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Presentation And Understanding Of Mortality Through Geospatial And Administrative Boundaries: An Examination Of Rates And Correlates Of Mortality In Texas Census Tracts

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Presentation And Understanding Of Mortality Through Geospatial And Administrative Boundaries: An Examination Of Rates And Correlates Of Mortality In Texas Census Tracts

by

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Capstone

Presented to the Faculty of the Graduate School of

The University of Texas Medical Branch

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Public Health

The University of Texas Medical Branch

July, 2015

Dedication

To my wife, Kat, for supporting me through the ups and downs of graduate school and to my family for always encouraging me to excel even if I am too smart for my own good.

Acknowledgements

Thank you to Dr. John Prochaska for all of his support and guidance on this project and through being a great colleague and confidant.

To Dr. Karl Eschbach for his continued support and help on this project and my dissertation work and, of course, for his eternal patience toward all these matters.

And to Dr. Jacques Baillargeon for his excellent feedback and support for this project and his support through my time at UTMB.

Finally, thank you to the Department of Preventive Medicine and Community Health for all of their support, guidance, and advocacy for my work and personal growth at UTMB.

Presentation And Understanding Of Mortality Through Geospatial And Administrative Boundaries: An Examination Of Rates And Correlates Of Mortality In Texas Census Tracts

Publication No._____________

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The University of Texas Medical Branch, 2015

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This capstone project analyses Texas vital statistics data through visual and tabular presentation of county-level age-adjusted mortality rates for all-cause and cause-specific mortality (including heart, cancer, and stroke) and through multilevel regression analyses of deaths at the census tract level, adjusting for individual and tract and demographic and socioeconomic factors.

County-level, mortality rates were developed for three racial/ethnic groups in Texas, non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. The rates were age-standardized based on the age structure of the total population of Texas. Rates are presented in tabular and visual formats using Texas Department of State Health Services Public Health Regions to allow for finer discussion of geographic areas within the state. For the tract data, deaths are analyzed using hierarchical Poisson regression model. This model used demographic factors including age, racial/ethnic category, and gender to identify correlates of deaths on the individual level. For the tract-level demographic factors (i.e. percent Hispanic (quartiles)), socioeconomic factors (percent in poverty (quartile)), and geographic identifiers (e.g. tracts in border counties and urban/rural

tracts) were used to identify are-level effects that influence the number of deaths in a tract. These models used population size within each tract as a variable exposure to account for larger population areas having more deaths. The visual and tabular analyses of counties showed that non-Hispanic Blacks, overall, had the worst mortality rates of all groups across the state. Hispanics showed lower rates than non-Hispanic Blacks, overall, and non-Hispanic Whites usually had the better rates of all groups. For all groups, within regions, and across the state, there was considerable variability though non-Hispanic Blacks, again, showed the worst patterns of mortality. Hispanics varied greatly across the state, doing very poorly along the eastern border of Texas but much better in the South, along the border. From the tract analyses, Hispanics, overall, did better than non-Hispanic Whites and non-Hispanic Blacks. This was especially true in areas of higher poverty and higher Hispanic populations.

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List of Abbreviations

UTMB	University of Texas Medical Branch
GSBS	Graduate School of Biomedical Science
TDC	Thesis and Dissertation Coordinator
GIS	Geospatial Information Systems
CDC	Centers for Disease Control and Prevention
U.S. (US)	United States
SF	Summary File
NHANES	National Health and Nutrition Examination Survey
MAUP	Modifiable Areal Unit Problem
SES	Socioeconomic Status
UK	United Kingdom
ACS	American Community Survey
RUCA	Rural-Urban Commuting Area
DSHS	Department of State Health Services
OMB	Office of Management and Budget
ICD-10	International Statistical Classification of Diseases and Related Health Problems: Revision 10
NCHS	National Center for Health Statistics
RHRC	Rural Health Research Center
QGIS	Quantum GIS
ICC	Interclass Correlation

CHAPTER 1

Introduction

This project seeks to understand how patterns of mortality in Texas are influenced by aggregation (areal units i.e., public health regions, counties, and census tracts) and what factors at the census tract level affect mortality outcomes across tracts. This capstone work is an attempt to begin answering how potential geographic variants in mortality are impacted through the intersection of demographic and socioeconomic factors at both the individual and area level within the state of Texas.

The interest in the relationship between place (i.e., geography) and the effects of health (especially mortality) has long had a place in history. One of the first examples from historical public health is the work of John Snow and the Broad Street pump. One could quibble about his science and its meaning in the era which he conducted his work[1], but his use of simple mapping helped build his case by chronicling the clustering of cholera cases near the Broadstreet pump. This work was a strong victory for public health. Though unknown at the time it became an exemplary case showing how spatially-distributed risks can contribute to health. More recently, we have tools that contribute to a better ability to map thanks to the advent of computers. These tools allow us to control for factors that Snow could not, including how patterns of mortality may be linked due to their closeness to one another (interdependence) and how the patterns of health may appear in concentrated areas due to similarities of the populations in those regions (clustering) to name two important examples.

Flash forward to the present time and we find that a systematic understanding of area effects on health and mortality is still in its infancy. The primary statistical method for this type of analysis is a multilevel regression analysis, which helps to deal with the hierarchically structured linkage between individual and area level causal associations. Hierarchical methods provide the strongest resource for understanding how differences in regions contribute to the distribution and change of health across regions. The emergence of computers in the last half century has also facilitated the ability to map disease and mortality across geographic regions. Related methods of analysis have arrived in the form of Geographic Information Systems (GIS). GIS are systems which allow for the creation, storage, development, analysis, and modification of geospatial information to be used to combine, analyze and display spatial data. Spatial data are data which are linked to a geographic place such as a zip code or a specific geographic point on a map.[2] These spatial analyses then apply statistical calculations to address the geographic relationships that contribute to the association between events within and between areal units of analysis.

RESEARCH QUESTIONS

Multiple analyses have been conducted in Texas using differing areal units for analysis including statewide trends, county trends, and regional differences. Census tracts have been limited in their use examining Texas mortality. Studying mortality patterns at the level of the census tracts allows investigation of the association between the characteristics of small local communities and mortality

The research questions for this capstone are: 1) how do regional patterns of mortality differ across the state and between racial/ethnic groups? 2) How is mortality at the local level (i.e., census tracts) influenced by individual and area-level effects in Texas?

SPECIFIC AIMS

These questions will be addressed through two specific aims:

Aim 1. Describe gross regional patterns of mortality for non-Hispanic Whites, non-Hispanic Blacks, and Hispanics in Texas through tabular representations and thematic mapping. Specifically, these analyses will look at all-cause mortality and major contributors to mortality based on the top causes of mortality as listed by the CDC.

Aim 2. Analyze the association between deaths and race/ethnicity, sex, and age at the individual level given census tract ethnic concentration, poverty, and rural/urban status for non-Hispanic Whites, non-Hispanic Blacks, and Hispanics.

SIGNIFICANCE

There are two principal contributions of this capstone to improving understanding by public health researchers, health care policy makers, and medical care providers of mortality patterns in the state of Texas.

First, an understanding of how presentation of data influences the perceptions of needs and resources for care can be critical for identifying spatial patterns to inform patients about geographically distributed risks, to inform decisions about actions to improve their well-being. Differences in conclusions drawn across differing levels of aggregation in Texas will help to highlight how our understanding of health patterns can be driven by the presentation of information.

Second, the influence of local area effects on mortality is a critical element of knowledge for health care and public health workers. To understand how the environment influences outcomes in a particular region can help a provider to understand what systematic barriers to care may preclude their patients from achieving good health and well-being. This project seeks to understand how geographic area influences mortality rates and health risks across the state and how individal and area-level effect directly influences mortality in Texas.

CHAPTER 2

Background and Literature Review

MORTALITY TRENDS IN THE UNITED STATES

Mortality is a barometer of the health of the population. Mortality trends are the convergence of the undercurrents of population and individual level norms, mores (cultural rules and bounds of right and wrong), and behaviors that drive health behaviors and practices. On a population level, these actual causes of death are largely unreported or unexamined, instead replaced by the most proximate cause of mortality.[3] Despite this, the findings from these population level analyses are no less important, spurring motivated and interested public health researchers to fully understand not only that mortality is occurring but how and why mortality patterns present in any particular fashion through time.

Mortality trends from 1980 to 2010 can be highlighted using the Health: United States Report from 2013.[4] This report provides data tables with data based on death certificates for the years 1980 and 2010 which can be used to show overall changes for the major contributors to mortality and patterns of change in specific racial/ethnic groups in the United States.

From 1980 to 2010, the overall age-adjusted mortality rate (Table 19; Health: United States) for the United States has shown a decline. In 1980, the rate was over 1,000 deaths per 100,000 and by 2010, the rate had declined to about 750 deaths per 100,000. By 2010, the highest age-adjusted death rate was non-Hispanic Blacks with a rate of 919 per 100,000 while non-Hispanic Whites had a rate close to the US average with 750 per 100,000 deaths. Hispanics, the other group of interest, had a death rate of about 565 per 100,000. This indicates a large difference in rates amongst groups.[4]

From 1980 to 2010, the top two contributors to mortality for the population of the US (Table 22) as a whole were "diseases of the heart" and "malignant neoplasms". From 1980 to 2010, "cerebrovascular diseases" and "unintentional injuries" were displaced from the third- and fourth-leading causes to the fourth- and fifth-leading causes by chronic lower respiratory diseases which was not even a top ten contributor in 1980.[4]

Breaking these numbers down by race/ethnicity and sex, data can be compared across groups in 2010 for Hispanics, Blacks, and Whites. For trends over time, however, data is only available for Whites and Blacks, as data for Hispanic were not presented in 1980. Looking at the top causes of death for 2010 (Table 22; Health: United States), malignant neoplasms and diseases of the heart are the top contributors for all three groups. When looking at diabetes, non-Hispanic Blacks had diabetes as the fourth leading cause of death (moving up from the 8th leading cause 20 years previously), Hispanics had diabetes as the fifth leading contributor, and non-Hispanic Whites had diabetes as the 7th leading cause (remaining stable in position through time).[4]

Despite a lack of available information from national sources, the patterns of mortality for Hispanics have been examined through other research. Specifically, a study by Sorlie and colleagues[5] compared mortality ratios for a large national cohort of non-Hispanics and Hispanics for an eight year period from 1979 to 1987. While this does not provide comparable results with the Health: United States report, it does indicate that Hispanics have lower mortality rates than non-Hispanics, overall. Combined with the Health: United States data and the US Life Tables after the addition of Hispanics, these results suggest that Hispanics have long held an overall mortality advantage over non-Hispanic Whites and non-Hispanic Blacks.

