of Sociology* 26(1):441–462.

Hartig, Terry, Richard Mitchell, Sjerp De Vries, and Howard Frumkin. 2014. "Nature and Health." *Annual Review of Public Health* 35:207–228.

Hofferth, Sandra L. and John Iceland. 1998. "Social Capital in Rural and Urban Communities 1." *Rural Sociology* 63(4):574–598.

James, Wesley L. 2014. "All Rural Places Are Not Created Equal: Revisiting the Rural Mortality Penalty in the United States." *American Journal of Public Health* 104(11):2122–2129.

Kawachi, Ichiro and Lisa Berkman. 2000. "Social Cohesion, Social Capital, and Health." *Social Epidemiology* 174:190.

Kawachi, Ichiro and Lisa F. Berkman. 2003. *Neighborhoods and Health*. Oxford University Press.

Kawachi, Ichiro and Bruce P. Kennedy. 1997. "Socioeconomic Determinants of Health: Health and Social Cohesion: Why Care about Income Inequality?" *Bmj* 314(7086):1037.

Kawachi, Ichiro, Bruce P. Kennedy, Kimberly Lochner, and Deborah Prothrow-Stith. 1997. "Social Capital, Income Inequality, and Mortality." *American Journal of Public Health* 87(9):1491–1498.

Klinenberg, Eric. 2002. *Heat Wave: A Social Autopsy of Disaster in Chicago*. Chicago: University of Chicago Press.

Lichter, Daniel T. and David L. Brown. 2011. "Rural America in an Urban Society: Changing Spatial and Social Boundaries." *Annual Review of Sociology* 37:565–592.

Lichter, Daniel T., Domenico Parisi, Michael C. Taquino, and Brian Beaulieu. 2008. "Race and the Micro-Scale Spatial Concentration of Poverty." *Cambridge Journal of Regions, Economy and Society* 1(1):51–67.

Link, Bruce G. and Jo Phelan. 1995. "Social Conditions as Fundamental Causes of Disease." *Journal of Health and Social Behavior* 80–94.

Link, Bruce G. and Jo Phelan. 2010. "Social Conditions as Fundamental Causes of Health Inequalities." *Handbook of Medical Sociology* 6:3–17.

Lochner, Kim, Elsie Pamuk, Diane Makuc, Bruce P. Kennedy, and Ichiro Kawachi. 2001. "State-Level Income Inequality and Individual Mortality Risk: A Prospective, Multilevel Study." *American Journal of Public Health* 91(3):385.

Macintyre, Sally and Anne Ellaway. 2000. "Ecological Approaches: Rediscovering the Role of the Physical and Social Environment." *Social Epidemiology* 9(5):332–348.

Macintyre, Sally, Anne Ellaway, and Steven Cummins. 2002. "Place Effects on Health: How Can We Conceptualise, Operationalise and Measure Them?" *Social Science & Medicine* 55(1):125–139.

MacTavish, Katherine and Sonya Salamon. 2001. "Mobile Home Park on the Prairie: A New Rural Community Form." *Rural Sociology* 66(4):487–506.

Masters, Ryan K., Bruce G. Link, and Jo C. Phelan. 2015. "Trends in Education Gradients of 'Preventable'Mortality: A Test of Fundamental Cause Theory." *Social Science & Medicine* 127:19–28.

Meijer, Mathias, Jeannette Röhl, Kim Bloomfield, and Ulrike Grittner. 2012. "Do Neighborhoods Affect Individual Mortality? A Systematic Review and Meta-Analysis of Multilevel Studies." *Social Science & Medicine* 74(8):1204–1212.

Murray, Christopher JL, Sandeep C. Kulkarni, Catherine Michaud, Niels Tomijima, Maria T. Bulzacchelli, Terrell J. Iandiorio, and Majid Ezzati. 2006. "Eight Americas: Investigating Mortality Disparities across Races, Counties, and Race-Counties in the United States." *PLoS Medicine* 3(9):e260.

Olshansky, S. Jay, Toni Antonucci, Lisa Berkman, Robert H. Binstock, Axel Boersch-Supan, John T. Cacioppo, Bruce A. Carnes, Laura L. Carstensen, Linda P. Fried, and Dana P. Goldman. 2012. "Differences in Life Expectancy Due to Race and Educational Differences Are Widening, and Many May Not Catch Up." *Health Affairs* 31(8):1803–1813.

