The Geography of Cerebrovascular Disease in Texas

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Bio:

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Abstract:

This study examines the spatial distribution of cerebrovascular disease (CVD) mortality rates in Texas counties from 1999–2003. The human ecology model is used to see how CVD relates with selected variables, specifically how CVD mortality rates relate to aquifer water hardness using the Mann-Whitney U test and independent samples *t*-test. The results show that counties with higher water hardness levels have lower CVD mortality rates. Results for race/ethnicity suggest that African Americans are more vulnerable to the disease, whereas Hispanic American CVD mortality rates were much lower. For further research, it would be of paramount importance to closely examine the actual water consumed in Texas counties to probe more rigorously the relationship between aquifer water hardness and CVD mortality.

Introduction

Cerebrovascular disease (CVD) is the third leading cause of death in Texas (Texas Department of State Health Services, 2005). Between 1999 and 2003, it was linked to the deaths of 52,532 people (Expert Data Health Programming, Inc., n.d.). CVD is connected to an estimated 150,000 deaths annually across the United States, and is responsible for long-term disability (U.S. National Center for Health Statistics, 2007). This study will focus on the spatial distribution of stroke and related variables in Texas counties, and explore the relationships among such factors as water hardness, race, income, and how they relate to CVD.

CVD includes all disorders in which areas of the brain become affected by a restriction in blood supply or bleeding in one or more of the cerebral blood vessels (Winkler, 1998). Typically, the arteries of the brain become defective, resulting in stroke. Within the disease, there are two main classifications. *Ischemic disease* causes a lack of blood flow, whereas *hemorrhagic disease* is an excess amount of blood supplied to the brain (Verma, Prewitt, & Deaton, 2007).

Risk Predictors of CVD

Previous research suggests that hard water may serve as a protective factor in CVD mortality (Ferrandiz et al., 2004). The usual suspects found in hard water are high levels of calcium and magnesium in the form of carbonates ("Hard Water," n.d.). Aquifers, which send water to counties within the state, can determine what types of minerals are carried through the water supply, resulting in hard or soft water (Meade & Earickson, 2005).

Similarly, race/ethnicity has been identified as a risk factor for CVD. In the United States, the disparity in the ratio of African American to Caucasian mortality is greatest for the incidence of stroke (Gorelick, 1998). Race is an important issue because the constructed racial categories define the social and economic disadvantages that impact a group's health status

(Gorelick, 1998). In the United States, African Americans have greater CVD mortality rates than any other race/ethnic group (Gorelick, 1998). Out of the CVD risk indicators, diabetes mellitus, obesity, and hypertension are more prevalent among African Americans, putting them at a further disadvantage (Gorelick, 1998). In contrast, previous research concluded that Hispanic Americans had rates that were substantially lower than those of other races (Gillum, 1995). These lower CVD mortality rates could be a result of natural conditions, such as lower blood pressure (Gillum, 1995).

Objective

As previously mentioned, this study examines the spatial distribution of stroke and related explanatory variables, including water hardness, race, and income in the spatial context of Texas counties. For this study, CVD is defined by ICD-10 Code 181. Mortality data from the Texas Department of State Health Services (TDSHS) for 1999–2003 were extracted from the Expert Data Health Programming vital data website. The mortality data was age-adjusted to the United States 2000 Census standard. Water hardness data came from the Texas Water Development Board's groundwater database.

Hypothesis

Three main hypotheses are tested for this research:

- Hypothesis 1: Increased water hardness is related to low CVD mortality. Counties with soft water will have a greater CVD mortality.
- Hypothesis 2: African American populations experience higher mortality rates compared to Hispanic American or Caucasian populations. Thus, counties with a high percentage of African Americans will have high CVD mortality rates.

- Hypothesis 3: Texas counties with lower median income experience slightly higher mortality rates.

Results: Geography of Disease in Texas

Figure 1 shows the spatial distribution of CVD mortality rates in Texas counties (1999–2003). Counties along the southwest coast of Texas appear to have the lowest rates of the disease, particularly the counties that border Mexico. However, counties in the northeast portion of Texas have higher CVD mortality rates. The mortality rates here range from 55.601 to 140.9 deaths per 100,000 people, generally exceeding the state average of 62.24. Thus, the further south one goes within Texas, the lower the CVD mortality rate appears to be. Areas in the northeast are occupied primarily by African Americans, and areas further south have larger Hispanic American populations.