Of additional concern is the effect of nativity on mortality outcomes amongst Hispanics. While the Hispanic paradox has long shown a surprising advantage for Hispanics on a large scale, more recent evidence suggests that being Hispanic may be of less concern for mortality than place of birth, with some evidence suggesting a largely universal immigrant advantage in mortality.[6]

Other research has indicated that this pattern is not universal, especially in localized regions, with studies from the San Antonio area indicating that Hispanics fair more poorly than their non-Hispanic White counterparts.[7] This research then indicates a potential geographic effect on mortality that is important to understand for public health research and has significant policy implications. Important in this discussion then, is how geographic area is associated with both health and mortality and how these influences drive the mortality patterns that we see. Next, specific examples of neighborhoods and area are discussed in terms of health and mortality and then a discussion of geographic boundaries follows to establish how the choice of boundaries may drive outcomes of research and allowing for researchers and policy makers to understand how their choice of boundaries can drive findings.

ASSOCIATION BETWEEN GEOGRAPHIC AREA, HEALTH AND MORTALITY

Central to the concept of area and health is the idea of "fundamental causes of disease". The basic tenants of this idea are that the social and economic conditions of the individual have a considerable impact on their access to resources which drives the well-being of the individual. The power of fundamental causes of disease is the idea that the influence of socioeconomic resources and their relationship to public health infrastructure may have a more meaningful impact on health than medical interventions in directing population health. Those who have more resources are protected because they can better navigate the changing health environment and those with fewer resources having a lower ability to navigate successfully. While there remains a considerable debate over the influence of medical professionals versus the influence of public health measures, it is likely best to consider a middle approach where both medical interventions and population health interventions interact to drive health shifts in the population.[8–14]

In addition to the effects of the area socioeconomic effects, there are effects of area related to segregation and ethnic density. At their core, the two concepts are interrelated with both signifying the effects of the racial/ethnic concentration of a minority group within an area on the health and mortality of persons living within the area. The major differences between the two are that ethnic density is often related to the advantageous effects of the concentration of Hispanics, and more specifically the effects appear to be related to Mexican Origin adults in an area. Segregation, on the other hand, seems to be a more negative effect and is often associated with Blacks. The difference between the two likely derives from the different primary source for the pattern of local ethnic homogeneity—in the case of Hispanics, co-location for social support among immigrants and their descendants, in contrast to patterns of housing discrimination and avoidance leading to the hypersegregation of Blacks.[15,16] These two aspects of area are important in developing an understanding of health and mortality patterns for minorities and support the idea that different regions can connote differing effects on well-being.

Also of interest to researchers on areal and neighborhood effects on health is the concept of social capital. Social capital is a term of sociological origin that is defined as "features of social relationships—such as levels of interpersonal trust and norms of reciprocity and mutual aid—that facilitate collective action for mutual benefit".[17(p121)] While social capital cannot be measured in the current study, it is related to resources explicitly and implicitly defined by segregation and concentration in a region and the less ability to connect to others, especially others who can provide support leads to increasing disadvantage. Social capital also allows for the policing of social norms within an area and the creation of a cohesive structured social environment.[17] The limitation of resources causes these systems to break down and drives some of the area/neighborhood effects that cause particular health patterns to emerge.

Further support for the hypothesis that there are effects of concentrated disadvantage comes from studies in different US cities. In a study of the Chicago area, Roberts[18] found that economic hardship, as identified by high poverty and high unemployment, was associated with a higher risk of low birthweight for mothers and differed by neighborhoods through the region. In another study by Hutchinson and colleagues, the effects of social capital were determined to drive differences in Black all-cause mortality in the city. Specifically, for Blacks in this study living in largely White neighborhoods mortality was higher than for Blacks living in largely Blacks neighborhoods. These effects were hypothesized to be largely driven by the amount of social capital available to residents in different neighborhood environments. Lower social capital was linked to worse mortality.[19]

In a study of the US population by Waitzman and Smith[20], the effects of area poverty were examined for Whites and Blacks aged 25 to 74 in the NHANES I medical survey from 1971 to 1975 and the NHANES I follow up in 1987. The findings of this study found that the area poverty as related to household income was a predictor of all-cause, cardiovascular, and cancer mortality. The effects were stronger in younger adults than in older adults. This finding indicates that there may be a survival effect for the older adults who have already surmounted the disadvantage created by area effects.

More recently, Doubeni and associates[21] examined the effects of neighborhood SES and premature mortality on early mortality in the United States. Their study, using AARP data, examined adults ages 50 to 71. For the analyses, tract measures such as education and percent black were used to test association between area and mortality. Their findings found that even in the older population that a higher socioeconomic disadvantage was associated with an increased risk of mortality. Further, the higher the socioeconomic disadvantage in a region, the higher the risk for adverse health risks such as diabetes, stroke, hypertension, emphysema, and reporting poor or fair health. One finding of interest was that those in good to excellent health showed a higher difference in the effects of deprivation than those who were of fair or poor health. These results indicate an effect of area socioeconomic pressures on mortality and well-being that differs by census tract, but that these effects may be tempered by the perceptions of health status reported by respondents.

GEOGRAPHIC BOUNDARIES AND HEALTH AND MORTALITY

When discussing area/neighborhood effects, it is important to acknowledge that the area of aggregation can have an important influence on the results of analyses. For the United States, the availability of socioeconomic data in public health data sets has historically been limited. The lack of adequate socioeconomic measures contributes to a considerable shortcoming in the ability of researchers to account for the influences of these measures on health and mortality. Without a means to control for socioeconomic effects, the findings of such research is then severely limited without some other means of introducing economic factors. One potential mechanism that has been shown to be of considerable use to health researchers is geospatial identifiers.[22] Geospatial identifiers are measures of area borders that provide aggregate values for selected areas. These areas are based on several different criteria and sources and they can be as small as a block or neighborhood and analyses could be as large as countries or geopolitical allegiances of countries. The level of detail, however, has a strong influence on the results of analyses. Any analyses should be driven by the research question and with an understanding that level of detail can drive conclusions made from analyses. One major concern for any level of research is the Modifiable Areal Unit Problem (MAUP). The MAUP is where the area of analysis is changed but the analysis type is not, leading to a faulty interpretation of the data related to differences in scale created by aggregation.[23] Boundaries are discussed from more local regions to broader levels of representation.

Neighborhoods

For many public health researchers, the most interesting area of analysis is the neighborhood. Neighborhoods are important because they are where people live out a good part of their lives. The neighborhood, then, can be a significant contributor to exposure to negative environmental and socioeconomic processes.[24–27] However, the neighborhood, though important, is difficult to gauge in the pursuit of research. This is primarily because a neighborhood is a subjective construct and unless a project is in a very small area, the ability to determine boundaries may be difficult if not impossible. Even in small areas, the definition of a neighborhood may be variable if not constantly shifting.[28–31] However, these discussions go beyond a mere academic concern for where neighborhood boundaries are drawn. The choice of area can influence within- and between- neighborhood variations of neighborhoods which can significantly impact analyses.[32] A study by Woods and Colleagues[33] drives this point home. In their analysis of the effects of geographic boundaries, SES, and breast cancer survival in the UK, they found that when using a larger geographic unit, the difference in survival between deprived and affluent areas was smaller due to aggregation effects. Finally, it is almost a fact of life that the availability of neighborhood level information is very limited and for many studies the need to examine larger areas makes the use of such measures almost impossible to be of use due to resources and time. This means that, while preferable, the use of neighborhoods may not be possible, or even useful for many studies. To address this issue, researchers have access to administrative and government/political identifiers which can be of use to approximate the neighborhood area.

Census Blocks

As mentioned above, when a measure of the neighborhood is not possible, researchers often use administrative boundaries to approximated neighborhoods. The smallest level of data for analysis is the Census Block Group. It is not the smallest geographic identifier developed by the Census, which also collects data on the block level; but it is the smallest level that is published as part of the available sample population data. In general, the block group will comprise of 600 to 3000 persons within an area.[34] Given that these features are statistical divisions, they may not accurately represent a “neighborhood as the boundaries may not cross similarly to the boundaries that often identify a neighborhood. That being said, block groups are often a means to identify a “neighborhood” for analysis purposes given that it may be difficult or impossible for a researcher to identify a neighborhood, especially across a large study area.

One issue here is that these block groups may differ given a geographic region. As you move from a rural area to an urban area (especially in the West), your census block group shifts from very large areas to very small areas, especially in metropolitan areas. Rural areas are also less uniform in their road and housing patterns due to more wide open areas and the necessity to work around geographic features.[35,36] This means that the use of census block groups to establish neighborhoods may not be equivalent (or meaningful) when examining effects across a region when a researcher is interested in examining effects outside of more densely populated areas. One way to address this is to examine only densely populated areas like metropolitan statistical areas when trying to examine neighborhood effects. For researchers that are more content with understanding general area effects, this is less of an issue and taking into account the area population or other effects can help to create a more representative view of area affects.

Census Tracts

Census tracts are developed through the aggregation of block groups and contain between 1,200 and 8,000 persons with an average of about 4,000 persons[37]. For socioeconomic data, census tracts are of most use for analysis as they have the most associated data reported by the government. While Census Block Groups may be of more value in terms of representing small distinct areas, the presence of more socioeconomic data and narrower confidence intervals for sample data at the tract level is a boon to researchers attempting to understand how area effects contribute to health and mortality effects for a population.

Depending on the purpose of research, the use of area measures should be considered carefully. For some effects of interest, analyses must be conducted based on very small areas. When using larger area indicators, the results could be lost. Related to this phenomenon, census tracts have been shown to create some smoothing of extreme values due to aggregation. However, research indicates that, overall, Census Tracts can be rather similar to block groups for analyses.[38,39] Without a more specific question in mind that needs a smaller area of analysis, the administrative boundaries may provide enough detail to allow for meaningful analysis.

Rural- Urban Commuting Area (RUCA).

RUCAs are a sub-county representation of urban and rural areas that allow for a much more detailed representation of rural and urban areas within a geographic region. The commuting files for tracts were developed through American Community Survey (ACS) data across a five year period from 2006-2010. Due to the use of estimates, there are some potential issues about the currency and precision of sample estimates, especially in small areas which are based on aggregation of samples across time. [40]

Other Administrative Boundaries

The provided examples are all administrative boundaries of one sort or another. Their advantage is that they provide detail for small areas. Other boundaries of note which are discussed only briefly here are counties and Health Service Regions. Counties are political boundaries within a state. They compromise subsections of a state and have a local center of power within each county. Health Service Regions within Texas are administrative boundaries for the Department of State Health Services to delegate public health resources and services.[41] These boundaries are valuable to provide in state comparisons of health needs for resources and management of health care and prevention.