Phelan, Jo C., Bruce G. Link, Ana Diez-Roux, Ichiro Kawachi, and Bruce Levin. 2004. "'Fundamental Causes' of Social Inequalities in Mortality: A Test of the Theory." *Journal of Health and Social Behavior* 45(3):265–285.

Phelan, Jo C., Bruce G. Link, and Parisa Tehranifar. 2010. "Social Conditions as Fundamental Causes of Health Inequalities: Theory, Evidence, and Policy Implications." *Journal of Health and Social Behavior* 51(1_suppl):S28–S40.

Phillips, Charles D. and Kenneth R. McLeroy. 2004. "Health in Rural America: Remembering the Importance of Place." *American Journal of Public Health* 1661–63.

Putnam, Robert D. 2000. "Bowling Alone: America's Declining Social Capital." Pp. 223–234 in *Culture and politics*. Springer.

Russell, Deborah J., John S. Humphreys, Bernadette Ward, Marita Chisholm, Penny Buykx, Matthew McGrail, and John Wakerman. 2013. "Helping Policy-Makers Address Rural Health Access Problems." *Australian Journal of Rural Health* 21(2):61–71.

Sampson, Robert J. 2003.Pp. 132–46 in *Neighborhood-level Context and Health: Lessons from Sociology*. New York: Oxford University Press.

Sampson, Robert J., Jeffrey D. Morenoff, and Thomas Gannon-Rowley. 2002. "Assessing 'Neighborhood Effects': Social Processes and New Directions in Research." *Annual Review of Sociology* 28(1):443–478.

Sampson, Robert J., Stephen W. Raudenbush, and Felton Earls. 1997. "Neighborhoods and Violent Crime: A Multilevel Study of Collective Efficacy." *Science* 277(5328):918–924.

Sherman, Jennifer. 2018. "'Not Allowed to Inherit My Kingdom': Amenity Development and Social Inequality in the Rural West." *Rural Sociology* 83(1):174–207.

Singh, Gopal K. and Mohammad Siahpush. 2006. "Widening Socioeconomic Inequalities in US Life Expectancy, 1980–2000." *International Journal of Epidemiology* 35(4):969–979.

Singh, Gopal K. and Mohammad Siahpush. 2014. "Widening Rural–Urban Disparities in Life Expectancy, US, 1969–2009." *American Journal of Preventive Medicine* 46(2):e19–e29.

Smith, Kristin E. and Ann R. Tickamyer. 2011. *Economic Restructuring and Family Well-Being in Rural America*. Penn State Press.

Subramanian, S. V. and Ichiro Kawachi. 2006. "Being Well and Doing Well: On the Importance of Income for Health." *International Journal of Social Welfare* 15(s1).

U.S. Bureau of the Census. 2016. *New Census Data Show Differences Between Urban and Rural Populations*. Washington, DC: U.S. Government Printing Office.

Washington State Department of Health. 2016. *Washington Tracking Network*. Olympia, WA.

Wilson, William Julius. 1987. *The Truly Disadvantaged: The Inner City, The Underclass, and Public Policy*. University of Chicago Press.

Winkleby, Marilyn, Catherine Cubbin, and David Ahn. 2006. "Effect of Cross-Level Interaction between Individual and Neighborhood Socioeconomic Status on Adult Mortality Rates." *American Journal of Public Health* 96(12):2145–2153.

Yang, Tse-Chuan, Leif Jensen, and Murali Haran. 2011. "Social Capital and Human Mortality: Explaining the Rural Paradox with County-Level Mortality Data." *Rural Sociology* 76(3):347–374.

Table 1—Descriptive Statistics for Adult Deaths, Washington state, 2012-2015

	All	Rural	Urban
	Proportion/Mean (SD)	*Proportion/Mean (SD)*	*Proportion/Mean (SD)*
Preventable mortality	0.59	0.64	0.59
Tract level			
Concentrated Disadvantage[1]	0.01 (0.72)	0.16 (0.68)	-0.01 (0.72)
Health Professional Shortage Area	10.31 (12.51)	28.09 (11.75)	9.06 (11.58)
Children living near park (%)	76.69 (32.19)	45.23 (32.36)	78.90 (31.01)
Non-voters (%)	5.72 (1.75)	5.15 (2.64)	5.76 (1.66)
Residential instability	10.52 (5.80)	7.31 (4.09)	10.76 (5.84)
Home ownership	63.99 (20.31)	67.68 (15.13)	63.72 (20.61)
N	1,430	94	1,336
Individual level			
Male	0.50	0.55	0.50
Age	75.93 (15.17)	75.16 (14.36)	75.98 (15.22)
Race/Ethnicity			
NH White	0.91	0.92	0.90
NH Black	0.03	0.01	0.03
Native American	0.01	0.05	0.02
Asian	0.03	0.01	0.03
Hispanic	0.02	0.03	0.02
Education			
< HS	0.15	0.20	0.15
HS	0.40	0.42	0.40
Some college	0.25	0.24	0.25
College or more	0.20	0.14	0.21
Marital Status			
Married	0.38	0.42	0.38
Never married	0.08	0.07	0.08
Divorced/Separated	0.189	0.19	0.19
Widowed	0.35	0.32	0.35
N	171,986	12,051	159,935