Water Hardness and CVD

Median water hardness for Texas counties was hypothesized to correlate negatively to CVD mortality rates for that county. The Ogallala Aquifer in the west provides hard water, but in contrast, the Trinity Aquifer supplies softer water, as shown in Figure 2. The Mann-Whitney U test was used to examine the differences in CVD between areas. The results show that the relationship was significant ($p < 0.05$), and confirmed a significant difference in CVD mortality between the two aquifers. An independent samples *t*-test revealed that the mean mortality in the Trinity Aquifer counties is 59.44 compared to 70.07 deaths per 100,000 people in the Ogallala Aquifer area, confirming the hypothesis. Thus, the western portion of the state with harder water had lower CVD mortality rates compared to the eastern portion with softer water.

Percent African American and Mortality Rates

It was initially hypothesized that counties with a greater percentage of African Americans in the population would also have higher CVD mortality rates. The northeast sector of Texas contains a larger portion of the African American population. It was found that there was a positive correlation between CVD mortality rates and percent African American ($r = 0.152$*, $p = 0.015$). This result also seems to be reflected in the map, as shown in Figure 3. These data are consistent with previous research, which showed that the incidence of stroke is approximately twice as high for African Americans as compared to Caucasians (Gorelick, 1998). This result is not surprising, because risk factors such as diabetes mellitus, hypertension, and obesity are generally more prevalent among African Americans.

Percent Hispanic American and Mortality Rates

In contrast, the percentage of Hispanic American population correlated negatively with CVD mortality rates ($r = -0.177$**, $p = 0.005$). The southern portions of Texas, occupied predominantly by Hispanic Americans, have lower CVD mortality rates, as shown in Figure 4.

Poverty and CVD Mortality Rates

Poverty was initially hypothesized to be a predictor of CVD rates; areas with lower income would be more susceptible to CVD mortality rates. The opposite result was found, but the relationship was not statistically significant ($r = 0.021$, $p = 0.744$). Perhaps because the Hispanic American population in Texas (with a lower income overall) generally has a negative correlation with the disease, various confounding factors might be introduced.

Discussion

The negative correlation between CVD and the percentage of the population that is Hispanic American may show a possible protective factor against the disease. This result might be attributed to what is referred to as the *Hispanic paradox.* One might expect to find similar

rates among Hispanic Americans as among the African American population due to similar socioeconomic circumstances. For example, both races have limited access to health care and have lower levels of income. Possible underreporting of Hispanic deaths and migrant effects may contribute to, but probably do not explain, the paradox (Franzini, Ribble, & Keddie, 2001). The Hispanic paradox attributes this to the fact that Hispanics have a younger median age and are more susceptible to communicable diseases, as opposed to degenerative ones such as CVD. Hispanics that experience stroke typically do so at younger ages and are more likely to recover (American Stroke Association, 2004). Other studies suggest that it may be due in part to lower blood pressure in Hispanics than non-Hispanics, which would serve as a protective factor when faced with this disease (Gillum, 1995).

Although median income is not found to be statistically significant, this result might be due to the socioeconomic status of the Hispanic American population in Texas. Perhaps because they have a lower socioeconomic status, they are more likely to perform manual labor, which might also serve as a protective factor against the disease. It is also important to note that data are aggregated at the county level, which may complicate data analysis.

Conclusions

CVD mortality rates in Texas counties appear to be influenced by water hardness and race/ethnicity, but analysis by median income did not reveal any statistical significance. Water hardness appears to be a protective factor in those counties supplied with hard water, resulting in lower mortality rates. It also appears that the African American population is more susceptible to CVD. Alternatively, Hispanic American populations are negatively associated with the disease.

CVD is not communicable, and therefore it can be difficult to narrow down the options when trying to control the disease. For further research, it would be paramount to closely

examine the actual water consumed in Texas counties to probe more rigorously the relationship between aquifer water hardness and CVD mortality.

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Figure 1. CVD Mortality Rates by County for the State of Texas