REGIONAL EFFECTS

In the review from Bécares and associates[42] highlighted above, one of the interesting findings for Blacks was that density conferred a protective effect for those in non-metropolitan areas, but the effect disappeared in metropolitan areas. These regional differences are likely related to the segregation effects described above and indicate that the concentration of disadvantage may play a role in areas effects for Blacks.

For Hispanics, research has also found that regional effects can drive differences. A study of tract percentage of Hispanics in a region showed a protective effect of high ethnic density against mortality which might be related to a “barrio advantage”, though a later publication indicated that these results may have been limited to this data only and was not largely supported by other research.[6,43] Of note is that most of these studies are related to overwhelmingly Mexican origin populations, limiting their generalizability to other Hispanic groups.

In research outside the United States, Bosma and associates[44] examined the effects of neighborhood characteristics on all-cause mortality. In their analysis, they found that low socioeconomic areas had poorer housing conditions, less social cohesion, and residents with more adverse psychological and behavioral responses. Further, they found that for those individuals who were able bodied, able to work or those with more socioeconomic resources that lived in areas of high unemployment rates and disability in an area were associated with a higher risk of mortality. This finding indicates that the neighborhood condition may drive negative effects even in those that have the available resources to respond; further supporting the findings above that implicate a concentration of poverty and disadvantage in driving negative health and mortality patterns.

WHY DO HISPANICS AND NON-HISPANIC BLACKS DIFFER?

While the research and debate over the meaning of boundaries will is likely to continue on unabated, a common finding in research, no matter the level is that Blacks and Hispanics, despite their similar socioeconomic profiles, differ greatly in their health and mortality outcomes through time. It has been posited that the central driver of these differences is how members of these minority groups are clustered within an area.

When looking at characteristics of areas such as neighborhoods on Hispanics and Blacks, evidence suggests that there are similar forces in play for each group. However, these groups differ in that the forces in play contribute to differing outcomes. Some researchers have suggested that explicit racism may be a primary driver of these differing effects acting through mechanisms such as racial segregation.[45]

Racial segregation is a multidimensional phenomenon of spatial areas that can influence those residents within segregated areas.[45,46] According to Massey and Denton, the elements of segregation include features such as evenness, exposure, clustering, centralization, and concentration. Evenness is how spread out the minorities are in one area compared to the greater urban environment, while exposure is how much contact can be made between groups. Clustering is how the groups are distributed in an area, either in large clumps or spread around, and centralization is how close to the center of an area the group is concentrated. Finally, concentration involves the pushing of minority groups into small dense areas with more concentration leading to more disadvantage.[46(pp373-374)] One all measures, Blacks have been found to be more disadvantaged and they are found to be highly disadvantaged on almost all dimensions. This "hypersegregation" for Blacks, a state of extreme segregation, is above and beyond that of other minority groups like Hispanics, overall, which may be a contributor to the differences in health and mortality.[46,47]

More recently, Bécares and colleagues [42] conducted a systematic review of ethnic density effects and health behaviors and well-being. In this review, they found mixed evidence for ethnic density, especially for Blacks in the United States. Of the studies examining Blacks included in the review, 3 ecological studies found a negative association between ethnic density and cancer, premature mortality, and overall mortality. Another two studies found a protective effect related to age effects and another third related to social capital. Another five studies of Blacks that did not use an ecological approach, one found a null association and two showed a negative association. However, these studies did not use multilevel models, so the results are not as strongly supported as the remaining two studies that showed a protective effect and used multilevel models.

For Hispanics, three studies of mortality found a protective effect across each group.[42] One ecological study examined found that effects were associated with both age and gender, with young adult to older adult males benefiting from density, but not effect was shown for females.[43]

Overall, then the evidence supports the idea that neighborhoods and areas can have a considerable influence on the health and mortality of those living within their borders. Pickett and Wilkinson[48] have argued that ethnic minority members living in majority white areas have access to more resources but this can lead them to be made more ostracized due to a lack of similar others. Alternatively, those living in an area of a higher density of similar ethnic minority members may be buffered from the negative effects of being the “other” The influence of stigma then differs due to the effects of the area on self and community perceptions.[31] Differing factors can drive what the final influence of these factors can be though more carefully controlled models seem to indicate more of a negative effect for Blacks and more of a positive effect for Hispanics, especially related to the effects of density in an area.

While there are many caveats and conditions that can play into the overall area effects, the current study does not examine them in any detail. They are provided here because they are an integral part of the influence of the larger area effects being examined here. Interested researchers should take these factors into consideration if they wish to get an up close and detailed analysis of a specific neighborhood or set of neighborhoods. As the area of interest increases, it is more difficult to capture all of these elements due to significant resource constraints that can quickly develop.

Also of concern in these analyses is how health is impacted across rural and urban areas. In a review of the literature, Eberhardt and Pamuk[49] found that rural and urban areas did not confer any monotonic relationship to mortality. However, patterns of importance did emerge. Of note in the review, they found that rural living was more associated with contributors to chronic disease mortality such as smoking and mortality while living in urban areas was more associated with homicide. In addition, the urban and rural areas were much more likely to be linked to mortality than suburban living. These disparities were contributed to likely differences in demographic and socioeconomic differences.

A working paper by Slifkin and colleagues[50] appears to support this contention. Their analysis of National Health Interview Survey, Medicare Current Beneficiary, and the National Center for Health Statistics 1991-1995 Compressed Mortality Files found that mortality patterns were impacted for Blacks and Others depending on the Metropolitan Statistical Area where the populations lived. Their analyses showed a troubling trend where ethnic minorities were at a much larger disadvantage than even their disadvantaged urban counterparts.

WHY TEXAS?

Most of the studies mentioned above have examined areas outside of Texas, or which cover a larger region of the Southwest than Texas alone. What follows is a specific examination of area and neighborhood effects through analyses within Texas, specifically.

To understand how area effects can impact health and mortality, a geospatial analysis within Texas provides a unique opportunity for analysis because it is such a wide geographic region with a very large Hispanic population which is continually growing.

Research on area effects and mortality in Texas has been primarily contributed to by Luisa Franzini and various colleagues.[51–56] Of primary interest to this paper is the research on area effects and mortality, specifically the paper by Franzini, Ribble, and Spears[52] which examines the effect of social position on mortality outcomes. Social position for this paper is measured through income inequality where inequality is measured through five components (including a Robin Hood index and several ratios; see Franzini, Ribble, and Spears[52]). Of methodological importance in this paper is that they stratified analysis according to county population size which allows for differing populations to be better measured by taking into account the base population when creating the analysis. This approach also showed that income inequality grew as the population size grew. Further, this research found further support for the Hispanic paradox literature, finding that with increased percentage of Hispanic in an area, there is a decreased risk of mortality.[52] While this level of sophistication is not available for this paper, this work shows that understanding of income inequality was more meaningful using inequality ratios compared to global assessments of inequality.

MEASUREMENT OF DEMOGRAPHIC AND SOCIOECONOMIC MEASURES

To develop policy, public health researchers must not just understand boundaries as they have been discussed in the preceding segment. There must also be work to understand how measures of demographic and socioeconomic status are classified and defined for measure and use across data sources. Of interest to the current research is the use of race/ethnicity and poverty measures as defined through state and government databases.

Measures of Race/Ethnicity

The measurement and tracking of race/ethnicity is deeply embedded in shifting cultural and political patterns through time. Often, the federal government leads the way on required information about particular classifications which are then followed by the states. This is not always the case, as states like Texas used a methodology to establish Hispanic Origin from Census and vital records based on surnames before Hispanic ethnicity was formally tracked in the federal statistical system.[57] The US Census adopted a Hispanic Origin question as a complete count item in1980, and overall adoption of a Hispanic Origin question for both Census and the death certificate was not fully complete until the 1990s.

In addition to the rise of the Hispanic Origin question, the racial identifier question has also had a significant shift through time. In the 1977 Office of Management and Budget Directive 15[58,59], the number of racial categories were expanded from four to five potential groups. Twenty years later, the 1997 OMB directive further expanded this to allow for a multiple-race selection, increasing the potential number of race group permutations to 31.[59,60]

To accommodate these changes in the race question through time, the Census utilizes a bridging algorithm to allow for a fluid comparison of populations through time to allow for trend analysis. The bridging process reduces the multiple-race response to the five categories established through the 1977 directive.[61]

Measures of Poverty

It is important to emphasize up front that there are multiple measures of poverty used by various researchers. While this literature is vast, the focus here is on the measures of poverty employed by the Census Bureau, namely single dimension measures.

When considering single dimension measures of poverty, it is important to understand how the measure is constructed. Meyer and Sullivan[62] argue that the poverty rate has eight elements.. For the Census measures of poverty, two major representations exist. First, the official census measure uses pretax income compared appropriately for families or single persons based on composition. (The 2013 Poverty Threshold by family size and number of children is available as an Excel spreadsheet [63]).The official Census measure uses pretax income and shared resources of the family in the last year to create their representation of poverty. No adjustments are applied to these measures except for an annual adjustment for inflation, and without consideration for geographic location..

Several criticisms have been levied against the official measure of poverty. In response, a supplemental measure was developed and released in 2011. This measure increased the estimated poverty for 2010 from 15.1 to 16.0% in the United States. As the Meyer and Sullivan point out, however, this measure is not really a scientific measure and instead based on political and subjective determinations of cutoff criterion.[62(p114)]

THE USE OF MORTALITY IN PUBLIC HEALTH PLANNING

For public health workers, the goal is often to use the most recent and available statistics to inform goals and future programs. Mortality statistics are limited as their release is delayed for a year or more. which in turn means that public health practitioners can be delayed in responding to immediate needs. However, despite this potential limitation, the basic use of mortality statistics is that they represent underlying patterns of health in various subpopulations and the population as a whole. For instance, as mentioned above, the top contributors to mortality have stayed stable through time while chronic lower respiratory disease has risen from nowhere to become a top contributor to mortality. Using mortality and health statistics, public health policy researchers have directed and influenced rules, regulations, and incentives/disincentives to help curb smoking.

Mortality statistics also indicate larger patterns of change across time and can lead public health researchers to further focus on what is not changing and understand why.

Hispanics, for example, show very high rates of diabetes and from the 1990s to present; these numbers have continued to climb. Breaking these numbers down further, Cubans show the lowest rates for Hispanics while Mexican and Puerto Rican Origin Hispanics show higher, similar, rates. Despite these differences, all groups showed an increase through time.[64] Taken together health and mortality patterns can indicate to health workers the areas of concentration necessary to assuage disparities in outcomes.