Notes: [1] Concentrated disadvantage is measured as mean of Z-scores of the following variables (percent of individuals below poverty line; percent of individual on public assistance; percent of female-headed households; percent unemployed; percent under 18 years).

Table 2—Multi-level logit models predicting preventable mortality (N= 171,986)

	Model 1				Model 2				Model 3				Model 4			
	OR	SE	95% C.I.		OR	SE	95% C.I.		OR	SE	95% C.I.		OR	SE	95% C.I.	
Level 2 (N=1430)																
Rural	1.25	0.04	1.17	1.33	1.18	0.03	1.11	1.24	1.17	0.03	1.11	1.23	1.13	0.03	1.07	1.20
Concentrated Disadvantage[1]									1.07	0.01	1.05	1.08				
HPSA[1]													1.03	0.01	1.02	1.05
Children near park (%)[1]																
Non-voters (%)[1]																
Home ownership (%)[1]																
Residential instability (%)[1]																
Level 1																
Sex *(ref: Female)*					1.49	0.02	1.46	1.52	1.49	0.02	1.46	1.52	1.49	0.02	1.46	1.52
Age					1.00	0.00	0.99	1.00	1.00	0.00	0.99	1.00	1.00	0.00	0.99	1.00
Age^2					0.99	0.00	0.99	0.99	0.99	0.00	0.99	0.99	0.99	0.00	0.99	0.99
Race/Ethnicity (ref: White)																
NH Black					0.94	0.03	0.88	1.00	0.93	0.03	0.87	0.99	0.95	0.03	0.89	1.01
Native American					1.41	0.07	1.28	1.54	1.37	0.07	1.24	1.50	1.40	0.07	1.28	1.54
Asian					0.89	0.03	0.84	0.95	0.89	0.03	0.84	0.94	0.90	0.03	0.85	0.95
Hispanic					0.89	0.03	0.83	0.95	0.87	0.03	0.81	0.93	0.89	0.03	0.83	0.95
Marital Status (ref: Married)																
Never married					1.25	0.03	1.20	1.30	1.25	0.03	1.19	1.30	1.25	0.03	1.20	1.30
Divorced/Separated					1.37	0.02	1.33	1.41	1.36	0.02	1.32	1.40	1.37	0.02	1.33	1.41
Widowed					1.22	0.02	1.19	1.25	1.21	0.02	1.18	1.25	1.22	0.02	1.19	1.25
Education (ref: < HS)																
HS					0.89	0.01	0.86	0.92	0.89	0.01	0.87	0.92	0.89	0.01	0.86	0.92
Some college					0.81	0.01	0.79	0.84	0.82	0.01	0.80	0.85	0.82	0.01	0.79	0.84
College or more					0.65	0.01	0.63	0.67	0.66	0.01	0.64	0.69	0.65	0.01	0.63	0.67
Intercept	1.46	0.02	1.43	1.49	2.79	0.27	2.30	3.38	2.78	0.27	2.29	3.37	2.77	0.27	2.29	3.37

Notes: All models control for population density. Asterisks (*) are not included because this is population data. [1]Variable is standardized. CD= Concentrated Disadvantage

Table 2 (Continued)