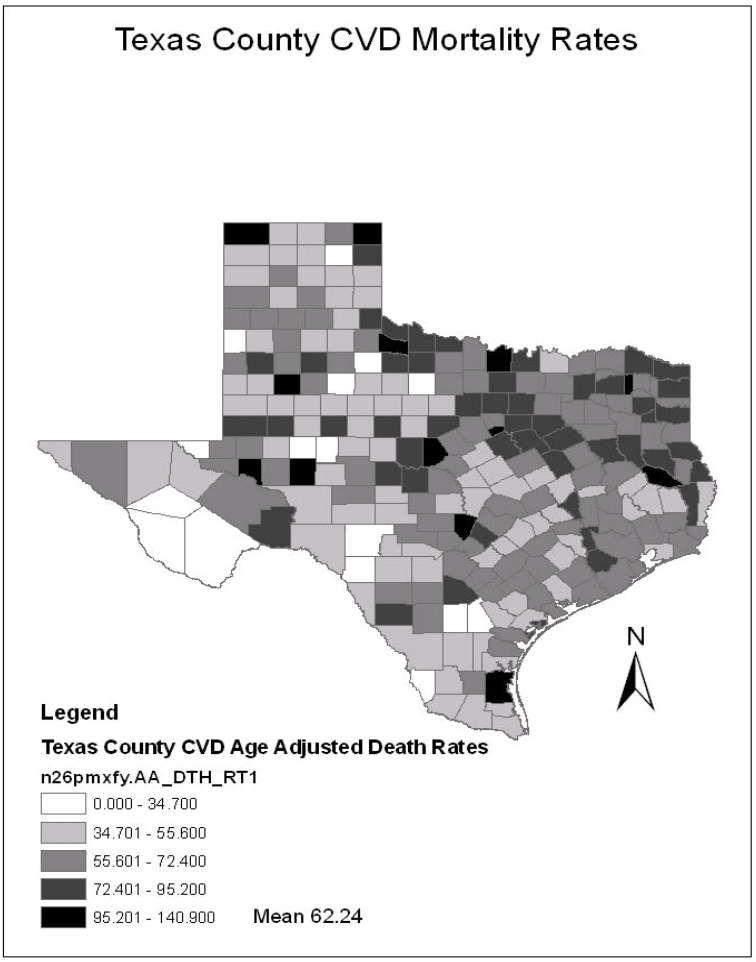
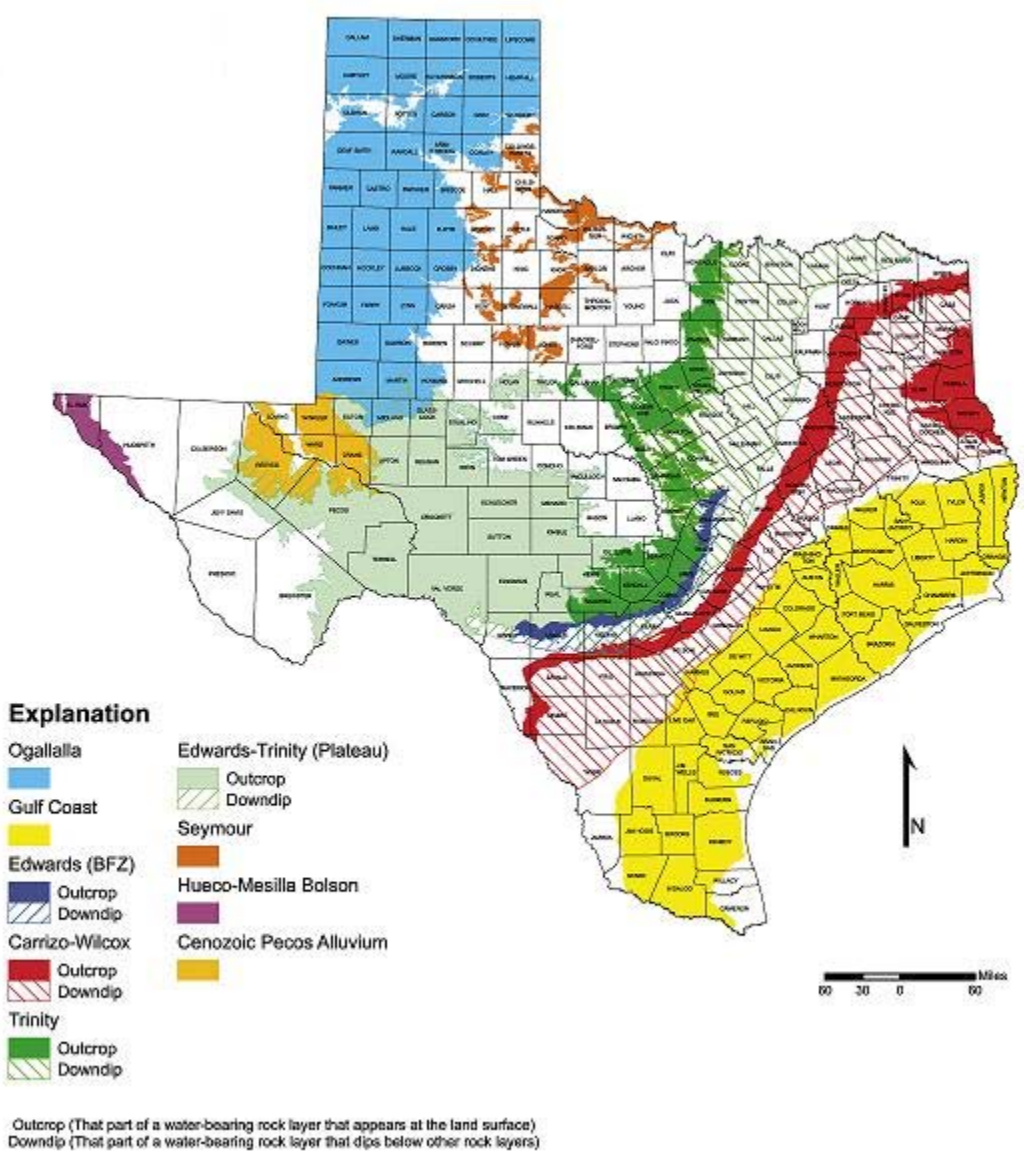