LIMITATIONS AND GAPS IN EXISTING LITERATURE

Previous research on Texas mortality has identified area differences based on population size of counties in Texas. While informative about the effects of economic and demographic influences on mortality, the examination does not take into account smaller areas of analysis and how these patterns of mortality can influence outcomes across local areas of analysis. Specifically, it does not address economic effects on the tract level, an important consideration in understanding how neighborhood level effects contribute to outcomes. Other research by Franzini[51] has focused on health and tract level effects such as income in Texas and this work supplements the gap between this research and Franzini's previous county level analysis of mortality for Texas. Combined with the previous literature, the analysis in this capstone can help to provide a complete picture of mortality outcomes in the state. Specifically, the use of census tract level data bridges the previous research by Franzini which examines mortality by county but only health outcomes at the local level.[51,52]

RATIONALE

This research examines gross regional patterns of mortality through chloropleth maps of rates by county and hierarchical linear analysis of difference in deaths across census tracts in Texas through the use of detailed mortality files for the state of Texas. Multiple possible contributors underlying area effects have been identified above. While many of these cannot be directly tested, they do provide insight into how area can contribute to mortality differences. The aims of this project are to describe geographic variations in mortality across different areal units using rate calculations for all-cause and cause specific mortality for the top causes of mortality in Texas. Further, using hierarchical modeling this project aims to analyze the influence of tract level effects like demographic concentration and economic factors on mortality counts across tracts. Understanding how regional area affects differ can also be used to contribute to public health. Where possible, methods will be applied that best represent important dimensions of area effects that contribute to mortality differentials between racial and ethnic groups.

Chapter 3

Data and Methods

For this capstone, mortality data and census identifiers are linked to establish numerators and denominators to calculate area mortality rates for visual and analytical comparisons of potential geographic, demographic, and socioeconomic disparities in mortality. Further, regression will be developed using individual and area factors related to mortality risk for all-cause mortality and select cause specific conditions.

Data for these analyses come from two sources: the vital statistics files come from the Texas State Department of Health Services from the year 1999 to 2001 and which are already housed at UTMB and open for use. These data contain multiple variables but for the interests of this project, the focus is on cause of death, census tract, county, sex, age, race/ethnicity, and place of birth. Population level data and census tract level measures will be taken from the United States Census Summary files.

Data in these files will be combined using geospatial identifiers tied to the tract level. While tract level data is not equivalent to a neighborhood, especially in relation to perceived neighborhood boundaries[28], the use of census tract data has been shown to be one of the better geospatial markers for studying small area effects of socio-economic composition.[38] Further, for this type of research, there is little reason to believe that the moving to a specific smaller neighborhood level would add much scientific value, at the same time that costs of data collection would increase significantly. Instead, this research is meant to provide a stepping stone for understanding the relationship between individual and area effects that highlight how health patterns are distributed across Texas.

To best estimate the relationship between area and individual risk factors included in the analyses, a multilevel regression model will be utilized. Research has indicated that inclusion of both individual- and area-level SES indicates effects on both levels, but when lacking individual level measures, the area effects can also be informative. Put another way, if you don't have an individual's income or assets, you can use economic factors from the area such as poverty or median income to represent economic effects, pooling individual and area effects of socio-economic status. Further, the use of a multi-level model can address missing individual income measures, especially when accounting for the ethnic distribution and density within an area. Area level measures will be identified based on the Hispanic origin, sex, age, and race data derived from the Census. Additionally, RUCA codes and border county identifiers are used to identify risk of mortality for rural/urban areas and regions that are close to the Mexico border. The use of these multiple measures can help to address the missing individual income level data and show how the effects of race ethnicity on the individual and area level interplay in their relation with mortality across areas.

Data Sources and Measurement

Data were obtained from Texas Vital Statistics System, Texas DSHS Public Health Region Classification and Border counties, Rural-Urban Commuting Area classifications, and Census Summary Files 1 and 3.

Age is defined as the age of death, in years, for the decedent as taken from the vital statistics file. Age is categorized into 20 year age categories and top coded at age 80 (0-19, 20-39, 40-59, 60-79, 80+). Large age groupings are used to to address the problem of small cell sizes across groups and settings given the small number of deaths in rural areas and for smaller racial/ethnic populations. And gender was controlled for in the model.

Table 1. Variable Identification, Definition, and Proposed Relationships

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Hypothesis	Variables	Definitions	Proposed Relationships
H1, H2	Deaths	Number of deaths in a county/census tract	Numerator/Dependent Variable
H1, H2	Race/Ethnicity	Non-Hispanic White, Non-Hispanic Black, Hispanic	Mortality should be higher for non-Hispanic Blacks and non-Hispanic Whites than Hispanics though non-Hispanics Blacks should have the highest rates of mortality, overall.
H1, H2	Age	Age of Population across Counties and Tracts in Texas	Age should be lower for Hispanics than Whites and Blacks, overall. And deaths should be linked to higher deaths overall. Rates will also be adjusted by age to account for different age composition.
H1, H2	Border County	County identified as a border county based on La Paz Agreement which identifies county within 100 km of US-Mexico border as Border County	Because tracts are encompassed entirely within counties, they are either border or non border depending on their location based on county data. This variable then identifies if a tract is within a border county or not.
H1, H2	Urban Rural Tract	Identification of the tract as rural or urban based on Rural Health Research Center Rural - Urban Commuting Area Codes	Rural and urban influences on health are different based on the social and economic environments each creates.
H1, H2	Population	The population for the tract multiplied by 3 to match the 3 year mortality data.	This variable is used to calculate rates and weight the death counts in hierarchical analysis to account for population size within a tract.
H2	Sex	Administrative determination of gender as "Male" or "Female"	Females should have a lower risk of mortality than males, overall
H2	Percent Hispanic	Percent of Hispanics in Census tract as a function of total Hispanic population in County	Ethnic concentration has been linked to improved mortality outcomes for Hispanics.
H2	Percent in Poverty	Percent of the Tract Population which is below the federal poverty threshold	Poverty is linked to poorer outcomes for health and mortality.

Race/ethnicity is the race/ethnicity of the decedent as reported in the vital statistics. One concern about ethnicity in vital statistics files is the misclassification by the coroner or other person who completed the death certificate. However, reporting of Hispanic ethnicity, especially in areas such as Texas with a large Hispanic population, the rate of misclassification is likely to be low to nonexistent depending on the area.

For this study, the racial/ethnic groups of interest are non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. For the Hispanic group, any member of any racial/ethnic group that also identifies as a Hispanic origin is classified as Hispanic. This means that a Hispanic Black would be reclassified as Hispanic in the state. Given the Hispanic composition of Texas, it is expected that most are of Mexican-origin, especially in more rural regions. Using data from the from the 2010 Integrated Public Use Microdata Series [65], the self-identified Mexican Origin population in Texas represents approximately 35% of the Texas population, constituting ~88% of all Hispanics in the state. When analyzing the Other category and ancestry, these numbers change when accounting for persons reporting a Mexican or Mexican American origin ancestry with Mexican adults now representing 89% of Hispanics. Puerto Ricans and Cubans, represent about 2% of Hispanics in the state and the remaining ~9% are classified as Other. Given the history and politics around Hispanics in the Southwest United States, the Mexican Origin population is likely even higher but the ability to identify them all would likely be futile given political effects on self-identification. Therefore, Hispanics will be grouped together in the mortality and Census data with the caveat that all effects will likely be conservative and represent only the Mexican Origin population.

Deaths are classified in two ways. The first classification of deaths is all-cause mortality. All-cause mortality is the sum of all of the deaths across each gender/ethnic group in the state; and the second classification, cause-specific deaths, is defined as cause-specific contributors to overall mortality. Second, to compliment the all-cause classification, cause-specific mortality is based on the ICD 10 113 cause recode. While both types of mortality counts will be used, not all cause-specific mortality groups will be used. The cause-specific contributors of interest here are lung related mortality (e.g. chronic lower respiratory disease, malignant neoplasm of bronchus, trachea, and lungs), heart related (e.g. ischemic heart diseases, atherosclerosis), stroke, homicide, and diabetes because they were major contributors to mortality amongst all three groups in 2000.[66] Availability of data will determine which if any of the above causes can be analyzed.

Numerator/Individual-Level Variables

Numerator and Individual-level data for this project come from the Texas Department of State Health Services (DSHS) Department of Health Statistics Death Record File for the years 1999 to 2001. These files are already housed at UTMB under the possession of a Preventive Medicine and Community Health faculty member and are available for use. The UTMB IRB has determined that secondary research with these data is not human subjects research and does not require IRB oversight. These files are an electronic record of any recorded death in Texas spanning the years 1999 to 2001. To maintain an emphasis on the Texas resident population only mortality death records for residents of Texas were kept in the data set which amount to 448,938 records out of 460,414 records, or 97.5% of all records kept for analysis.

Deaths. Deaths is the count of reported deaths available in the death records for Texas residents in the years 1999 to 2001. Deaths are also classified by the top 10 cause-specific contributors to mortality with the top three contributors to mortality used for thematic mapping and hierarchical analyses. While the causes listed previously were of most interest, only the top three contributors to mortality in Texas: heart-related mortality, cancer-related mortality, and stroke related mortality were used here. The top three contributors were chosen for two reasons, the first is that the scope of this project does not allow for all categories to be analyzed and, even if that were not an issue, the further down the list you go the sparser the data become due to the very few number of deaths for some census tract/groups in those categories. Therefore, these three contributors were selected because they provided the most data for analysis and have the most substantive importance for understanding mortality patterns in the state. For the HLM analyses, the all-cause classification is used with the total death count being used as the dependent variable.

Cause-specific mortality is identified by the primary cause of death as listed on the decedent's death record. The ICD-10 classification is then reclassified using a crosswalk available from the National Center for Health Statistics to reclassify ICD-10 codes for the 113 cause recode[67]. The recoded causes were further categorized using the classification of the 113 causes of death into their primary cause groups (including categories such as heart-related mortality, stroke, and cancer) to match the categories represented in the top contributors to mortality for the United States as reported by the NCHS[68].

Gender. Gender is reported on the death record.

Ethnicity. Ethnicity is the reported ethnicity of the decedent as listed on the death record. While death records are known to be problematic, it is assumed that for the purposes here that the records are correctly identified. For more information on mortality record classification issues and strategies for data correction see Arias et al.[69]

Age. Age is the reported age of the population matched to the reported age of the decedent. Ages are categorized in 20 year age categories and top-coded at age 80 (0-19, 20-39, 40-59, 60-79, 80+) due to sparseness of data, especially for minorities in rural areas.