	Model 5				Model 6				Model 7			
	OR	SE	95% CI		OR	SE	95% CI		OR	SE	95% CI	
Level 2 (N=1430)												
Rural	1.16	0.03	1.10	1.22	1.21	0.03	1.15	1.28	1.14	0.04	1.06	1.22
Concentrated Disadvantage[1]									1.03	0.01	1.01	1.05
HPSA[1]									1.02	0.01	1.01	1.04
Children near park (%)[1]	0.98	0.01	0.96	0.99					0.97	0.01	0.95	0.98
Non-voters (%)[1]					1.05	0.01	1.04	1.07	1.04	0.01	1.02	1.05
Home ownership (%)[1]					0.96	0.01	0.94	0.97	0.96	0.01	0.94	0.99
Residential instability (%)[1]					0.99	0.01	0.97	1.01	0.99	0.01	0.98	1.01
Level 1												
Sex *(ref: Female)*	1.49	0.02	1.46	1.52	1.49	0.02	1.46	1.52	1.48	0.02	1.45	1.52
Age	0.99	0.00	0.99	1.00	0.99	0.00	0.99	1.00	0.99	0.01	0.99	1.00
Age^2	0.99	0.00	0.99	0.99	0.99	0.00	0.99	0.99	0.99	0.00	0.99	0.99
Race/Ethnicity (ref: White)												
NH Black	0.94	0.02	0.88	1.00	0.93	0.03	0.87	0.99	0.93	0.03	0.87	0.99
Native American	1.40	0.07	1.27	1.54	1.38	0.07	1.23	1.49	1.34	0.06	1.22	1.47
Asian	0.89	0.03	0.84	0.95	0.88	0.03	0.83	0.94	0.89	0.03	0.84	0.95
Hispanic	0.89	0.03	0.83	0.95	0.87	0.03	0.82	0.93	0.86	0.03	0.81	0.92
Marital Status (ref: Married)												
Never married	1.25	0.03	1.20	1.31	1.25	0.03	1.20	1.30	1.25	0.03	1.20	1.30
Divorced/Separated	1.37	0.02	1.33	1.41	1.37	0.02	1.33	1.41	1.36	0.02	1.32	1.40
Widowed	1.22	0.02	1.19	1.25	1.22	0.02	1.18	1.25	1.21	0.02	1.18	1.25
Education (ref: < HS)												
HS	0.89	0.01	0.86	0.92	0.89	0.01	0.87	0.92	0.90	0.01	0.87	0.93
Some college	0.81	0.01	0.79	0.84	0.82	0.01	0.79	0.85	0.83	0.01	0.80	0.86
College or more	0.65	0.01	0.63	0.67	0.66	0.01	0.64	0.68	0.67	0.01	0.64	0.69
Intercept	2.76	0.27	2.27	3.35	2.77	0.27	2.29	3.37	2.74	0.27	2.26	3.32

Notes: All models control for population density. Asterisks (*) are not included because this is population data. [1]Variable is standardized.

Table 3—Multi-level logit models predicting preventable mortality—Rural only (N=12,051)

	Model 1				Model 2				Model 3				Model 4			
	OR	SE	95% C.I.		OR	SE	95% C.I.		OR	SE	95% C.I.		OR	SE	95% C.I.	
Concentrated Disadvantage[1]	1.09	0.04	1.02	1.17												
HPSA[1]					1.01	0.03	0.88	1.07								
Children near park (%)[1]									0.98	0.03	0.92	1.03				
Non-voters (%)[1]													1.01	0.02	0.97	1.05
Home ownership (%)[1]													0.96	0.07	0.84	1.10
Residential instability (%)[1]													0.99	0.04	0.92	1.07
Intercept	2.94	1.22	1.31	6.62	2.94	1.22	1.30	6.65	2.87	1.19	1.27	6.48	3.01	1.25	1.34	6.79

Notes: All models control for population density, age, sex, race, education, and marital status. Asterisks (*) are not included because this is population data. [1]Variable is standardized.

Table 4—Multi-level logit models predicting preventable mortality—Urban only (N=159,935)

	Model 1				Model 2				Model 3				Model 4			
	OR	SE	95% C.I.		OR	SE	95% C.I.		OR	SE	95% C.I.		OR	SE	95% C.I.	
Concentrated Disadvantage[1]	1.07	0.01	1.05	1.08												
HPSA[1]					1.03	0.01	1.02	1.05								
Children near park (%)[1]									0.98	0.01	0.96	0.99				
Non-voters (%)[1]													1.06	0.01	1.04	1.07
Home ownership (%)[1]													0.96	0.01	0.94	0.98
Residential instability (%)[1]													0.99	0.01	0.97	1.01
Intercept	2.77	0.28	2.27	3.39	2.77	0.28	2.27	3.39	2.76	0.28	2.26	3.37	2.82	0.28	2.31	3.44

Notes: All models control for population density, age, sex, race, education, and marital status. Asterisks (*) are not included because this is population data. [1]Variable is standardized.