Figure 2. Geographical Location of Aquifers in Texas Counties



(Texas Water Development Board, retrieved February 16, 2008, from http://www.twdb.state.tx.us/publications/reports/State_Water_Plan/2002/PCX%20Graphics/Fig%2005-08.jpg)

Figure 3. Percentage African American Population by County in the State of Texas

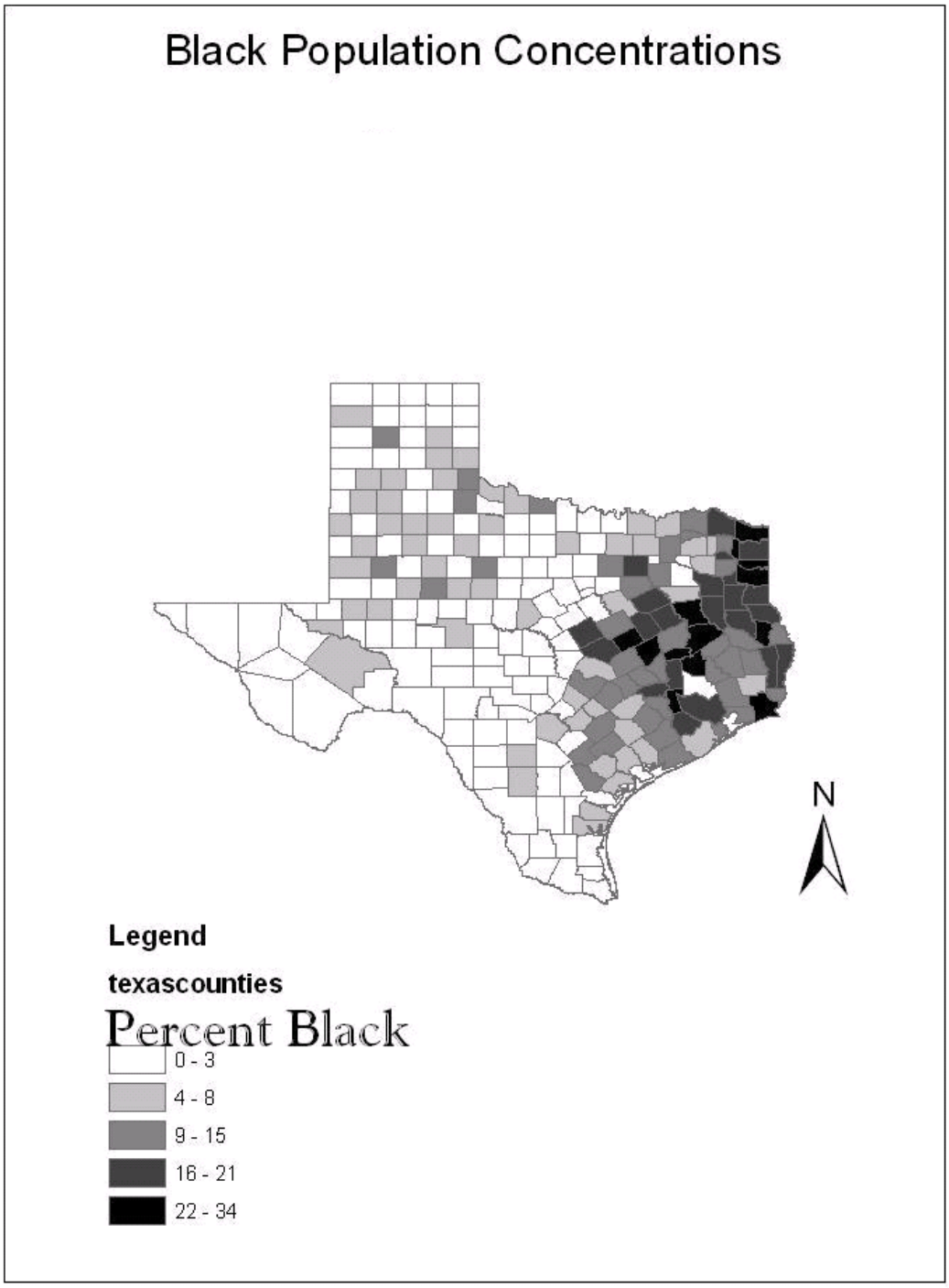


Figure 4. Percentage Hispanic American Population by County in the State of Texas