Population. Population is the population count of the tract from the census year. It is aggregated by age, gender, and ethnicity as the exposure for the deaths in the hierarchical linear model.

For the hierarchical linear modeling, in approximately 1,000 age group/tract combinations, the population was less than the number of deaths in the tract due to reporting errors and other problems. This represented less than 1% of cases and to address the problem without removing deaths, the population was set equal to the number of deaths. This does create a potential bias in the data by increasing the population but it preserves the patterns of deaths across the state.

Denominator/Second-Level Variables

For the denominator and tract-level components, data are taken from several sources including the 2000 Decennial Census Summary File 1[70], the 2000 Decennial Census Summary File 4[71], the Rural Health Research Center Rural-Urban Commuting Area (RUCA) codes[72], DSHS Public Health Region Files[73], and the DSHS Designation of Border Counties[74]. All records kept for analysis are related to information available for Texas census tracts and counties for the year 2000.

Percent Hispanic. Percent Hispanic is the percent of the population living in a tract that is of Hispanic origin. It is derived by dividing the Hispanic origin population by the total population. This variable is categorized based on quartiles of the percent Hispanic in Texas. Percent Hispanic is derived from the 2000 Census SF1.

Percent in Poverty. The percent in poverty represents the percentage of the population living in each tract that is classified as living below poverty. Percent in Poverty for each tract is categorized based on quartiles calculated on the state level. This variable is taken from the 2000 Census SF 4.

Urban/Rural Classification. This variable is based on the RHRC RUCA Codes using the RHRC RUCA Categorization D.[72] It is a binary variable identifying a tract as either rural or urban. This variable is created through the RUCA Code classification and the 2000 Census SF 1.

Border Classification. Border county classification is based on the La Paz Agreement which classifies any county within 100 km of the US-Mexico Border as a Border County as part of an environmental treaty between Mexico and the United States created in 1983.[75] This is a binary variable and is derived from data available through the DSHS[74] and the 2000 Census SF 1.

Where there are numerator data but not denominator data, population values are replaced with the death values so that the model will run in HLM. If both population and deaths are equal to zero in tract, then the data is dropped because it provides no information for analyses.

MISSING AND INCOMPLETE DATA

For the numerator data, several elements are missing due to incomplete or missing data. Firstly, the race category has 276 (.0006%) cases which were missing a classification. These cases were categorized as Other. While race is classified as Other for missing values, other data are imputed using available information from other covariates and hotdeck imputation.

Imputation

Hotdeck imputation classifies missing and non-missing information based on other covariates and then randomly replaces missing covariate information based on known values from other records. This introduces 'real' data to fill missing responses based on covariate patterning.[76]

For age, there were 88 (.0002%) cases which were missing information. These cases were imputed using hotdeck single imputation based on sex, race, cause, and Hispanic origin. For the Hispanic origin question, there were 997 (.002%) cases missing a classification and, therefore, imputation was used to ensure completeness of records.

Finally, a considerable amount of data was missing for census tracts identification with 13.6% (60,864 of 448,938) of cases not having a census tract identified. This breaks down to 16% missing for non-Hispanic White males, 13% for non-Hispanic White females, 11% for non-Hispanic Black males, 9% for non-Hispanic Black females, 13% for Hispanic males, and 10% for Hispanic females. Due to the considerable loss of information should these cases be removed imputation was again used to ensure the most number of records.

Deaths were treated as a randomly occurring event and each classified as a case. They were then imputed by county to ensure that deaths were listed within their area of origin to prevent cases being over-classified for areas with little or no population. While a multiple imputation may have also allowed for classification, the scope of this project limited such an endeavor and the use of a random classification such as this may be more appropriate for classifying death especially where this project is more interested in the effects of spatial distribution on mortality. It has also been argued elsewhere that multiple imputation may over-classify data due to known constraints whereas a more simple random imputation distributes the deaths more widely across space which is more representative of the true distribution of deaths.[77]

ANALYSIS

For Aim 1, the hypothesis is that there will be differences in mortality rates across regions and that with each public health regions will show considerable variation in all-cause and cause-specific mortality for Hispanics and non-Hispanics within the regions.

Thematic Mapping

The data will also be presented visually as chloropleth maps across counties and through tabulation within public health regions to identify patterns of mortality as related to demographic and socioeconomic effects on the individual and area level of analysis.

Age-Standardized Mortality Rates

Rates were developed for the total population, non-Hispanic Whites, non-Hispanic Blacks, Other non-Hispanics and Hispanics using county geographies. The rates were developed using census tract level values which were aggregated for counties, with DSHS regions used to identify clusters of counties for presentation purposes. For the rates all calculations are multiplied by 100,000 to allow for a standard rate to compare across all groups.

The rates were age-standardized using the population distribution for the state of Texas across 20 year age categories. The adjustment was made for the total population within a tract and for Hispanics, non-Hispanic Whites, and non-Hispanic Blacks in each county. Due to the disaggregation of data across counties and age groups, there are several missing points for data and rates at the county level. This does create some missing points for mapping, especially for racial/ethnic minorities, but represents the difficulties with using small areal units for analysis and also provides insight on how populations are distributed through the state. Other non-Hispanics were not mapped due to small values and sparse data.

Classification

To allow for comparison between groups, the bins for classification were created manually so that all groups were constrained to the same criteria though some constraints differed due to the level of the areal unit (e.g., census tract cut-off points differ from counties and DSHS) or cause of death (e.g., cause specific-disease rates had different cut-offs compared to the total death rate). The classification cuts-offs were based on the needs that arise from the rates and the ability to best present the rates across racial/ethnic groups to determine the most effective bin structure. Chloropeth maps were then created using QGIS 2.8[78] to show mortality rates across Texas counties.

Hierarchical Linear Modeling

For Aim 2, it was hypothesized that the death counts (dependent variable) would differ across census tracts based on geographic, demographic, and socioeconomic effects at the individual- and area-level. To assess these potential differences, a hierarchical linear Poisson model will be used to address the individual level effects at each tract examining the distribution of deaths across sex, race/ethnicity, and age groups while also accounting for population level effects of the tract using the aggregated tract measures. A Poisson model is appropriate here because the data are count data and the distribution of the data best fits with this model. Population counts for each tract will be multiplied by 3 to match the three year structure of the death counts and used to represent as a measure of variable exposure for deaths across census tracts in Texas.

A multilevel Poisson regression is appropriate here because of the vast differences in the count data across the census tract and because of the nesting of data within individual and tract levels. The models are also set up to account for the variation in population size for each age-sex-ethnicity group within each tract using variable exposure Poisson modeling.

Two models were used for this analysis. A main effect model examined the association between level-1 factors like sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanics, Other non-Hispanics), and age. A second cross-level model was also run which included level-1 and level-2 factors to test the relationship between regional and individual level effects. Due to problems with convergence, race/ethnicity variables were set as fixed effects. Age and sex were left as random effects.

CHAPTER 4

Results

AIM 1. THEMATIC MAPPING AND TABULAR DATA

Table 2. Categorization of Age-Adjusted County Death Rates for mapping by Type of Death

Table 2. Categorization of Age-Adjusted County Death Rates by Type of Death

Type of Death	Bin Size	Max Bin	Rate per
Total	250	1000+	100,000
Heart	75	300+	100,000
Cancer	50	200+	100,000
Stroke	20	80+	100,000

County-Level Age-Adjusted Death Rates

There are 254 counties in Texas, so presenting all counties at one time would be too unwieldy. Instead, counties are presented tabularly within DSHS Public Health regions (Figure 1) and general patterns of counties within regions are presented thematically and discussed for each region to better classify data for presentation and comprehension. The tables and maps are provided for all-cause mortality and the top three contributors to deaths in Texas: heart-related mortality, cancer-related mortality, and stroke related mortality. For the rates, some values are zero; and these values are excluded from the tables and the thematic maps because they may not represent appropriate measures of rates, especially in the minority populations.

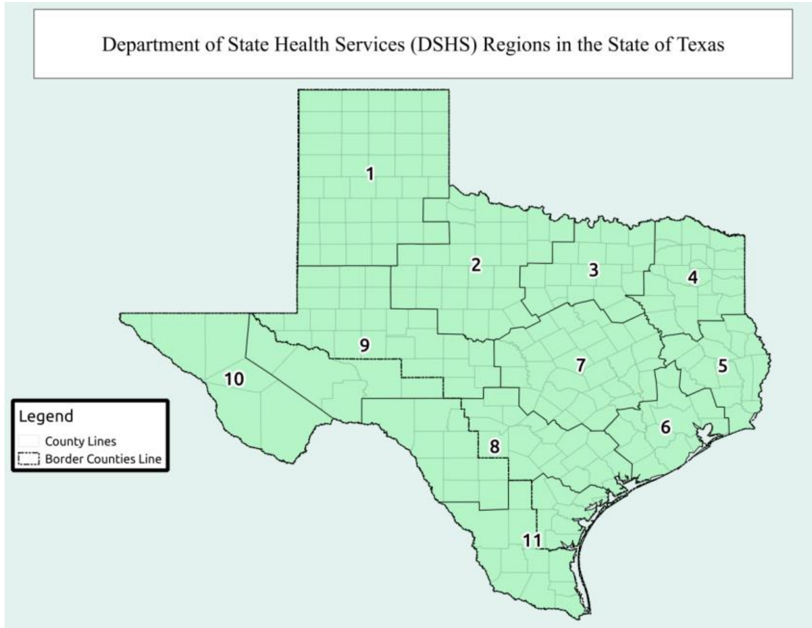

Figure 1. Texas DSHS Regions with Border County Line

ALL-CAUSE MORTALITY

For the all-cause ASMR (Table 3; Figure 2) the total population had the highest rates, overall, in counties to the east of the state with the lowest rates along Border regions (Figure 1). Non-Hispanic Whites showed relatively high rates across the state, with the lowest rates Central Texas regions and very high rates in Border regions. Non-Hispanic Blacks did the worst amongst all groups with the highest rates amongst almost every county in Texas across all region. Hispanics showed the best rates along the Border with worsening patterns toward the north and the worst patterns on the Eastern side of the state.

HEART-RELATED MORTALITY

For the heart-related ASMR (Table 4; Figure 3) the total population had the highest rates, overall, in counties in the panhandle and northeast of the state with the lowest rates along the Border and lower central Texas. Non-Hispanic Whites showed

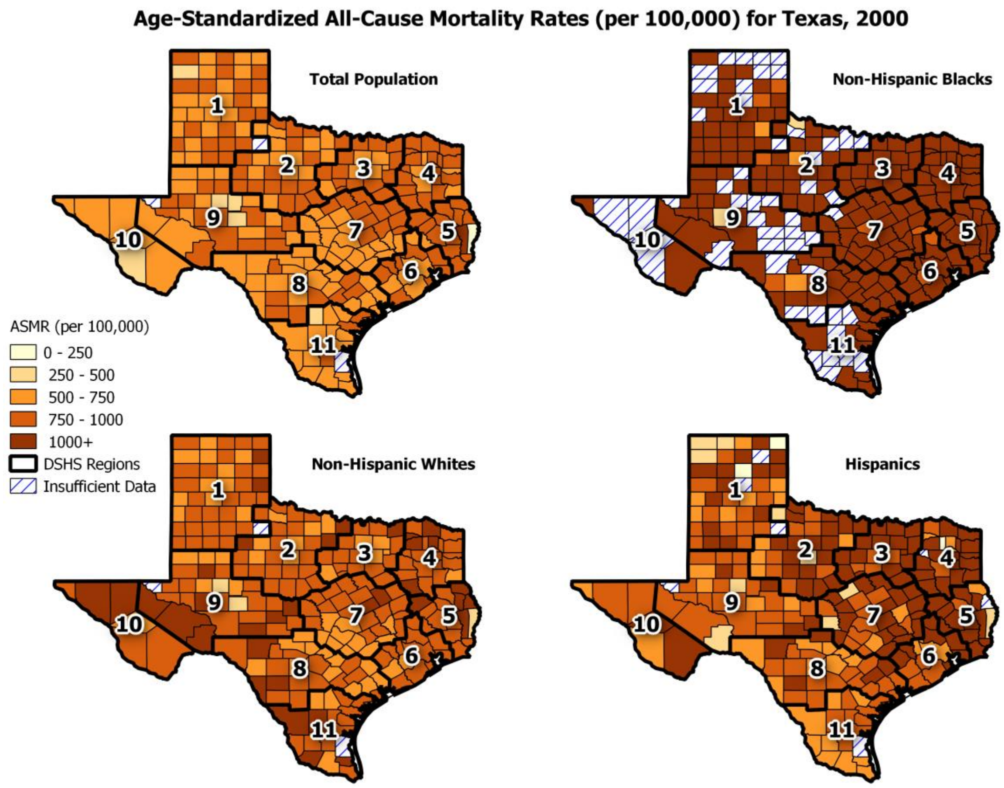

Figure 2. Age-Standardized All-Cause Mortality Rate (per 100,000) across DSHS Regions and Counties, 2000

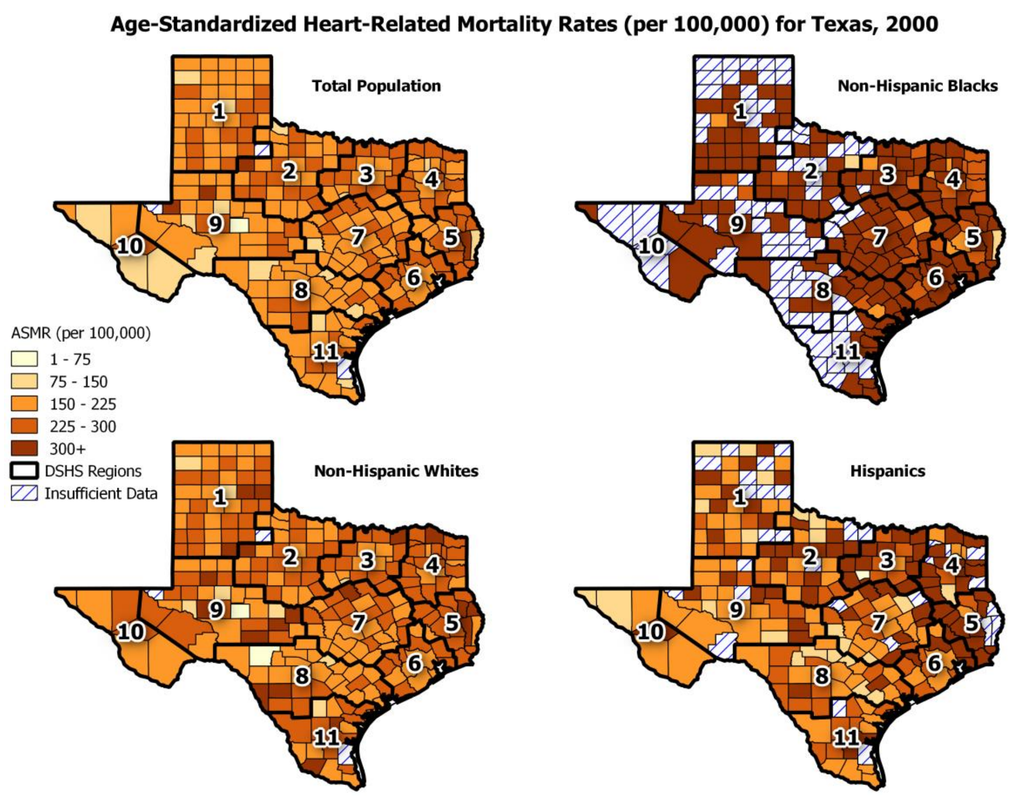

Figure 3. Age-Standardized Heart-Related Mortality Rate (per 100,000) across DSHS Regions and Counties, 2000

relatively high rates across the state, with the lowest rates Central Texas regions and very high rates in Border regions. Non-Hispanic Blacks had very sparse data across the Western and border regions of Texas but again performed the worst across almost all areas. Hispanics showed the best rates along the Border and into Central Texas with the worst overall rates toward the northeast and the eastern side of the state.

Cancer-Related Mortality Rates

For the cancer-related ASMR (Table 4; Figure 4), the total population had the lowest rates in regions toward the north and in Border areas. The highest rates were in the east and central regions. For non-Hispanic Whites, the rates were relatively similar amongst regions with the lowest rates in the Panhandle region and the highest rates across the border and to the north-northeast regions of the state. Non-Hispanic Blacks again showed sparse data to the West and in the Border regions of Texas with high rates across almost all regions and counties in Texas with available data. Hispanics had sparser data for cancer-related deaths, especially in the north-northeast part of the state. Overall, the rates were lower for Hispanics across the regions. Though the lowest rates were again toward the border and up into the central regions of Texas. The north-north east region had some of the highest rates for Hispanics.

Stroke-Related Mortality Rates

For stroke-related ASMR (Table 5; Figure 5), rates, overall, were very low across the state compared to other causes. The total population showed the highest rates in regions in the east-northeast similar to other regions with the lowest rates in the Panhandle and the Border regions of Texas. Non-Hispanic Whites showed similar patterns to the total population but there was also sparser data for the Border regions for

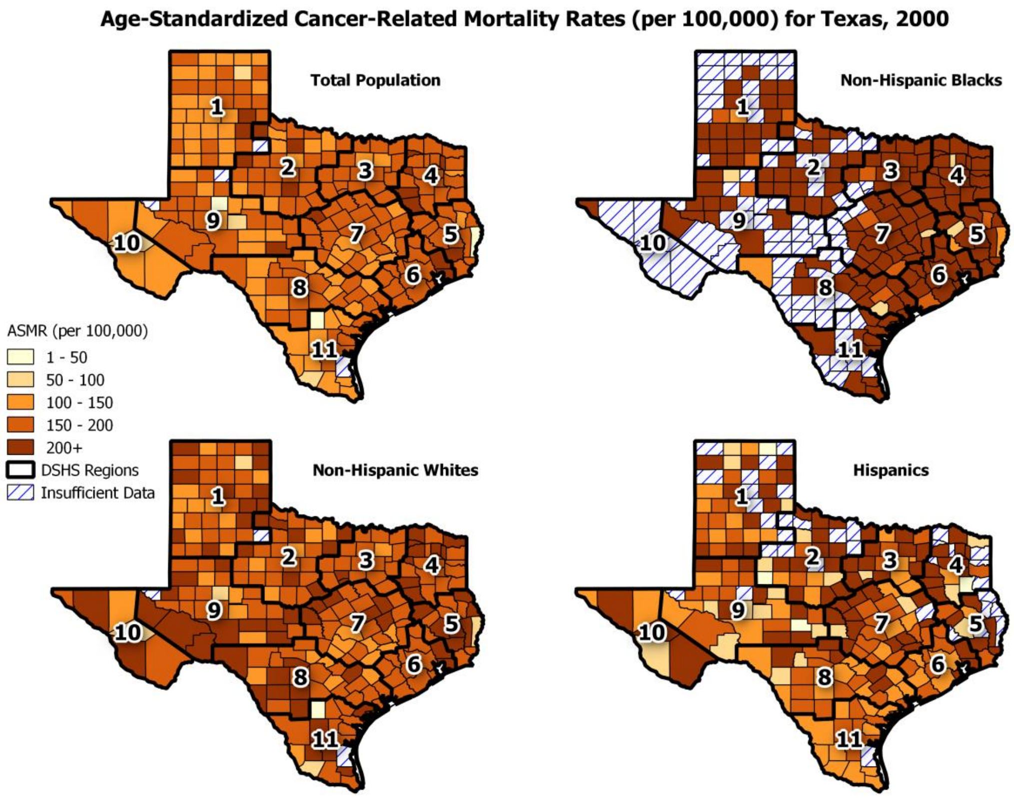

Figure 4. Age-Standardized Cancer-Related Mortality Rate (per 100,000) across DSHS Regions and Counties, 2000

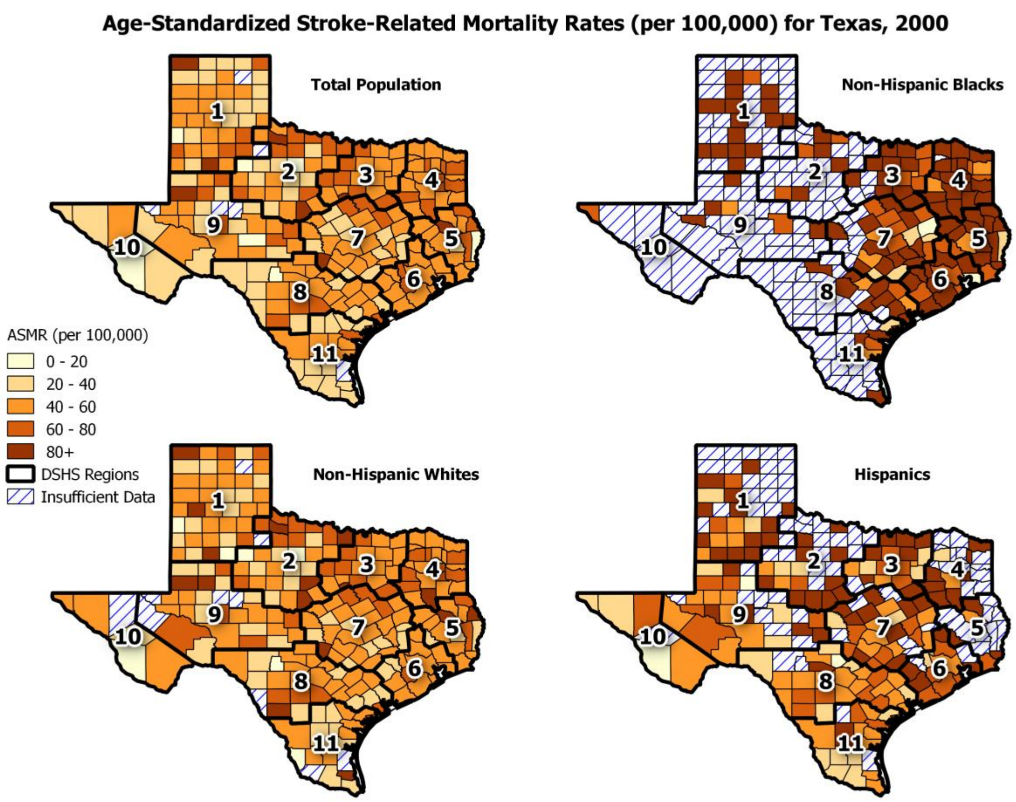

Figure 5. Age-Standardized Stroke-Related Mortality Rate (per 100,000) across DSHS Regions and Counties, 2000

non-Hispanic Whites. For non-Hispanic Blacks, data was very sparse in west and border regions of Texas and in regions with data, mostly toward the east, non-Hispanic Blacks showed much higher rates, overall. Hispanics had sparser data to the north-northeast of the state and showed the best rates again along the Border regions and into Central Texas. The worst regions were toward the north-northeast, overall.

Aim 2. Hierarchical Poisson Regression Modeling

To test which geographic factors were associated with deaths in Texas, a variable exposure Poisson regression model was run in HLM 7.[79] First, a main effects model was run to determine individual effects on deaths across tracts and then a cross-level interaction model was run to test the relationship between level-1 and level-2 variables.

Table 3. Model 1

Main Effects Model for Hierarchical Poisson Regression Model with Variable Exposure

	Coefficients	IRR	95% CI	p-value
Intercept (Hispanic)	-6.75	0.001	0.001, 0.001	**<.001**
Female	-0.34	0.71	0.71, 0.72	**<.001**
Ethnicity				
White	0.15	1.16	1.15, 1.18	**<.001**
Black	0.42	1.52	1.50, 1.54	**<.001**
Other	0.38	1.47	1.42, 1.52	**<.001**
Age				
Age 20-40	0.38	1.46	1.42, 1.52	**<.001**
Age 40-60	1.45	4.26	4.18, 4.34	**<.001**
Age 60-80	3.11	22.3	21.91, 22.71	**<.001**
Age 80+	4.61	99.97	98.18, 101.80	**<.001**
Intercept d.f.	*4331*			
Slope d.f.	*66073*			

For the Main Effects model (Table 3), women had a ~30% lower chance of dying across tracts than men when controlling for other factors. For non-Hispanic Whites, the risk of deaths across tract is 16 percent higher than for Hispanics while Blacks and Other non-Hispanics both had about 50% higher chance of dying across tracts, overall. By age, each group has a higher risk of mortality than the age 0-20 group with a range from 1.46

Table 4. Model 2

Cross-Level Hierarchical Poisson Regression with Variable Exposure for Deaths

	Coefficients	IRR	95% CI	p-value
Intercept 1 (Hispanic)*				
Intercept 2	-6.67	0.00	0.001, 0.001	<**.001**
%Hispanic				
Quartile 1	0.85	2.35	2.221, 2.481	<**.001**
Quartile 2	0.53	1.70	1.620, 1.776	<**.001**
Quartile 3	0.18	1.19	1.147, 1.241	<**.001**
% in Poverty				
Quartile 1	-0.31	0.73	0.706, 0.761	<**.001**
Quartile 2	-0.24	0.78	0.758, 0.811	<**.001**
Quartile 3	-0.16	0.85	0.825, 0.879	<**.001**
Urban Tract	0.09	1.09	1.063, 1.126	<**.001**
Border County	-0.24	0.79	0.755, 0.824	<**.001**
Female	-0.33	0.72	0.711, 0.720	<.001
White				
Intercept	0.36	1.43	1.408, 1.450	<**.001**
%Hispanic				
Quartile 1	-1.11	0.33	0.317, 0.345	<**.001**
Quartile 2	-0.69	0.50	0.486, 0.517	<**.001**
Quartile 3	-0.24	0.78	0.765, 0.802	<**.001**
Black				
Intercept	0.64	1.89	1.839, 1.948	<**.001**
%Hispanic				
Quartile 1	-1.13	0.32	0.306, 0.340	<**.001**
Quartile 2	-0.69	0.50	0.479, 0.523	<**.001**
Quartile 3	-0.32	0.73	0.700, 0.756	<**.001**
Other	0.04	1.04	1.006, 1.081	**0.021**
Age				
Age 20-40	0.37	1.44	1.412, 1.474	<**.001**
Age 40-60	1.44	4.23	4.151, 4.310	<**.001**
Age 60-80	3.09	22.08	21.689, 22.482	<**.001**
Age 80+	4.59	98.72	96.940, 100.525	<**.001**
*Intercept d.f.**	*4331*			
Slope d.f.	*66073*			

at age 20-40, 4.26 times higher risk at age 40-60 and 22 times higher risk age 60-80 and almost 100 times the risk of dying for the 80+ group, when controlling for other factors.

For the cross-level model (Model 2, Table 4), Hispanic density quartiles, % of population in poverty quartiles, urban tracts, and border tracts were introduced at the second level. Non-Hispanic White and non-Hispanic Black variables were set to interact with Hispanic density. Gender, age, and Other non-Hispanics were left without interaction.

For Hispanics, living in areas with lower Hispanic density was associated with 20% at the third quartile to 2.4 times higher risk of dying in the lowest Hispanic quartiles compared to Hispanics in the highest quartiles, when controlling for other factors. And Hispanics in low areas of poverty were 15% to 27% less likely to die of mortality in areas of lower poverty. And living in urban tracts was associated with 9% higher mortality while living in border regions was associated with 20% lower mortality when accounting for other factors. Women saw little change in their risk of mortality with level 2 factors introduced.

For non-Hispanic Whites, the risk of mortality increased to about 43% higher risk for Whites than Hispanics across tracts when accounting for Hispanic Density. Within Hispanic %quartiles, Whites had 20% lower risk of mortality in the 3rd quartile and the risk of mortality dropped with quartiles to almost 70% lowest risk of mortality in quartile 1.

For Blacks, the risk of deaths increased to 90% higher when accounting for Hispanic density. Blacks also showed a lower risk of mortality outside of the highest % Hispanic tracts with a 30% lower risk in quartile 3 and 70% lower risk in quartile 1.

When controlling for other factors, Other non-Hispanics decreased to only a 4% higher risk of mortality across tracts. And the risk of mortality across age groups remained fairly stable after controlling for other factors.

CHAPTER 5

Discussion

SUMMARY

The main purpose of these analyses was to identify how mortality varies across a large geographic area (in this case, Texas) and to understand how individual and area-level effects drive overall differences. To this end, mortality was presented through a thematic and tabular presentation to provide visual and basic information at the county level and then mortality was analyzed at the census tract level to identify local area correlates of mortality. The goals of this project and these two different approaches to analyses were to identify the potential public health policy implications for public health and medical practitioners in Texas.

To accomplish this, first, rates were calculated across counties and then presented within DSHS Public Health Regions. These rates were then presented visually through chloropleth maps across counties and with DSHS Region boundaries and through tabulations (DSHS Regions). Second, deaths across census tracts were analyzed with multilevel Poisson regression models to examine individual level correlates of death counts and area level effects. The key findings of these analyses are presented below.

KEY RESULTS

From the maps presented, it is evident that mortality, both all-cause and cause-specific, varies across the state. For Hispanics in Texas, all-cause age-adjusted mortality was worse in the northern and eastern parts of Texas and was improved nearer to the border. The total population follows this pattern as well, with lower age-adjusted all-cause mortality rates nearer to the border. Overall, non-Hispanic Whites had the lowest age-adjusted all-cause mortality rates near large urban centers and toward the Panhandle of Texas. Non-Hispanic Blacks, however, showed an almost universally higher age-adjusted rate of all-cause mortality across the entire state and rates that were much higher overall due to pockets of unstable data for analyses.

This pattern was very similar across all of the age-adjusted cause-specific rates with Hispanics usually faring better along the border and being worse in the north and eastern parts of Texas. The age-adjusted cause-specific rate maps also showed how sparseness of data was an increasingly important issue, especially for non-Hispanic Blacks in western and southern Texas. For non-Hispanic Blacks, one pattern of note is that data availability drops precipitously towards the border and in Western Texas counties. Non-Hispanic blacks are less populous in these areas so they are less likely to die there and less likely to be reported. This also leads to less stable estimates of mortality in some counties, which may explain some of the very high rates calculated for non-Hispanic Blacks. Similarly, Hispanics on the Eastern border were especially at-risk, with rates oftentimes much higher than non-Hispanic Blacks in those same regions.

While data issues are an obvious concern especially in places where ethnic minorities are less represented, depending on where a researcher is looking to conduct their research and the resources available, secondary data may be the only means of identifying patterns. However, using these resources should be conditioned on the caveat that you cannot get into a neighborhood directly. A finer level of presentation provides much more explicit representations of the effects of region on health across an area but restricts available data. Smaller areas do not have data aggregated for very small populations which can be especially influential for minority populations living in largely White areas. These areas then may be difficult to evaluate from data alone and community interaction and involvement come into play.

And at the more local level, information about who lives within a region is extremely important. The HLM model attempts to address the Hispanic density and other issues that may influence patterns of mortality at the tract level. The models used in this analysis indicated that most of the variance in groups is related to race/ethnicity of the populations within a region. Though second-level effects also played a strong role in the effects on where populations died. When controlling for second level factors like Hispanic density, percent in poverty, urban tracts and border tracts, Hispanics had lower risk of deaths than other groups.

Hispanics were at least risk of mortality when they lived along the border and when they lived in areas with higher Hispanic density while non-Hispanic Whites and non-Hispanic blacks fared better in areas that had a lower Hispanic density. Additionally, when controlling for Hispanic density and other factors at the tract level, Whites and Blacks showed worse mortality than in Model 1.

The social markers addressed at the second level are often linked to sources of considerable burden which cannot be addressed here, including racism (perceived and real), differing access to economic resources, neighborhood quality and upkeep related to city policies, and a whole variety of other issues. These area effects are shown through the effects of ethnic density, race/ethnicity, sex, and poverty. The multilevel modeling of death counts for tracts helps elucidate some of the local level effects of interest related to poverty and ethnic segregation effects but more local work is needed.

Taken together, then, the two approaches provide valuable insight into the effects of both aggregation on understanding health and modeling with visualizations provides researchers an insight in to differing patterns of mortality and how these patterns may manifest first from the geographies chosen for presentation but also from differential exposures and risk through time. Analyzing social problems, especially in a large geographically diverse area like Texas, requires multiple sources of information then provide better insight for researchers and care providers toward the needs and risk factors of populations that depend on their work to get improved access to care and services.

CONCLUSIONS

Given the above information, researcher and health practitioners must be mindful of the data they use when making conclusions about health and well-being. The availability of data is usually on a large scale using state, region, or county data to present information. While informative, this may lead a person to come to faulty conclusions about either their work or the populations they serve.

The representation and presentation of geographic scale has several limitations and certain steps can be taken to make for a more convenient presentation. However, with each choice, various pitfalls and errors can be introduced. By using age-adjustment for the rates and demographic, socioeconomic, and geographic information for the HLM models, it is hoped that some of the potential biases can be addressed by major drivers of mortality patterns.

This research also supports previous work that indicates that when social factors concentrate, they may influence the outcomes for people living in those regions. Being poor and being poor in an area where other people are poor may lead to varying effects. Hispanics appear to have some advantage over other groups especially in areas of higher Hispanic populations, and even after controlling for poverty, which may indicate potential social or cultural advantages for that group. Other research has shown non-Hispanic Blacks to not have a similar advantage with concentrated populations[46] which may indicate further racial/ethnic patterns of segregation and discrimination that cannot be measured here. Overall, however, concentration of poverty can be limiting though the effects vary across age and ethnic groups which may be related to limited access to health services, groceries, transportation, and other amenities which can impact our day to day lives and well-being.

Strengths

The mortality data is based on state recorded data. This data is collected by the state and in most cases an identifier for a geographic location is provided down to the tract level. This information then allows for largely accurate assessment of mortality location. This research also uses censal year population data for the denominator data. This data is more likely to be representative of the population trends of an area compared to estimates of the population data. Finally, by providing an analysis of both modifiable areal units and the hierarchical modeling, this analysis provides insight into the uses of mortality data in Texas and shows how the population sizes, especially for minority groups, can influence the assessment of needs by health practitioners and public health researcher across different levels of aggregation. This supports the argument that to understand the health of a community more work must be done within the community to get the most information and data to work with.

Limitations

Limitations of area boundaries

Despite all of this work, any boundaries are likely to never be “appropriate”. Too many factors can contribute to what people consider to be their neighborhood. And more recent research indicates that boundaries may be different with some viewing their house only as a place to sleep, significantly narrowing their perception of the neighborhood and further muddying the “neighborhood” concept.[24,30] Further, the use of aggregated measures of SES and income may not accurately represent the effects of income within a neighborhood limiting any development of a causal link.[24] This is not meant to discourage research, as any knowledge is likely better than none. Instead, this is to highlight to those interested in the subject that the concept of neighborhood and “area” can be murky and will likely never attain a perfect objective criterion.

The data is also limited in that certain populations may be very limited in population size and record availability. The lack of information may lead to extreme values being calculated for rates which biases actual effects in an area. More direct research on an area and its needs would help to provide sufficient focus to overcome problems from higher level data. Though given the total number of tracts this problem is likely not a serious detriment.

Finally, the use of hotdeck imputation versus multiple imputations may lead to differing results. While I believe that the use of the random classification of a census tracts based on counties on to the current records helps to minimize erroneous data and to make more appropriate analyses, there is a case that using more information from a multiple imputation process may lead to differing results. Future work may look into this potential difference to determine how deaths are redistributed using either of these methods.

GENERALIZABILITY

These specific findings can only be used for the state of Texas in the specific period of time in which they were used. This data comes from a specific period in time and is limited in its use for actual trends for that time period.

That being said, while these data are not the most current, they are illustrative of effects of differing levels of presentation and analysis. These effects are influential across all types of research and their existence is of critical importance for all researchers to bear in mind. Shifting borders and areas of analyses can lead to very different conclusions and the incorrect aggregation and subsequent interpretation can limit drive resources away through negative influence on policy. It may not always be feasible for a one sized approach and the use of more fine-tuned data can provide those in the position to affect change in a more positive manner which allows for both the internal dynamics of the community as well as larger social influences to be taken into account.

Further, data will be examined across time to understand how patterns and relationships have changed through time. The differences in patterns across time can be illustrative of changing mortality pressures across each ethnic group across time and indicates which areas of health have seen the least amount of change through time.

Appendix A: Additional Figures and Mortality Rate Tabulations for Hispanics and non-Hispanics

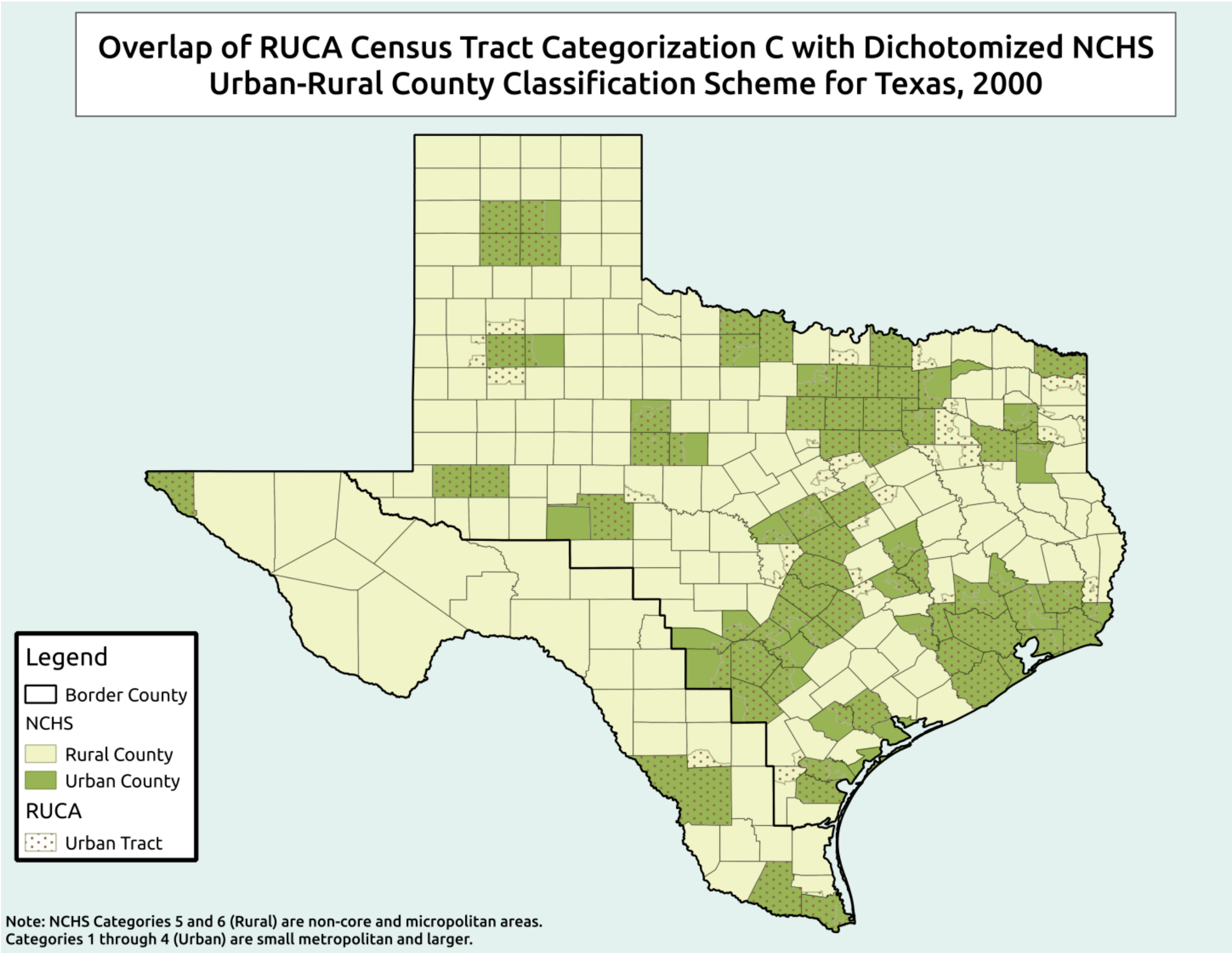

Figure A1. Rural-Urban Classification Based on Tract/County Distinctions

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Vita

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He completed his primary education in Bridgeport, NE in the Bridgeport Public Schools system and prior to attending the University of Texas Medical Branch in Galveston, L.J attended the University of Wyoming.

He has a dual Bachelor's of Arts (2003-2008) degree from the University of Wyoming in Sociology and Psychology and a Master of Arts (2008-2010) degree in Sociology, also from the University of Wyoming. L.J is currently a Doctoral candidate and a Master of Public Health candidate at the University of Texas Medical Branch (2010 to present).

L.J currently has four publications including:

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- Siordia, C., Panas, L.J., Markides, K.S. 2012. Predictive Demi-Span Equations for Estimation of Stature in Aged Mexican Americans. *The Journal of Frailty and Aging*, 1, 118-122.
- Siordia, C., Panas, L.J., and Delgado, D.J. 2012. Geographing Latinoization in the U.S. Mainland: Mexican Origin Latino Population Growth between 2000 and 2010 by County. Report in the *Hispanic Economic Outlook*, Spring: 9-14.
- Panas, L.J. (April 2014). Assessment of the D'Feet Mobile Mammography Program: Galveston County, TX. Produced as an assessment and policy brief for the Galveston County Health District.

He has taught several special lectures for sociology and public health courses and has acted as a teaching assistant for both Sociology and Epidemiology courses. His area of expertise is Medical Sociology, Social Demography, and Social Epidemiology. His research emphasizes race/ethnicity, disparities in health and mortality, and social determinants of health.

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This capstone was typed by Lawrence Panas. Any errors or grammatical quirks are solely the responsibility of the author.